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FIS COMMUNICATIONS 2019

in Physical Education, sport and recreation

Book of Proceedings

Ministry of Education, Science and Technological Development Republic of Serbia

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FOREWORD

Dear Authors, esteemed Scientists,

It is with deep satisfaction that I write this Foreword to the Proceedings of the XXII International Scientific Conference "FIS COMMUNICATIONS 2019" held in Niš, October 17 - 19, 2019.

International Scientific Conference "FIS COMMUNICATIONS 2019" continues a tradition of bringing together researchers, academics and professionals from all over the world, experts in sport, physical education and recreation.

The Proceedings Book is consisted of 47 full papers written by more than 180 authors from 17 countries. Papers are divided into six sessions depending on the topics investigated as follows: Physical Education, Individual Sports, Team Sports, Physical Activity and Health, Sports Medicine and Physiology and Interdiciplinary.

In addition to the contributed papers, three invited keynote presentations were given by professor Stephen Silverman from the College of Education, Florida Atlantic University, USA, professor Sigmund Loland from the Norwegian School of Sport Sciences, Oslo, Norway, and professor Sanela Škorić from the Faculty of Kinesiology, University of Zagreb, Croatia. Distinguished keynote speakers covered very interesting topics from research methods and planning successful research careers, across the very actual topic of the using new technologies in sport, to the always needed competences of the sports managers.

These Proceedings will furnish the scientists of the world with an excellent reference book. I trust also that this will be an impetus to stimulate further study and research in the field of sports science.

We thank all authors and participants for their contributions.

Chair of the Scientific Committee

Nenad Stojiljković, PhD

CONTENTS

Plenary Sesion

PLANNING: THE ESSENTIAL INGREDIENT FOR A PRODUCTIVE RESEARCH CAREER

Stephen Silverman[1]

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UDC 613.2:796

ABSTRACT

This presentation will focus on the key role of planning in developing and sustaining a research program. The first part of the presentation will focus on helping doctoral students to become productive researchers. Using a model for planning doctoral research (Locke, Spirduso, & Silverman, 2014) various steps will be discussed that help graduate students efficiently develop their research program. I will emphasize that quality doctoral research gives students a good start on their career so they can develop into research-active scholars who will develop a productive, focused research program. It will be noted that doctoral advisors have obligations to assist students in transitioning from the role of student to that of professor. When students understand the multidimensionality of their new role as a university faculty member, the forethought and planning by the student and academic advisor—throughout doctoral study—assists in that transition. The second part of the presentation will focus on developing and sustaining a research program as a faculty member. As part of this discussion I will address the necessity of delimiting the areas of research and planning in a rational manner to make certain that subsequent studies build on previous research and that publications follow a logical pathway. It will be stressed that researchers develop a reputation while producing consistent, focused, and quality research over a long period of time. In order to do this planning and constantly supplementing and augmenting the plan is necessary so that scholars do not have periods without research production and refereed research publications. A method to keep productive throughout a research career will be discussed and shown how it helped in my research career. I will conclude with advice for doctoral students, early-career scholars, and for seasoned scholars since planning and research production often is dependent on where scholars are in their career.

ETHICS AND TECHNOLOGY IN SPORT

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UDC 796:62

ABSTRACT

Technology, understood broadly as human-made means to realize human interests and goals, has many functions in sport. I discuss possibilities and challenges when it comes to the role of technology in realizing sport values.

In a first section, I provide a tentative categorization of sport technologies and list some of these possibilities and challenges. Body techniques, sport equipment, and innovative training technologies such as smart watches and movement sensors raise questions of fairness, equal access and risk of harm. Some technological innovations such as the sharkskin swimsuit, or so-called self-correcting golf balls, also challenge core ideas of the nature of performance in the affected sports.

The most heated ethical debates concern biomedical technologies used with the intention to enhance performance. I pay particular attention to technologies that are administered by external expertise and do not require athlete insight and control such as drugs (doping).

In a second section, and using practical examples and normative theory, I propose an ethically reflective way of distinguishing between admirable, acceptable, and non-acceptable technology in sport. I argue in favour of what I refer to as a thick theory of sport in which athletic performance at its best can be understood as an embodied instantiation of morally admirable human excellence. The thick theory implies opening for technology based on athlete insight, control, and responsibility, and rejecting technology administered primarily by external expert systems.

I conclude with reflections upon future technological challenges to sport, in particular challenges posed by genetic technologies.

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COMPETENCIES OF SPORT MANAGERS

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ABSTRACT

First master degree programme in sport management was established in 1966 in Ohio University (Stier, 1993). The list has since than grown to almost 250 master programmes in USA, around 30 in Europe, 13 in Asia, 7 in Canada, 5 in Australia, and 1 in New Zeland, India and Africa (NASSM, 2019). According to Petry, Froberg and Madella (2006), sport management professions in Europe are educated in two main ways: "the first way is to get the basic education from "Sport Sciences" and then in the end of the studies specialize on more or less sport management related management, financing, economics etc. or special sport management subjects; the second is to star with general management, economics, financing etc. and then specialize in the end on sport management or closely sport management related subjects." (p. 173) Although some curricular guidelines to different sport management types of programmes can be found, the research of sport management master's programs within the U.S. "indicate that there is not a common core of classes students take that provide uniformity among programs." (Willet, Brown and Goldfine, 2017) which confirms (the need for) always present curricula adaptations (Braunstein-Minkove, DeLuca, 2015). In order to develop a curriculum, one should define the area (industry), occupations for that area, activities for each occupation as well as corresponding competencies, and finally learning outcomes (see Petry, Froberg, Madella, 2004, 2005, 2006). Competencies "cover a broad range of higher order skills and behaviours that represent the ability to cope with complex, unpredictable situations." (Westera, 2001:80) It is a "proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development." (Council of the European Union, 2017:14) A number of researchers addressed the issue of competencies of sport managers (Barcelona, Ross, 2004; DeSensi, Kelley, Beitel, 1990; Farner, Schüttoff, 2019; Horch, Schütte, 2003; Jamieson, 1987; Ko, Henry, Kao, 2011; Lambrecht, 1987; Petry, Froberg, Madella, 2004, 2005, 2006; Retar, Plevnik, Kolar, 2013; Škorić, 2008, 2009, 2018). Studies were conducted in different setting (private, public), included practitioners, academia and students, and covering a broad range of employment opportunities (in both recreational and competitive sport). Although competencies are context specific, majority of the research find communication and organising skills as the most important ones (DeSensi, Kelley, Beitel, 1990; Farner, Schüttoff, 2019; Horch, Schütte, 2003; Lambrecht, 1987; Petry, Froberg, Madella, 2004, 2006; Škorić, 2009, 2018) and recommend curriculum development to be broad and interdisciplinary.

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Individual Sports

THE INFLUENCE OF COORDINATION ON THE RESULTS IN SPORTS CLIMBING: THE UNDERLYING RELATIONS

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UDC 616:796

ABSTRACT

The aim of the research was to determine the relations and influences of coordination on the result in sports climbing in women. The research was conducted on a sample of 11 female participants, aged 16±1.55 years, participants of the Youth World Cup in Arco-Italy 2015. The research was conducted by the use of 3 variables for the estimation of coordination (the obstacle course backwards in seconds - POLN, coordination with a baton - KOPA and 20 steps with a baton - 20IP), and 3 variables for the estimation of the result in sports climbing (bouldering - BOULDER, lead climbing – LEAD and speed climbing - SPEED). Based on the obtained results we can conclude the following: There aren't statistically significant relations between sets for the estimation of coordination and the overall result in sport. However, there is a statistically significant influence of coordination on the result in lead climbing both at the multivariate and some univariate level of each variable individually. This means that the participants whose coordination is at a higher level show better results in this discipline. However, the analysis of the influence of coordination on the success in disciplines of bouldering and speed climbing did not show a statistically significant influence at the multivariate level. A general conclusion is that the development of this ability of the climbers should by no means be neglected.

Keywords: coordination, bouldering, lead and speed climbing

INTRODUCTION

Climbing is a movement-dependent sport. The vast majority of climbers overlook this fact, preferring to concentrate on more concrete and measureble issues like strength and flexibility… No other factors in training rightfully deserve more attention than coordination and technique. (Goddard & Neumann, 1993) Climbing technique comes down to linking basic foot, hand, and body positions into one flowing, upward motion. The basic positions are easily outlined, but their permutations are infinite. (Bisharat, 2009)

All climbing disciplines demand strength, endurance and skills acquired during long systematic training. Physical preparation for sports climbing implies increased volume and specificity of the trainings as forwarding towards the elite athletes sports form. Since majority of sports climbers do not follow any expert plan of training (Twight & Martin, 1999) but utilize their 'feelings' it is assumed that more advanced climbing formula could be obtained by the administration of systematic and documented sports climbing's principles, these being frequencies, intensity, duration and types of trainings (Wilmore & Costill, 1999) which are to be selected considering specific motor abilities of each single climber.

Most of the researchers involved in sports climbing dealt with the study of general and specific strength and endurance as the key factor in success in sports climbing (Grant et al., 1996; Grant et al., 2001; Binney & Cochrane, 2003; Watts et al., 2003; Schweizer & Furrer, 2007; España-Romero et al., 2009; Stanković, 2009; Stanković et al., 2011; Puletić, 2014). It was also proven that specific flexibility (Grant et al., 1996; Grant et al., 2001; Puletić, 2014;) and balance (Testa, Martin, & Debû, 1999; Quaine & Martin, 1999; Ignjatović et al., 2016) influence the result in sports climbing. A very small number of authors studied coordination as one of the most important motor skills responsible for success in sports climbing (Magiera, & Ryguła, 2007; Orth, Davids, & Seifert, 2016). Good coordination has always been taken for granted and trained through

mental visualization of the direction of the climb (Stanković et al., 2011). Considering the fact that coordination represents the joint effect of the nervious system and the skeletal muscles within the movement process (Pržulj, 2000) and that it takes part in the realization of each movement structure, from the most simple to the most complex, the influence and importance of these abilities increase with the complexity of the motor activity, and usually is manifested in situaitons which require a quick solution to a problem at the motor level (Herodek, 2006). As a result, perceptual and motor adaptations that improve skilled coordination are highly significant for improving the climbing ability level (Orth, Davids, & Seifert, 2016).

However, it has been confirmed by many authors that performance in sport climbing cannot only be defined by means of one variable, but it is a set of different groups of human abilities, skills and properties. (Glèe & Rousselet, 2003; Goddard & Neuman, 2000; Mermier et al., 2000; Guyon & Broussouloux, 2004; Hörst, 2003; Magiera, & Ryguła, 2007).

The aim of the work is to determine the relations and influences of coordination on the result in sports climbing.

METHODS

Subjects

The sample of the participants was extracted from the population of female participants, aged 16±1.55 years, at the Youth World Cup in Sport Climbing in Arco-Italy held from August 28, 2015 to September 6, 2015. The research was conducted on 11 participants, and the sample involved each participant, provided that they were healthy at the time of testing and voluntarily agreed to participate in the research.

Measuring instruments

In this study, the following tests were applied to estimate the coordination of the sport climbers: the polygon backwards in seconds (POLN), coordination with a baton (KOPA) and 20 steps with a baton (20IP). The applied set of tests of general power was taken from the research of Kurelić et al. (1975). It has been used numerous times in basic experimental research and has an appropriate level of metric characteristics in explaining the tested motor dimensions. The result in sports climbing, and simultaneously the criterion variables were represented by the result in bouldering (BOULDER), lead climbing (LEAD) and speed climbing (SPEED) expressed in points, achieved at the Youth World Cup in Arco-Italy in 2015 in these three disciplines.

Statistical analysis

The statistical methods of analyses included:

Descriptive statistics comprised: number of participants (N), mean value (Mean), standard deviation (SD), minimum (Min) and maximum (Max) numerical results, range (Range) and standard error of the mean value (Error). Discriminative measurements were performed by two procedures: Skewness (Skew) pointing to the symmetry of substance layout around the arithmetic mean and Kurtosis (Kurt) designating peakedness or flatness of distribution.

The correlation of predictor and criterion variables (each with each) was shown in the matrix of intercorrelations and cross-correlations.

To determine the relations of coordination to sports climbing success, a canonic correlation analysis was used. This analysis explains the relation structure for the two sets of variables. The followings were computed: size of the canonic correlation (Canonicl R), Canonic power of determination (Canonicl R2), Bartlett Lambda test (Chi-sqr), Degree of freedom (df) and Degree of significance (p). In column (Root) a structure of isolated canonic factors was shown.

To determine the influence of the predicting variables (tests of the coordination) on each criterion variable, a regression analysis was used. It contains the following parameters: coefficient of correlation (r), coefficient of the partial correlation (Part–r), standardized regression coefficient (Beta), vector of the standardized regression coefficient (t), significance of beta coefficient (p-level), coefficient of the multiple correlations (R) coefficient of the determination (R2), and the level of the significance of regression connection on a multivariate level (p).

Raw data were processed by means of Statistica 10.0 software package. Statistical significance was determined at the level of $p<0.05$.

RESULTS

Table 1. Descriptive Statistics for the estimation of coordination in sports climbers and the results in sports climbing

Variables	N	Mean	Min	Max	Range	SD	Error	Skew	Kurt
POLN(s)	11	8.30	7.04	9.36	2.32	0.693	0.209	-0.1983	-0.1560
KOPA(s)	11	3.86	3.27	4.89	1.62	0.408	0.123	1.4427	4.3749
20IP(s)	11	12.55	10.49	19.33	8.84	2.643	0.797	2.1248	4.2640
BOULDER(points)	11	43.64	0.00	100.00	100.00	33.494	10.099	0.6890	-0.3323
LEAD(points)	11	27.27	0.00	100.00	100.00	35.191	10.611	1.2052	0.4350
SPEED(points)	11	3.73	0.00	26.00	26.00	7.837	2.363	2.7367	7.8716

Analysing Table 1 showing the results of the central and dispersion parameters of the applied variables it can be stated that discrimination of the tests is good because in the intervals of the minimal (min) and maximal (Max) results comprise always about 3 to 5 standard deviations (SD), which enables us to state significant sensibility of all applied tests. By reviewing the data responsible for the symmetry of the distribution around the arithmetic mean (Skew) we can notice that the distribution is symmetric for the variables POLN and BOULDER, slightly curved to the left in variable LEAD and KOPA, and strongly curved to the left in variables 20IP and SPEED. By analyzing the kurtosis we can notice that the results in variables KOPA, 20IP and SPEED are quite compressed, whereas they are lengthy in other variables (POLN, BOULDER and LEAD).

Table 2. Matrix of intercorrelations

Variables	POLN	KOPA	20IP	BOULDER	LEAD	SPEED
POLN(s)	1.000					
KOPA(s)	0.083	1.000				
20IP(s)	0.444	-0.031	1.000			
BOULDER(points)	-0.438	-0.159	0.213	1.000		
LEAD(points)	-0.401	-0.210	0.448	0.433	1.000	
SPEED(points)	-0.556	-0.512	-0.036	**0.713**	0.229	1.000

Note: Marked correlations are significant at $p < .05$

Analysing matrix of correlation (table 2) it can be concluded that the intercorrelations of the applied variables for the estimate of the coordination and results in sports climbing we can notice only one statistically significant coefficient. It is coefficient between the variables SPEED and BOULDER (0.731), which are responsible for the evaluation of success in sports climbing. The other coefficients were not statistically significant.

Table 3. Canonic factors of coordination and success in sports climbing and their significance

	Canonicl - R	Canonicl – R^2	Chi-sqr.	df	p
1	0.9341	0.8726	16.435	9	0.0584
2	0.6013	0.3615	3.041	4	0.5510

The canonic correlation analysis (table 3) showed that no statistically significant canonical factor was isolated, that is, that there was no statistically significant connection between the group of variables for the evaluation of coordination and the group of variables for the evaluation of success in sports climbing. As a result, no further analysis of the factor structure of the left and right set was carried out.

Table 4. Regression analysis of the variable BOULDER by means of the system of variables of coordination

Variables	r	Part-r	Beta	Std.Error of Beta	t(7)	p-value
POLN(s)	-0.438	-0.602	-31.539	15.807	-1.9953	0.0862
KOPA(s)	-0.159	-0.115	-7.355	24.060	-0.3057	0.7687
20IP(s)	0.213	0.501	6.332	4.131	1.5328	0.1692
R= 0.637		R^2= 0.406	F(3,7)= 1.596		p< 0.27432	

Table 4 shows the results of relatedness of the system for the estimation of coordination and the results in BOULDER climbing. By analyzing these results it can be said that there is no statistically significant correlation of the system on a multivariate level $p < 0.27432$. This explains the relatively high coefficient of multiple correlation $R = 0.637$, as well as the coefficient of determination $R^2 = 0.406$ which explains the correlation of the whole system of coordination and criterion variable with about 41%. Also, there is no significant influence at the univariate level too.

Table 5. Regression analysis of variable LEAD by means of the system of variables of coordination

Variables	r	Part-r	Beta	Std.Error of Beta	t(7)	p-value
POLN(s)	-0.401	-0.747	-37.157	12.495	-2.9737	**0.0207**
KOPA(s)	-0.210	-0.211	-10.872	19.020	-0.5716	0.5855
20IP(s)	0.448	0.764	10.238	3.266	3.1350	**0.0165**
R= 0.815		**R^2= 0.664**		**F(3,7)= 4.608**		**p< 0.04402**

Analysing Table 5, which shows results of the connectedness of the system of coordination and the results in LEAD climbing, it can be noticed that the coefficient of multiple correlation was 0.82 (R = 0.815), which explains the common variability between the system and criterion variable with about 66% (R^2 = 0.664). These results give a statistically significant explanation of the criterion variable by means of the system for the estimation of coordination ($p < 0.04402$), thus it can be concluded that system for the estimation of coordination has a statistically significant influence on LEAD climbing.

By analyzing single regression coefficients, it can be noted that two of three coefficients are statistically significantly related to the criterion variable BOULDER. These include the POLN test with a coefficient of significance of $p<0.0207$ and the 20IP test with a coefficient of significance of $p<0.0165$.

Table 6. Regression analysis of the variable SPEED by means of the system of variables of coordination

Variables	r	Part-r	Beta	Std.Error of Beta	t(7)	p-value
POLN(s)	-0.556	-0.643	-6.999	3.151	-2.2214	0.0618
KOPA(s)	-0.512	-0.567	-8.726	4.796	-1.8194	0.1117
20IP(s)	-0.036	0.293	0.667	0.824	0.8101	0.4445
R= 0.754		R^2= 0.569		F(3,7)= 3.080		p< 0.09962

By analyzing the data in Table 7, which shows the results for the influence of coordination on the SPEED climbing, we can conclude that there is no statistically significant connection within the system at the multivariate level $p < 0.09962$. The coefficient of multiple correlation was 0.75 (R = 0.754), which explains the common variability between the system and criterion variable with about 57% (R^2 = 0.569). There was also no statistically significant influence of individual variables for estimation of coordination on the result in SPEED climbing.

DISCUSSION

An analysis of the corresponding canonic functions (table 3) points to the assumption that result in sports climbing don't depends on coordination, considering that there is no isolated statistically significant factor. This means that these two systems of variables are not closely related, that is, that the overall placement on climbing competitions in all three climbing disciplines is not closely related to the results achieved on the tests of coordination. This connection should still be sought in the tests of strength and endurance. (Goddard & Neumann, 1993; Grant et al., 1996; Grant et al., 2001; Schweizer & Furrer, 2007; España-Romero et al., 2009; Stanković, 2009; Stanković et al., 2011; Puletić, 2014), specific flexibility (Grant et al., 1996; Grant et al., 2001; Puletić, 2014;) or/and balance (Testa, Martin, & Debû, 1999; Quaine & Martin, 1999; Ignjatović, Stanković & Pavlović, 2016).

The regression analysis of the connection of the system for the estimate of coordination and each of the variables for the estimation of the result in sports climbing individually is shown in Tables 4, 5 and 6. Based on their analysis in can be concluded that there is a statistically significant influence of coordination on the result in lead climbing, while no such influence exists in the case of boldering and speed climbing. This means that the participants whose coordination was at a higher level achieve better results in lead climbing. Within a framework of the individual influence on lead climbing, the 20IP

test and POLN test were highly influential. Bearing in mind that this significance was determined in the case of the POLN test with a negative, and in the case of the KOPA test with a positive sign, we can conclude that the higher ranking female competitor in lead climbing will be the one who achieved better results for the POLN test, and lower results for the 20IP test.

Considering that coordination is under the extensive influence of the nervous system (Goddard & Neumann, 1993; Nićin, 2000; Pržulj, 2000; Herodek, 2006; Orth, Davids & Seifert, 2016) and that elite climbers exhibit advantages in detection and use of climbing opportunities when visually inspecting a route from the ground and when physically moving though a route (Orth, Davids & Seifert, 2016), The development of this ability should not by any means be neglected by climbers, since in a sport which is achieving a peak of its own, even the slightest feature could decide between winning or losing.

CONCLUSION

Based on the obtained results one can conclude the following:

There aren't statistically significant relations between sets for the estimation of coordination and the overall result in sport.

However, there is a statistically significant influence of coordination on the result in lead climbing both at the multivariate and some univariate level of each variable individually. This means that the participants whose coordination is at a higher level show better results in this discipline. However, the analysis of the influence of coordination on the success in disciplines of bouldering and speed climbing did not show a statistically significant influence at the multivariate level. A general conclusion is that the development of this ability should by no means be neglected by climbers.

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INFLUENCE OF KINEMATIC KICK START PARAMETERS ON TIME TO 10 METERS IN MALE SPRINT SWIMMERS

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ABSTRACT

The aim of this study was to examined the influence of kinematic kick start parameters on time to 10 m which determines the efficiently executed swimming start. Fifty-five male sprint swimmers (Age = 20.24 ± 2.85 yrs., Height = 1.82 ± 0.63 m, Weight = 74.8 ± 7.72 kg, FINA2017 – long course = 526.40 ± 115.49 points) completed two kick-starts corresponding to 10 m with maximum swim effort. The sample of predictor variables included four kick-start kinematic parameters for the estimation of swimming start (Angle of the rear knee joint at set position, Angle of the front knee joint at set position, Angle of the front knee joint at take-off position and Body Entry Angle) and maximum swim effort coresponding to 10 m was a criterion variable (T10m). The influence of starting parameters on T10 m was examined by regression analysis. According to the results obtained in this research there is one statistically significant optimum multiple regression model for kinematic kick start parameters to predict the T10m witch defined using variables: Angle of the front knee joint at set position and Angle of the front knee joint at take-off position ($F = 3.44$, $p = 0.04$). It can be concluded that the key kinematical parameters for the effective execution of the swimming start are represented by angle of the front knee joint at set position (127.05 ± 8.96 degrees) and angle of the front knee joint at take-off position (109.29 ± 14.14 degrees).

Keywords: swimming, starting block, take-off angle

INTRODUCTION

The swim start technique has evolved, from the conventional start (arm swing), grab start, track start to the kick start. Starting velocity can be measured up to 10 m distance mark (Arellano et al., 1996; Blanksby, Nicholson, & Elliott, 2002; Beretić et al. 2013) or the 15 m mark (Mason and Cossor, 2000; Cossor and Mason 2001; Tor et al. 2015). In the grab start both feet are positioned parallel with toes curled over the front edge of the starting block. The track start has one foot at the front edge of the block, the other is displaced towards the rear of the block with hands grabbing the front edge of the starting block. The kick start is a modified track start that allows the rear foot to be placed upon a kick plate which is set up at a 30-degree angle from the surface of the block and can be moved through five different locations on the starting platform. Starting block for kick start designed by Omega (OSB11, Corgemont, Switzerland), and has the international FINA approval. There have been many publish studies that have compared different techniques of swimming start (Blanksby, Nicholson, & Elliott, 2002), or evaluated different elements of foot placement on the block (Breed and McElroy, 2000; Takeda et al., 2012), entry angle (Groves & Roberts, 1972) and starting position (Welcher, Hinrichs, and George, 2008; Honda, Sinclair, Mason, & Pease, 2012). Previous studies (Honda, Sinclair, Mason, and Pease, 2010; Nomura, Takeda, and Takagi, 2010) found significant differences between kick start and track start and concluded that using the kick plate proved advantageous during the start. Kinematic analysis is an important element in training programs, and involves an evaluation of strategies used by elite athletes (Jorgić, Okičić, Stanković, Dopsaj, & Thanopulos, 2011).

The purpose of this study was to determine the influence of kinematic kick start parameters on time to 10 m i.e. angle of foot placement on the block at

set position and take-off position on start velocity of elite competitive swimmers.

METHODS

Subjects

The sample consisted of 55 active male swimmers (Age = 20.24 ± 2.85 yrs., Height = 1.82 ± 0.63 m, Weight = 74.8 ± 7.72 kg, FINA2017 – long course = 526.40 ± 115.49 points) at a competitive level. All the participants' parents provided written consent after being informed of the test protocol. The protocol of the study was approved by the ethical committee of the University of Niš, Faculty of Sport and Physical Education, Serbia, and they conformed to the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Procedure

To evaluate the kinematic kick start parameters where used: Angle of the rear knee joint at set position (UZNNB), Angle of the front knee joint at set position (UPNNB), Angle of the front knee joint at take-off position (UPNNO) and Body Entry Angle (UUTUV) taken from the image obtained by the camera expressed in degrees. To evaluate effective execution of the swimming start we used Time to 10 m (T10m), which represent time from the starting signal to the point where the apex of the swimmer's head pass through a mark line drawn on the image obtained by the camera expressed in seconds (s).

Before the participants began the testing all of them had a warming up swim of 20 to 25 minutes, which consisted of a full stroke swimming, sprints and starts. The participants were instructed to perform a maximum swim effort up to the 10 m using kick start. The test was repeated two times with a 5-minute break between tests in same day, and the test with the fastest results was used for further analysis. The starting block (SO2-X, Alge Timing - Austria) specifications were as follows: the height above the water surface was 0.72 m; the starting platform was 0.56×0.56 m, with 8º slope; the kick pedal used as a back plate was set 0.44 m from the front edge of the platform at a 30º angle to the starting platform. One transverse video camera (GoPro, Hero 4 Black Edition) with a frequency of 120 fps equipped with a wide angle to obtain a wider field of vision were positioned at 5 m perpendicular to the long axis of the pool. The lane buoys in the pool and starting block were used as distance markers. Each race was analyzed with specialized software Kinovea, Version 0.8.15 (www.kinovea.org).

Statistical analysis

To determine the influence of kinematic kick start parameters on time to 10 m, a regression analysis (backward method multiple-regression analysis) was used, where the following statistical parameters were calculated: the multiple correlation coefficient (R), the coefficient of determination (R2), the result of the F-test (F) and level of statistical significance (p). In order to determine the influence of each individual variable in the regression analysis, the following was calculated: the coefficient of the partial correlation (part-r), the correlation coefficient (r), standardized coefficients of a partial regression (Beta), the results of the t-test (t) and statistical significance (p). All the statistical operations were performed using software SPSS 19.0. and the level of significance was set at $p \leq 0.05$.

RESULTS

Table 1. Descriptive statistics (n=55).

Variables	Mean	Std. Deviation	Cv	Minimum	Maximum
Age (year)	20.24	2.848	14.1%	17	28
Height (m)	182.0945	6.28615	3.5%	161.50	194.50
Weight (Kg)	74.8182	7.72011	10.3%	57.80	89.90
FINA (points)	526.40	115.494	21.9%	350	795
T10m (s)	4.3069	0.35332	8.2%	3.70	5.86
UZNNB (degrees)	97.80	13.622	13.9%	70	125
UPNNB (degrees)	127.05	8.955	7.0%	106	146
UPNNO (degrees)	109.29	14.139	12.9%	75	153
UUTUV (degrees)	37.73	7.243	19.2%	25	56

Legend: Mean - mean, Std. Dev - standard deviation, Cv: coefficient of variation, Min - minimal result, Max - maximal result

Table 2. Backward method multiple-regression analysis (n=55).

Variables	Unstd. Beta	Beta	t	p	R	R^2_{adjust}	Std. Err. Est.	F	p
UPNNB	-0.009	-0.238	-1.774	0.082	0.342	0.083	0.338	3.439	**0.040**
UPNNO	0.008	0.307	2.292	**0.026**					

Legend: Unstd.Beta = Unstandardized regression coefficient values, Beta = Standardized regression coefficient values, t = Standardized regression coefficient significance tests, p = Standardized regression coefficient level of significance, R= Multiple correlation coefficient, R2 adjust = Adjusted determination coefficient, Std. Err. Est. = Standard error of the estimate, F = Multiple regression analysis significance tests, p = Multiple correlation level of significance.

Table 1. shows the values of basic parameters of descriptive statistics for all the studied variables. The results of the regression analysis in Table 2. indicate the optimum multiple regression model for kinematic kick start parameters to predict the T10m was defined using variables UPNNB and UPNNO (F = 3.439, p = 0.040) which explain 8% of the variance with standard error of the estimated level of ± 0.34 s. Also, there is a statistically significant partial influence of variable UPNNO (t = 2.292; p = 0.026) for the tested group of swimmers. A negative sign indicates that higher values of UPNNB (127.05 ± 8.96 degrees) influence faster execution of swimming start while smaller values of UPNNO (109.29 ± 14.14 degrees) affect faster execution of swimming start.

DISCUSSION

In the kick start, the rear knee joint angle had a value close to 90 degrees. The results of this research indicate that the tested group of swimmers (T10m = 4.30 ± 0.35 s; UZNNB = 97.80 ± 13.62 degrees; UPNNB = 127.05 ± 8.96 degrees; UPNNO =109.29 ± 14.14 degrees; UUTUV = 37.73 ± 7.24 degrees) has higher values of UZNNB (97.80 vs. 90 degrees) and UPNNB (127.05 vs. 120 degrees) than recommended in the manufacturer of starting blocks with a back plate that was approved by FINA (OSB11, Corgemont, Switzerland). Previous research has shown that the lower body muscle potential represent major component that affect the overall start performance (Croin and Hansen, 2005; Beretic et al., 2013). The obtained results confirm the fact that the angle in the knee joint should be from 105 to 120 degrees in order to achieve the maximal muscle force production (Lindahl, Movin, and Ringqvist, 1969), similar results were also found in the Yamauchi, Mishima, Fujiwara, Nakayama, and Ishii (2007) studies that concluded that maximal muscle force when the foot position was at 80-90% of the leg length witch is approximately 106 degrees to 128 degrees. Jorgić et al. (2011) found difference in the take-off angle between the grab and the track start where the take-off angle was a significant smaller (p=0.04) in the track start. Maglischo (2003) considered that in the grab start, the angle of take-off should be at 30 to 40 degrees. On the basis of our results and the results of the previous studies, we consider that kinematic kick start parameters as one of most important things for efficiently executed swimming start.

CONCLUSION

According to the results in this study, we can conclude that there is statistically significant influence of kinematic kick start parameters on time to 10 m. Key kinematical parameters for the effective execution of the swimming start are represented by angle of the front knee joint at set position and angle of the front knee joint at take-off position. In addition, in the kick start we recommend that the anglee of the rear knee joint at set position had a value close to 90 degrees, also front knee joint at set position had a value close to 120 degrees.

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DIFFERENCES IN PACE BETWEN MEN AND WOMEN IN THE HALFMARATHON

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ABSTRACT

The aim of this study was to describe the differences in the running pace between men and women in the half marathon. We used the results of first 50th man and women competitors from the 2017 Vienna Half Marathon, The race was divided into 5 segments, from 0 - 5km, 5 - 10km, 10 - 15km, 15 - 20km, 20 - 21,1km, which measured the change in pace of running in both men and women. Based on the obtained results, it can be concluded that the variability in the pace decreases to the third segment in men, but in the fourth and fifth segments it increases sharply, while the situation in women is almost similar. Mostly the reason for this is because runners generally start much faster at the start of the race, when they are more rested, there is euphoria and adrenaline at the start, overestimate their capabilities and how much they are currently ready and/or follow the pace of other runners. Women dictate the pace better than the men in the half marathon, but as the race progresses, they slow down the pace of the race too. They run above average until the third segment, ie from 10 to 15km, where there is a sharp fall in the pace of running in the fourth and fifth segments. It was found that there were statistically significant differences in the pace of running between men and women only in the third segment of the halfmatathon race (between 10 and 15km).

Keywords: pace, fatigue, race tactics, effect

INTRODUCTION

Long distance running disciplines are physically very demanding disciplines. For success in these disciplines, aerobic energy sources (aerobic glycolysis and lipolysis) and, to a lesser extent, anaerobic lactate sources, are the most important. From a motor point of view, long distance running requires a high level of endurance in racing. Running long distances has its roots in prehistoric times. Back then, it was extremely important for people's survival and survival that they could run long distances in search of food in a short time. Even today, there are tribes in Africa who hunt by chasing animals for tens of kilometers, until the animal is exhausted. (Ćuk & Rakić, 2019).

Running at a uniform speed is, both in physical and tactical terms, a significant factor in achieving results in mid- to long-distance running. An appropriate strategy for running a tactically efficient race begins with selecting the optimal running speed. Running pace is closely correlated with running tactics in the race. For each competition in each sport, preparation also consists of a tactical plan to ensure the best possible placement or victory. Practicing and applying tactics comes into play in the initial forms of training and competition, in its simplest form. Later, tactics become more important when the level of technical mastery and physical preparation is raised to a higher level.

Running a tactically efficient race can be a deciding factor in achieving the expected results and placement. The appropriate strategy starts with choosing the optimal running speed. Running in the middle and long distances are very popular athletic disciplines in the world. In order to be able to resist the various tactical variants, runners in the medium and long distances must be well trained in changing the pace of running and have so-called "A sense of running pace." An important feature of any tactical procedure is the athlete's ability to immediately apply the appropriate tactical variant useful under specific conditions under the newly created conditions. (Stefanović, 1981; Fratrić, 2006; Ozolin, Voronin & Primakov, 1989)

The basic precondition for successful racing tactics is excellent physical and mental preparation, as well as good pace rating and effort dosing.

Running at a uniform speed is characterized by minimal changes in speed throughout the race. More studies of experimental and theoretical character have confirmed that uniform running implies such a mode of movement where no major changes in the speed of running occur (Homenkov, 1977; Petrović i sar., 1980; Suslov, 1982; Malacko i Rađo, 2004; Fratrić, 2006; Stefanović, Juhas i Janković, 2008).

The aim of this study is to describe the differences in the pace of running between men and women in the half marathon.

METHODS

To evaluate the pace we used the results of first 50th man and women competitors from the 2017 Vienna Half Marathon, Data was downloaded from the site: www.vienna-marathon.com. The race is divided into 5 segments, from 0 - 5km, 5 - 10km, 10 - 15km, 15 - 20km, 20 - 21,1km, which measured the change in pace of running in both men and women.

Descriptive statistics and a t-test were made from statistical data processing. The data were processed in Microsoft Excel 2013 software package.

RESULTS

Table 1. Race segments and change in running pace of a man and a woman in a half marathon

	0-5km		5-10km		10-15km		15-20km		20-21.1km	
	M	F	M	F	M	F	M	F	M	F
Mean	1,97	1,37	-0,14	0,19	-0,56	-0,03	-2,50	-2,70	-3,00	-3,28
SD	2,08	2,75	1,49	1,00	0,87	1,04	2,28	2,08	3,67	3,68
Minimum	-1,65	-4,17	-3,28	-2,08	-3,79	-2,84	-8,77	-9,30	-15,36	-9,68
Maksimum	7,01	9,95	3,97	2,46	1,69	1,82	5,73	2,58	7,19	9,28
CV	94,66%	49,75%	-9,63%	19,32%	-65,16%	-3,58%	-109,63%	-129,76%	-81,97%	-88,99%
Range	8,66	14,13	7,26	4,55	5,49	4,68	14,52	11,88	22,56	18,97
T-value	1,22		-1,38		-2,89		0,46		0,34	
P-value	<0,112		<0,087		<0,003		<0,322		<0,365	

Table 1 shows the data related to the change in running speed during the five race segments. In the first segment, the mean values in men are 1.97 and in women 1.37; the coefficient of variation is 94.66% for men and 49.75% for women.

In the second segment (5 - 10km), the average value of change of pace in men is -0.14 and in women 0.19; coefficient of variation -9.63%, and in women 19.32%.

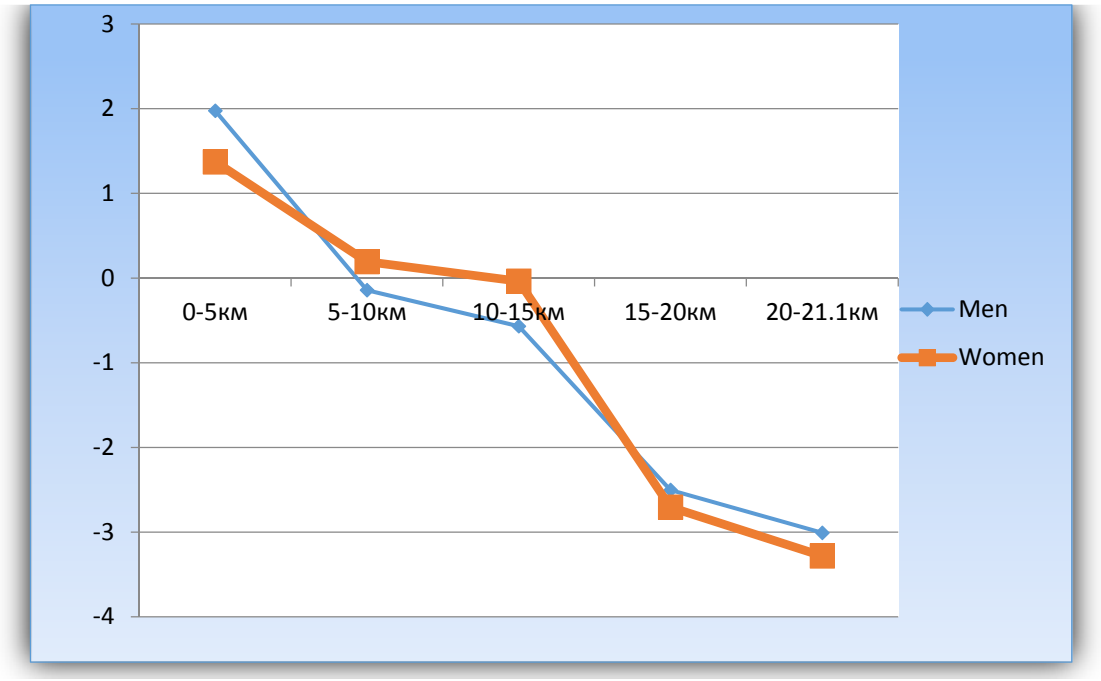
In the third segment (10 - 15km) the average value of the change of pace in men is -0.56, and in women -0.03; the coefficient of variation is -65.16% in men and -3.58% in women.

In the fourth segment (15 - 20km), the average value of change of pace in men is -2,50 and in women -2,70; the coefficient of variation is -109.63% for men and -129.76% for women.

In the fifth segment (20 - 21.1km), the average value of change of pace in males is -3.00 and in females -3.28; coefficient of variation -81.97% for men and -88.99% for women.

Regarding variability in the first segment in men is 2.08, in the second 1.49, in the third 0.87, in the fourth 2.28 and in the fifth 3.67. While for women in the first segment is 2.75, in the second 1.00, in the third 1.04, in the fourth 2.08 and in the fifth 3.68. From this it can be concluded that in men the variability up to the third segment decreases, but in the fourth and fifth segment it increases sharply and in women it is almost similar to the situation in men.

T-test tested the differences in pace between men and women and found that there were statistically significant differences only in the third segment of the halfmatathon race (between 10 and 15km).



Graph 1. Changes in the pace of running by segment in the half marathon men and women

Graph 1 shows that men run much faster in the first segment than the average speed, then drop sharply in the second segment, and are slightly below average. In the third, fourth and fifth segments of the race this drop is drastic.

Women have a slightly different situation than they dictate the pace better than the men in the half marathon, but as the race progresses, they slow down the pace of the race too. They run above average until the third segment, ie from 10 to 15km, where there is a sharp fall in the pace of running in the fourth and fifth segments.

DISCUSSION

The main findings of this study are that in men, variability in tempo to the third segment decreases, but in the fourth and fifth segments it increases sharply, while the situation in women is almost similar. Mostly the reason for this is because runners generally start much faster at the start of the race, when they are more rested, there is euphoria and adrenaline at the start, overestimate their capabilities and how much they are currently ready and/or follow the pace of other runners. This is supported by previous research (Abbiss & Laursen, 2008; Lima-Silva et al., 2010; Deaner & saradnici. 2015; Nikolaidis, Ćuk & Knechtle, 2019). Men are particularly likely to adopt a "risky" pace, where an individual starts the race at a fast early pace (relative to their abilities) and this increases their chanse of slowing down later.

It was also noted that women dictate the pace better than the men in the half marathon, but as the race progresses, they slow down the pace of the race too. These results are consistent with previous research (Deaner & saradnici. 2015; Nikolaidis, Ćuk & Knechtle, 2019; Cuk, Nikolaidis & Knechtle, 2019). This is most likely because physiological factors can contribute to the gender difference in marathon pacing, for example, men are more susceptible to muscle glycogen consumption, which can contribute to greater fatigue or slowing down the pace of running. Men may be more sensitive to deceleration because, during endurance exercises, women typically have a lower oxygen exchange ratio, showing that they use proportionally more fat and less carbohydrates at a given exercise intensity. Generally, women have larger proportional areas of muscle type I fibers that are more resistant to fatigue, especially for long-term exercise.

Regarding the coefficient of variation in women it is generally around 7% and more uniform, while in men it is around 4%, but the variability was from segment to segment. Also, there were statistically significant differences in the pace of running between men and women only in the third segment of the halfmatathon race (between 10 and 15km).

CONCLUSION

Based on the obtained results, it can be concluded that the variability in the pace decreases to the third segment in men, but in the fourth and fifth segments it increases sharply, while the situation in women is

almost similar. Mostly the reason for this is because runners generally start much faster at the start of the race, when they are more rested, there is euphoria and adrenaline at the start, overestimate their capabilities and how much they are currently ready and/or follow the pace of other runners. Women dictate the pace better than the men in the half marathon, but as the race progresses, they slow down the pace of the race too. They run above average until the third segment, ie from 10 to 15km, where there is a sharp fall in the pace of running in the fourth and fifth segments. It was found that there were statistically significant differences only in the third segment of the halfmatathon race (between 10 and 15km).

This could be greatly reduced if runners were able to prepare better tactics for a particular race. They should be more careful with the starting pace of the run and even have some pacemakers to follow. Now technology has advanced so there are smartwatches where the pace of the race can be set and if the runner runs faster the clock beeps him, so it can be of great benefit to the runner so as not to overdo the first part of the race.

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DIFFERENCES IN SPINAL COLUMN POSTURAL STATUS IN CHILD AND ADOLESCENT JUDO PRACTITIONERS

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ABSTRACT

As a form of physical activity, judo includes among its goals the development and activation of the entire musculature of the body, which is of special significance in the light of the findings of studies to date, indicating a high extent of impairment of postural status among children, as well as an attendant muscular disbalance. Consequently, the objective of this study is to identify any differences in spinal column postural status among children and adolescent judo practitioners. The participant sample comprised 30 child judo practitioners and 33 adolescent judo practitioners from the Judo Club "Kinezis" from Niš, with over one year of experience practicing judo. Diagnostics of spinal column postural status in the frontal and sagittal planes was conducted using the "Spinal Mouse" instrument. Statistical results, presented as percentages, for children judo practitioners, are as follows: KIF (10%), RLT (40%), NKT (50%), LOR (10%), RLL (36.7%), NKL (53.3%), SKO (63.3%), and NKF (36.7%). Statistical results, presented as percentages, for adolescent judo practitioners, are as follows: KIF (30,3%), RLT (36,4%), NKT (33,3%), LOR (27,3%), RLL (9,1%), NKL (63,6%), SKO (57,6%), and NKF (42,4%). Results of the Mann Whitney U test indicate no statistically significant differences between the two groups in terms of postural status for the thoracic portion of the spinal column on the sagittal plane (p=0.549), nor for the lumbar portion of the sagittal plane (p=0.135), or the frontal plane of the spinal column (p=0.644). The results thus obtained indicate a high incidence of postural disorders; however, this is percentually better in children practicing judo compared against their peers who do not practice judo.

Keywords: kyphosis, lordosis, scoliosis, flat back, differences, incidence

INTRODUCTION

While postural status can have a considerable influence on one's health status and ability to work, especially during the childhood developmental period, the modern way of life has an adverse effect on postural status, leading to a rise in hypokinesia, which in turn results in muscular imbalance (Đokić, Međedović, & Smiljanić, 2011). Incorrect sitting or standing for prolonged periods of time, the use of inadequate chairs and desks at school, heavy school bags, as well as certain endogenous factors, can all have an adverse effect on the spine, leading to its deformation in terms of morphology and function (Medojević & Jakšić, 2007). Technological progress has enabled us to perform numerous activities while exerting a small amount of energy, resulting in reduced mobility and increased muscular disbalance. Moreover, children spend increasing amounts of time sitting at their computer, or lying in front of the television screen, which can lead to postural deformities (Bubanj, Živković, Živković, Milenković, Bubanj et al., 2012). In a large number of cases, hypokinesia is one of the principal causes of deformities occurring along the spinal column. Disorders located on the frontal and sagittal planes of the spine include scoliosis, hyperkyphosis and hyperlordosis (Jorgić, Milenković, Ždrale, Milenković, Stanković et al., 2015). Scoliosis located on the frontal plane presents as a lateral curvature of a portion of the spine or the entire spine, whereas hyperkyphosis is a deformity located in the thoracic portion of the spine's sagittal plane, with a backward-facing convexity (Živković, 2009). Similarly, hyperlordosis is a postural deformity on the sagittal plane of the spinal column; however, it is located in the cervical and lumbar regions, with a forward-facing convexity (Milenković, 2007). In accordance with findings regarding the factors that can cause muscular imbalance along the spinal column and, in turn, cause postural disorders, the optimal preventive action is activating the

musculature starting in early childhood, thus preventing postural disorders. As a sport and physical activity, judo is part of the group of foundation sports, ideal for early activation of all muscle groups (Bratić, 2003). This discipline includes a multitude of polystructural, acyclical movements and numerous techniques, with complex elements that enhance and develop coordination, strength, balance, and endurance (Nurkić, Bratić, Mitić, & Kafentarakis, 2017). Judo also has a beneficial effect on overall development, both mental and physical, by activating the body's entire muscle system. In view of all the benefits of practicing judo from an early age, the objective of this study is to identify the incidence of spinal postural disorders, as well as to identify any differences in spinal postural status among child and adolescent judo practitioners.

METHODS

Subjects

The study included 63 subjects. Within this group, 30 participants were children and 33 were adolescents, all of whom had been practicing judo at the "Kinezis" Judo Club in Niš for a minimum of one year.

Procedure

The measuring instrument "Spinal Mouse" was used in order to determine spinal postural status on the sagittal and frontal planes (Idiag, Fehraltdorf, Switzerland, www.idiag.ch). The "Spinal Mouse" is part of a group of instruments used in invasive postural status diagnostic methods. The instrument's validity and reliability has been established by previous studies (Mannion, Knecht, Balaban, Dvorak & Grob, 2004; Post & Leferink 2004). The device has also been implemented on subjects of different ages (Jorgic, Milenković, Ždrale, Milenković, Stanković et al., 2015; Jorgić, Milenković, Milenković, Stanković, & Bubanj, 2015). Based on the data regarding the postural status on the sagittal plane, obtained during measurements using this device, the following variables were identified: KIF- kyphotic bad posture, RLT – flat back in the thoracic region NKT – normal posture in the thoracic portion of the sagittal plane, LOR – lordotic bad posture, RLL – flat back in the lumbar region, NKL – normal posture in the lumbar region on the sagittal plane, SKO- scoliotic bad posture, and NKF – normal posture on the frontal plane.

Statistical analysis

The results obtained during the measurements are presented as frequencies and percentages. In order to identify any differences between the groups, the non-parametric statistical Mann Whitney U test will be used, within the SPSS software, version 20.

RESULTS

Table 1. Spinal postural status on the sagittal plane in children judo practitioners.

SPINAL POSTURAL STATUS ON THE SAGITTAL PLANE									
SPINAL POSTURAL STATUS IN THE THORACIC REGION OF THE SAGITTAL PLANE					**SPINAL POSTURAL STATUS IN THE THORACIC REGION OF THE LUMBAR PLANE**				
	Frequency	Percent	Valid Percent	Cumulative Percent		Frequency	Percent	Valid Percent	Cumulative Percent
NKT	15	50.0	50.0	50.0	NKL	16	53.3	53.3	53.3
KIF	3	10.0	10.0	60.0	LOR	3	10.0	10.0	63.3
RLT	12	40.0	40.0	100.0	RLL	11	36.7	36.7	100.0
Total	30	100.0	100.0		Total	30	100.0	100.0	
KIF- kyphotic bad posture, RLT – flat back in the thoracic region, NKT – normal posture in the thoracic region of the sagittal plane, LOR – lordotic bad posture, RLL – flat back in the lumbar portion, NKL – normal posture in the lumbar region of the sagittal plane.									

Based on the results presented in Table 1, namely the presentation of basic descriptive statistics parameters regarding the numeric and percentual incidence of spinal deformities in the thoracic and lumbar regions of the sagittal plane, among child judo practitioners, the following results were obtained: kyphotic bad posture was found in 3 participants (10%), lordotic bad posture in 3 participants (10%), flat back in the thoracic region in 12 study participants (40%), and flat back in the lumbar region in 11 participants (36.7%).

Table 2. Spinal postural status on the frontal plane in child judo practitioners.

SPINAL POSTURAL STATUS ON THE FRONTAL PLANE				
	Frequency	Percent	Valid Percent	Cumulative Percent
NKF	11	36.7	36.7	36.7
SKO	19	63.3	63.3	100.0
Total	30	100.0	100.0	
SKO- scoliotic bad posture, and NKF – normal posture on the frontal plane.				

Based on the results provided in Table 2, namely the presentation of basic descriptive statistics parameters regarding the numeric and percentual incidence of spinal deformity on the frontal plane among child judo practitioners, we see that scoliotic bad posture was present in 19 participants (63.3%).

Table 3. Spinal postural status on the sagittal plane in adolescent judo practitioners.

SPINAL POSTURAL STATUS ON THE SAGITTAL PLANE									
SPINAL POSTURAL STATUS IN THE THORACIC PORTION OF THE SAGITTAL PLANE					SPINAL POSTURAL STATUS IN THE LUMBAR PORTION OF THE SAGITTAL PLANE				
	Frequency	Percent	Valid Percent	Cumulative Percent		Frequency	Percent	Valid Percent	Cumulative Percent
NKT	11	33.3	33.3	33.3	NKL	21	63.6	63.6	63.6
KIF	10	30.3	30.3	63.6	LOR	9	27.3	27.3	90.9
RLT	12	36.4	36.4	100.0	RLL	3	9.1	9.1	100.0
Total	33	100.0	100.0		Total	33	100.0	100.0	
KIF- kyphotic bad posture, RLT – flat back in the thoracic region, NKT – normal posture in the thoracic portion of the sagittal plane, LOR – lordotic bad posture, RLL – flat back in the lumbar region, NKL – normal posture in the lumbar portion of the sagittal plane.									

Based on results presented in Table 3, namely a presentation of the basic descriptive statistics parameters regarding the numeric and percentual incidence of spinal deformity in the thoracic and lumbar regions of the sagittal plane, the following results were obtained for adolescent judo practitioners: kyphotic bad posture was present in 10 study participants (30.3%), lordotic bad posture in 9 participants (27.3%), flat back in the thoracic region in 12 participants (36.4%), and flat back in the lumbar region in 3 participants (9,1%).

Table 4. Spinal postural status on the frontal plane in adolescent judo practitioners.

SPINAL POSTURAL STATUS ON THE FRONTAL PLANE				
	Frequency	Percent	Valid Percent	Cumulative Percent
NKF	14	42.4	42.4	42.4
SKO	19	57.6	57.6	100.0
Total	33	100.0	100.0	
SKO- scoliotic bad posture, and NKF – normal posture on the frontal plane.				

Based on the results presented in Table 4, namely a presentation of the basic descriptive statistics parameters regarding the numeric and percentual incidence of spinal deformity in the frontal plane in adolescent judo practitioners, scoliotic bad posture was found in 19 participants (57.6%).

Table 5. Statistical significance of differences between the participants' ages.

Test Statistics[a]			
	SPINAL POSTURAL STATUS IN THE THORACIC REGION OF THE SAGITTAL PLANE	SPINAL POSTURAL STATUS IN THE LUMBAR REGION OF THE SAGITTAL PLANE	SPINAL POSTURAL STATUS ON THE FRONTAL PLANE
Mann-Whitney U	454.500	399.000	466.500
Wilcoxon W	919.500	960.000	1027.500
Z	-.599	-1.496	-.463
Asymp. Sig. (2-tailed)	**.549**	**.135**	**.644**
a. Grouping Variable: participant age			

Based on the results obtained in Table 5, there are no statistically significant differences in the spinal postural status between the children and adolescents judo practitioners, whether on the sagittal plane, thoracic region (sig=0.549) or lumbar region (sig=0.135), or on the frontal plane (sig=0.644).

DISCUSSION

The results obtained in the present study indicate a high incidence of postural disorders along the spinal column among the study participants; however, the results are better, viewed as percentages, among young judo practitioners than they are among their peers who do not practice this sport (Milošević & Obradović, 2008; Obradović, & Milošević, 2008). Focusing on the thoracic and lumbar regions of the sagittal plane, we found a somewhat higher percentage of flat back among children judo practitioners, in 12 participants for the thoracic region (40%), and in 11 participants for the lumbar region (36.7%), while scoliotic bad posture was found in 19 participants (63.3%). Among adolescent judo practitioners, only the percentages for scoliotic bad posture were increased, present in 19 participants (57.6%).

Based on results obtained in this study, using the Mann Whitney U test, it was established that no statistically significant difference exists between the groups in terms of postural status in the thoracic region of the sagittal plane (p=0.549), not in the lumbar region of the sagittal plane (p=0.135), and the frontal plane of the spine (p=0.644). In view of the fact that children of this age are yet to encounter major changes during their further growth and development, practicing judo may help correct these minimal irregularities, and it would be advisable to keep track of any changes along the spinal column in the future, and include specific corrective exercises as needed. While the presence of spinal postural disorders was clear, it can be said that, due to the fact that the study participants practice sport, there were no statistically significant differences in postural status between child and adolescent judo practitioners, on the sagittal plane, thoracic and lumbar regions, nor on the frontal plane. The findings of earlier studies into this problem whose participant sample comprised children who did not practice a sport indicate a considerably higher incidence of postural disorders (Milošević & Obradović, 2008; Obradović, & Milošević, 2008). Judo, with its various movements and deployment of all muscle groups, helps strengthen the musculature and improve the body's muscular balance, resulting in correct postural status, and even in the correcting of already existing irregularities. These results are in line with results of previous studies into the postural status of children athletes and non-athletes. Lack of physical activity in children is the most frequent cause of damning results obtained regarding postural status, and it is a major factor in muscular disbalance. Consequently, we would like to emphasize judo as a physical activity, or sport, which can help maintain correct spinal postural status, but also enhance motor skills, physical ability, and overall health of a young body (Trivić, Obadov, Vujkov, & Pejčić, 2010). Based on the results of the present study, we would like to recommend the practice of judo as a way to contribute to optimal development, growth and muscular balance in children.

CONCLUSION

The results obtained in the present study indicate a high incidence of postural disorders; however, these results are more favorable, when viewed as percentages, among children practicing judo than among their peers with no organized physical activity. Such results constitute an important piece of information not only for parents and coaches, but also for sports and health associations whose primary goal must be children's health and their optimal growth and development. In view of the insights presented above, there is need for further analyses, including longitudinal studies, in order to ascertain whether physical activity in the form of judo can also help correct postural disorders in children and adolescents.

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DESCRIPTIVE PROFILE OF THE REVERSE PUNCH (GYAKO TSUKI) KINEMATIC CHARACTERISTICS MEASURED BY IMU SENSOR TECHNOLOGY

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ABSTRACT

Reverse punch *(Gyako tsuki)* is the most frequently used pointing technique in elite karate competitors. It is a sequential movement, coordinating lower and upper limbs, and it is executed in a less than 400ms. Variation in the movement sequence could affect kinematic variables such as acceleration, which is considered to be one of the factors that contribute effectiveness of karate technique. Therefore, the aim of this paper was qualitative evaluation of kinematic motion patterns of the reverse punch. Three male competitors, members of a Serbian national senior karate team, were included in study. Measurements of the kinematic characteristics were performed using IMU (Inertial Measurement Unit) sensor device, and descriptive analysis showed specific phases of the reverse punch performed by different subjects. It is a "double peak" acceleration which has been detected in both, hand and body acceleration, and can be explained as kinematic manifestation of muscle contraction.

Keywords: gyako tsuki, wearable sensors, motion pattern, acceleration

INTRODUCTION

Reverse punch *(Gyako tsuki)* is the most frequently used pointing technique in elite karate competitors (Koropanovski et al., 2008; Tabben et al., 2015). Since the reverse punch execution requires less than 400ms (Hofmann, Witte, & Emmermacher, 2008) which makes it very fast movement, referees decision is made up on experience and capability to recognize elements that make it point worth on a global scale. However, under the global picture lie subtle differences that can be detected only by integrating technology into training and competition.

Accordingly, training in order to make technique as close as to ideal model and overcome subjective assessment of its quality nowadays requires the implementation of electronic devices such as sensors (Worsey et al., 2019). Wearable miniature IMU (Inertial Measurement Unit) sensor device, in that matter, can provide valuable information about movement patterns (Umek, Tomažić, & Kos, 2015; Kos et al., 2019). IMU sensors includes micro-electromechanical system (MEMS) – accelerometer, gyroscope and magnetometer (Kos et al., 2019), providing precise information regarding the values of the angular velocity and the sum of gravitational and inertial linear accelerations (Camomilla et al., 2015). Using sensors in combat sports, that is in karate, is demanding and thus represents novel approach in understanding kinematic patterns of punches and kicks.

Reverse punch (RP) is a sequential movement, coordinating lower and upper limbs. It is commonly executed in a front stance, and the technique is delivered by the hand on the opposite side to the leading leg. The kinetic chain involves a series of related movements involving the ankle of the back leg, knee, hip, shoulder, elbow and wrist of punching fist (Jovanović, 1992). In that matter, movement patterns can be established, and RP can be analysed thru specific phases (Hofmann, Witte, & Emmermacher, 2008). Accordingly, it is reasonable to assume that variation in the movement sequence could affect kinematic variables such as acceleration.

Acceleration is considered to be one of the factors contributing effectiveness of karate techniques. Moreover, it is believed to affect the impact directly (Loturco et al., 2013). Gianino (2010) has noted that

RP is uniformly accelerated technique with the acceleration of about 63 m/s^2. There are clear suggestions that, besides power and strength, technical aspects of punch are one of the main factors influencing variation in acceleration (Loturco et al., 2013).

Therefore, the aim of this paper is quantitative evaluation of kinematic motion patterns of the RP measured by IMU sensors technology. The present study investigated segmental acceleration of the reverse punch in order to determine its descriptive profile and to understand how changes in movement acceleration appear in punch motion.

METHODS

Subjects

Three male competitors, members of a Serbian national senior karate team, with an average age, height, and body mass of 20.33±1.15 years, 1.85±0.03 m, and 81.33±5.03 kg, respectively, participated in this study.

The study was conducted following the ethical standards recognized by the Declaration of Helsinki and was approved by the Ethics research Committee of the Faculty of Sport and Physical Education, University of Belgrade.

Procedure

The same experienced examiners conducted field testing. Subjects completed a 15 minute warm up session before testing. The technique was executed in a front left stance, and the RP was delivered by the dominant hand. All subjects were right-handed. After they were familiarized with the procedure, subjects performed test consisted of three consecutive punch delireved in front stance. The starting postion was still, and the thenque was executed in motion which consisted of front leg slinding forvard.

Variables

Kinematic characteristics of the RP were performed using an IMU sensor (STMicroelectronics LSM6DS33, 2017). Two IMU sensors were atached to the center of gravity on the back and the upper side of the glove (lying on the dorsal side of the punching fist), respectively (Figure 1).

The following descriptive indicators were obtained: absolute acceleration of hand on all three axes (AbsAccH), acceleration of hand in the horizontal axis (AccHx) and absolute acceleration of body on all three axes (AbsAccB). Characteristic phases of the technique execution (start of movement, peak of acceleration and peak of deceleration) were recorded.

Obtained descriptive indicators were measured in the first part of RP, until the impact.

Statistical analysis

The purpose of present study was detection of the characteristic movement patterns and collection of the data, meaning acceleration of body segments identified as of the main importance in technique execution. Therefore, descriptive analysis was applied, where mean value (MEAN) and standard deviation (SD) were calculated.

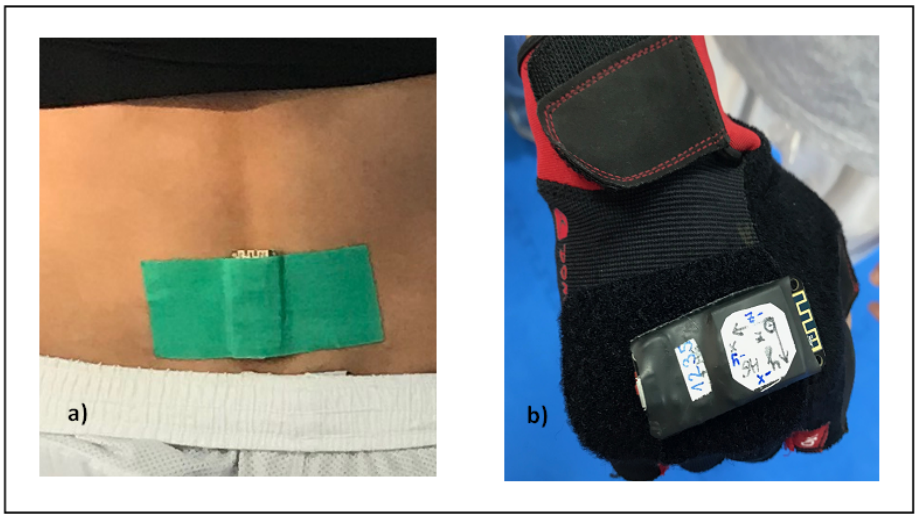


Figure 1. The position of IMU sensor attached to body (a) and upper side of the glove (b).

RESULTS

Figure 2 shows signals acquired from IMU sensors representing acceleration of hand on the horizontal axis (AccHx), which is the primary axis of arm movement and absolute acceleration of the body (AbsAccB). Pictures are illustrating movement pattern during the RP execution and two distinctive peak acceleration phases. On the Table 1 Double peak acceleration values and time of occurrence in relation to the impact are shown.

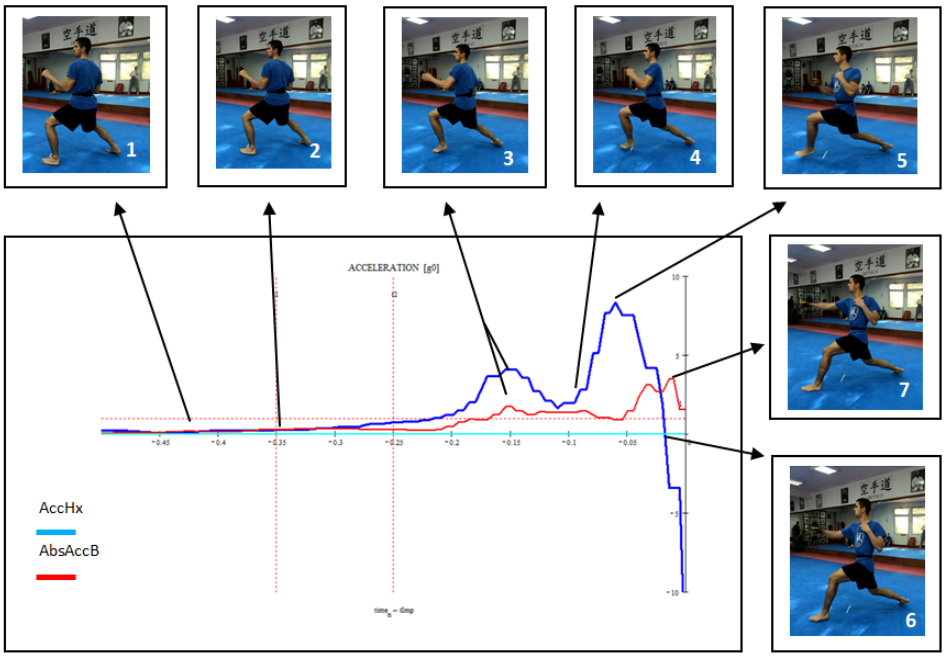


Figure 2. Movement pattern during the reverse punch execution.

In sequence the pictures show:

(1) Starting position of the karate athlete preparing for the execution of the RP in front fighting stance.

(2) Beginning of the signal of the body movement. At this point first movement of the hand can be registered, but it should be noted that it is due to the movement of the body.

(3) Almost at the same time, or near, first of two peaks of acceleration can be registered. They represent acceleration of the body and acceleration of the hand.

(4) The beginning of the second peak of hand acceleration.

(5) The second peak of hand acceleration. The beginning of the signal of the second peak of the body is near.

(6) Maximal velocity of hand and beginning of the deceleration.

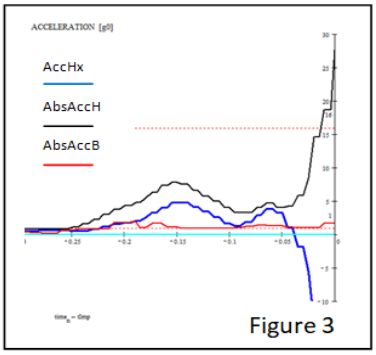
(7) Second peak of body acceleration.

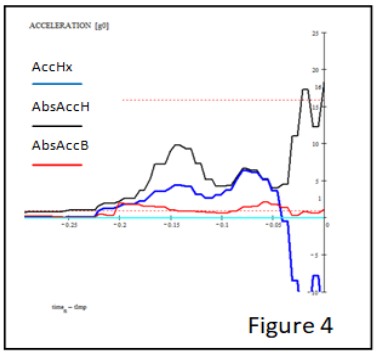
Table 1. Double peak acceleration values and time of occurrence in relation to the impact.

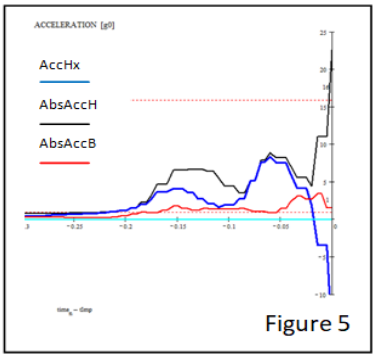
		peak_Acc_1		**peak_Acc_2**	
		time (sec)	Acc (g_0)	time (sec)	Acc (g_0)
Subject 1	AbsAccH	-0.140	6.7005	0.060	8.8821
	AccHx	-0.154	4.1109	0.060	8.3707
	AbsAccB	-0.154	1.7642	0.010	3.4768
Subject 2	AbsAccH	-0.146	9.7979	0.080	6.6362
	AccHx	-0.146	4.4511	0.080	6.4226
	AbsAccB	-0.201	2.1847	0.060	2.1398
Subject 3	AbsAccH	-0.155	7.8665	0.065	4.7054
	AccHx	-0.155	4.7844	0.065	3.9065
	AbsAccB	-0.210	1.8174	0.174	1.728
ALL	**AbsAccH**	**-0.147±.008**	**8.122±1.564**	**-0.068±.010**	**6.741±2.090**
	AccHx	**-0.152±.005**	**4.449±0.337**	**-0.068±.010**	**6.233±2.238**
	AbsAccB	**-0.188±.030**	**1.922±0.229**	**-0.081±.084**	**2.448±0.914**

Figures 3, 4 and 5 are representing acquired signals for all three different subjects. Each graph is showing: acceleration of hand on the horizontal axis, absolute acceleration of the body and absolute acceleration of the hand (AbsAccH).

Figures 3, 4 and 5. Acceleration of hand on the horizontal axis, absolute acceleration of the body and absolute acceleration of the hand (AbsAccH) for all three different subjects







DISCUSSION

Considering the sensitivity of the IMU sensor to subtle differences in movement patterns, our focus was on descriptive analysis of specific phases of the RP performed by different subjects. Although RP can be characterized as a simple, fast movement, it is possible to be executed in different manner. Never the less, one distinctive mark can be noted. It is a "double peak" acceleration which has been detected in both, hand and body acceleration. This can be explained as kinematic manifestation of muscle contraction which has been researched in study of McGill et al. (2010).

To clarify, McGill et al. (2010) have conducted analysis a variety of strikes and found a "double peak" of muscle activity. They concluded that first peak was due to the onset of movement. As the hand gained the speed, relaxation phase occurred. This was followed by a second peak. The same pattern was observed in some torso muscles. Namely, the first peak was usually measured just before, or during beginning of the first limb motion, while the second one was very close to impact.

The findings of present study support these conclusions and represent a linking piece which explains kinematic scheme of RP. Based on the obtained results, it can be concluded that the average time to reach the first peak of the absolute acceleration value is -0.147 ± 0.008 sec, for the fist acceleration value of 8.122±1.654 g_0 (Table 1). It can be argued that the first peak of acceleration hand reaches at the expense of body movement. A second peak of acceleration happens in average -0.068±.010 sec before impact, and the movement at this point is consequence of arm and not just body motion. Average value of acceleration reaches 6.741±2.090 g_0. Interestingly, when observed just on the horizontal axis, hand reaches first peak of acceleration -0.152±.005 before impact, with fist acceleration value of 4.449±0.337 g0. Second peak occurs at the same moment as in AbsAccH, but with slight difference in value 6.233±2.238 g_0. As said before, body initiates movement. That can be confirmed through absolute peak of body acceleration which has been detected around 40 ms before AbsAccH, with average value of 1.922±0.229 g_0.

CONCLUSION

The main goal of the present study was to investigate segmental acceleration of the reverse punch in order to determine its descriptive profile. Analysis showed that one distinctive mark can be noted. Despite individual differences, a double peak acceleration in both, hand and body, is recognized.

Although the sample of this study was limited, the results obtained are significant because they confirm conclusions of previous research. Namely, on the bases of findings up to date, a double peak can be explained as kinematic manifestation of muscle activation.

Further more, presented study showed existence of somewhat different technique performance. This kind of information is valuable in training process of elite competitors, since small aberration can significantly affect the quality of the technique. Besides, subtle differences can only be detected using sensitive sensors that allow deeper insight into kinematic patterns. Presented findings can provide valuable feedback concerning improvement of

performance through corrections made in specific phases of punch delivery.

The question arises: does optimal performance (meaning, delivering an RP that meets the pointing criteria) involves different execution conditions, or it is possible to define ideal pattern model? In order to provide more detailed information, future studies need to be done.

ACKNOWLEDGEMENTS

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DIFFERENCES IN THE POSTURAL STATUS OF THE ARCHES OF THE FEET IN CHILD AND ADOLESCENT JUDO PRACTITIONERS

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UDC 615.085

ABSTRACT

A side effect of the modern age, hypokinesia is attended by an increase in muscular disbalance, which in turn results in postural disorders. As a sport or physical activity, judo encompasses within its techniques the potential to activate the body's entire muscular system, with the legs, or rather the feet, bearing the most responsibility for providing support during the performance of various techniques. In accordance with the above, the objective of this study is to establish the differences in postural status of the arches of the foot in child and adolescent judo practitioners, as well as its incidence. The participant sample comprised 30 children judo practitioners and 33 adolescent judo practitioners, members of the Judo Club "Kinezis" from Niš, who had been practicing judo for a minimum of one year. The podoscope "Pedic" (Hungary), accompanied by the relevant software, was used in order to diagnose the postural status of the foot's arches. The results of percentage statistics for children judo practitioners are as follows: Pes Nor (23.3%), Pes PlL (70.0%), Pes P2L (6.7%). The results of percentage statistics for adolescent judo practitioners are as follows: Pes Nor (15.2%), Pes PlL (69.7.0%), Pes P2L (15.2%). The results of the Mann-Whitney U test indicate no statistically significant difference between the groups pertaining to the postural status of the arches of the feet (p=0.233). Based on the results, we conclude that the incidence of the flat feet postural deformity is exceptionally high among the participants, children and adolescent judo practitioners.

Keywords: flat feet, pes cavus, foot deformity incidence

INTRODUCTION

The development of modern technologies has effected changes in people's lifestyle. One attendant consequence is the decrease in physical activity, which affects postural status considerably. The term postural status primarily refers to the correct alignment of various body parts, requiring the least energy expenditure and strain. Little energy is expended when maintaining the correct body posture expends little energy even though it is a labile position with a small support surface area and a relatively large center of mass (Milenković, 2007).

Hypokinesia and insufficient movement result in insufficient muscular activation throughout the body, and especially in the legs. The resultant deformities are genetically determined to a certain extent, and are also influenced by various exogenous factors, so the foot and the knee emerge as sites where the majority of abnormalities present. Data obtained during systematic health screening in schools indicates that locomotor disorders in children mostly refer to issues with the spine and feet (Sabo, 2006).

The structure of the foot employs three arches in order to maintain stability and the required elasticity. Lack of timely prevention and early detection in this area is another reason why so many children present with a foot deformity. Numerous studies indicate that flat feet is the most frequent lower extremity disorder, with a particularly high incidence among schoolchildren (Videmšek, Klopčič and Karpljuk, 2006; Mihajlović, Tončev & Hmjelovjec, 2008). Children who start walking earlier, who do not engage in enough physical activity, and those who are obese have a higher risk of developing foot deformity (Pfeiffer, Koty, Ledl, Hauser and Sluga, 2006).

The cause of the pes planus deformity can be congenital or acquired (Bogdanović, Ilić & Vidaković, 2015). Congenital flat feet is rare; rather, human

babies are born with flat feet, but this changes with the growth and development of the locomotor system.

Congenital pes planus, on the other hand, is a severe deformity, whose cause is largely unknown. Typically, it includes pathological changes on the talus bone.

Acquired flat feet refer to a static deformity of fallen arches of the feet (Bogdanović, Ilić & Vidaković, 2015). It can occur due to a variety of causes, of which the following are the most dominant: rickets, different kinds of leg muscle hypotonia or atrophy, injuries, and other conditions. The extent of pes planus can be determined in two ways: by clinical diagnosis and by plantogram analysis (Živković, 2000).

Numerous analyses and studies have established that any changes or imbalances in the body, and especially in the lower extremities and the feet, can have an effect on the postural status and functional status of the entire body.

Physical activity contributes to better muscular balance both in children and in adults. Organized physical activity, like judo, engages nearly all the muscles of the body. With judo, this is owing to the wealth of techniques that are mostly performed by relying on the unprotected, or bare, feet for support. Additionally, judo practitioners' feet bear the brunt not only of one's own weight, but also, typically, of the weight of one's opponent during the performance of the various techniques, which also contributes toward the strengthening of the muscles both of the plantar and of the dorsal portion of the foot. In view of the above, the objective of this study is to establish the incidence of postural deformities of the foot and any differences therein between children and adolescent judo practitioners.

METHODS

Subjects

The study included 63 participants, all judo practitioners. The practitioners were divided into two groups based on their age, with 30 children judo practitioners and 33 adolescent judo practitioners. The participants were all judo practitioners who had been practicing judo actively for a minimum of one year at the Judo Club "Kinezis" in Niš.

Procedure

The measuring instrument "Pedic" (Hungary) was used, along with the requisite software, to determine the postural status of the arches of the feet. The following foot variables were established: Pes Nor – normal foot arch; PesPlL – pes planus first degree of deformity; PesP2L – pes planus second degree of deformity; PesP3L – pes planus third degree of deformity; Pes CAV – pes cavus. The methodology of measuring is provided in the study by Milenković, Živković, Bubanj, Živković, Stanković, Bubanj, R., & Cvetković (2011).

Statistical analysis

Measurement results were processed using the SPSS program for statistical data analysis, version 20. Study results are presented as percentages and frequencies. The non-parametric Mann Whitney U test was used for determining the differences between the groups.

RESULTS

Table 1. Postural status of the arches of the foot in children and adolescent judo practitioners.

POSTURAL STATUS OF THE ARCH OF THE FOOT									
POSTURAL STATUS OF THE ARCH OF THE FOOT IN CHILDREN JUDO PRACTITIONERS					POSTURAL STATUS OF THE BACK ARCH OF THE FOOT IN ADOLESCENT JUDO PRACTITIONERS				
	Frequency	Percent	Valid Percent	Cumulative Percent		Frequency	Percent	Valid Percent	Cumulative Percent
Pes Nor	7	23.3	23.3	23.3	Pes Nor	5	15.2	15.2	15.2
Pes PlL	21	70.0	70.0	93.3	Pes PlL	23	69.7	69.7	84.8
Pes P2L	2	6.7	6.7	100.0	Pes P2L	5	15.2	15.2	100.0
Total	30	100.0	100.0		Total	33	100.0	100.0	
Pes Nor – normal arch of the foot; PesPlL – first degree pes planus; PesP2L – second degree pes planus.									

The results presented in Table 1 show the basic parameters of descriptive statistics concerning incidence of foot deformity in child and adolescent judo practitioners, provided as numerals and percentages. The results obtained indicate the following: first-degree pes planus was present in 21 participants (70%) of children judo practitioners, while second-degree deformity was only present in

two child participants (6.7%). With adolescent judo practitioners, the first-degree flat feet deformity was present in 23 participants (69.7), while second-degree deformity was found in 5 participants (15.2%).

Table 2. Statistical significance of differences in the participants' ages.

Test Statistics[a]	
	POSTURAL STATUS OF THE ARCH OF THE FOOT
Mann-Whitney U	425.000
Wilcoxon W	890.000
Z	-1.194
Asymp. Sig. (2-tailed)	**0.233**
a. Grouping Variable: participant age	

Results of the Mann Whitney U test, presented in Table 2, indicate no statistically significant differences in the postural status of the arches of the feet between children judo practitioners and adolescents judo practitioners (sig=0.233).

DISCUSSION

The results obtained in the present study, at the level of descriptive statistics, indicate a very high incidence of postural disorders of the arch of the foot. Another significant insight is that the flat foot deformity present in the study participants was of a functional degree, namely, that it was a result of muscular disbalance, with weak muscles on the dorsal side of the foot initiating the lowering of the arch.

In terms of percentages, the result obtained in the present study indicate a high incidence of first- and second-degree flat foot deformity in both children and adolescents practicing judo actively, namely 76.7% and 84.9%, respectively. The incidence of fallen arches, viewed as percentages, among judo practitioners, as compared against young people of the same age who are not actively practicing an organized physical activity indicates that this percentage is lower for judo practitioners (Puzović, Đorđević, Karaleić, Obrenović, Medić, & Jakovljević, 2010; Protić-Gava, Šćepanović, & Batez, 2013). Furthermore, the results obtained using the Mann Whitney U test indicate no statistically significant difference in terms of first-degree and second-degree flat feet incidence (p=0.233).

It is worth emphasizing that the present study did not find structural flat feet deformity in any of the participants, which should offer some encouragement for both the participants themselves and their parents, but also coaches and relevant healthcare providers, since this indicates that only the initial stages of the deformity are present, stages which can be overcome through physical activity alone, as the changes are localized exclusively on the muscles. In addition, pes cavus was not found in any of the study participants, which also speaks to the role judo can play in enhancing muscular balance in the plantar and dorsal sides of the foot both in children and in adolescents.

The participants in the study are representative of the age groups which are at the beginning of a phase of intensive growth and development, that is puberty. For this reason, any current information obtained about their postural status is subject to change due to insufficient muscular strength or power, as well as due to ongoing bone growth which in turn affects the lengthening of muscles and the reduction of their strength. However, judo remains a sport rich in muscle-activating techniques for the entire body, and especially for the legs and feet, since the majority of techniques are performed while standing, thus encouraging the strengthening of the muscles of the plantar and dorsal portions of the foot. The results of the present study, compared to earlier studies, indicate that the muscular balance for the plantar and dorsal sides of the foot is considerably enhanced. Moreover, one should take into account the fact that these are younger participants who have any competitive participation in the sport ahead of them, where the training process will ask much greater physical exertion and effort from them, that is, increased strength, which will inevitably lead to improved muscular balance for the plantar and dorsal sides of the foot.

CONCLUSION

Based on the results obtained in the present study, we conclude that there is a high incidence of the flat feet deformity of the first and second functional degree in child and adolescent judo practitioners. Additionally, there were no statistically significant differences between the two age groups regarding the incidence of flat feet deformity. While damning, the results indicate that children of the same age largely present with the pes planus deformity of the first and second functional degrees. Such results are important insights, primarily for health centers and corrective exercise providers engaged in postural deformity correction, for physical education teachers, as well as for the parents and children themselves, in order to act

preventatively, but also in order to attempt to correct any functional flat foot deformities in children and adolescents. In view of the results obtained in this study, further, more in-depth research is warranted in order to gain more insights into this problem and conduct an empirical study with the objective of establishing the effects of judo practice during childhood and adolescence on correcting existing functional flat feet deformities.

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INFLUENCE OF STRENGTH OF LOWER EXTREMITIES ON PERFORMANCE SUCCSESS ON FLOOR EXERCISE

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ABSTRACT

The aim of the study was to determine the influence of strength of lower extremities on performance succsess on floor exercise with young gymnasts. The sample of respondents for this research consisted of 20 top gymnasts from eight countries (Austria, Bosnia and Herzegovina, Bulgaria, Russia, Slovenia, Serbia, Croatia and Switzerland), aged 14 to 16 years, three to 10 years of training (average 6.9) and body weight from 31kg to 58kg (average weight 43.52kg). IMADAZ2H-1100 Japanese Digital Dynamometer with WinWedge 3.4 software was used to evaluate the absolute and relative strength of the lower extremity muscles. And for further statistical analysis the results from the competition were taken ("D" and "E" score, and the sum of "D" and "E" scores were taken as final score).Descriptive statistics and regression analysis were used for all variables to determine the influence of muscle force on competition score. The results of the regression analysis showed that there is no statistically significant influence of lower extremity strength on the performance success on floor exercise with gymnasts. The results of this research can provide useful guidance and serve as an adequate basis for further research in artistic gymnastics.

Keywords: artistic gymnastics, strength, muscle force, floor

INTRODUCTION

There are a number of different and complex movements in artistic gymnastics, and they also have great demands on their successful performing in given spatial and temporal conditions. Successful exercise in artistic gymnastics requires a certain morphological constitution of the gymnast (Tabaković, Turković & Hadžikadunić, 2014). Under artistic gymnastics, the widest audience experiences sports, conceptually defined as a competitive discipline of polystructural content (exercises are performed in all three planes of motion and about all three axes of rotation) acyclic type and with strictly defined rules as a convention in practice. Exercises in artistic gymnastics are very diverse and some of them are more demanding in terms of different forms of strength, some in terms of coordination, flexibility, balance, and some sublimate more motor skills. For this reason, the application of exercises on the apparatus and on the floor indisputably affects the overall motor status of a person (Petković, Veličković, Petković, Hadži – Ilić, i Mekić, 2013). Floor is one of the gymnastics apparatus that is present in allaround in both men and women. Floor exercises should contain predominantly acrobatic elements in combination with other gymnastic elements: of strength, balance, handstands, choreographic combinations that are linked to a harmonic rhythmic whole and are performed within the intended area of 12x12m (Petković, Veličković, Petković, Hadži – Ilić, i Mekić, 2013). Strength, as one of the motor skills, is defined as a person's ability to resist an outside force witth tension of muscles or to move his body (Stojiljković, 2003). Opavski (1971) identifies strength with force and says that "force is the ability to transform muscular tension in the composition of motor units into a kinetic or potential form of mechanical energy".

Strength is also defined as an athlete's ability, which is manifested when overcoming various external resistance (Fratrić, 2006). The most common criterion for the classification of motor ability strength is the ratio of the magnitude of the force exerted and the mass of the body. On this basis it is possible to isolate: absolute strength (the

maximum muscular strength that a man can develop with his overall muscle mass) and relative strength (the amount of power he can develop per kilogram of his weight) (Stojiljković, 2003). Relative power is more important than absolute in artistic gymnastics. The reason for this is the fact that gymnasts carry only their bodies when performing elements and entire ensembles, without additional external loads (Paunović, Đurović, Veličković, Živković, & Stojanović, 2018). Because of all the above, it is important to determine is there an influence of the absolute and relative strength of the lower extremities on the success of performing floor exercises, which is the aim of this research.

METHODS

Subjects

The subject sample consisted of 20 gymnasts from Austria, Bosnia and Herzegovina, Bulgaria, Russia, Slovenia, Serbia, Croatia, Switzerland, aged 14 to 16 years (avg 15,19) and body weight from 31 kg to 58 kg (avg 43,52 kg). Respondents had a training period from three to 10 years (avg 6,9). All methods and procedures of this investigation were approved by the ethical committee of the University of Niš, Faculty of Sport and Physical Education, Serbia, and they conformed to the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Procedure

The measurement of lower extremities muscle force was performed just before the competition, tako da nije uticalo na sam ishod takmičenja. For maximum force estimation the maximum force of the leg extender was measured (**LEGA**). The Japanese digital IMADA Z2H-1100 with the WinWedge 3.4 software was used to measure the maximum muscle force of the lower body exstensors. The value displayed on the digital meter is the absolute value of the maximum force. When the absolute value of the force is divided by the weight of the participants, the relative force value is obtained (**LEGR**). Competition scores taken for further statistical processing were individual grades „D“ (**DVAL**) and „E“ (**EVAL**), and the sum of the scores „D“ and „E“ (**FVAL**) was taken as final score, on the floor in an international tournament „Laza Krstić i Marica Dželatović“,held at Novi Sad. Body weight measurements were performed according to the recommendations of an international biological program (Đurašković, 2001). An electronic scale was used to measure body weight brand „Tefal” with a measurement accuracy of 0.1 kg.

To measure the maximum force of the leg extensors the respondent holds the dynamometer behind and under the back, whereby the knees are slightly flexed and the feet are spaced in wide of the hips. The chain that connects the stand to the digital force bar is fully tightened. The respondent pulls the dynamometer evenly from the starting position with arms outstretched with lower limb extensor muscle strength during which he performs an extension of the knee joint. The result is read in Newtons (N). Test description of test is taken from Dopsaj, 2010.

Statistical analysis

Descriptive parameters were first calculated for each variant, for this purpose were calculated:

- Minimum value (MIin),
- Maximum value (Max),
- Range (Range),
- Arithmetic mean (Mean),
- Standard deviation (Std),
- Skewnes (Skew),
- Curtosis (Kurt),
- Kolmogorov smirnov Z test (p).

A regression analysis was used to determine the influence of the relative strength variables on the competition results in all around, where the following statistical parameters were calculated: **p** = Standardized regression coefficients level of significance, **R**= Multiple correlation coefficient, **R2 adjust** = Adjusted determination coefficient, **F** = Multiple regression analysis significance tests. The data obtained by this research were processed by the statistics package „SPSS v20“.

RESULTS

Table 1. Descriptive statistics

Variables	Mean	Std	Range	Min	Max	Skew	Kurt	KS-Z test	
								Ksz	p
LEGA	17,69	4,41	14,08	10,57	24,66	-,27	-1,13	,629	,823
LEGR	2,66	1,03	3,72	1,30	5,02	0,86	0,01	,147	,200
DVAL	3,83	,49	1,70	2,80	4,50	-,52	-,89	,852	,463
EVAL	8,03	1,29	6,10	2,95	9,05	-3,52	13,85	1,324	,060
FVAL	11,82	1,63	7,65	5,75	13,40	-2,89	10,44	1,032	,238

Legend: **LEGA** – leg extensor absolute muscle force, **LEGR** – leg extensor relative muscle force, **DVAL** – "D" score, **EVAL** – "E" score, **FVAL** – final score, **Mean** – mean, **Std** – standard deviation**, Range** – range, **Min** – lowest score, **Max** – highest score, , **Skew** – skewness, **Kurt** – curtosis, **Ksz** – KSZ test values, **p** – KSZ test statistical significance

Table 1 shows the basic parameters of descriptive statistics. It can be stated that the values of skewnes and curtosis are within normal values. In the case of "E" score and final score, great curtosis is expressed, and the reason is the way of scoring in artistic gymnastics.

Table 2. Regression analysis of the lower extremity absolute force on a "D" grade

R	R^2_{adjust}	F	p
,114	,013	,238	,631

Legend: **R –** multiple correlation coefficient, **R² adjust** – adjusted determination coefficient, **F –** multiple regression analysis significance tests, **p** – standardized regression coefficients level of significance

Table 2 shows the results of the regression analysis of the lower extremity absolute force on the "D" score, which represents start value with all weight and specific requirements. The regression coefficient between the absolute force and the "D" score was .114 which represents a very small correlation with no statistical significance (p = .631). The coefficient of determination is .013 and indicates an inability to execute on the basis of force, weight exercise variance prediction, that is, the absolute values of the leg force do not affect on the result with given sample of gymnasts

Table 3. Regression analysis of the lower extremity absolute force on a "E" grade

R	R^2_{adjust}	F	p
,252	,063	1,217	,284

Legend: **R –** multiple correlation coefficient, **R² adjust** – adjusted determination coefficient, **F –** multiple regression analysis significance tests, **p** – standardized regression coefficients level of significance

Table 3 shows the results of the regression analysis of the lower extremity absolute force on the "E" grade, which represents deductions for aesthetic, technical and compositional errors. The regression coefficient between the absolute force and the "E" score was .252, which is a small correlation with no statistical significance.. The coefficient of determination is .063 and indicates the inability to predict the variance of exercise performance based on the absolute force of the lower extremities.

Table 4. Regression analysis of the lower extremity absolute force to the final score

R	R^2_{adjust}	F	p
,246	,061	1,161	,295

Legend: **R –** multiple correlation coefficient, **R² adjust** – adjusted determination coefficient, **F –** multiple regression analysis significance tests, **p** – standardized regression coefficients level of significance

Table 4 shows the results of the regression analysis of the lower extremity absolute force on the final score, which is the sum of "D" and "E" score. The regression coefficient between the absolute force of the lower extremities and the final score is .246, which represents a small correlation with no statistical significance. The coefficient of determination is .061 and indicates the inability to predict, on the basis of absolute force, the variance on the final score of exercises on floor.

Table 5. Regression analysis of the lower extremity relative force on a "D" grade

R	R^2_{adjust}	F	p
.114	.013	.238	.631

Legend: **R –** multiple correlation coefficient, **R^2 adjust** – adjusted determination coefficient, **F –** multiple regression analysis significance tests, **p** – standardized regression coefficients level of significance

Table 5 shows the results of regression analysis of the lower extremity relative force to the "D" score. The regression coefficient between the relative force and the ''D'' score is .114 which is a small correlation with no statistical significance. The coefficient of determination is .013 and indicates on impossibility to make a prediction of variance based on force on the ''D'' score.

Table 6. Regression analysis of the lower extremity relative force on a "E" grade

R	R^2_{adjust}	F	p
.252	.063	1.217	.284

Legend: **R –** multiple correlation coefficient, **R^2 adjust** – adjusted determination coefficient, **F –** multiple regression analysis significance tests, **p** – standardized regression coefficients level of significance

Table 6 shows the results of regression analysis of the lower extremity relative force to the "E" score. The regression coefficient between the relative force and the "E" score is .252 which is a small correlation with no statistical significance. The coefficient of determination is .063 and indicates the inability to predict the variance of ''E'' score on the basis of force.

Table 7. Regression analysis of the lower extremity relative force to the final score

R	R^2_{adjust}	F	p
.252	.063	1.217	.284

Legend: **R –** multiple correlation coefficient, **R^2 adjust** – adjusted determination coefficient, **F –** multiple regression analysis significance tests, **p** – standardized regression coefficients level of significance

Table 7 shows the results of regression analysis of the lower extremity relative force on the final score. The regression coefficient between the relative force and the final score is .334, which is a slightly higher correlation than the two previous tables (table 5 and 6), but still a small correlation with no statistical significance, and means that the relative force determines the final score with 11.1%.

DISCUSSION AND CONCLUSION

The aim of this study was to investigate the influence of lower extremities muscle force on the performance of floor exercises with young gymnasts. Based on the obtained results, it can be concluded that the values of the absolute and relative forces of the lower extremities do not have a statistically significant effect on the performance of floor exercises in artistic gymnastics with gymnasts aged 14 to 16 years.

As there is a small amount of research that has dealt with this topic (only one), there is little room for discussion and comparison of the results obtained. The results obtained from this study indicate that there is no statistically significant influence of the absolute and relative force of the lower extremities on "D" and "E" score or on the final score on floor with gymnast's. The results obtained in this research completely agree with the results obtained in the research of Paunovic et al (2018). The authors of this research examined the influence of the relative force of different muscle groups on the result in all-round with young gymnasts. The results of the regression analysis showed that there was no statistically significant influence of the set of variables on the result in all-round ($p = 0.653$), as

with any variable individually (BACKMAX = 0.841, LEGMAX = 0.413, BICMAX = 0.926, SHOMAX = 0.149). The authors concluded that on the success in all-round at this age affects many factors, as well as stage fright, anxiety, competitive experience and many others.

Moskovljevic (2013) in his study talks about the repetitive and explosive power of the legs. The results indicate that explosive and repetitive strength allows easier jumps, longer flight time, shorter ground contact time, and higher jump height. Similar results were obtained by Bojanic (2016) which confirms the hypothesis of a positive effect of base-motor potentials on strength. Hall, Bishop & Gee (2016) were intended to determine the effect of plyometric training when added to ordinary gymnastics training and came to the conclusion that an additional two hours of plyometric training improved performance aspects at the vault. The subject of some research to date has been determining predictive values and relationships of morphological characteristics and success in sports gymnastics (Ljasotović, 1975; Sejdić, 1982; Wagner, 1984; Rašidagić, 2001; Hmjelovjec, 1984, 1989, 2002; Tabaković, 2000, 2003). The results of the conducted researches mostly confirmed that morphological characteristics have a very big influence on the success in executing elements in artistic gymnastics.

As for researching of strength in other sports Garrido et al. (2012) have obtained an association between the maximum isometric force of hand grip and swimmer 100m freestyle results. Dopsaj, Ivanović, Blagojević & Vučković (2009) have come up with results that indicate a higher hand grip force of the weightlifters from normally and well-trained fourth-year students of Academy of Criminology and Police Studies. Results which indicates that top athletes and non-athletes have the same ability to develop the muscular force of the leg extender, were obtained by Ivanović et al. (2012). The foregoing researches represents good idea for further researches in artistic gymnastics. Given that in artistic gymnastics, gymnasts have a grip for appartus on four of six apparatus, future research could test the connection and the impact of the hand grip force on the results on these apparatus. The maximum and relative forces of different muscle groups should also be compared, between gymnasts and non-athletes (Paunović, Đurović, Veličković, Živković, & Stojanović, 2018).

Success in sports largely depends on many basic and specific motor abilities and their connectedness which is significant for achieving the best possible result in competitive conditions (Bokan, 2009). The reason for the results obtained in this study is to be found in the age of the respondents as well as a number of other factors that affect the outcome at this age. Regardless of the results obtained, this research provides a good basis for further research in which the influence of other muscle regions on the performance of exercises on other apparatus and exercises in all round can be examined, as well as in a sample of respondents of different ages and competitive levels. It can also provide guidance for the development of certain muscle groups that have the greatest impact on success on specific apparatus, and thus help in the training process and contribute to better results.

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THE MOST FREQUENTLY USED JUDO TECHNIQUES IN ACCORDANCE WITH CURRENT SPORT RULES

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ABSTRACT

The research aimed to determine which judo techniques are most commonly used in competitions, in accordance with current rules prescribed by the World Judo Federation (IJF). The analysis included 13 studies, which analyzed 34 judo competitions from 1981 to 2014. Leg judo techniques (Ashi waza) have been found to be the most commonly used techniques from 1981 to 1999, compared to other groups of techniques, especially for heavyweight competitors. In the period from 2000 to 2009, hand judo techniques (Te waza) had the most common application, and after the rule changes from 2009 and 2010, there would be a equal application of hand and leg judo techniques. The equilibrium between the use of hand and leg judo techniques continued after the 2013 rule change. The general conclusion is that the rule changes influenced what techniques the judokas commonly use during the match. Individually, the following techniques are most commonly used in judo in the studies analyzed: Uchi mata and Seoi nage (most often), Ko uchi gari, Ko soto gari, Kata guruma, Te guruma, Kuchiki taoshi, Morote seoi nage, Ippon seoi nage, O uchi gari, Harai goshi, Tani otoshi, O soto otoshi, De ashi barai and others. The conducted analysis can have practical application and contribute to judo coaches in planning the training process, especially in the part of planning the strategy and tactics for competition.

Keywords: judo, techniques, analysis, rules

INTRODUCTION

In judo it is often the case that, despite the competitiors extraordinary psycho-physical fitness and high ranking in World's Judo Federation (International Judo Federation - IJF), they finish their competition in the first fight. Also, it is not uncommon for lower ranked fighters to win the world's most important competitions. All this indicates that the outcome of the judo fight is not easy to predict, which makes judo as a sport more interesting for both, the audience and the world of science. Judo is a sport with a specific movement structure, a large number of throwing techniques and ground techniques, as well as specific competitor characteristics, requiring unique psychological preparation that can significantly offset the lack of physical, functional and technical ability (Bratic, 1998). During a judo fight, dynamic situations change constantly with changes in the grip and position of both fighters, which requires a good dynamic stereotype of the grip and throw, as well as a good ability to effectively reorganize those dynamic stereotypes (Cicovic, Simonovic, & Antonov, 2012).

The first rules of judo were written by its creator, Jigoro Kano, in 1884 for the purposes of fighting in Kodokan, the judo school he founded (Stankovic, 2015). In order to popularize judo as well as to promote its attractiveness to the viewers, the rules of judo have been constantly changing to this day. Thanks to the change of rules, the dynamics of judo fighting changed from competition to competition. Changes in judo rules also led to changes in the technical and tactical approach to judo combat by competitors and coaches, changes in psycho-physical preparation, etc. Accordingly, a continuous change in the rules of judo was followed by various scientific studies in order to determine the impact of the rule change on different segments of judo fight and competition.

Studies on the analysis of judo fighting have become increasingly widespread in the scientific public (Kopas, Drid, & Obadov, 2008; Vukotic, Drid, &

Obadov, 2008; Boguszevski, 2010, 2011; Adam, Smaruj, & Tyszkowski, 2011; Witkowski, Maslinski, & Kotwica, 2012; Segedi, & Sertic, 2012; Kajmovic, & Radjo, 2014; Stankovic, 2015 and others). Under the rules until 2006, the judges paid much attention to the position of judokas on the edge of the contest area. Leaving the contest area a few centimeters would entail a penalty that in most cases was difficult to offset (Drid, & Todorov, 2017). The changes to the rules of the fight introduced in 2006 were intended to limit the referee's role in competitions (Boguszewski, 2011). Changes concerning the conduct of combat at the edge of the contest area, when judokas are in a vertical position, allowed the fight to continue if judoka initiated the attack while one of the fighters had contact with the contest area. In 2006 and 2007, guidelines were introduced for punishing inactive combat. Passive combat was penalized, which aimed to create more dynamic judo fights.

One of the most important changes in 2009 is the elimination of the smallest point (koka), and the ban of the leg gripping (the grip is punished with shido). In the event of a draw at the end of a 5-minute match, the golden score is reduced from five to three minutes. The rules since 2010 have aimed to make judo more attractive and dynamic in the attacking phase, so that the fighting ends with an ippon (Boguszewski, 2011). Throws that include touchnig directly the legs of opponents such as: morote gari, kuchiki taoshi, kibisu gaeshi, kata guruma, suki nage, were limited (Adam et al., 2012). Direct gripping of the opponent's legs was punished by disqualification (hansoku make) unless the action followed in response to the opponent's attack or the continuation of his own initial attack (Stankovic, 2015).

As the most significant changes in the rules since 2013, Stankovic (2015) points out that the importance of penalty points has been reduced because penalty points have not been converted into positive points for the opponent, so positive action was superior to punishment. When fighting in a standing posture, each grip on the leg also caused qualification. The change was also introduced to grip fighting by forbidding the breaking of the grip with two hands. The 2013 rules, brought an unlimited amount of time in overtime, where the fight ended with a point for one of the opponents (Miarka et al., 2014).

The problem of this paper is reflected in the collection, selection and analysis of scientific papers, which were essentially based on the analysis of the frequency of the application of throwing techniques in judo combat. The aim of the study is to determine which and to which group of techniques belong the most commonly used throwing techniques, in accordance with current rules prescribed by the World Judo Federation (IJF).

METHOD

Literature search

The research papers whose results were analyzed in this paper were collected on the basis of the electronic search engines Scopus and PubMed. The search selected papers that were mainly extracted by the use of keywords: judo, techniques, analysis, rules.

Data collection

In order to include the papers in the analysis, it was necessary to satisfy the following criteria: that the research analyze the most commonly used judo techniques in competitions, that the competitions took place in senior and junior age category and the third criterion was that the works covered engaged in competitions prior to the current rules defined in 2017.

A theoretical consideration of the problem

The basic method in collecting scientific papers was the descriptive method, which was used in conjunction with theoretical analysis. Based on the keywords and according to the subject and purpose of the research, 13 studies were allocated for the purposes of the paper. The aforementioned number of surveys is considered optimal, as a total of 13 studies have analyzed 34 judo competitions, including the most significant such as the Olympic Games, World and European Championships.

THE RESULTS

Table 1. Review of research papers

Current rules	Research	Competition	Years of maintenance	The most commonly used groups of judo techniques	The most commonly used single of judo techniques
Analysis of competitions from 1981 to 1999	Sikorski, Mickiewicz, Majle, & Laksa (1987, according to Stankovic, 2015)	World Championship European Championship Championship of Poland	1981, 1983, 1985 1982, 1984, 1985 1983, 1984, 1985	Te waza (-78kg) Ashi waza (+78kg)	Seoi nage, Uchi mata, Ko soto gari and Ko uchi gari
	Sterkowicz & Franchini (2000)	World Championship	1995, 1997, 1999	Ashi waza (-78kg) Ashi waza (+78kg), in all competitions except 1999 - Te waza (-81kg)	/
		Olympic Games	1996		
Analysis of competitions from 2005 to2008	Kopas, Drid, & Obadov (2008)	Serbia Championship for men	2007	Te waza	Kata guruma, Tani otoshi and Uchi mata
	Vukotic, Obadov, & Drid (2008)	Serbia Championship for women	2007	Te waza	Ippon seoi nage, Harai goshi and Uchi mata
	Boguszewski (2010)	Olyimpic Games World Championship World Cup (Warsaw)	2008 2005 2005, 2006, 2007, 2008	Te waza Ashi waza	Uchi mata, Kuchiki taoshi and Seoi nage
	Witkowski, Maslinski, & Kotwica (2012)	Olympic Games	2005	Te waza, Ashi waza, Sutemi waza, Koshi waza	Seoi nage, Kata guruma, Kuchiki taoshi, Uchi mata, Sumi gaeshi, Ko soto gake, Ko uchi gari, Morote gari, Tomoe nage
	Sertic, Segedi, & Vucak (2009)	European Junior Championship Zagreb-Croatia	2008	Te waza	Kata guruma, Te guruma, Seoi nage
				Sutemi waza	Tani otoshi, Soto makikomi
				Ashi waza	Uchi mata, Ouchi gari, Kouchi gari
				Koshi waza	Harai goshi, Sode tsurikomigoski

DISCUSION

Research by Sikorski et al., in 1987 (according to Stanković, 2015) and Sterkowicz & Franchini (2000) analyzed the World Championships (1981-1999), then the European Championships (1982 - 1985) the Olympic Games (1996) and the Polish Championships (1983-1985). Based on the 13 competitions analyzed, it was concluded that leg techniques (Ashi waza) were the most represented in the above competitions. Competitors belonging to the lighter weight category (-78kg to 1999 and -81kg from 1999) within the 10 analyzed championships used hand techniques (Te waza), while in the remaining 3 championships from 1981 to 1999 they used the leg techniques (Ashi waza). Competitors who competed in the heavyweight category (+ 78kg until 1999 and + 81kg since 1999) dominantly used leg techniques (Ashi waza) in all 13 championships Sikorski et al., 1987 (according to Stankovic, 2015) singled out the most dominant single techniques; Seoi nage, Uchi mata, Ko soto gari and Ko uchi gari. The importance of the isolated techniques was also confirmed in the study by Sertic & Szegedi (2012), where the authors based on the ratings of 8 judo experts ranked the 60 most important judo techniques, rating each technique individually with grades 1 to 5. According to this classification, all 8 evaluators rated 5 the Uchi mata technique (1st place by importance, along with Ippon seoi nage and Morote seoi nage techniques), Ko uchi burns 4.86 (2nd place by importance), Ko soto gari 3.86 (9th place by importance).

In the period related to competitions from 2000 to 2009, 5 studies were analyzed (Kopas et al., 2008; Vukotic et al., 2008; Boguszewski, 2010; Witkowski

et al., 2012; Sertic et al., 2009). These studies included 10 different competitions in the men's and women's competitions. It is characteristic to point out that hand techniques (Te waza) were the dominant group of techniques in the analyzed period. Having analyzed a significant period of time with very important competitions (World Cup 2005; Serbian Championship 2007; Olympic Games 2008; World Cup Warsaw 2005-2008; European Junior Championship 2008), it can be concluded that the rules favored the dominance of hand/arm techniques. The dominance of hand/arm techniques in the analyzed period is probably one of the reasons for the 2009 and 2010 rule change, which prohibited direct grasps of the opponent legs. Individual techniques which were the most frequently used were: Uchi mata, Seoi nage, Kata guruma, Te guruma, Kuchiki taoshi and others.

According to rules introduced in 2010, direct grips on the opponent's legs were penalized by disqualification. Techniques such as: Morote gari, Kuchiki taoshi, Kibisu gaeshi, Kata guruma, Sukui nage, were limited. Between 2009 and 2010, 3 research papers were analyzed (Adam et al., 2011; Drid et al., 2013; Trivic et al., 2013). The 2010 rule change have influenced the dominance of the technique groups between the 2009 and 2010 World Cups. Adam et al., 2011, found that te waza techniques were more dominant in the 2009 World Cup, whereas in the 2010 World Cup, ashi waza techniques were more dominant. By analyzing the 2012 London Olympics in the men and women category (Drid et al., 2013; Trivic et al., 2013), the authors conclude that seniors were more dominant in using hand techniques, while women were more dominant in using leg techniques). Individual, Seoi nage, Morote seoi nage and Uchi mata stood out as the most commonly used techniques. Based on the results obtained, it was concluded that the 2009 and 2010 rule changes reduced the dominance of te waza techniques that was represented in competitions until 2008.

According to the 2013 rules, 3 surveys were analyzed (Miller et al., 2013; Kajmovic & Radjo, 2014; Stankovic, 2015), which included 4 competitions (World Cup 2011 and 2014; British Championship 2013; Championship of Bosnia and Herzegovina 2013 and 2014). The dominant techniques at the British Championships (2013) as well as at the Bosnia and Herzegovina Championships were leg techniques. At the 2014 World Cup, hand techniques were dominant. The 2013 rule change did not jeopardize the dominance of te waza, but did allow for an increase in the use of ashi waza and koshi waza. The championships analyzed highlight the following dominant and most effective individual techniques: Ippon seoi nage (1st place), O uchi gari (3rd place), Uchi mata (1st place), Ko uchi gari (2nd place), Harai goshi (5th place), Tani otoshi (9th place), O soto otoshi (10th place), De ashi barai (not separated in 60 significant techniques, according to Sertic & Segedi 2012), Soto maki komi (15 site) and others. Within the parentheses is the importance of the techniques rancked in the article published by Sertić and Segedi (2012). Since certain techniques had the same value of the arithmetic mean of the defined grade, the brackets represent the values that the technique occupies in the rank list according to the values of the arithmetic mean of the grade, so it happens that different techniques share the same place.

CONCLUSION

Based on the results obtained, it was found that techniques from groups of hand and leg techniques were most commonly applied in judo, while sacrificial and hip techniques were significantly less prevalent. Analyzed by period, leg techniques were more dominant in the period from 1981 to 1999, especially for competitors in the heavier categories. From 2000 to 2009. te waza techniques were absolutely dominant. The application of the new rules from 2009 and 2010 diminished the dominance of hand techniques, so that in the analyzed competitions from 2011 to 2013, there was an equal application of hand and leg techniques. This trend of equality between domination, or more frequent use in the fight between hand and leg techniques, continued after the rule change from 2013 and remained until the last analyzed competitions from 2014.

Individually most commonly used are: Uchi mata and Seoi nage (most often), Ko uchi gari, Ko soto gari, Kata guruma, Te guruma, Kuchiki taoshi, Morote seoi nage, Ippon seoi nage, O uchi gari, Harai goshi, Tani otoshi, O soto otoshi, De ashi barai, Soto maki komi and others.

The analysis of the most commonly used judo techniques provides a clearer picture of judo fights in the competition, differentiates the techniques whose application dominates the fight, and therefore decides the winner. The analysis conducted can have practical application and contribute to judo coaches in planning the training process, especially in the planning of the competition strategy and tactics.

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PREDICTION OF RESULTS OF FEMALE PARASWIMMERS IN FREESTYLE DISCIPLINES AT TOKYO 2020 PARALYMPICS

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ABSTRACT

The aim of the research was to determine the trend in the development of the results of female paraswimmers who won medals in freestyle disciplines in the last five Paralympic Games (POG) and the formation of a prediction result model at the next Tokyo 2020 POG. First of all, a database of the best results on the last five POG in all classes was created. After that, the equation of the trend and the results (times) that the female paraswimmers are to achieve are calculated in order, hypothetically, to win the appropriate medal at the next POG. Due to the lack of continuity of some disciplines, the results for classes S1, S2, S3, S4 and S14 were not processed. The trend of development of results on the POG for the class of S5, S6, S7, S8, S9, S10, S11, S12 and S13 in the freestyle has been determined. The significance of this research is that the problem of women in the Paralympic sport is being addressed, which is a rarity in the previous research. Also, the results and the conclusion of this research provide a (mathematical) response to coaches of para-swimmers, and that is the result of which their female para-swimmer must swim in order to expect a medal at the next Tokyo 2020 POG.

Keywords: Paralympic Games, Para swimmers, female, freestyle.

INTRODUCTION

Para-swimming rules are adopted from International Swimming Federation (FINA) rules and is in program of the Paralympic Games (POG). Para-swimmers are compete individually (backstroke, breaststroke, butterfly, freestyle, medley) and within the team (relays) on POG, world and continental championships, as well as other competitions (Burkett & Mellifont, 2008). Para-swimmers are classified according type and level of impairment. System of sport classification enables to para-swimmers fair competition – to compete with competitors with similar function/disfunction (Tweedy & Vanlandewijck, 2011). International Paralympic Committee (IPC) has special approach toward participation of women with disability in sports training and sports competition. Para-swimming classification and disciplines are identical for both genders (Tweedy & Vanlandewijck, 2011) as well as selection and training sessions. That is the reason why there should be no gender differences in result prediction of medal winners in next Tokyo POG 2020. The aim of the study is to predict the results of medal winners in the following Paralympic Games (POG) in the freestyle disciplines in female competition.

METHODS

First of all, a database of the medal winners results in freestyle disciplines at the last five POG was made and all classes are included.. The results of the female para-swimmers in classes S5 to S10 were

taken into account in the data processing. Based on the established trend of results development, female para-swimmers medal winners in freestyle disciplines in the last five POG - a model for predicting the results of the para-swimmers of possible medal winners at the next 2020 POG has been developed.

RESULTS

Given the fact that after 2000 POG a ban on the participation of athletes followed (participation ban at 2004 POG, 2008 POG), prediction model creation of freestyle medal winners on 2020 POG was not possible for class S14. In addition, the IPC abolished some disciplines. For these reasons, data processing was performed only for those disciplines that were in the program at the last five POG. Likewise, due to rationalization, the IPC merged disciplines in classes S1, S2, S3, S4 and S5.That decision handicapped the „lower classes“ competitors and trend analysis for classes S1, S2, S3 and S4 was not able to be done.

In the S5 class, the trend of improving results (disciplines 50m, 100m, 200m) was broken in each of the disciplines. In the 50m freestyle class S5, this trend was broken at 2004 POG when the gold medal winner had a poorer result than the previous 2000 POG. The same is true for the bronze medalist at 2012 POG. In the 100m discipline for the S5 class this the trend has been broken seven times. In the 200m discipline for the S5 class this trend has been broken six times.

In class S6, the trend of improving results (disciplines 50m, 200m) was broken in two of the three disciplines. In discipline 50m for class S6, this trend was broken at POG 2004, when all medal winners had poorer results than the previous 2000 POG. The same is true for silver medalist at 2008 POG. In discipline 100m for class S6 the results the medal winners of the last five POG have been steadily improving. This trend has not been disturbed during the last five POG. In the 200m discipline for the S6 class, this trend was eroded at 2016 POG when the bronze medalist had a lower swim performance than previous 2012 POG.

In class S7, the trend of improving results (disciplines 50m, 100m) was broken in two of the three disciplines. In the 50m class S7 discipline this trend was broken at 2016 POG when the silver medal winner had a poorer result than the previous 2012 POG. In the 100m discipline for the S6 class this trend was broken at 2016 POG when all the winners medals had a poorer result than in previous 2012 POG. In the 400m discipline for the S7 class, the results for the women's para-swimmers who were medal winners of the last five POG improved steadily. This trend has not been interrupted on the last five POG.

In class S8, the trend of improving results (disciplines 50m, 400m) was broken in two of the three disciplines. In the 50m class S8 discipline, this trend was broken at POG 2004, when the bronze medal winner had a poorer result than the previous 2000POG. The same is true for the POG 2008 silver medalist. the female para-swimmers who have been medal winners in the last five POG have been steadily improving. This trend has not been eroded by any of the last five POG. In the 400m discipline for the S8 class, this trend was eroded at 2012 POG when silver bronze medal winners had a lower swim performance than previous POG 2008.

In class S9, the trend of improving results (disciplines 50m, 400m) was broken in two of the three disciplines. In the 50m discipline for the S9 class, this trend was broken at POG 2016 when the silver medal winner had a poorer result than the previous POG 2012. The same is true for the 100m silver medal winner at the POG 2012. This occurred in the 400m discipline, as all medal winners at the last POG and gold and silver medal winners at the POG 2012 had a poorer result than the previous POG.

In S10 class, the trend of improving results (disciplines 50m, 100m, 400m) was broken in two of the three disciplines. This class is characterized by the 50m event, as all medal winners at the 2004 POG and 2008 POG had a poorer result than the previous POG. In the 100m discipline for the S10 class, this trend was broken at the POG 2004, when the winner of the 2004 POG. In Athens, they had a lower result than the previous 2000 POG. In the 400m discipline for the S10 class this trend was broken at the 2004 POG when all medal winners had poorer results than previous 2000 POG.

In the 50m event for the S11 class, the results of the women's para-swimmers - medal winners in the last five POG have improved steadily. This trend has not been disturbed during the last five POG. In the 100m discipline for the S9 class, this trend was broken at 2016 POG when the gold medal winner had a poorer result than the previous 2012 POG. The same is true for the 100m silver medal winner at 2012POG. The 400m freestyle discipline was not held at the last POG 2016.

In the 50m discipline for the S12 class, the results on the women's para-swimmer medal winners from POG 2000 to POG 2012 have been steadily improving. This trend was eroded at the last POG when all medal winners had a worse result than some of their previous games. The 100m and 400m disciplines for the S9 class were not held at the last POG 2016.

In the 100m discipline for the S13 class, the results of medal-winning female para-swimmers

from 2000 POG to 2008 POG have improved steadily. This trend was eroded at 2012 POG when gold and bronze medal winners performed worse than previous POG.

Table 1. Results of the last five POG in the freestyle and results prediction for the 2020 POG (classes S2-S10).

Discipline	POG 2000			POG 2004			POG 2008			POG 2012			POG 2016			POG 2020		
	G	S	B	G	S	B	G	S	B	G	S	B	G	S	B	G	S	B
S2 50m	75.46	77.14	82.13	78.60	88.70	92.90	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	**H/A**	**H/A**	**H/A**
S2 100m	163.67	180.49	184.46	169.38	192.70	197.93	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	**H/A**	**H/A**	**H/A**
S3 50m	59.92	60.03	61.81	58.16	66.57	66.60	57.05	57.43	64.22	48.11	48.39	55.72	H/O	H/O	H/O	**H/A**	**H/A**	**H/A**
S3 100m	123.94	125.37	127.26	128.09	136.24	139.06	H/O	H/O	H/O	104.32	112.91	119.76	90.07	94.71	94.86	**H/A**	**H/A**	**H/A**
S4 50m	39.23	49.59	51.08	39.22	52.50	53.18	46.27	52.81	53.28	H/O	H/O	H/O	40.13	40.51	40.53	**H/A**	**H/A**	**H/A**
S4 100m	90.06	105.11	107.99	85.07	101.00	101.59	104.11	110.25	115.33	H/O	H/O	H/O	H/O	H/O	H/O	**H/A**	**H/A**	**H/A**
S4 200m	192.79	209.65	223.25	182.00	230.92	231.42	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	**H/A**	**H/A**	**H/A**
S5 50m	36.65	37.65	38.36	37.26	37.53	37.62	35.88	37.12	37.53	35.88	36.50	37.89	36.87	37.13	37.37	**36,23**	**36,57**	**37,24**
S5 100m	78.99	82.05	83.42	79.96	80.46	81.33	76.65	81.57	82.20	78.55	80.57	82.56	78.85	80.47	83.21	**77,85**	**80,19**	**82,27**
S5 200m	164.61	175.99	176.46	169.99	173.86	178.84	167.47	169.51	172.51	169.74	171.79	176.11	168.33	170.91	171.37	**170,19**	**168,74**	**171,19**
S6 50m	36.02	36.23	37.44	36.14	36.43	37.65	35.60	36.52	37.21	34.77	35.32	36.11	33.43	33.68	34.41	**33,23**	**33,77**	**34,28**
S6 100m	79.72	80.10	82.23	77.43	79.52	82.87	78.75	79.29	79.36	73.33	74.82	76.83	71.40	73.47	74.43	**69,90**	**72,05**	**72,65**
S6 400m	379.13	384.50	385.70	349.18	362.59	365.24	341.34	343.76	349.70	319.17	320.18	333.73	317.01	321.37	324.87	**294,89**	**295,88**	**305,90**
S7 50m	34.98	35.55	36.00	34.34	34.92	35.17	33.84	33.92	34.50	32.63	33.18	33.30	32.42	33.16	33.26	**31,59**	**32,19**	**32,24**
S7 100m	74.64	76.02	78.05	74.61	75.09	75.89	71.82	72.09	72.93	69.39	71.63	72.61	69.99	72.80	72.85	**67,73**	**70,56**	**70,36**
S7 400m	332.33	335.08	345.09	320.26	332.10	339.13	317.41	321.01	328.22	299.02	318.55	318.93	305.77	318.20	323.17	**292,65**	**310,80**	**311,70**
S8 50m	31.85	32.92	33.32	31.51	32.11	32.95	32.09	32.20	32.37	31.13	31.44	31.55	29.73	30.13	30.53	**29,88**	**29,89**	**30,05**
S8 100m	70.25	71.12	72.46	69.67	69.86	72.29	66.91	68.48	68.56	65.63	68.07	68.37	64.73	65.08	65.16	**62,914**	**64,36**	**63,81**
S8 400m	311.73	318.92	339.13	307.88	322.99	326.29	290.17	294.49	297.21	282.28	300.50	309.36	280.33	287.82	289.49	**267,96**	**279,54**	**277,43**
S9 50m	30.94	31.29	31.88	29.52	30.63	30.66	29.20	29.33	29.80	29,12	29.21	29.28	28.29	29.13	29.30	**27,70**	**28,20**	**28,22**
S9 100m	67.12	67.27	68.41	62.83	65.31	66.40	61.44	63.85	63.89	62.77	63.45	63.62	60.91	62.81	62.93	**59,27**	**61,30**	**60,93**
S9 400m	293.83	299.56	303.92	268.09	286.57	299.51	263.81	279.73	284.60	270.18	280.01	282.87	282.56	282.58	283.66	**269,56**	**273,53**	**273,76**
S10 50m	28.44	28.83	28.95	28.75	29.68	30.41	28.51	28.92	29.13	28,10	28.24	28.67	27.37	27.72	28.21	**27,40**	**27,58**	**28,11**
S10 100m	61.67	62.78	64.31	63.65	64.46	65.14	61.57	61.59	61.91	60.89	61.09	61.58	59.31	59.85	61.13	**59,17**	**59,19**	**59,84**
S10 400m	283.93	288.96	291.05	291.08	293.55	297.77	273.15	278.11	279.44	274.55	276.46	277.23	269.96	275.09	275.49	**265,19**	**268,99**	**268,70**

POG – Paralympic Games, **N/O** - discipline was not held, **N/A** - analysis was not done for not maintaining discipline at last POG, **G** - gold medal, **S** - silver medal, **B** - bronze medal

Table 2. Results of the last five POG in the freestyle and results prediction for the 2020 POG (classes S11-S14).

Discipline	POG 2000			POG 2004			POG 2008			POG 2012			POG 2016			POG 2020		
	G	S	B	G	S	B	G	S	B	G	S	B	G	S	B	G	S	B
S11 50 m	33.51	33.75	33.98	32.35	33.22	33.58	31.39	31.95	32.45	30.94	31,01	31.67	30.73	30.76	31.23	**29,69**	**29,68**	**30,36**
S11 100 m	74.31	74.47	75.61	72.10	73.25	73.48	68.96	69.65	71.08	67.29	69.83	70.25	68.03	68.31	68.55	**64,93**	**66,38**	**66,59**
S11 400 m	337.17	343.28	349.08	H/O	H/O	H/O	H/O	H/O	H/O	314.36	315.48	320.27	315.08	316.36	325.14	**H/A**	**H/A**	**H/A**
S12 50 m	28.67	29.42	30,04	28,02	28,74	29,14	27,07	27,82	28,23	26.90	27.54	27.75	27.53	28.38	29,03	**26,62**	**27,40**	**27,82**
S12 100 m	61.57	64.84	65.98	61.99	63.52	64.33	59.47	61.24	61.57	58.41	60.00	60.23	H/O	H/O	H/O	**H/A**	**H/A**	**H/A**
S12 400 m	293.95	298.00	301.68	291.20	292.16	302.42	H/O	H/O	H/O	277.89	278.60	279.75	H/O	H/O	H/O	**H/A**	**H/A**	**H/A**
S13 50m	28.62	28.80	29.60	28.47	28.89	29.00	27.85	27.88	28,04	27.46	27.91	27.94	27.34	28.00	28,02	**26,88**	**27,52**	**27,25**
S13 100 m	62.38	62.98	65.20	61.74	63.30	63.69	58.87	60.26	60.46	59.56	60.07	61.90	59.19	59.77	60.07	**57,78**	**58,38**	**58,65**
S13 400 m	H/O	H/O	H/O	283.23	289.51	289.66	268.64	277.37	277.50	H/O	H/O	H/O	259.59	264.18	283.49	**H/A**	**H/A**	**H/A**
S14 50m	29.13	29.37	29.55	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	**H/A**	**H/A**	**H/A**
S14 100m	63.35	64.92	65.10	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	H/O	**H/A**	**H/A**	**H/A**
S14 200m	134.90	135.97	140.64	H/O	H/O	H/O	H/O	H/O	H/O	132.63	133.18	134.80	123.30	126.92	130.20	**H/A**	**H/A**	**H/A**

POG – Paralympic Games, **N/O** - discipline was not held, **N/A** - analysis was not done for not maintaining discipline at last POG, **G** - gold medal, **S** - silver medal, **B** - bronze medal

DISCUSSION

Regarding physical impairment, it was stated earlier that trend analysis was not done for classes S1, S2, S3 and S4 because they were merged with class S5 by administrative decisions. In this way, female para-swimmers in the first four classes of physical impairment were disadvantaged (Burkett & al., 2018). In the S5 class, there are as many as 33.3%

of cases (15 out of 45) where female para-swimmers who won a medal had a slower time than some of the previous POG who won the same medal.

Female para-swimmers in 'middle classes', S6 and S7, have similar times in the disciplines 50m and 100m, which is probably due to similar indicators of the race elements, and above all the start (Clephas et al., 2019), which is in most cases performed by. Class S6 contains as many as 11% of cases (5 out of 45) where female para-swimmers who won a medal had a slower time than some of the previous POG who won the same medal. In the S7 class, there are as many as 9% of cases (4 out of 45) where female para-swimmers who won a medal had a slower time than some of the previous POG who won the same medal.

"High classes" male and female para-swimmers with physical impairment (S8, S9, S10), train with junior and senior swimmers without disability (Fulton et al., 2010). In the S8 class, there are as many as 9% of cases (4 out of 30) where female para-swimmers who won a medal had a slower time than some of the previous POG who won the same medal. In the S9 class, there are as many as 16% of cases (7 out of 45) where female para-swimmers who won a medal had a slower time than some of the previous POG who won the same medal. In the S10 class, there are as many as 22% of cases (10 out of 45) where female para-swimmers who won a medal had a slower time than some of the previous POG who won the same medal. One suggestion for improving swim performance and results in female para-swimmers in categories S6, S7 and S8 is to work on muscle mass and upper body strength (Dingley et al., 2015). The times elapsed for female para-swimmers with physical impairment differ from class, which is a consequence of clean swimming speed, stroke frequency and stroke index (Tejero et al., 2018).

When it comes to classes involving female para-swimmers with visual impairment (classes S11, S12 and S13), there is a trend of improvement in results, with sporadic cases of stagnation compared to some of the previous POG. It has also been observed that the results of female para-swimmers medal winners of "high classes" have better times than medal winners in "lower classes" at the same POG (Souto et al., 2017), although different levels of visual impairment do not affect the track elements. In the S11 class, there are as many as 3% of cases (1 in 30) where female para-swimmers who won a medal had a slower time than some of the previous POG who won the same medal. In the S12 class, there are as many as 20% of cases (3 out of 15) where female para-swimmers who won a medal had a slower time than some of the previous POG who won the same medal. In the S13 class, there are as many as 30.3% of cases (6 out of 30) where female para-swimmers who won a medal had a slower time than some of the previous POG who won the same medal.

Earlier it was stated that the creation of the prediction model in freestyle medal winners at 2020 POG could not be done for class S14. However, it can be noted that there were improvements in the results (discipline 200m freestyle) at the last two POG. The assumption is that the specialization of female para-swimmers with intellectual impairment within that discipline has been made, so much progress is evident. A favorable circumstance for this class is that there is no significant correlation between the level of intellectual impairment and swimming performance, which leaves coaches more opportunities to influence the quality of their female para-swimmers (Gilderthorp et al., 2018), primarily in explosive power and cardiovascular fitness (Daly et al., 2006).

This study shows presence of differences between classes which is consequence of start, swimming performance and impairment (Dingley et al., 2014). Progress in all classes and disciplines is consequence of interdisciplinar approach. Participation of experts from many fields and proffesions (swimming coaches, dry-land and water conditional coaches) contributs results imrovement. Still, coach of female para-swimmers is the person that has to sublimates and consider specifity of impairment, classes and discipline, individual characteristics, specific mechanisms of physical adaptations, which is not present in literature (Puce et al., 2018).

CONCLUSION

The overall rating is that the scores of the female para-swimmers medal winners in all classes in freestyle disciplines during last five POG has been improved. On the other hand, occasionally there were cases where results emerged medal winners female para-swimmers on last five POG were weaker than previous POG, what happened in male competition (Veličković & al., 2015).

The significance of this research is that it addresses women's issues in Paralympic sport. Also, the results and conclusion of this research provide a (mathematical) answer to coaches in para-swimming – which result is necessary for their female para-swimmer to obtain in order to get medal at next POG.

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SEXUAL MATURITY IN FEMALE RHYTHMIC GYMNASTS OF DIFFERENT COMPETITION PROGRAMS AND AGE GROUP CATEGORIES

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ABSTRACT

Rhythmic gymnastics is a sport discipline with specific physiological, biomechanical and aesthetic requirements which change with the level of skills, training load, and they usually increase with the competition level. Serbian Gymnastics Federation formed three competition programs ("A", "B" and "C", i.e. high-, medium- and low-level program), which differentiate in the competition rules, and it can be assumed that these different requirements of the different types of competition programs have resulted in some differences between these groups, and in particular in the dynamics of growth and maturation. The main objective of this study was to examine and compare sexual maturity of 126 rhythmic gymnasts (RGs) distributed in five age group categories (15 seniors, aged 16 years and older; 25 juniors, aged 14-16 years; 26 advanced-level RGs, aged 12-14 years; 38 intermediate-level RGs, aged 9-12 years; 22 beginners, aged 6-9 years) and two competition programs ("A"=42; "B"=84). Their baseline characteristics (age, body height and mass, body mass index, onset of menarche, years of training experience) were established, as well as their sexual maturity (telarche, adrenarche and length of period since menarche). The data were analyzed (Descriptive statistics, Kolmogorov-Smirnov test, Mann-Whitney *U* test) using the SPSS 21.0. Research results showed the absence of statistically significant differences in sexual maturity of "A" and "B" competitors and in each of five age group categories. Taken as a whole, sexual maturity does not discriminate significantly "A" and "B" RGs, irrespective of age group category.

Keywords: rhythmic gymnastics, breast development, axillary hair development, menarche

INTRODUCTION

Growth and maturation are characterized by individual variation and, in addition to being under the influence of genetics and neuroendocrine control, environmental factors (type, intensity, frequency and duration of sports training) also have an impact on these two processes. Therefore, physical activity, particularly intensive sport training, is one of such environmental factor, and sport-specific requirements are imposed over all claims associated with normal growth, maturation and development. Rhythmic gymnastics (RG), as an artistic and aesthetic, specific and highly specialized competitive discipline, is a sport that, apart from intensive physical stress, is characterized by high energy expenditure (two major factors which modulate the function of pituitary gland, that is, causing dysfunction of the gonadal axis), prepubertal stage is prolonged and pubertal development is entirely shifted to a later age (Georgopoulos, Markou, Theodoropoulou, Vagenakis, Mylonas, & Vagenakis, 2004).

In the past 20 years, the authors were concerned with comparing the degree of sexual maturity mostly in athletes and non-athletes, where a significant delay of puberty in rhythmic gymnasts compared to non-athletes was found (Klentrou & Plyley, 2003; Canelas, 2009; Gruodytė-Račienė, Jürimäe, Saar, Cicchella, Stefanelli, Passariello, & Jürimäe, 2012). The age of menarche of rhythmic gymnasts compared to their mothers and sisters was also examined and it was found that the delayed menarche is positively correlated with the intensity of training (Georgopoulos, Markou, Theodoropoulou, Paraskevopoulou, Varaki, Kazantzi, Leglise, & Vagenakis, 1999). Some authors were interested in comparing younger and older senior RGs (Ávila-Carvalho, Klentrou, da Luz Palomero, & Lebre, 2013), and the results of research indicated the acceleration, given that younger seniors got menarche in earlier age. In all of these studies, the

impact of training intensity in the RG is not sufficiently studied, and that is exactly what, among other things, differentiates competition programs in this sport. Serbian Gymnastics Federation has formed three competition programs ("A", "B" and "C", i.e. high-, medium- and low-level program) which all differentiate in some competition rules, i.e. in items like: final score, the maximal number of body difficulties, scoring of body difficulties, age category classification, number of routines and type of apparatus, training hours per week, etc., and it is absolutely legitimate to assume that these different requirements in different competition programs could produce differences among them, and especially in growth and maturation dynamic. As tribute to this assumption, there were some researches interested in comparing gymnasts of different performance level (di Cagno, Baldari, Battaglia, Brasili, Merni, Piazza, Toselli, Ventrella, & Guidetti, 2008; Broda & Poliszczuk, 2009; da Silva & Rocha, 2011; Purenović-Ivanović, Popović, Moskovljević, & Penčić, 2017; Purenović-Ivanović, Bogdanović, Popović, Uzunović, & Živković, 2018; Ranđelović, 2019), where dissimilarities in anthropometric and many other values between elite and low(er) profile gymnasts of the same age were recorded. The purpose of the current study was to examine and compare sexual maturity of rhythmic gymnasts (RGs) of different competition programs, within each of five age group categories.

METHODS

Subjects

One hundred and twenty-six RGs, between the ages of 7 and 20 years, voluntarily participated in the study [Mean±SD, age: 11.95±3.09 years, body height: 147.76±14.61 cm, body mass: 37.75±11.72 kg, BMI: 16.79±2.26 kg/m^2, age of menarche (n=32): 13.57±1.18 years, sports experience: 5.88±2.79 years]. All of the participants are individual competitors at national and/or international level in an "A" and "B" program (i.e. high- and medium-level competition program), distributed in five age group categories according to the official age classification of the Serbian Gymnastics Federation (see Table 1).

Table 1. Distribution of study participants according to age group category, competition program and country of competition

Age Group Categories	6th "Montenegro Cup 2013" (Budva, Montenegro)	2014 National Championships (Belgrade, Serbia)	TOTAL
Seniors	-	7A + 8B	7A + 8B = **15**
Juniors	1A + 5B	12A + 7B	13A + 12B = **25**
Advanced	2A + 7B	5A + 12B	7A + 19B = **26**
Intermediate	5A + 13B	4A + 16B	9A + 29B = **38**
Beginners	6A + 3B	13B	6A + 16= **22**
TOTAL	**14A + 28B = 42**	**28A + 56B = 84**	**42A + 84B = 126**

Legend: A- "A" program (national- and international-level RGs competing according to FIG rules), **B-** "B" program (national- and international-level RGs, but with less demands for difficulties compared to an "A" program RGs).

Procedure

The first part of the testing was conducted at the end of June 2013 in Budva (Montenegro), when 14 elite (i.e. "A" program competitors) and 28 international-level gymnasts (i.e. "B" program competitors) were tested. During the 2014 National Championships held in Belgrade (Serbia) on October 25th and 26th, the second testing was performed and it included 28 top-level (i.e. "A" program competitors) and 56 national-level Serbian gymnasts (i.e. "B" program competitors). Both competitions were organized under the FIG rules of the previous Olympic cycle (2013-2016). All testing was performed in accordance with the ethical standards of the Helsinki Declaration (WMA, 2001).

All the measurements were taken by the authors in optimal climatic conditions, with the participants in their underwear, and according to the methods proposed by the International Biological Programme (Weiner & Lourie, 1969). The Martin anthropometer was used for obtaining the RGs' body height (in cm), while body mass (in kg) and body mass index (BMI, in kg/m^2) were assessed with a tetrapolar bioelectrical impedance device, Omron BF511 (Kyoto, Japan). Data on their age, years of training experience, age of menarche and axillary hair

development, i.e. adrenarche (from AH1 to AH3, where AH1 is prepuberty, AH2 is puberty, and AH3 is postpuberty), were collected by interviewing the participants. RGs' telarche stage was estimated by Tanner method (Tanner, 1962), which implied the participants' self-assessment: standardized figure drawings depicting Tanner's sexual maturation stages of breast development were shown to the participants, and they were asked to rate it (from B1 to B5, where B1 is prepuberty, B2 to B4 is puberty, and B5 is postpuberty).

Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences, version 21.0 (IBM SPSS 21.0, SPSS Inc, Chicago, USA). Descriptive statistics [average value (Mean), Standard Deviation (SD), Range] were summarized for all variables. Normality was tested using the one-sample Kolmogorov-Smirnov test (K-S). A Mann-Whitney *U* test was performed with the aim of determining the differences in sexual maturity between RGs of high and medium competition/training level within each of five age group categories. The level of significance was set at $p<0.05$.

RESULTS AND DISCUSSION

The baseline characteristics of the "A" and "B" study participants, divided into five age group categories, are presented in Tables 2 and 3, respectively.

Table 2. Baseline characteristics of **"A"** study participants

Age Group Categories	Variables	Age (yrs)	Body Height (cm)	Body Mass (kg)	BMI (kg/m²)	Menarcheal Age (yrs)	Training Experience (yrs)
"A" Seniors (n=7)	*Mean±SD*	17.56±1.66	165.9±8.17	57.1±6.0	20.73±1.49	14.13±1.11	10.71±1.98
	Range	16.22 – 20.34	154.4 – 178.2	51.4 – 67.0	19.0 – 23.3	13.0 – 15.92	9.0 – 14.0
	K-S (Sig.)	.470	.917	.884	.739	0.832	.831
"A" Juniors (n=13)	*Mean±SD*	14.52±0.73	162.24±8.24	48.81±7.22	18.43±1.61	13.51±1.27	8.39±1.5
	Range	13.3 – 15.82	146.1 – 176.7	31.0 – 62.7	14.5 – 20.4	11.58 – 15.17	5.0 – 10.0
	K-S (Sig.)	.907	.768	.787	.820	0.793	.416
"A" Advanced (n=7)	*Mean±SD*	12.04±0.5	150.44±6.14	35.46±4.0	15.59±0.66	-	6.14±1.46
	Range	11.38 – 12.63	142.2 – 157.5	30.2 – 40.5	14.5 – 16.3	-	4.0 – 8.0
	K-S (Sig.)	.839	.867	.993	.944	-	.588
"A" Intermediate (n=9)	*Mean±SD*	10.03±0.83	137.47±6.43	28.4±3.04	15.0±0.69	-	5.56±1.51
	Range	8.71 – 11.09	125.1 – 145.7	22.7 – 32.6	13.7 – 15.8	-	3.0 – 8.0
	K-S (Sig.)	.986	.921	.941	.766	-	.954
"A" Beginners (n=6)	*Mean±SD*	7.49±0.46	127.38±5.66	23.78±2.61	14.62±0.42	-	2.58±0.92
	Range	7.04 – 8.11	123.3 – 138.5	21.2 – 28.7	13.9 – 15.0	-	1.5 – 4.0
	K-S (Sig.)	.952	.393	.528	.989	-	.887
Total "A" sample (N=42)	*Mean±SD*	12.65±3.38	150.59±15.71	40.02±13.1	17.06±2.52	13.85±1.18	6.96±2.91
	Range	7.04 – 20.34	123.3 – 178.2	21.2 – 67.0	13.7 – 23.3	11.58– 15.92	1.5 – 14.0
	K-S (Sig.)	.932	.586	.357	.142	0.998	.635

Legend: "A"- "A" program, **n, N**- number of study participants, **Mean**- average value, **SD**- standard deviation, **K-S-** Kolmogorov-Smirnov test**, Sig.-** significance, **yrs**- years, **BMI-** Body Mass Index.

Menstrual cycle is a very sensitive system and, as such, it is subject to changes due to the reduction of body weight, inadequate nutrition, intense exercise, diseases and psychosocial factors (Ray, 2005). Aesthetic sports such as the most typical representative of this group- rhythmic gymnastics, requires special morphotype of RGs (long and thin limbs, a minimum percentage of fat, the absence of the subcutaneous adipose tissue), which these athletes exposes to an increased health risk of eating disorders (Ray, 2005). Eating disorders are automatically associated with the menstrual cycle irregularities (Purenović-Ivanović, 2014), as well as with the bone density reduction, i.e. osteoporosis (Warren & Shantha, 2000; Moreira, Prass, Vargas, & Silva, 2007; di Cagno, Marchetti, Battaglia, Giombini,

Calcagno, Fiorilli, Piazza, Pigozzi, & Borrione, 2012). Early specialization of these athletes, during the prepubertal stage, further increases the risk of developing these disorders. Bearing in mind these important facts, we consider necessary discussing their BMI and the relation with the onset of menarche. When speaking of "A" senior RGs, and based on the BMI cut-off points for girls of different ages (CDC, 2000), it can be stated that their BMI value is within the normal range (Table 2). As for the time of the onset of menarche, on average, in all of the "A" senior RGs there was a "delay" of puberty, given that the average age of first menstruation was 14.13 years, like in a numerous of previously reported studies (Georgopoulos et al., 1999; Klentrou & Plyley, 2003; Theodoropoulou, Markou, Vagenakis, Benardot, Leglise, Kourounis, Vagenakis, & Georgopoulos, 2005; Ávila-Carvalho et al., 2013). The situation is similar in case of "B" senior RGs (Table 3), but on average the menarche delay is a little less compared to "A" senior RGs (13.88 vs. 14.13 years).

In the case of "A" junior RGs, only one of them was found underweight, i.e. her BMI has low value for a girl of that age; the remaining "A" juniors (92.31%) are of normal nutritional status. In 46.15% of "A" junior RGs the menarche was recorded, and they started menstruating with 13.5 years of age, on average (Table 2). As for the "B" junior RGs, the situation is similar: all are of normal weight, exactly half of them (50%) are menstruating, with an average years of onset of menarche like in case of their "A" peers- 13.63 years (Table 3). In the case of BMI of "A" advanced-level RGs, it is within the normal range for girls of that age, but when it comes to the menarche, it did not happen yet (Table 2). In contrast to "A" advanced-level RGs, the situation with "B" RGs is slightly different: in 15.79% of them a low nutritional status was recorded so as low BMI, and menarche in 26.32% of "B" advanced-level RGs (average menarcheal age is 12.33, Table 3). When the recorded value of body mass index of "A" and "B" intermediate-level RGs are compared, one can notice that the differences are minimal: only one gymnast in "A" program is undernourished (11.11%), while that percent is bit higher in "B" program (17.4%). The situation with menarche is identical: there are no recorded cases of menarche neither in sample of "A" nor "B" intermediate-level RGs (Tables 2 and 3, respectively). In the subsample of beginner RGs, the differences are almost missing: they are all of normal weight, except one obese gymnast from "B" program, and as for menarche, at this age group category it's onset is not recorded.

Table 3. Baseline characteristics of **"B"** study participants

Age Group Categories	Variables	Age (yrs)	Body Height (cm)	Body Mass (kg)	BMI (kg/m²)	Menarcheal Age (yrs)	Training Experience (yrs)
"B" Seniors (n=8)	*Mean±SD*	17.49±1.17	163.39±5.73	54.11±3.54	20.26±0.82	13.88±0.99	7.94±2.18
	Range	16.16 – 19.76	150.0 – 169.0	47.4 – 58.7	19.1 – 21.4	13.0 – 16.0	5.0 – 11.0
	K-S (Sig.)	0.698	0.334	0.994	0.999	0.367	0.896
"B" Juniors (n=12)	*Mean±SD*	14.54±0.79	163.7±5.75	48.39±5.08	18.01±1.17	13.59±1.22	7.58±1.56
	Range	13.31 – 15.59	153.2 – 173.9	40.0 – 57.8	16.4 – 19.8	12.0 – 15.5	4.0 – 9.0
	K-S (Sig.)	0.955	0.996	0.969	0.702	0.985	0.526
"B" Advanced (n=19)	*Mean±SD*	12.33±0.99	151.63±9.63	40.3±8.79	17.28±2.07	12.33±0.77	5.58±2.12
	Range	10.57 – 13.8	136.0 – 164.4	25.5 – 53.2	13.8 – 21.4	11.5 – 13.5	0.5 – 9.0
	K-S (Sig.)	0.979	0.691	0.950	0.951	0.868	0.369
"B" Intermediate (n=29)	*Mean±SD*	10.14±0.81	140.69±5.71	30.44±4.57	15.32±1.41	-	4.7±1.95
	Range	8.91 – 12.02	128.8 – 151.4	22.6 – 40.2	12.7 – 18.9	-	1.0 – 8.0
	K-S (Sig.)	0.779	0.862	0.930	0.914	-	0.534
"B" Beginners (n=16)	*Mean±SD*	8.24±0.74	128.76±5.89	25.84±2.81	15.56±1.08	-	2.5±1.64
	Range	6.67 – 9.08	120.1 – 139.3	20.8 – 30.8	13.6 – 18.7	-	0.5 – 6.0
	K-S (Sig.)	0.514	0.934	0.998	0.437	-	0.289
Total "B" sample (N=84)	*Mean±SD*	11.6±2.89	146.34±13.9	36.61±10.87	16.66±2.13	13.38±1.16	5.29±2.56
	Range	6.67 – 19.76	120.1 – 173.9	20.8 – 58.7	12.7 – 21.4	11.5 – 16.0	0.5 – 11.0
	K-S (Sig.)	0.145	0.309	**.049***	0.159	0.756	0.069

Legend: "B"- "B" program, **n, N**- number of study participants, **Mean**- average value, **SD**- standard deviation, **K-S-** Kolmogorov-Smirnov test**, Sig.-** significance, **yrs**- years, **BMI**- Body Mass Index.

*absence of normal distribution (significant at p=0.05)

As for the normality of data distribution (K-S test), in the subsample of "A" RGs there was no statistically significant variation in any of the five examined variables (Table 2). When it comes to the

distribution of data in the group of "B" RGs (Table 3), a statistically significant deviation is recorded only for variable Body Mass (K-S, Sig.=0.049) and in case of total "B" sample. Considering that in the subsamples of "A" and "B" intermediate-level and beginner RGs (Tables 2 and 3, respectively), as well as in case of "A" advanced-level RGs (Table 2), the data on menarcheal age are missing (they are all in prepubertal stage), so as the variability, therefore it was not possible to examine the normality of that data distribution.

Early menarche is associated with psychosocial and health problems (Gluckman & Hanson, 2006; Herman-Giddens, 2007): women who got their first period in early age, have an increased risk of breast cancer (Kelsey & Gammon, 1990), depression (Joinson, Heron, Lewis, Croudace, & Araya, 2011) and cardiovascular diseases (Lakshman, Forouhi, Sharp, Luben, Bingham, Khaw, Wareham, & Ong, 2009). If we consider the onset of menarche in our sample of examinees, a slight "delay" in "A" RGs is evident in comparison to their peers from "B" program, which contributes to the fact that intensive training in prepuberty, as case in "A" competition program compared to "B", has its important place (Sundgot-Borgen, 1996).

In Tables 4 and 5 the average values of the recorded sexual maturity parameters in "A" and "B" RGs, respectively, of each age group category, so as for the total "A" and "B" samples, are presented. When it comes to sexual maturity of "A" senior RGs, they are all in puberty (B3- 28.6%, B4- 71.4%, AH2- 100%, MEN- 100%). The situation is similar when it comes to their peers from "B" program. When considering the normality of the data distribution, the deviation was recorded only for the variable AH in the subsample of "B" senior RGs (p=0.03, Table 5), whereas the testing of the same parameter in the subsample of "A" peers omitted due to the lack of variability (they are all in the same stage, i.e. AH2, Table 4).

Table 4. Sexual maturity in **"A"** RGs of different age group categories

Age Group Categories	Variables	B	AH	MENS (yrs)
"A" Seniors (n=7)	*Mean±SD*	3.71±0.49	2.0±0.0	3.43±2.46
	Range	3.0 – 4.0	2.0 – 2.0	0.46 – 7.17
	K-S (Sig.)	0.141	-	0.928
"A" Juniors (n=13)	*Mean±SD*	3.08±0.76	1.92±0.49	0.64±0.94
	Range	1.0 – 4.0	1.0 – 3.0	0.0 – 2.45
	K-S (Sig.)	**0.044***	**0.026***	0.225
"A" Advanced (n=7)	*Mean±SD*	1.86±0.89	1.57±0.53	-
	Range	1.0 – 3.0	1.0 – 2.0	-
	K-S (Sig.)	0.739	0.324	-
"A" Intermediate (n=9)	*Mean±SD*	1.11±0.33	1.0±0.0	-
	Range	1.0 – 2.0	1.0 – 1.0	-
	K-S (Sig.)	**0.016***	-	-
"A" Beginners (n=6)	*Mean±SD*	1.0±0.0	1.0±0.0	-
	Range	1.0 – 1.0	1.0 – 1.0	-
	K-S (Sig.)	-	-	-
Total "A" sample (N=42)	*Mean±SD*	2.26±1.21	1.55±0.55	0.77±1.64
	Range	1.0 – 4.0	1.0 – 3.0	0.0 – 7.17
	K-S (Sig.)	**0.003***	**0.000***	**0.000***

Legend: "A"- "A" program, **n, N**- number of study participants, **Mean**- average value, **SD**- standard deviation, **K-S-** Kolmogorov-Smirnov test**, Sig.-** significance, **B**- breast development (telarche), **AH**-axillary hair development (adrenarche), **MENS**- length of period since menarche, **yrs** - years.

*absence of normal distribution (significant at p=0.05)

In case of "A" junior RGs, only one of them is in prepubertal stage (B1, AH1, menarche not recorded), while the rest of them are in puberty. Statistically significant absence of normal data distribution (K-S test) is recorded in case of parameters B ("A": Sig.=0.044; "B": Sig.=0.045) and AH ("A": Sig.=0.026; "B": Sig.=0.002) (Tables 4 and 5, respectively). Even 42.86% of "A" advanced-level RGs is in prepubertal stage (B1, AH1, the absence of menarche), while in the remaining 57.14% of them puberty has already started; menarche is not recorded in this age group category of "A" sample, thus a possibility to test the normality of the variables' data distribution is missing (Table 4). In the subsample of "B" advanced-level RGs, a smaller percentage of those in prepuberty is recorded (only 26.32%), while in the remaining 73.68% a puberty has started, but without menarche. For the variables AH and MENS in the

subsample of "B" advanced-level RGs, a statistically significant deviation from the normal distribution is recorded (p=0.036, p=0.004, respectively; Table 5). In case of "A" and "B" intermediate-level RGs, the situation is identical in terms of menarche (it is missing), as well as of adrenarche (AH1: 100%), but when it comes to telarche the situation is as follows: in 11.11% of them from "A" and in 24.14% from "B" program, the beginning of puberty is recorded (B2 at 10.55, i.e. 10.8 years of age, respectively). The identical situation, in terms of data distribution normality, is recorded: the testing was not possible for variables MENS (none of intermediate-level RGs didn't got the menarche) and AH (due to lack of variability), and in case of variable B, a statistically significant deviation was recorded (p=0.016, p=0.000; Tables 4 and 5, respectively). In the youngest age group category of both competition programs, a prepuberty is recorded (B1, AH1, the absence of menarche), so as statistically significant deviation from the normal data distribution, in all of the three parameters (p<0.05, Tables 4 and 5). Also, when it comes to data distribution of the sexual maturity parameters, a significant deviation was recorded in total "A" and "B" sample (p<0.05, Tables 4 and 5).

Table 5. Sexual maturity in **"B"** RGs of different age group categories

Age Group Categories	Variables	B	AH	MENS (yrs)
"B" Seniors (n=8)	*Mean±SD*	3.88±0.64	2.13±0.35	3.62±0.52
	Range	3.0 – 5.0	2.0 – 3.0	3.11 – 4.63
	K-S (Sig.)	0.358	**0.030***	0.940
"B" Juniors (n=12)	*Mean±SD*	3.08±0.52	2.08±0.29	0.54±0.79
	Range	2.0 – 4.0	2.0 – 3.0	0.0 – 2.0
	K-S (Sig.)	**0.045***	**0.002***	0.243
"B" Advanced (n=10)	*Mean±SD*	2.26±0.93	1.58±0.69	0.18±0.41
	Range	1.0 – 4.0	1.0 – 3.0	0.0 – 1.44
	K-S (Sig.)	0.157	**0.036***	**0.004***
"B" Intermediate (n=11)	*Mean±SD*	1.24±0.44	1.0±0.0	-
	Range	1.0 – 2.0	1.0 – 1.0	-
	K-S (Sig.)	**0.000***	-	-
"B" Beginners (n=8)	*Mean±SD*	1.0±0.0	1.0±0.0	-
	Range	1.0 – 1.0	1.0 – 1.0	-
	K-S (Sig.)	-	-	-
Total "B" sample (N=49)	*Mean±SD*	1.94±1.11	1.39±0.58	0.46±1.11
	Range	1.0 – 5.0	1.0 – 3.0	0.0 – 4.63
	K-S (Sig.)	**0.000***	**0.000***	**0.000***

Legend: "B"- "B" program, **n, N**- number of study participants, **Mean**- average value, **SD**- standard deviation, **K-S-** Kolmogorov-Smirnov test**, Sig.-** significance, **B**- breast development (telarche), **AH**-axillary hair development (adrenarche), **MENS**- length of period since menarche, **yrs** - years.

*absence of normal distribution (significant at p=0.05)

Figures 1 and 2 are graphic comparisons of the obtained data for the "A" and "B" samples in total (Figure 1) and for the five subsamples within two competition programs (Figure 2). The differences we see in the presented Figures the Mann-Whitney *U* test has not confirmed. Namely, the test results indicate the absence of statistically significant differences between an "A" and "B" senior, junior, advanced-level, intermediate-level and beginner RGs' sexual maturity, although we can see that the differences do exist.

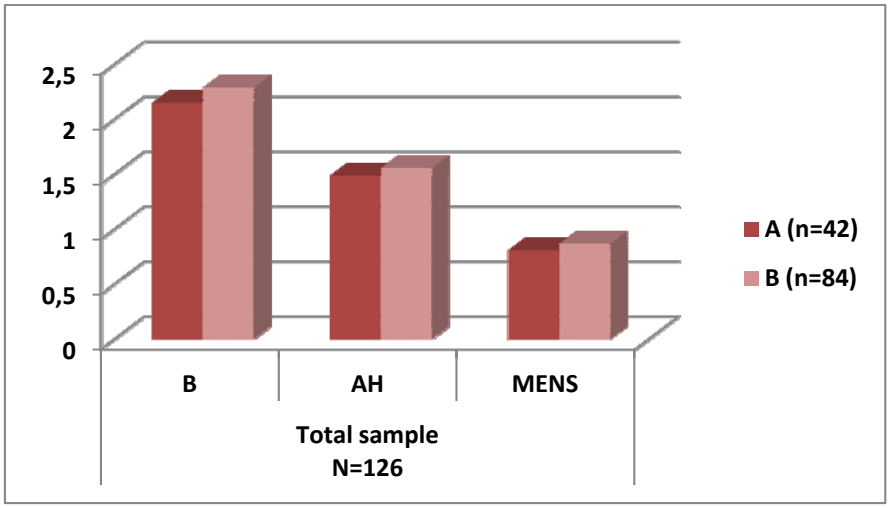

Figure 1. Values of sexual maturity data recorded in RGs of different competition programs ("A" and "B")

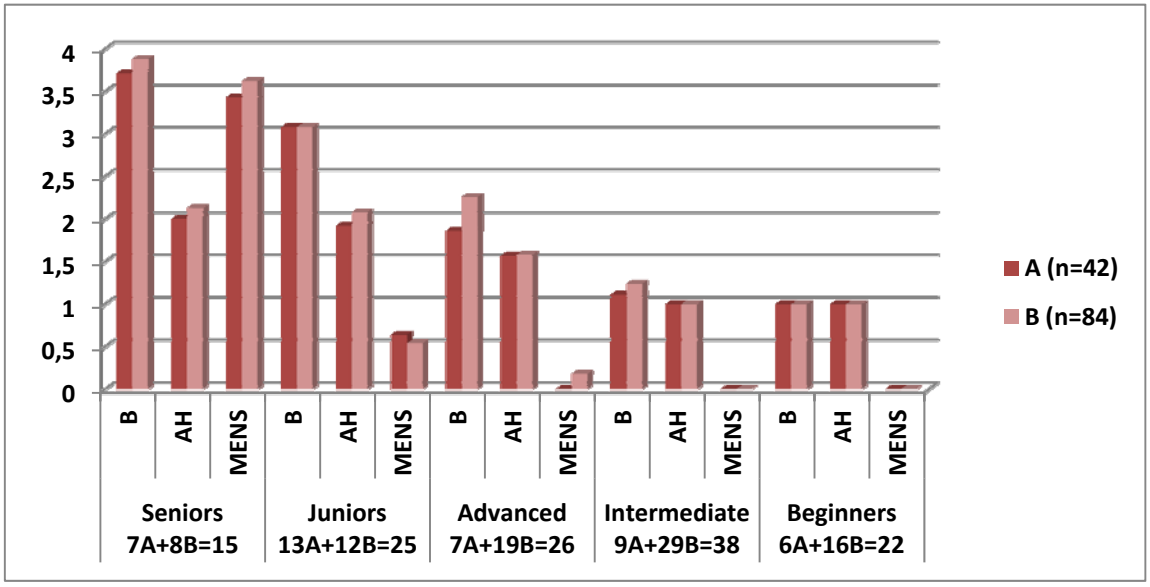

Figure 2. Values of sexual maturity data recorded in RGs of different age group categories (seniors, juniors, advanced-level, intermediate-level and beginners) and competition programs ("A" and "B")

CONCLUSION

By data analysis we obtained results which are somewhat expected: a greater degree of sexual maturity and earlier entry into puberty was recorded mostly in "B" rhythmic gymnasts (when considering the each age group category separately). Therefore, the fact that "A" rhythmic gymnasts train more often, i.e. more times per week (usually every day), and thereby their daily training sessions last longer, is probably the main reason for a lower degree of sexual maturity to that established in their peers from "B" competition program. Despite the lack of statistically significant differences, by this study once again is indirectly pointed out that the training load a significant factor affecting the gonadal axis of rhythmic gymnasts.

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PREDICTING OF THE BUTTERFLY RESULTS OF FEMALE PARASWIMMERS AT 2020 PARALYMPICS

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ABSTRACT

The aim of the study is to predict the results of medal winners in the following Paralympic Games (POG) in the butterfly discipline in female competition in physical disability.

Database of all results of medal winners in the 50m and 100m butterfly disciplines at the last five POG (2000 Sydney, 2004 Athens, 2008 Beijing, 2012 London and 2016 Rio de Janeiro) has been created. The data in classes S5 to S10 were taken into consideration in the data processing. Due to the lack of continuity in the discipline of 50m butterfly for class S5, no results were processed for this class.

Based on the established trend of results development, medal winners in the 50m and 100m butterfly disciplines in the last five POG. A model for predicting the results of possible medal winners at the next POG 2020 has been developed.

The obtained results will be of significance for further detailed analyzes on prediction of results in the 50m and 100m butterfly disciplines. It should be noted that the results obtained will primarily be used for the purpose of achieving better results than previously achieved. This work is gaining in importance as coaches can now know (hypothetically) what result their Para swimmer needs to achieve in order to hope for one of the medals.

Keywords: Paralympic Games, Para swimmers, female, butterfly.

INTRODUCTION

Swimming - a sport incorporated since 1960 in Rome as one of the most significant Paralympic sports (Dolenec, 2017). To ensure fair competition, swimming, like any other Paralympic sport, has a classification system that ensures that victory is determined by the development of swimming skills, abilities, strength, stamina, tactical maturity and mental readiness, the same factors that are required to succeed in non-Paralympic sports (Tweedy & Vanlandewijck, 2011). Classification is specific to sport, as disability affects the ability to perform in different sports to varying degrees. As a consequence, an athlete may meet the criteria in one sport but may not meet the criteria in another sport (Swimming classification, 2018).

POG are the highest form of competition for athletes with disabilities (Evershed et al., 2012). Swimming has been part of the POG program from the very beginning - POG in Rome in 1960 (Burkett et al., 2018). It is the most massive sporting event for people with disability and for which athletes have been purpose fully preparing for the best result for four years. When it comes to paragliding, para-swimmers compete in 14 classes (Dingley et al., 2015). Para swimmers compete in five styles (butterfly, back, breast, freestyle and mixed style), in individual competition and relays. Butterfly is a discipline represented for all three disabilities: physical disability (at distances of 50m for classes S5, S6 and S7 and 100m for classes S8, S9 and S10), visual impairment (100m distance for class S13 in which unified classes S11 and S12) and intellectual disability (100m distance for class S14).

The aim of the study is to predict the results of medal winners in the following Paralympic Games

(POG) in the butterfly discipline in physical disability.

METHODS

First, a database of all the results of the medal winners in the 50m and 100m butterfly disciplines at the last five POG (2000 Sydney, 2004 Athens, 2008 Beijing, 2012 London and 2016 Rio de Janeiro) was made. The results of the para-swimmers in classes S5 to S10 were taken into account in the data processing.

Based on the established trend of results development, medal winners in the 50m and 100m butterfly disciplines in the last five POG. A model for predicting the results of the para-swimmers of possible medal winners at the next POG 2020 has been developed.

RESULTS

Table 1. Results of the last five POG in the 50m butterfly discipline for the S5 class and forecasting results for the 2020 POG.

POG	50 m butterfly S5		
	G	S	B
2000	41,13	41,22	41,44
2004	44,7	**44,7**	44,7
2008	H/O	H/O	H/O
2012	**41,76**	**42,67**	**46,62**
2016	43,62	**45,67**	**45,74**
2020	**N/A**	**N/A**	**N/A**

POG – Paralympic Games, **N/O** - discipline was not held, **N/A** - analysis was not done for not maintaining discipline at last POG, **G** - gold medal, **S** - silver medal, **B** - bronze medal

In the 50m butterfly discipline for the S5 class, the results of the medal winners in the last five POG have improved steadily (Table 1). However, this trend was eroded at the 2012 POG when all medal winners did not have a better swim than the previous POG when this discipline was held (2004). This has also happened at the last POG of 2016 in the case of silver and bronze medal winners. For the first time, in the 50m butterfly event for the S5 class, the result of the medal winner was worse than at previous POG in 2004 (silver medal). Otherwise, at the 2008 POG, this discipline was not held, so data processing to calculate the trend was not performed.

In the 50m butterfly for the S6 class, the results for the medal winners in the last five POG have improved steadily (Table 2). Only this trend was broken at the POG in 2004 when the gold medal winner had a slower time than the previous 2000 POG.

In the 50m butterfly discipline for the S7 class, the results for the medal winners in the last five POG have improved steadily (Table 2). However, this trend has been eroded by the last two POG (2012 and 2016) when the gold medal winners had a slower time than previous 2008 POG. Likewise, the winners of the silver and bronze medals at the 2008 POG had a lower result than the winners of those medals at the previous POG of 2004.

Table 2. Results of the last five POG in butterfly disciplines for the S6-S7 classes and predicting results for the 2020 POG.

POG	50 m butterfly S6			50 m butterfly S7		
	G	S	B	G	S	B
2000	39,13	41,85	42,47	38,81	39,43	41,61
2004	40,25	41,03	41,96	37,37	37,47	38,30
2008	38,44	39,93	40,72	34,47	37,87	38,49
2012	36,05	37,65	39,26	35,16	36,03	36,50
2016	35,58	36,45	36,81	35,07	35,46	35,97
2020	**34,50**	**35,13**	**36,04**	**33,27**	**34,44**	**34,25**

POG – Paralympic Games, **G** - gold medal, **S** - silver medal, **B** - bronze medal

Table 3. Results of the last five POG in the S8-S10 butterfly disciplines and predicting results for the 2020 POG.

POG	100 m butterfly S8			100 m butterfly S9			100 m butterfly S10		
	G	S	B	G	S	B	G	S	B
2000	82,33	85,34	87,41	75,49	75,90	77,08	H/O	H/O	H/O
2004	83,04	83,85	84,78	67,54	72,01	76,61	72,30	73,06	74,66
2008	71,64	72,54	76,18	66,74	70,92	70,98	69,44	70,53	71,27
2012	70,32	71,53	73,28	69,30	69,79	70,10	64,43	68,55	69,08
2016	69,04	70,32	70,53	67,90	68,00	69,21	62,65	66,92	68,77
2020	**63,48**	**64,01**	**64,86**	**65,37**	**65,92**	**66,12**	**62,11**	**66,71**	**67,97**

POG – Paralympic Games, **G** - gold medal, **S** - silver medal, **B** - bronze medal

In the 100m butterfly discipline for the S8 class, the results for the medal winners in the last five POG have improved steadily (Table 3). Only this trend was eroded at the POG in 2004, when gold and silver medal winners had a slower time than previous 2000 POG.

In the 100m butterfly discipline for the S9 class, the results for the medal winners in the last five POG have been steadily improving (Table 3). Only this trend was eroded at the 2012 and 2016 POG, when gold medal winners had a poorer result than the 2008 POG winner.

In the 100m butterfly discipline for the S10 class, the results for the medal winners in the last five POG have improved steadily (Table 3). This trend has never been disrupted.

DISCUSSION

The focus of this paper was on the analysis of the results of para-swimmers with physical disabilities. There is a noticeable trend of improvement in the results at each subsequent POG, when it comes to the medal winners, which is both in appearance and in male competition (Miloradović et al., 2018).

Class S5 is specific, as swimmers from the lower classes (S1, S2, S3 and S4) also perform in the disciplines of this class. In doing so, they were placed at a disadvantage by the swimmer in the first four classes of physical disability (Burkett & al., 2018). Likewise, the specificity of this class is the diversity in disability distribution. This means that paramedics of different disabilities are members of this class (eg, high bilateral amputation of the hands with one shorter lower extremity, paraplegia, cerebral palsy ...). In the S5 class, there are as many as 50.0% of cases (6 out of 12) where para-swimmers who won a medal had a slower time than some of the previous POG winning the same medal, which shows that there is much room for improvement. It must also be speculated that some of the results achieved are currently unachievable, as the coaches had some information that saw the "light of day" years later.

Only one in 15 cases (7%) found that a POG medal winner was poorer compared to a previous POG in the 50m butterfly S6 class. This phenomenon shows the focus of trainers and para-swimmers, but also of the complex organizations that, above all, the National Paralympic Committee that provide for better preparation.

More than one quarter (27%), more precisely four out of 15 cases, show that the time of a para-swimmers who has won a medal in one of the last five POG in the 50m butterfly in the S7 class has run out. This phenomenon is explained by the fact that due to the distance that is the shortest in the Paralympic program (50m), there are limits in physical abilities that can improve the available training knowledge.

Although the mathematical model "announces" an improvement in results at the next 2020 POG in Tokyo, practice has shown that there is often no progression to medal-winning para-swimmers (compared to medal-winners at some of the previous POG). The reason for this phenomenon can be explained by the short distance (50m) of the discipline and limited training knowledge for these classes (S5, S6 and S7).

13%, ie. in two out of 15 cases in the 100m butterfly discipline in classes S8 and S9 it happened that a medal winner did not have a better swim time than in previous POG. Longer distance and the possibility of more variations in training may explain this phenomenon.

Of all classes in which female para-swimmers with physical disabilities perform, the smallest degree of physical and motor impairment is present in class S10. In the 100m butterfly discipline, progress was always made in the drifting times of the para-swimmers. Coaches' experience shows that in addition to swimming training, there is a lot of supplemental dry training. Likewise, selection for this class goes in the direction of selecting those swimmers with minimal physical disability who converge toward the very limit of disability.

CONCLUSION

The authors' assumption is that the obtained results will be of significance for further detailed analyzes of prediction of results in the 50m and

100m butterfly disciplines in para-swimmers. Also, it is assumed that the foregoing prediction, between the foregoing, will have a motivational character in paraswimmers. It should be noted that the results obtained will primarily be used for the purpose of achieving better results than previously achieved. This work is important because coaches can now know what result their swimmer needs to achieve in order to hope for one of the medals.

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Team Sports

GOAL ORIENTATION AND MENTAL TOUGHNESS OF YOUNG SERBIAN BASKETBALL PLAYERS

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ABSTRACT

Goal orientations depict the ways in which a player defines and experiences success and failure and evaluates his competence. Mental toughness is a quality of a player to cope with many demands in sport and stay determined, focused, confident and more in control under pressure situations. The aim of this research was to explore goal orientation and mental toughness of young athletes involved in major international competition. Sample included members of Serbian national U16 basketball team at Euro 2015 (N=21). TEOSQ (Duda, 1989) and MTQ (Goldberg, 1998) were applied. Descriptive statistics, Cronbach's alpha and Pearson correlation coefficient were conducted in SPSS, version 22. Mean values, for task (M=4.26; SD=0.50) and ego (M=3.71; SD=0.69) goal orientation, and for all mental toughness variables: motivation (M=5.54; SD=0.66), pressure (M=5.52; SD=0.92), concentration (M=5.44; SD=0.79), confidence (M=5.23; SD=0.93), rebound (M=5.09; SD=1.03) were significant. Significant correlations were found between motivation and task (r=0.604) and ego (r=0.513) orientation. Young basketball players showed orientation toward goal of achieving higher levels of one's own competencies rather than status and normative achievement related to others. Their strongest component of mental toughness was motivation, and the weakest point was rebound ability. Motivation appeared to be the key component for promoting sports development and enhancing overall mental toughness.

Keywords: goal orientation, mental toughness, motivation, basketball

INTRODUCTION

Since sport psychology emerged as distinct scientific discipline and applied science field, many attempts have been made to help coaches and athletes in their pursuits (Weinberg & Gould, 2011; Mladenovic, 2018). Goal orientation (Duda, 1989; 1992) and mental toughness (Jones et al, 2002; Goldberg, 1998) are some of the most important psychological constructs with great impact on sports development of young athletes and their behavior in performance situation.

There are two types of goal orientation in literature, *task orientation* and *ego orientation* (Duda, 1989). It is assumed that these two orientations depict the ways in which a person defines and experiences success and failure and evaluates competences. Task orientation exists when a person is primarily motivated to master a certain task, overcome the challenges by skills development, and promote efficiency. Success is estimated by the perception of actual level of personal competence when compared to the previous personal achievement. When goal orientation is ego orientation, the reference for the evaluation of personal competence is in others. Success and failure are estimated by direct comparison to the achievements of others. A person is primarily motivated to demonstrate normative competence (Mladenovic & Trunic, 2015).

According to experience of coaches and athletes, mental toughness might be more important in determining the final outcome of a sporting event, than any other psychological factor. It can be defined as personal state of being that allows an individual to perform with his greatest potential and to reach his ideal competitive state. It is a state of being where an individual feels most energized, most confident and most strong. Mental toughness is a quality of players to cope up better than opponents towards same goal despite pressure and adversity (Jones et al, 2002; Williams, 1998).

In this research we used Goldberg's (1998) framework of mental toughness. According to Goldberg, mental toughness can be described and measured through five aspects of mental functioning

in competitive situation: rebound ability, ability to handle pressure, ability to concentrate and stay confident, and ability to stay motivated in competitive situation.

Rebound Ability refers to mental potential to rebound from adversity setbacks and obstacles encountered before and during the performance (Goldberg, 1998). It is one of the most important psychological skills successful athletes possess. Falling behind in a match, making a mistake that costs your team a score, getting an unfair call from a referee, encountering a hostile crowd and experiencing inclement weather, are just a few examples of adversity which athletes must frequently overcome if they are to be successful. The best performers in sports are able to bounce back from adversity-setbacks and obstacles they face before and during performances.

Handling Pressure is mental potential to deal with different external and internal factors that may rise a feeling of pressure (Baric, 2011). Internal factors can be represented by some dispositional factors like personality traits, ego strengths, personal beliefs, self-confidence, and previous experience. External factors are, for example, the athlete-coach relationship or the relationships between team-mates, the level of competition, the importance of the game, the presence of audience, and public pressure.

Concentration is the ability to focus effectively on the task at hand while ignoring distractions, and is a vital prerequisite of successful performance in sport (Schmidt & Lee, 2011). Other research findings stated that concentration is the ability to remain focused on the task at hand, and maintain that focus over a period of time. Being able to remain fully focused especially when faced with adversity is consistently reported as an important mental toughness attribute (Jones et al, 2007; Gucciardi, Gordon & Dimmock, 2008). Regardless of what is going on in the environment, mentally tough athletes have strong attentional control skills and are able to focus on the task at hand (Bull & Shambrook, 2005).

Confidence in sport, according to Vealey & Chase (2008), refers to the belief that an athlete possesses about his ability to be successful in sport in general (trait sport confidence) and in specific sport competitions (state sport confidence). In sport practice it is usually assumed that if an athlete has belief in his sport abilities, he will be less likely to become anxious before big games or high pressure situations such as overtime or free throw.

Motivation is a particularly relevant issue in sport. It can be defined as direction and intensity of effort. Intensity refers to the quantity of effort, while direction refers to what a person is drawn too. Evidence suggests that enhanced motivation promotes learning, performance, enjoyment, and persistence in sport, among other benefits (Mladenovic, 2016). In basketball, motivation is a key psychological trait that is needed to excel. Players need high levels of motivation to push themselves to their limits and to be able to deal with the pressures of training and playing constantly each week.

The aim of this research was to explore goal orientation and mental toughness of young athletes involved in major international competition. We wanted to explore which goal orientation is more dominant among young basketball players and what aspects of mental toughness are more developed at 15 to 16 years of age. Also, the aim was to explore if there is correlation between goal orientations and mental toughness variables.

METHODS

Two instrument were applied.

Goal orientations was measured by TEOSQ (Duda, 1989). The questionnarie consists of 13 items, six for ego, and seven for task orientation, on 5-point Likert type scale.

Mental toughness was measured by MTQ (Goldberg, 1998). This questionnarie consists of 30 items, six for each of five mental toughness variables: rebound, pressure, concentration, confidence, motivation. Each item is scaled on 7-point Likert type scale.

Subjects

The research included 21 male participants, U16 basketball players of the Serbian national team. Four examinees were aged 15, while the others are aged 16.

Procedure

The research was conducted during summer of 2015, as a part of psychological assessment and preparations for the European Championship in Lithuania.

Statistical analysis

Cronbach's alpha was used for reliability analysis. Descriptive statistics (Mean value, SD, t-test) was applied for exploring each variable of goal orientation and mental toughness. Correlation between goal orientation and mental toughness variables was explored by conducting Pearson's correlation coefficient. All analyses were done in SPSS, version 22.

RESULTS

Reliability analysis was conducted applying Cronbach's alpha. Values of Cronbach's alpha for TEOSQ scale was over 0.7 (α=0.76 for ego, and α=0.75 for task subscale). For MTQ reliability analysis showed α value 0.9, but on subscales values of α were lower (rebound α=0.77; pressure α=0.76; concentration α=0.63; confidence α=0.74; motivation α=56).

Descriptive statistics using one sample t-test revealed significance for all Mean values of explored variables (Table 1). Young basketball players appeared to be more orientated toward task than ego goals. Considering mental toughness variables, the highest Mean value was obtained for motivation variable, and the lowest Mean value, with standard deviation above 1, is obtained for rebound ability.

Table 1. Descriptive statistics for Goal orientations and Mental toughness, for U16 Serbian basketball team at Euro 2015 (N=21).

	Mean	SD	Minimum	Maximum	t-test	df
Ego	3.70	.695	2.17	5.00	24.437**	20
Task	4.25	.504	3.00	4.86	38.697**	20
Rebound	5.08	1.030	2.67	6.83	22.613**	20
Pressure	5.51	.929	3.00	6.67	27.200**	20
Concentration	5.43	.794	4.00	6.83	31.341**	20
Confidence	5.23	.925	3.50	6.67	25.892**	20
Motivation	5.54	.664	3.67	6.50	38.236**	20

**p<0.01

Correlation analysis revealed significant inter-correlations between goal orientations, and all mental toughness variables, except motivation (Table 2). Motivation variable of mental toughness is significantly correlated with goal orientation variables.

Table 2. Correlation and inter-correlation of Goal orientations and Mental toughness, for U16 Serbian basketball team at Euro 2015 (N=21).

	1	2	3	4	5	6	7
1. Ego	1	**.448***	.144	.257	.050	.153	**.513***
2. Task	.448*	1	-.110	.212	.177	.307	**.664****
3. Rebound	.144	-.110	1	**.684****	**.692****	**.815****	.089
4. Pressure	.257	.212	.684**	1	**.564****	**.730****	.379
5. Concentration	.050	.177	.692**	.564**	1	**.810****	.311
6. Confidence	.153	.307	.815**	.730**	.810**	1	.304
7. Motivation	.513*	.664**	.089	.379	.311	.304	1

**p<0.01;
*p<0.05

DISCUSSION

Psychological variables are assumed to determine champions in sport when all other individual and team sports qualities are at the approximately same level (Mladenovic, 2018). That is usually the case at major international championships, such as European or World championships in basketball. For young athletes aiming to enter senior sports level, equally important are developmental dimensions of any sports quality at the particular moment, just as success at competition (Mladenovic, 2011; Mladenovic & Marjanovic, 2011; Mladenovic et al, 2016).

In this research, task orientation was more emphasized among young basketball players than ego orientation. But it seems there are more

individual differences in ego orientation, with even maximum values on the scale. It means there are some young basketball players, at the age of 15 of 16 years, who gives more attention to one's own sports status and superior sports qualities. In science as well as in practice, differentiation between two goal orientations is relevant in sports context and it is connected with the perception of cause of success and failure in sport. Ego orientation is connected with the perception of sports situation as a context used to increase self-respect and status. The cause of success in sport is attributed to one's own superior sports competences when compared to other athletes. Task orientation is connected with the strategy of working hard and continually on the development and improvement of competences. The success is seen as the result of persistence and effort. The situation of sports achievement is seen prosocially, as a place when relative competences of athletes are measured in specific moment (Duda, 1992). For young athletes, it is important for success in a current competition, as well as for further sports development, to put focus on one's own persistence and effort more than on 'ego superiority' toward others at the particular moment (Mladenovic et al, 2015).

When it comes to mental toughness, nowadays this mental attribute is acknowledged as most important in sporting performance (Hodge, 1994; Goldberg, 1998; Mladenovic, 2017). In early work on the issue, Loehr (1991) emphasized that athletes and coaches felt that at least 50% of success is due to psychological factors that reflect mental toughness. Similarly, Gould et al (1987) reported that more than 80% coaches rated mental toughness as the most important psychological attribute for success in sport. Many other sport psychology researches (e.g., Burton & Raedeke, 2008; Robazza, Pellizzari, & Hanin, 2004; Vealey, 2007) over the last decades have investigated the cognitive and emotional factors associated with sports achievements in an attempt to identify the personality characteristics of skilled athletes and the mental preparation strategies that they use to perform successfully. Psychological characteristics commonly accepted as being major contributors to success within the area of sporting performance appeared to be motivational factors, self-confidence, and the ability to cope with and interpret anxiety-related symptoms as facilitative under pressure (Hanton et al, 2008; Hardy et al, 1996; Mellalieu et al, 2009). But the characteristic that is frequently used to describe why certain individuals have become "the best in the world" in their respective sports is that of "mental toughness" (Loehr, 1991; Williams, 1988). In basketball, 16 years of age might have important role in further sports affirmation up to senior level of competition (Trunic & Mladenovic, 2014). On that unique personal and sports path, goal orientations and development of mental toughness mindset are of great importance.

In this research, as we followed Goldenberg's concept of mental toughness, results indicate motivational aspect of mental toughness as most developed among young basketball players, while there are most individual differences in rebound ability. It seems that although young basketball players in our research had will to push themselves hard in the competition, they are still not enough 'tough' to overcome setbacks and rebound from obstacles before and during the game. But certainly, 'good news' is that mental toughness is trainable variable, since it is believed that it is not inherited gift (Jones et al, 2002). Significant correlation between motivation variable of mental toughness and goal orientation indicate that specific mental training program might be based on athlete's motivation and involve coaches as important figure in sports and personal development of young athletes (Mladenovic et al, 2015; Mladenovic & Trunic, 2014). This research goes in line with evidence supporting important role of motivation in sports development and success (Mladenovic, 2016). Further researches should clear potential mediation role of motivation in establishing mental toughness mindset.

CONCLUSION

Psychological variables such as goal orientations and mental toughness might play important role in sport success, and it is of great importance to pay attention to development and nourishment of such mental qualities at younger age. In this research, young basketball players of U16 Serbian national team, showed higher level of task goal orientation. Motivational aspect of mental toughness was somewhat emphasized and the rebound ability with lowest mean value and widest individual differences among players. Correlation analysis indicate connection between goal orientations and mental toughness mainly through motivation variable. Motivation appeared to be the key component for promoting sports development and enhancing overall mental toughness. It is on future research to clear the role of motivation in establishing mental toughness mindset and potential mediation role of motivation between mental toughness and goal orientations in sport.

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DIFFERENCES IN AGILITY OF BASKETBALLS IN RELATION TO PLAYING POSITIONS IN THE TEAM DURING THE COMPETITION SEASON

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ABSTRACT

Agility is one of the most important abilities for successful basketball, as the activities of this motor ability are very present during the game. Agility development should be tailored to player positions in the team. On a sample of 15 basketball players in regard to positions in the team (Agility T Test, Hexagon Agility Test, Illinois Agility Test and Lane Agility Drill) differences in agility were found in relation to player positions at the beginning and the end of the competitive season. Differences were determined by Student's T-test. The results showed that the basketball players achieved qualitatively better numerical values at the final testing in agility in all player positions, that this difference is the greatest in the positions of the backs and centers and that the players in the position of the wing are somewhat less pronounced, which was expected. Based on these results, it is possible to monitor the status of the basketball player in relation to the positions on the team and on that basis program the training more correctly and precisely during the competitive season.

Keywords: basketball, agility, competitive season, team positions, differences.

INTRODUCTION

Basketball is a collective sports game and it requires players to have a specific motor and cognitive skills and technical and tactical skills, or anticipation in the game. Five players from both teams are constantly in the game, which allows a lot of combinatorics and creativity on the field, considering the size of the pitch and the readiness of the players. Today's state-of-the-art basketball requires a high level of preparedness for all players, regardless of the positions they play in the team (Ademović, 2016). If each player is not prepared at the level required by top basketball, fatigue occurs and players cannot adequately move around the field and create better positions for receiving the ball and completing the action (Forlan, 2010). Agility is one of the most important skills for successful basketball. It is an ability whose activities are highly represented during the match. Having agility combined with other abilities and features together make it a prerequisite for creating quality basketball players. Players constantly change direction and direction of movement, stopping quickly to create themselves and teammates in the best position to receive the ball and successfully realize the attack. For this reason, agility training plays an important role in the comprehensive training of basketball players, for which playing in all positions on the field is as successful as possible, which most authors point out in their researches (Kremer & Gomez, 2010; Asadi & Arazi, 2012; Lehnert, Hůlka, Malý, Fohler & Zahálka, 2014; Nikolic, 2016; Mitic, et al., 2018). Agility is a motor skill that needs to be adjusted to player positions if we want to make the right selection of players relative to positions in the team and generally viewed through roles and tasks in the team (Kocić and Berić, 2015). It follows from the foregoing that for the quality and early selection of players in relation to positions in the team, it is necessary for the experts in the field of sports and basketball coaches to know the fact that agility is a motor ability, which due to its characteristic movements is essential for all player positions. However, players in the positions of a game organizer, backs and low wingers should just have the foremost task in the game related to the motility characteristics of agility motor ability. In this way, players in the aforementioned positions could create an advantage over their opponent. If players in high wing and center positions have agility-like activities as motor skills, it will be advantageous over the opponent primarily in demarcation actions, timely placement in the triple threat position, and timely

stoppage. It is precisely timely stopping, as an action in the course of the game that matters because of the continuation, that is, the next action that follows. The timing of stopping depends on the quality of creating the best shot position on the basket or adding to the free agent (Ademović, 2016; Kocić, 2007). Agility is the ability to quickly change the direction of movement, stop and leave in a controlled manner (Semenick, 1990). Agility is a synthesis of almost all physical abilities an athlete possesses (Verstegen & Marcelo, 2010). Changing the direction of movement, stopping and accelerating the action, essential for successful basketball play, depend on coordination and explosive power (Fratric, 2006). Agility is, to a large extent, genetically predetermined, which means that no real increase in average results can be expected from the programmed basketball training process (Kocic and Beric, 2015). More recently, the term speed reversal has been frequently used (Sekulic, Spasic, Mirkov, Cavar, & Sattler, 2013; Delextrat, Grosgeorge, & Bieuzen, 2015), which should actually represent agility, since in essence agility is a rapid change of direction and direction of movement. The aim of this research was to determine the differences in motor skills of agility in relation to player positions in the team after the second part of the competitive season.

METHODS

Subjects

The sample of respondents in this study consisted of 15 basketball players from the basketball club OKK "Konstantin" from Niš. Respondents were divided into three groups, namely: players at the back positions (five), players at the wing and low post positions (five) and players at the center position (five). OKK "Konstantin" Basketball players from Nis in the 2018/19 season competes in the Second Federal League of Serbia.

Procedure

The following measuring instruments were used to assess agility: Agility T-Test, Hexagon Agility Test, Illinois Agility Test, and Lane Agility Drill. All of these basketball players' agility benchmarks are downloaded from Topend Sports: http: //www.topendsports.com/testing/tests/index.htm.

Statistical analysis

Student's T-test was used to determine differences in agility between basketball players in relation to player positions on the team at the end of the second part of the competitive season.

RESULTS

Table 1 Basic statistical parameters for assessing the agility of basketball players in relation to the position on the team at initial testing

Groups	Tests	N	Mean	Min.	Max.	Range	S.D.	Skewness	Kurtosis
guards	T-test	5	10.10	9.60	10.30	0.70	0.31	-1.451	1.335
	Hexagon	5	12.06	10.60	13.50	2.90	1.23	0.080	-2.233
	Illinois	5	16.26	15.40	16.70	1.30	0.52	-1.529	2.412
	LA Drill	5	13.76	13.10	14.60	1.50	0.57	0.593	0.444
wings	T-test	5	10.24	10.10	10.60	0.50	0.21	1.918	3.878
	Hexagon	5	12.30	11.40	13.20	1.80	0.71	-0.106	-1.078
	Illinois	5	17.24	16.50	18.10	1.60	0.73	0.002	-2.623
	LA Drill	5	13.92	13.20	15.10	1.90	0.73	1.301	2.077
centers	T-test	5	10.30	9.80	11.00	1.20	0.52	0.356	-1.601
	Hexagon	5	12.80	12.00	13.20	1.20	0.50	-1.301	0.708
	Illinois	5	17.70	16.60	19.00	2.40	0.88	0.519	0.913
	LA Drill	5	13.80	12.70	15.30	2.60	0.96	0.927	1.577

Table 1 shows the basic statistical parameters of basketball players' agility at initial testing. The results indicate that a decrease in sensitivity was observed in all tests due to the fact that less than six standard deviations are within the range of minimum and maximum results. Skewness in most tests indicates a slight asymmetry, as their value does not exceed the limit of ± 1.00, except for the T-test (-1.451) and Illinois (-1.529) in the escape group; T-test (1,918) and LA Drill (1,301) in the wing group; Hehagon (-1,301) in center group. Kurtosis values show results below 2.75, which represents a fuzzy distribution, except for the T-test (3.878) in the wing group.

Table 2 Basic statistical parameters for assessing agility in relation to the position on the team in the final test

Groups	Tests	N	Mean	Min.	Max.	Range	S.D.	Skewness	Kurtosis
guards	**T-test**	5	9.28	9.10	9.50	0.40	0.16	0.518	-1.687
	Hexagon	5	10.48	10.00	11.00	1.00	0.46	-0.197	-2.716
	Illinois	5	15.34	14.50	15.70	1.20	0.51	-1.497	1.694
	LA Drill	5	13.02	12.50	13.60	1.10	0.48	0.132	-2.467
wings	**T-test**	5	9.48	9.20	9.70	0.50	0.19	-0.590	-0.022
	Hexagon	5	11.58	10.80	12.40	1.60	0.78	-0.022	-2.960
	Illinois	5	16.22	15.80	17.10	1.30	0.60	0.983	-1.190
	LA Drill	5	13.48	12.90	14.20	1.30	0.61	0.231	-2.727
centers	**T-test**	5	9.42	9.20	9.70	0.50	0.19	0.590	-0.022
	Hexagon	5	12.04	11.50	12.60	1.10	0.50	0.099	-2.813
	Illinois	5	15.84	15.20	16.20	1.00	0.38	-1.517	2.608
	LA Drill	5	12.90	12.50	13.40	0.90	0.36	0.320	-0.870

Table 2 shows the basic statistical parameters of basketball players' agility in the final testing. The results indicate that a decrease in sensitivity was observed in all tests due to the fact that less than six standard deviations are within the range of minimum and maximum results. Skewness in most tests indicates a slight asymmetry since their value does not exceed the ± 1.00 limit, except for the Illinois (-1.497) tests in the escape group; Illinois (-1,517) in the center group. Kurtosis values show results below 2.75, which is a fuzzy or "platikurtic distribution", except for the Hexagon test (-2,960) in the wing group and (-2,813) center group.

Table 3 T-test for evaluating differences in the final position's different positions against initial testing

Groups	Tests	Mean (иницијално)	Mean (финално)	T-value	p
guards	**T-test**	10.10	9.28	6.61	**.003**
	Hexagon	12.06	10.48	4.29	**.013**
	Illinois	16.26	15.34	24.59	**.000**
	LA Drill	13.76	13.02	4.23	**.013**
wings	**T-test**	10.24	9.48	8.72	**.001**
	Hexagon	12.30	11.58	1.91	.128
	Illinois	17.24	16.22	6.67	**.003**
	LA Drill	13.92	13.48	1.80	.146
centers	**T-test**	10.30	9.42	3.61	**.023**
	Hexagon	12.80	12.04	3.52	**.024**
	Illinois	17.70	15.84	5.89	**.004**
	LA Drill	13.80	12.90	2.89	**.045**

Table 3 shows the results of the T-test of agility and it can be seen that the significance of the differences between the initial and final testing of basketball players is noticeable in most tests and in all groups. The Hexagon (.128) and LA Drill (.146) tests show no significant differences in wing basketball. From the obtained results it can be seen that there are differences with respect to the positions of the players in the team and that they are the most pronounced in the final compared to the initial measurement in the players at the positions of the backs and centers. There is a difference in the position of the winger in half of the tests, and in the other two tests, they showed no statistical significance.

DISCUSSION

Agility is a motor skill that is among the most important in the equation of success in playing basketball. Such individuals who possess the capacity for agility type activity should be selected. On the other hand, if we decompose a basketball game, it can be concluded that activities of the type of agility are very prevalent. First of all, we mean a large number of rapid changes in direction of movement in a relatively small area, sudden stops, starting to run the ball or dribbling, short sprints, etc. All of the above has a foothold precisely in agility. Current methods of basketball preparation differ from those used in the past. In the past, sports experts and basketball coaches have taken the position that basketball development requires only basketball. Today's approach is different and

involves a combination of different training systems. Agility training is of particular importance for the comprehensive preparation of basketball players (Ostojic, Mazic, & Dikic, 2006; Delextrat & Cohen, 2008; Issurin, 2009; Metaxas, Koutlianos, Sendelides, & Mandroukas, 2009; Kremer & Gomez, 2010). The characteristics of the game are, first and foremost, frequent and rapid changes in direction and direction of movement, rapid and sudden stops, most often after mastering the force at short distances. Also, quick and timely demarcations and breakthroughs are common, with the aim of achieving the best possible scoring position. Basketball is a sports game of above-average people, where players in the center and high wing positions stand out and should be given special attention in agility training (Jakovljevic, Karalejic, Pajic & Mandic, 2011). The results of this research have shown that there are differences caused by the competitive season in the motor ability of agility in players in all three positions, as the authors of previous studies have confirmed in similar studies (Delextrat and Cohen 2009; Mitić, et al., 2018: Stojanović , et al., 2018). The biggest difference is with the players in the positions of the backs and centers, while the wings also have progress, but it is less pronounced compared to the two mentioned positions. The results obtained in the parameters of agility, in addition to other factors, directly influenced the placement and the overall result, but also the better score of wins and losses at the end of the second half of the competitive season, which Tsitskaris, et al., (2003) also proved in his research. That is why it can be concluded that agility type activities are highly correlated with competitive success (Shaji & Isha, 2009; Bal, et al., 2011; Ademović, et al., 2014; Mitić, et al., 2018; Stojanović, et al., 2018).

CONCLUSION

The results of this study showed that the values of motor agility during the competitive season differ from all three player positions on the team at the end of the second part of the competitive season. They are most pronounced in the players in the positions of the backs and centers, and the difference is slightly less pronounced in the players in the position of the wing. The importance of the research is reflected in the detection of the activity of basketball players' agility type in relation to the positions they play in the team at the beginning and end of the competitive season. Also, by monitoring the parameters of the activity type of agility during the competition, it is possible to make certain adjustments and directing the state of training in the desired direction, as well as planning and programming of the training, based on the results obtained. Particularly significant should be the fact that the parameters are monitored in relation to the positions in the team, and it is known that agility training is conducted on the basis of this fact. Success in performing agility-type actions has a great impact on the result, and therefore the additional importance of the research that has been conducted is in this fact. This ability monitoring approach more clearly defines the parameters that affect the competitive outcome. The research conducted so far has mainly dealt with the impact and effects of certain abilities during the preparation period or during the transition period. This research makes a contribution, as agility activities are monitored during the competitive season.

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DIFFERENCES IN BODY COMPOSITION AND MOTOR ABILITIES AMONG FEMALE HANDBALL PLAYERS RELATING TO POSITIONS IN THE TEAM

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ABSTRACT

Handball belongs to complex sports, structured by different simple and complex movements, and the demands and tasks of the game differ between the player positions in the team. The objective of this study was to provide body composition and motoric abilities of an Serbian elite woman handball team. On a sample of 15 handball players divided into three groups by playing positions (backs n=5, wings n=5 and pivots/goalkeepers n=5)were determined differences in body composition on the "Omron BF511" body scale, speed (Sprint 5, 10, and 30 m), agility (New agility without ball, Straight Slalom without ball, Straight Slalom with ball, Zig-Zag 100 without ball and Zig-Zag 100 with a ball) and explosive leg strength (Squat jump, Counter Movement Jump - CMJ, CMJ free arm, Single-leg vertical countermovement jumps (CMJ right leg, CMJ left leg). To determine the differences among the female handball players in relation to their positions in the team, the ANOVA and a post-hoc analysis were used. The results showed that the backs and the pivot/goalkeepers group were statistically significantly higher in body height and mass than the wing players, and also had higher basal metabolism values. No statistically significant difference was found between the groups in speed, as well as in the explosive power of the legs, except in the CMJ left leg test, where players at the back and wing positions had greater jump height. Agility results show the difference only in the Zig-Zag 100 with a ball test, in favor of a group of players on the back and wing positions.

Key words: Female handball, body composition, motoric abilities, differences, playing positions.

INTRODUCTION

Handball is considered a complex sport, which means that it comprises different simple and more sophisticated movements. The contact game is allowed between the players and clearly defined by the rules. It is dominated by natural movements (jumping, running and throwing) combined with complex coordination and technical movements performed through multiple players' cooperation. Modern female handball is a physically demanding intermittent team sport, in which the players are exposed to a large relative load with the usage of aerobic and anareobic energy sources. High-intensity movements are dominated by anaerobic capacity consumption; therefore, the amount of work in this regime is limited. The modern trend in handball development implies that the players have universal tactical and technical knowledge and skills in order to complete the tasks successfully in many positions throughout the different stages of the game. However, the tasks and demands depend on the players' positions, which hampers determining the extent to which individual anthropological characteristics of a player influence the successfulness in this sport.

The morphological characteristics of the players determine their positions in the game to a large extent. Goalkeepers are usually the tallest players who have a large portion of subcutaneous fatty tissue in the overall body mass (Šibila & Pori 2009; Grujić, 2016). Pivots and left and right backcourts are very similar in terms of their morphological characteristics, with pivots having slightly bigger muscular mass, more fatty tissue and more accentuated transversal measurements (Srhoj, Marinović & Rogulj, 2002; Šibila & Pori, 2009; Taborsky, 2007). Contrary to other players, left and right wingers are not that tall, have lower body mass and lower values of subcutaneous fatty tissue. As a

rule, the top players more commonly have accentuated longitudinal and transversal dimensions of the upper extremities as well as the muscular mass and the lower values of the body mass index – BMI (Massuça & Fragos, 2015). A few studies have shown that along with technical and tactical skills, anthropometric characteristics represent decisive factors in successfulness in the sport (Gorostiaga, Granados, Ibanez & Izquierdo, 2005; Gorostiaga, Granados, Ibanez, Gonzalez-Badillo & Izquierdo, 2006; Urban & Kandráč, 2013).

Some players' positions require certain anthropological types of players depending on the specific functions and the position itself. The analysis of the types of movements and the speed during top competitors' games (Michalsik, Madsen & Aagaard, 2013) showed that the shortest distances during the game demanded low intensity on the part of the players (standing and walking around for 4 km), moderate intensity though running at a slower pace, sideway and backward movements (9 to 12 km), whereas the longest distances demanded high-intensity running and sprint (15,5 to 22 km). Left and right wingers cover the longest distances during the game, with the high intensity movements (3.6 km), followed by pivots (2.3 km) and then left and right backs (1.3 km). Depending on the positions, wingers and pivots cover the longest distances in games (app. 4500 m) as opposed to left and right backs (app. 4000 m). The time spent in the game also influences the distance covered, so the players who spend the whole game playing cover 1 km more than those who play with timeouts or breaks. When it comes to the differences in motor abilities between the players with respect to their positions, the wingers dominate in certain types of explosive power, speed, agility and the frequency of the leg movements, whereas the goalkeepers dominate when it comes to flexibility (Rogulj, Srhoj, Nazor, Srhoj & Čavala, 2006).

Many authors have conducted research in the field of physical and physiological characteristics of top handball players (Rannou, Prioux, Zouhal, Gratas-Delamarche & Delamarche, 2001; Táborský, 2007; Trninić, Papić, Trninić & Vukičević, 2008; Zapartidis, Toganidis, Vareltzis, Christodoulidis, Kororos & Skoufas, 2009; Šibila & Pori, 2009; Chaouachi, Brughelli, Levin, Boudhina, Cronin & Chamari, 2009; Milanese, Piscitelli, Lampis, & Zancanaro, 2011; Grujić, 2016; Bojić - Ćaćić, 2018). The results of those studies point to the fact that physiological and motor profiles of the players depend on anthropometric characteristics to an extent, and that there are certain differences in motor abilities among handball players. However, in the last decade only few studies have dealt with the differences in morphological and motor characteristics of female handball players with respect to their playing positions (Zapartidis, Toganidis, Vareltzis, Christodoulidis, Kororos & Skoufas, 2009; Milanese, Piscitelli, Lampis, & Zancanaro, 2011; Urban & Kandráč, 2013; Michalsik, Madsen & Aagaard, 2013; Weber, Wegner & Wagner, 2018).

The aim of this research was to determine the differences in body composition, explosive power, speed and agility in top female handball players with respect to their playing position.

METHODS

The sample of examinees

The examinees in this research were 15 handball players aged 23.9 ± 3.6, all members of the female handball club 'Naisa' from Nis, which competed in Serbian Super League in the 2018/ 19 season. The participants were divided into three groups, based on their playing positions (the wingers, n=5, the backs, n=5 and the pivots/ goalkeepers n=5).

The sample of measurements

The body composition was measured with 'Omron BF511' scales which provided precise data on the body mass, fat percentage, muscle percentage, body mass index (BMI) and daily metabolism. The Body Mass Index (BMI) was calculated as the ratio between body mass in kilograms and squared body height in meters (kg/m2).

In this research we used five tests for the evaluation of explosive power. Tests were used to evaluate the hight of vertical jumping (Bosco, Luhtanen, & Komi, 1983): Squat Jump (SJ); Countermovement Jump (CMJ), Countermovement Jump Free Arm (CMJ free arm), Single-leg vertical countermovement jump - right leg (CMJ right leg) and Single-leg vertical countermovement jump - left leg (CMJ left leg). 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).

Test 5, 10 i 30m Sprint was used for the evaluation of speed (Ellis et al., 2000). A system of photocells (Witty, System, Microgate, Bolzano, Italy) was set at the starting line, at a distance of 5m, 10m, and 30m from the start, in order to measure lap time, along with an increase in speed. 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 test requires the

maximal performance of the 30m sprint. The participant assumes a high start position at 50cm from the start line, and is instructed that the goal line is to be passed as soon as possible.

Agility was measured with five tests, using a system of Electronic Timing Gates"Witty System"(Microgate, Bolzano, Italy): New Agility Coverta Without Ball, Straight Slalom without ball, Straight Slalom with ball, Zig-Zag 100 without ball and Zig-Zag 100 with ball. All measuring instruments for agility are taken from Topend Sports: http://www.topendsports.com/testing/tests/index. htm. The data analysis was carried out using the SPSS program for statistical analysis. For all the obtained data, the following was calculated: the basic central and dispersion parameters (Mean, Skewness, Kurtosis, Range, Min, Max, and SD). To determine the differences in body composition, explosive power, speed and agility among the female handball players in relation to their positions on the team, the Analysis Of Variance for independent samples - ANOVA was used (the statistical level of significance was set at $p<0.05$) and a post-hoc analysis.

RESULTS

Univariate analysis of the body composition variance (Table 1) shows that there is a statistically significant difference in the following tests: height .003, body mass .008, and daily metabolism .007, on the basis of the F-relationship coefficients and their significance (P-level).

Table 1. Univariate analysis of the body composition variance in female handball players playing different positions

Measures	Mean (backs)	Mean (wings)	Mean (pivots/goalkeepers)	F	P-level
Height	177.00	166.20	177.30	9.89	**.003**
Weight	73.22	56.80	73.18	7.41	**.008**
BMI	23.34	20.58	23.24	2.77	.102
% fat	28.52	25.28	30.06	1.87	.196
% muscle	31.56	31.86	30.68	0.41	.675
Basal Metabolism	1535.40	1292.00	1527.00	7.77	**.007**

For the final definition of the determined differences the post hoc test was done – Fisher LSD test (Table 2) and the results show that there is a statistical difference between the backs and the wingers in their body height (.003), body mass (.006) and basal metabolism (.005), and a statistical difference between the wingers and the group comprised of the pivots and the goalkeepers (in their body height .002, body mass .006 and basal metabolism .006).

Table 2. Post hoc test measuring body height (Fisher LSD test)

Measures	Playing position	Mean	{1}	{2}	{3}
Height	1 - backs	177.00		**.003**	.918
	2 - wings	166.20	**.003**		**.002**
	3 - pivots/goalkeepers	177.30	.918	**.002**	
Weight	1 - backs	73.22		**.006**	.994
	2 - wings	56.80	**.006**		**.006**
	3 - pivots/goalkeepers	73.18	.994	**.006**	
Basal Metabolism	1 - backs	1535.40		**.005**	.907
	2 - wings	1292.00	**.005**		**.006**
	3 - pivots/goalkeepers	1527.00	.907	**.006**	

Univariate analysis of the explosive power (Table 3) shows that there is no statistically significant difference in any of the tests, on the basis of the F-relationship coefficients and their significance (P-level).

Table 3. Univariate analysis of the explosive power in female handball players playing different positions

Measures	Mean (bekovi)	Mean (wings)	Mean (pivots/goalkeepers)	F	P-level
SJ	25.96	25.18	23.78	0.32	.731
CMJ	27.32	28.72	24.76	1.63	.237
CMJ arm	32.56	33.46	29.86	0.88	.442
CMJ right leg	13.26	13.18	10.88	2.65	.111
CMJ left leg	13.60	13.38	11.08	3.53	.062

However, for the CMJ left leg test (.062) the post hoc test was done due to the borderline values of significance (table 4). The results proved that there was a statistically significant difference between the backs and the group comprised of the pivots/ the goalkeepers (.034) and the wingers and the group comprised of the pivots/ the goalkeepers (.049) but the values were not high enough to influence the overall significances among the three groups.

Table 4. Post hoc test for the CMJ left leg test in female handball players playing different positions

CMJ left leg	{1} 13.60	{2} 13.38	{3} 11.08
1 - backs		.838	**.034**
2 - wings	.838		**.049**
3 - pivots/goalkeepers	**.034**	**.049**	

Univariate analysis of the speed variance (Table 5) shows that there is no statistically significant difference in any of the tests, on the basis of the F-relationship coefficients and their significance (P-level).

Table 5. Univariate analysis of the speed variance in female handball players playing different positions

Measures	Mean (backs)	Mean (wings)	Mean (pivots/goalkeepers)	F	P-level
Sprint 5m	1.30	1.25	1.27	1.03	.386
Sprint 10m	2.18	2.06	2.12	2.00	.178
Sprint 30m	5.22	4.83	5.08	1.84	.200

Univariate analysis of agility (table 6) shows that there is a statistically significant difference only in the test Zig-Zag 100 with the ball (.048), on the basis of the F-relationship coefficients and their significance (P-level). For the final definition of the determined differences the post hoc test was done (table 7), which showed a statistically significant difference between the wingers and the group comprised of the pivots/ the goalkeepers (.017).

Table 6 Univariate analysis of agility in female handball players playing different positions

Measures	Mean (backs)	Mean (wings)	Mean (pivots/goalkeepers)	F	P-level
New agility Koverta (without the ball)	8.25	7.73	8.43	2.66	.111
Slalom without the ball	8.27	7.99	8.31	1.56	.250
Slalom with the ball	9.24	9.00	9.54	1.37	.291
Zig- zag 100 without the ball	5.76	5.53	6.07	3.41	.067
Zig- zag 100 with the ball	5.97	5.79	6.34	3.97	**.048**

Table 7 Post hoc test for the test Zig-Zag 100 with the ball in female handball players playing different positions

Zig- zag 100 with the ball	{1} 5.97	{2} 5.79	{3} 6.34
1 - backs		.404	.083
2 - wings	.404		**.017**
3 - pivots/goalkeepers	.083	**.017**	

Due to the borderline values of significance the post hoc test for the test Zig-Zag 100 without the ball was done (table 8) (.067) and it was established that there was a statistical difference between the wingers and the group comprised of the pivots/ the goalkeepers (.023) and which was not, in this case, high enough to influence the overall significances among the three groups.

Table 8. Post hoc test for the test Zig-Zag 100 without the ball in female handball players according to different playing positions

Zig- zag 100 without the ball	{1} 5.97	{2} 5.79	{3} 6.34
1 - backs		.289	.162
2 - wings	.289		**.023**
3 - pivots/goalkeepers	.162	**.023**	

DISCUSSION

Previous research has proven that there are differences in the body composition in female handball players playing different positions (Rogulj et al., 2005; Zapartidis et al., 2009), and our results show that the wingers are of statistically significant lower body height and body mass than the rest of the players, and that they have the lowest basal metabolism rate. These coincide with the previous results in female handball players' morphological characteristics (Srhoj & al., 2002; Rogulj & al, 2005; Šibila & Pori, 2009; Vila, Manchado, Rodriguez, Abraldes, Alcaraz & Ferragut, 2012; Urban & Kandráč, 2013; Michalsik, Madsen, & Aagaard, 2013) and can be explained by the roles these players have in the game, which imply swift changes from the offence to defence, shooting, very often without any contact with the opponent players, as well as landings with different types of falls. On the other hand, the obtained results show that there are no statistically significant difference in the body composition of the backs and the group comprised of the pivots/ the goalkeepers. Some possible reasons for that might be the demands associated with those playing positions. The backs usually have the task to complete the shooting actions while jumping from longer distances. Similarly to the pivots, they are almost always in close contact with the opponent's defence players, which requires accentuated body height and muscular mass. The results are in concord with the recent research conducted by the following authors Milanese, Piscitelli, Lampis & Zancanaro, 2011. The position of a goalkeeper is completely different from all the other playing positions when it comes to its technical and tactical demands. The goalkeeper plays within limited space; she is relatively static, uses fast and simple movements, which need a smaller amount of energy; therefore, they belong to the mesomorphic-endomorphic body constitution, as opposed to the wingers. Our results show that the handball players who have the positions of the pivots or the goalkeepers are much taller, have larger body mass and the values of basal metabolism than the wingers, which has been proven by some previous studies (Milanese, et al., 2011; Vila, et al., 2012; Urban & Kandráč, 2013).

When it comes to the explosive leg power, our results do not show any statistically significant difference in female handball players in different playing positions, except for the CMJ left leg test, in which the backs and the wingers had better results than the pivots/ goalkeepers. The reason for there not being differences is presumably in the influence of the training process, aiming at the utilization of explosive power as the dominant ability, on the successful development of all technical and tactical elements. It should be emphasized that one leg jumps are more common with the backs and the wingers so that can serve as a justification for slightly better results. The earlier research did not show any statistically significant differences in the explosive leg power in female handball player in different positions (Vila et al., 2012).

Our results do not show any statistical differences in speed in female handball players in different playing positions. Taking into consideration the importance of this ability in all the positions, the pivots and the goalkeepers included, the results obtained are justified. However, it is possible that they were influenced by the motivation during the very process of testing, as well as the players' selection for the afore mentioned position. Contrary to our results, some studies have proven that the wingers are significantly faster than other positions (Šibila et al., 2004; Rogulj et al., 2005; Zapartidis et al. 2009).

Speed and agility are motor abilities which are closely connected and have a significant influence on the successfulness in handball. When it comes to basic motor abilities, the speed of movements is linked to the ability of ball manipulation and determines, to a large extent, the performance of the players in different playing positions, except for the Zig-zag test with the ball, in which the wingers were better than the pivots/ the goalkeeper group. Taking into consideration the fact that movements with the ball are not dominant with the goalkeeper and the pivot, the obtained results are expected and justified.

The similar results can be found in some earlier research in which the back and the wingers showed domination in the tests of agility with the ball (Čavala &Katić, 2010).

The future trends in handball development will probably erase the sharp boundaries between the playing positions. However, the roles and the tasks

will remain the key components of the tactical and technical activities required from a player in a certain position. Due to their different roles in different stages of the game, it is necessary to establish and perfect universal technical and tactical knowledge.

CONCLUSION

The results obtained in this research show that there are no statistically significant difference in the explosive power of the lower extremities, speed and agility in female handball players in different playing positions. The differences are obvious when it comes to the body composition of the players and the results point to the fact that the wingers are of statistically significant lower body height and body mass, and that the values of their basal metabolism are also lower than those of the other players. These relations can serve as one of the helping methods in determining the extent to which the players have been trained and prepared. In addition, the results can serve as a guideline for the selection of the players as well as for planning and programming specific training sessions for the players in the positions of left and right backs, left and right wingers, pivots and goalkeepers.

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INFLUENCE OF KINEMATIC PARAMETERS ON BALL VELOCITY OF THE HANDBALL PENALTY THROW

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ABSTRACT

The aim of this study was to investigate the influence of some kinematics parameters (upper extremity, trunk position) on ball velocity of the handball penalty throw. Thirty female elite handball players (height: 1.73 ± 0.08 m; mass: 69 ± 8.9 kg; BMI 22.9 ± 2; training experience: 12.3 ± 6.2 yrs), playing in the first Serbian Handball League from two different clubs volunteered to participate in the present study. The research was of transversal character, during the competition period. An angle of upper body relative to the ground (deg); Shoulder internal rotation (deg); Elbow flexion (deg), that is, the angle closing the longitudinal axis of the upper arm with the longitudinal axis of the forearm was analyzed by Kinovea 0.8.2 kinematic analysis software. Pearson linear correlations were used to calculate the influence of kinematic parameters to throwing ball velocity. A strong negative correlation was calculated between the angle of upper body relative to the ground with the throwing ball velocity (r=-0,496) whereby the big angles relative to the ground was followed by the reduction throwing ball velocity. It has been proven existence of the mean negative correlation between variables shoulder internal rotation and the throwing ball velocity (r=-0,299). Between variables the elbow flexion and the throwing ball velocity there was mean positive correlation (r=0,402), which means that by increasing the angle of elbow flexion increases ball velocity. It can be concluded that the tested kinematic parameters have an influence on the throwing ball velocity in performing a penalty throw in team handball.

Keywords: team handball, throwing velocity, ball velocity, kinematics, penalty throw

INTRODUCTION

Competitive success in team handball depends of the numerous factors such as the anthropometric characteristics, the technical skills and tactics and highs levels of power, force and throwing velocity (Hoff, & Almåsbakk, 1995). In competition, 6-9% during the game constitute penalty throw (Wagner & Müller, 2008). The aim of the offensive handball players is to throw a ball on goal from a position from 7 m distance without being tackled or obstructed by the opposing goalkeeper. An important fact is that the faster the ball is thrown at the goal, the less time defenders and goalkeeper have to save the shot what is important aspect for success (Marković, S., & Marković, K, 2018).

The overarm throw is an example of a complex, discrete and fast movement with a clear beginning and end. It can be divided into six phases: wind-up, stride, arm cocking, arm acceleration, arm deceleration, and follow-through (Werner, Fleisig, Dillman, & Andrews, 1993; Van den Tillar & Ettema, 2007). Maximal internal rotation, maximal elbow flexion and ball release speed are some of characteristic points, which identify the phases of overarm throw. Van den Tillar & Ettema, 2004 used a model that predicted that 73% of the contribution to the ball velocity was explained by the maximal elbow extension velocity and the maximal internal rotation velocity shoulder during the throw.

The velocity of handball throw is dependent on the aspects such as body segments coordination and the technical skills not only on the on the muscular strength (Marković, S., & Marković, K, 2018). Some authors described differences in ball velocity of elite team-handball players revealing that greatest ball velocity was achieved in the standing throw with run-up (26.3 ± 3.2 m•s-1) rather than the standing throw without run-up (23.5 ± 2.2 m•s-1) (Bayios & Boudolos, 1998). This fact indicates that the throwing ball velocity depends on the technique performance, the way the feet, body and arm are positioned. It is not determined how much all throwing kinematics parameters separatly have an

influence on throwing ball velocity, which is an extremely difficult research task since the shot is a complex kinetic chain whose parts are almost impossible to isolate and decompose individually.

The aim of this study was to investigate the influence of some kinematics parameters (upper extremity, trunk position) on ball velocity of the handball penalty throw.

METHODS

Subjects

Thirty female elite handball players (height: 1.73 ± 0.08 m; mass: 69 ± 8.9 kg; BMI 22.9 ± 2; training experience: 12.3 ± 6.2 yrs), playing in the first Serbian Handball League from two different clubs volunteered to participate in the present study. All participants had a certificate from the physician that they were healthy and able to fulfill the requirements that were expected of them, at the time of testing.

Procedure

The research was of transversal character, during the competition period. The testing procedure was standardized (Van den Tillar & Ettema, 2007). The subjects had a warm-up period of 30 min, which needed to be prepared for the optimal organism condition, to have the best respond to the tasks. Each subject performed a shot 3 times from the ground at a distance of 7 m from the goal. A Casio Exillim F1 camera was placed on the side of the throwing arm, recording all three attempts. The task was to hit the target as strong as possible, that is, the upper half of the standard size handball goal (2 m x 3 m). Behind the goal was an interrogator who measured the speed of each shot by radar (Pocket Radar). When the testing was completed, the shot that had the highest velocity of all three attempts was analyzed by Kinovea 0.8.2 kinematic analysis software. For the throwing kinematics parameters were tested three variables: An angle of upper body relative to the ground (deg); Shoulder internal rotation (deg) and Elbow flexion (deg), that is, the angle closing the longitudinal axis of the upper arm. The point describing the center of this angle is the region of the lateral epicondylus (lat. epicondylus lateralis). Maximal throwing ball velocity was also one of the analyzed variables. The phase of ball throwing was analyzed, that is, the moment when the ball leaves the hand of the subject.

Statistical analysis

Statistical analysis was conducted via IBM SPSS Statistics 19 (Statistical Package for Social Sciences, v19.0, SPSS Inc., Chicago, IL, USA) software. To provide basic summaries about the sample and tested variables descriptive statistics was used: average value (MEAN), standard deviation (SD), coefficient of variation (cV%), Minimum (MIN) and Maximum (MAX). Pearson linear correlations were used to calculate the influence of kinematic parameters to ball velocity.

RESULTS

Table 1 shows the basic statistical parameters for kinematic variables and ball velocity for a throw from the ground with a distance of 7 m from the goal (penalty throw).

Table 1 Basic descriptive statistics for the kinematics parameters and ball velocity

Variables	N	MEAN	MIN	MAX	Std. Deviation	Coefficient of variation
An angle of upper body	**30**	**69,17**	**50,00**	**83,00**	**7,38**	**54,49**
Shoulder internal rotation	**30**	**49,53**	**5,00**	**98,00**	**17,54**	**307,64**
Elbow flexion	**30**	**130,37**	**91,00**	**168,00**	**16,23**	**263,34**
Ball velocity	**30**	**75,87**	**61,00**	**93,00**	**9,29**	**86,26**

Descriptive values of kinematic variables (angles) are shown in degrees (°), while ball velocity values are expressed in km/h. Average value of the angle of upper body relative to the ground was 69,17±7,38, average value of the angle of shoulder internal rotation was 49,53±17,54, average value of the angle of elbow flexion was 130,37±16,23 and average value of ball velocity was 75,87±9,29. Minimal value of ball velocity variable was 61 and maximal was 93.

Table 2 Pearson linear correlation coefficients, P-values between kinematic parameters and ball velocity and coefficient of determination (the percentage of variance)

Variables	N	**Ball velocity**	*p*	%Variance
An angle of upper body	**30**	**-0,496****	**0,005**	**25**
Shoulder internal rotation	**30**	**-0,299**	**0,109**	**5**
Elbow flexion	**30**	**0,402***	**0,028**	**16**

**p<,001 (2-tailed).

Relationship between tested kinematic parameters of penalty throw and the ball velocity was express by Pearson linear correlation. Satisfaction with the assumptions of normality, linearity and homogeneity of variance was confirmed by preliminary analyzes. A strong negative correlation was calculated between the angle of upper body relative to the ground with the throwing ball velocity (r=-0,496) whereby the big angles relative to the ground was followed by the reduction throwing ball velocity. It has been proven existence of the average negative correlation between variables shoulder internal rotation and the throwing ball velocity (r=-0,299). Between variables the elbow flexion and the throwing ball velocity there was average positive correlation (r=0,402), which means that by increasing the angle of elbow flexion increases ball velocity.

DISCUSSION

Earlier research has found that the highest velocity of the ball is achieved by shot from the ground from the run-up (100%), then from the ground without run-up (93%) and jump shot (92%)(Wagner, Pfusterschmied, Von Duvillard & Müller, 2011). This study examined the correlation between the selected kinematic parameters to the throwing ball velocity. Kinematic parameters described the angles in the elbow and shoulder joint and the angle of the upper body relative to the ground at the ball release time. According to Van den Tillar & Ettema, 2007 it is considered that two main contributors to the total ball velocity (73%) are the internal rotation of the shoulder together with the extension of the elbow. They found that those subjects who had a smaller angle at the elbow joint at the time of the ball release had achieved higher ball velocity (angle that engages the outside of the forearm with an imaginary axis that is an extension of the upper arm). Our results indicate that subjects who achieved higher ball velocity also had a greater angle at the elbow joint (the angle closing the longitudinal axis of the upper arm with the longitudinal axis of the forearm). Such data confirm the fact that greater acceleration can be achieved if there is greater leverage. Both studies show a significant correlation of extension range with shot efficiency even though the tested sample was of different sex. The highest ranked handball players who competed in the national competition, some of whom were also representative, took part in this research. The angle of the shoulder internal rotation achieved by the handball players was 49.53 ± 17.54 °, while for the handball players in the study of Van den Tillar & Ettema, 2007 it was about 65 ° and subjects who had a faster shot also had a greater angular velocity of shoulder internal rotation. We did not prove that these results were consistent with this study, but we found that by increasing the angle of shoulder internal rotation, the throwing ball velocity decreases and vice versa.

According to some studies about kinematics parameters of shot from the ground 7 m distance from the goal it is proved that elite female handball players had the angle of upper body relative to the ground 65,8±7,9°. Such data can be considered as s model considering that the subjects were the female handball players of the Norwegian national selection (Van den Tillaar & Cabri, 2012). Average value of the angle of upper body relative to the ground was 69,17±7,38 what was a little difference which may be justified by different body structure. Considering that the results do not differ significantly, it can be concluded that there is a great similarity in the technique of taking a shot from the ground 7 meters distance from the goal in top handball players regardless of nationality. Statistical processing has found that the big angles relative to the ground was followed by the reduction throwing ball velocity. This can be explained by the fact that the standing throw involves keeping the lead foot on the floor during the throw and is typical for the penalty throw in team handball (Wagner, Pfusterschmied, Von Duvillard & Müller, 2011). The fact is that the throwing ball velocity also depends on the muscular strength of the abdominal musculature when it comes to this segment of the body, so the results can be explained if the subject flexes the body more during the shot, giving a stronger impulse, the faster the ball throw.

CONCLUSION

Based on the obtained results, it can be concluded that the kinematic parameters at the moment of ball

release (the moment when the ball left the hand of the subject) have an influence on the throwing ball velocity, at a shot 7 m distance from the goal. This data indicates that coaches should pay attention to the method of taking a shot from 7 meters, in the training cycle, as it is often a crucial factor for winning games. Each team should have its own statistician who will keep an eye on the number of missed and scored penalties in the match so that the records can contribute to the improvement in the realization of the same and, consequently, to the reduction of the number of errors. Higher throwing ball velocity in the top handball players of this research is conditioned by decrease of the upper body angle in relation to the ground, decrease of the angle of shoulder internal rotation and increase of the range of extension in the elbow joint. If the lever of the throwing arm is higher and a stronger force is created that will cause increased flexion in the hip joint (reduced upper body angles relative to the ground), the throwing ball velocity will be higher.

The information obtained can be useful for coaches in planning training programs, especially in the period when new handball players are created. Future research in the field of kinematic analysis of handball throwing should be based on current knowledge. A suggestion for further research is to examine whether the longitudinal dimensionality of certain parts of the hand (arm length, forearm, or upper arm) and the whole arm affect the velocity of ball release. It is also advisable to carry out similar research with the male population of elite handball players.

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RELATIONSHIP BETWEEN ANTHROPOMETRIC CHARACTERISTICS AND EXPLOSIVE STRENGTH OF ARM AND SHOULDER REGION IN WHEELCHAIR BASKETBALL PLAYERS

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ABSTRACT

The aim of this study was to investigate the relationship between anthropometric characteristics and explosive strength of arm and shouldar region in wheelchair basketball players.The sample of respondents were wheelchair basketball players, national team of Serbia (n=12), age (22-49 ± 7,61), with at least three years of sports experience in this sport. In this study, the following variables were used to access anthropometric characteristics: sitting height (SEDVIS), body weight (TT), arm length (DUZRU), shoulder width (SIRRAM), upper arm circumference (OBNA), and chest circumference (OBGR). For the motor variable, the explosive strength of arm and shoulder region (BCMED) was selected. Of the statistical techniques, Pearson's correlation was used to determine the association between the variables. The results of this study showed that there was a statistically significant association between the variables (DUZRU, BCMED) (p=0,02) and between the variables (OBGR, BCMED) (p=0,02), while there was no statistically significant association with the other variables. Future research should include other motor abilities, especially situational motor abilities that are relevant to basketball, given that it is abundant in different situational and motor phases. It would be interesting to see to what extent the efficiency of wheelchair basketball players from different positions in the game is determined by anthropometric characteristics along with situational motor abilities, in order to more easily understand the complexity of the wheelchair basketball itself.

Keywords*:*wheelchair basketball, anthropometric characteristics, explosive strength, relationship.

INTRODUCTION

Wheelchair basketball is one of the most popular sports among Paralympic disciplines in persons with different types of disabilities, according to the International Federation of Wheelchair Basketball Federation (IWBF) classification protocol (Iturricastillo, Granados & Yanci, 2015). Wheelchair basketball is played in more than 80 countries at a competitive level and attracts the interest of male and female coaches and work analysts (Angel-Gomez, Perez, Molik, Szyman & Sampaio, 2014). Given the wide range of functional and motor abilities of wheelchair basketball players, it is necessary to establish a clasification system that ensures equal participation for all eligible athletes (Molik, Laskin, Golbeck, Kosmol, Rekowski, Morgulec-Adamowicz, Rutkowska, Marszalek, Gajewski & Angel-Gomez, 2017). Players receive points ranging from 1,0 (for players with the lowest physical function) to 4,5 points (for players with the highest physical function including players with minimal disabilities) based on the classification (Александровић, Јоргић и Мирић, 2016; Molik et al., 2017). According to IWBF rules, the maximum number of points a team can have on the field is 14 (1p+2p+3p+3,5p+4,5p=14) (Molik et al., 2017). Basketball consists of activities that require explosive power, speed and medium intensity (Akınoğlu & Kocahan, 2017). Wheelchair basketball requires the biomechanical and coordination engagement of the upper extremity muscular apparatus, especially the shoulder region muscular apparatus. The greatest contribution is made by the shoulder flexors during the pushing phase, i.e., the propulsion and the shoulder extensors during the retropulsion phase, or during the returin to the zero position (Akınoğlu & Kocahan, 2017). In addition to biomechanical parameters, other parameters should also be considered for the performance of

wheelchair basketball players such as: physiological, psychological, motor functioning and control, level of technical and tactical knowledge and anthropometric parameter.

That anthropometric characteristics are significant for the basketball player's situational efficiency and that every basketball player's position in the game depends on antropometric characteristics, studies have confirmed (Hoare, 2000; Jeličić, Šekulić & Marinović, 2002; Gerodimos, Manou & Kellis, 2005; Carter, Ackland, Kerr & Stapff, 2005; Koley, Singh & Sandhu,2010; Petrović, Ramos, Šolaja, Golik-Perić & Obradović 2013; Apostolidis & Emmanouil, 2015; Borović, Rupčić, Matković, Garafolić i Daić, 2016; Gomez, Mendez, Zanetti, Leite & Junior, 2017; Gryko et al., 2018).The difference is that the respondents were not wheelchair basketball players, but basketball players without disabilities, but studies clearly indicate the significant impact of anthropometric characteristics in basketball, and that it would be worth paying attention to them, when analyzing the situational effectiveness of wheelchair basketball players. On the other hand, analyzing and searching the literature, it can be concluded that there is a relatively small number of studies that have addressed the problem of anthropometric characteristics in wheelchair basketball players (Angyan, Teczely, Zalay & Karsai, 2003; Wang, Chen, Limroongreungrat & Change, 2005; Ciliga, Petrinović-Zekan & Trošt, 2006; Cavedon, Zancarano & Milanese, 2015; Granados, Yanci, Badiola, Iturricastillo, Otero, Olasagasti, Bidaurrazaga-Letona & Gil, 2015; Oliveira, Oliveira, Guimarães & Costa, 2017; Ferreira, Souza, Nascimento, Tartaruga, Portela, Mascarenhas & Queiroga, 2017).

The aim of this study was to investigate the relationship between anthropometric characteristics and explosive strength of arm and shouldar region in wheelchair basketball players.

METHODS

Subjects

The sample consisted of wheelchair basketball players, Serbian national team players (n=12), age group (22-49 ± 7,61), with at least three years of sports experience in that sport, and who train at least three times a week.

Procedure

In this study, the following variables were used to access anthropometric characteristics: Sitting height (SEDVIS), Body weight (TT), Arm length (DUZRU), Shoulder width (SIRRAM), Upper arm circumference (OBNA) and Chest circumference (OBGR). For the motor variable, the explosive strength of arm and shoulder region was selected. A 2 kg medicine ball was used to evaluate the explosive power of the shoulder region and arm - Medicine ball throwing (BCMED).

Statistical analysis

All statistical analyzes were processed through „IBM SPSS Statistics" (version 23,0). Descriptive statistics were used for all variables: arithmetic mean (MEAN), standard deviation (SD), minimum value (MIN), maximum value (MAX). A Pearson correlation (r) was used to determine the association between anthropometric characteristics and explosive strength of arm and shoulder region. Significance level (p) was at $p<0,05$.

RESULTS

Table 1. Descriptive description of all variables

VARIABLES	N	MIN	MAX	MEAN	SD
SEDVIS	12	120,30	155,60	140,23	11,29
TT	12	65,00	98,00	78,20	8,80
DUZRU	12	69,50	83,80	75,98	4,22
SIRRAM	12	46,80	52,10	48,78	1,75
OBNA	12	21,00	35,00	29,34	5,15
OBGR	12	87,00	114,00	100,37	8,79
BCMED	12	6,00	10,00	7,79	1,30

Legend: N - number of respondents, MIN - minimum value, MAX - maximum value, MEAN - arithmetic mean, SD - standard deviation, SEDVIS - Sitting height, TT - Body weight, DUZRU - Arm length, SIRRAM - Shoulder width, OBNA - Upper arm circumference, OBGR - Chest circumference, BCMED - Explosive strength of arm and shoulder region.

Table 1. shows the basic descriptive data for the variables observed in this study; statistical entity count, minimum value for each variable, maximum value for each variable, calculation of arithmetic mean for each variable, and calculation of standard deviation values for each variable.

Table 2. Relationship between anthropometric variables with a variable explosive strength of arm and shoulder region (BCMED)

VARIABLES	r	p
SEDVIS	0,33	0,29
BCMED		
TT	0,47	0,12
BCMED		
DUZRU	**0,65**	**0,02**
BCMED		
SIRRAM	0,36	0,23
BCMED		
OBNA	0,15	0,63
BCMED		
OBGR	**0,65**	**0,02**
BCMED		

Legend: r - correlation value, p - statistical significance coefficient, SEDVIS- sitting height, TT- body weight, DUZRU - arm length, SIRRAM - shoulder width, OBNA- upper arm circumference, OBGR - chest circumference, BCMED -explosive strength of arm and shoulder region.

Table 2. shows the significant correlation between the variables as well as the strength of the correlation, or the relationship between them. Analyzing this table, one can see the correlation between the SEDVIS variable and BCMED is weakly distributed (r=0,33), and not statistically significant (p=0,29). There was no statistically significant association between the TT and BCMED variables (p=0,12). However, if the Pearson correlation value is analyzed, it can be concluded that the correlation between TT and BCMED is moderate (r=0,47). With the DUZRU and BCMED variables, analyzing the Pearson correlation value (r=0,65), it can be concluded that a strong correlation is present between the variables with statistical significance (p=0,02). Relatively weak correlation (r=0,36) was present with SIRRAM and BCMED, but not statistically significant. The weakest Pearson correlation, that is, the correlation between the two variables, was detected with OBNA and BCMED (r=0,15) without statistical significance. With the OBGR and BCMED variables, analyzing the Pearson correlation value (r=0,65), it can be concluded that a strong correlation with statistical significance is present (p=0,02).

DISCUSSION

Analyzing the wheelchair basketball game as a hole, it can be concluded that it is full of various actions and reactions of players, different phyisological intensity (anaerobic-aerobic), motor, situational motor (movement, addition, catching, driving, dribbling, kicking), psychological, technical and tactical functioning. In wheelchair basketball players, motor functioning, motor control and upper limb strength are very important for situacional performance, because of the specifity of the movement. The movement of wheelchair basketball players is realized by two biomechanical phases: propulsive and retropulsive. Wheelchair basketball requires the biomechanical and coordination engagement of the upper extremity muscle apparatus, especially the shoulder region muscle apparatus. The greatest contribution is made by the shoulder flexors during the pushing phase, namely the propulsion, and the shoulder extensors during the retropulsion phase, or during the return to the zero position (Akınoğlu & Kocahan, 2017). The overall structure of the biokinematic model of a wheelchair basketball player is complex, because it depends on numerious factors that can affect the performance and success of the wheelchair basketball player (motor, biomechanical, functional, neurophysiological, morphological etc.). This study examined the relationship between anthropometric characteristics and the explosive strength of arm and shoulder region in wheelchair basketball players, in order to better understand the role of anthropometric characteristics on the basketball players' situational efficiency. It should be noted that so far, no scientific research in Serbia has been done on wheelchair basketball players, which aimed to examine whether anthropometric characteristics can affect the performance of wheelchair basketball players, and which of them can contribute most to this. On the other hand, in the scientific literature, relatively few scientific studies have addressed the anthropometric characteristics of wheelchair basketball players (Angyan, Teczely, Zalay & Karsai, 2003; Ciliga, Petrinović-Zekan & Trošt, 2006; Cavedon, Zancarano & Milanese, 2015; Granados, Yanci, Badiola, Iturricastillo, Otero, Olasagasti, Bidaurrazaga-Letona & Gil, 2015; Oliveira, Oliveira, Guimarães & Costa, 2017; Ferreira, Souza, Nascimento, Tartaruga, Portela, Mascarenhas & Queiroga, 2017; Wang, Chen, Limroongreungrat & Change, 2018). It is also very important to point out that not all anthropometric variables were examined in this study, and that only one motor ability was

included, which is why conclusions should be drawn cautiously. Because of all this, it is difficult to compare the results of this study with those of the aforementioned studies. In this study, the respondents were wheelchair basketball players, national team of Serbia, who have experience competing in international basketball games. Of all the variables observed in this study, the Pearson correlation found a statistically significant association for the variables (DUZRU, OBGR) with variable (BCMED). The length of the arms gives the player a greater chance of effectively adding the ball to his teammate, while on the other hand, the circumference of the chest, i.e., the mass of the chest, allows for an adequate accumulation of mechanical force that will make a significant contribution to the ball throwing. In each case, both variables coordinate together, so the correlation of both variables is significant (p=0,02). For variables (SEDVIS, TT), there is no statistically significant correlation with variable (BCMED). However, if correlation values are observed, it can be seenthat there is a relatively weak correlation between the variable (SEDVIS) with the variable (BCMED), while the correlation value between the variable (TT) with variable (BCMED) is mean (r=0,47). The body weight value expressed in kilograms of body weight was quantified and statistically analyzed, but other body composition variables were omitted (body fat, body fat percentage, muscle mass, percentage of muscle mass, visceral fat, visceral fat percentage, BMI), that could contribute to explaning why there is no correlation between the variable (TT), and variable (BMCED). It should be noted that it is extremely complex to arrange weight measurements for wheelchair users (Ciliga, Petrinović-Zekan & Trošt, 2006). Therefore, the quantitative values of body weight in this study were collected by subjects reporting their body weight. The anthropometric measurement of the sitting height variable (SEDVIS) is specific, because respondents are not able to measure it in the way people with disabilities are measured, since players are wheelchair users. For other variables (SIRRAM, OBNA), there was no statistically significant correlation with the variable (BCMED). A possible reason why there is no correlation between the variable (OBNA) and variable (BCMED) should be looked at in terms of body weight, which varied among subjects on the one hand, while on the other, as said for variable (TT), the others were omitted variables that make up the overall body status of individuals, so it is necessary to interpret the results carefully. As another reason, the morphological profile of the respondents was heterogeneous, so this difference probably had an effect on the result itself.

The shoulder width from the biomechanical point of view allows a greater degree of freedom in terms of mobility, on the one hand, while on the other shoulder region provides stability for performing the shot. In futher studies, it is necessary to continue exploring the impact of anthropometric characteristics on the situacional performance of wheelchair basketball players, with the inclusion of other motor abilities, above all, situacional motor abilities, whose role is important in basketball.

CONCLUSION

The results of this study showed that there was a statistically significant association between the variables (DUZRU, BCMED) and between the variables (OBGR, BCMED), while the other variables were not statistically related to the variable (BCMED). This study did not examine all anthropometric characteristics, as well as the fact that only one motor ability was tested, so the conclusions should be drawn with caution. It is necessary to continue exploring the anthropometric characteristics of wheelchair basketball players in to find out to what extent their role is crucial and necessary for basketball success at games. Future research should include other motor abilities, especially situational motor abilities that are relevant to basketball, given that it is abundant in different situational and motor phases. It would be interesting to see to what extent the efficiency of wheelchair basketball players from different positions in the game is determined by anthropometric characteristics along with situational motor abilities, in order to more easily understand the complexity of the wheelchair basketball itself.

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THE RELATIONSHIP BETWEEN MUSCULAR FITNESS AND BODY COMPOSITION IN FOOTBALL

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ABSTRACT

Introduction. The characteristics of players based on their positions on the team are useful for determining a player's profile, which based on specific requirements. Body height and body weight are significantly connected to the physical requirements of the game of football among young football players. The aim of this research is to determine the connections between body composition and the differences based on player position on the team on a sample of young football players. The method. The study is of the transversal kind, and includes junior and cadet football players. It included 49 football players, 23 cadets, competing in the Cadet league of Serbia, and 26 juniors competing in the Quality league of Serbia. The sample of variables which was used in the research consists of the following set of eight variables: five variables for the evaluation of body composition, and three variables for the evaluation of explosive power (countermovement jump (CMJ), countermovement jump free arms (CMJA), and the squat jump (SJ)). The results. No statistically significant connection was determined between the variables of explosive power and the variables of body composition among the cadets, while among the juniors the TM shows a statistically significant, moderate, negative connection on the tests CMJ (-.472), CMJA (-.408), and SJ (-.467). Statistically significant differences between the groups can be found only between midfielders and forward players in lean body mass (.027) and variables of muscle mass (.031). Discussion and conclusion. The research indicates that there is a statistically significant connection between the variables of the percentage of body fat and the tests of explosive power only among the juniors, while in the case of the remaining variables, and the cadets, no connections were determined. The results indicate that it could be assumed that this increase in the percentage of body fat has a negative impact on the fitness of the players. In the case of differences in terms of player position on the team, the results indicate that there is no great and significant difference in the values of explosive power and body composition of football players.

Keywords: maturation, power, reaction rate, hamstring, Q ankle

INTRODUCTION

In addition to the various challenges in football, there are also types of movement which require maximal effort over a short period of time, such as sprinting, acceleration, agility and jumping (Gunnar, & Svein, 2015). Football is an activity in which sporadic high intensity exercise programs are combined with movements of lower intensity (Stølen, et al., 2005). By analyzing competitive activities in football, on the individual or team level, we can identify those moments in the game which to a greater or smaller extent influence the final result (Castelano, Casamichana, & Lago, 2012; Liu, & Gomez, 2014; Liu, et al., 2015). The speed and explosive power of the lower extremities are considered a precondition for success in junior league football (Reilly, Bangsbo, & Franks, 2000). Explosive power refers to the activities which enable the muscles to realize maximal power in the shortest period of time (Kaeding, & Whitehead, 1998). The development of explosive power must at the same time also include strength training, speed training, training for the development of aerobic capacities and flexibility. Understanding physical requirements and their features in the case of football players, in relation to age, player position, and load, can improve the physical performance of the players (Manson, 2013). The characteristics of the players in terms of their positions on the team is useful for determining player profiles, which are based on specific requirements. Body height and body weight

are significantly related to physical requirements which the game itself demands of young football players (Mathisen, & Petersen, 2015). However, we cannot speak of one isolated characteristic of body composition or a single ability which is the deciding factor for the end result. The most favorable values of body composition can lead to an improvement in the general level of fitness and anaerobic power (Nikolaidis, 2014). Football players have lower levels of body fat and an increased percentage of muscle mass (Popovic, et al., 2014). Excess body fat can be the result of unnecessary load and can decrease effectiveness during play (Bajramović, et al., 2019). Tests for the evaluation of explosive power of the lower extremities indicated a statistically significant connection with competitive success in the case of professional football players (Arnason, et al., 2004; Mujika, et al., 2009; Wisløff, Helgerud, & Hoff, 1998). Studies focusing on muscle power mostly present these results as the values of the vertical jump, assessed using various tests. The tests which are most frequently applied to evaluate explosive power of the lower extremities are the countermovement jump (CMJ), countermovement jump with arms (CMJA), and the squat jump (SJ). Studies which analyzed the vertical jump indicated that the values range from 55.6–63.4 cm (Strudwick, Reilly, & Doran, 2002; Thomas, & Reilly, 1979), while other studies have determined that the values for the countermovement jump in the case of professional football players range from 41.4–41.6 cm (Casajus, 2001; Cometti, et al., 2001). The connection between body composition and the parameters of physical fitness are in some sports used for professional sports selection (Miller, et al., 2002; Sawyer, et al., 2002; Stuempfle, Katch, & Petrie, 2003). However, there is still an insufficient number of studies of this kind involving young football players. Body composition is usually divided up into fat and lean body mass. It could be assumed that an increase in body fat has a negative impact on the physical fitness of the athletes (Doxey, et al., 1987). On tests used to evaluate physical fitness and body fat among younger athletes, lower results for physical fitness were recorded when the values of body fat exceeded 10% (Mcleod, Hunter, & Etchison, 1983).

The aim of this research is to determine the connection between body composition and the differences based on player position on the team, on a sample of younger football players.

METHODS

Subjects

The research included a sample of 49 football players of the FC Radnicki from Nis, juniors and cadets, divided into two subsamples. The first subsample included 26 junior football players, of a chronological age of (18±0.5 yrs), while the second subsample included 23 cadets, of a chronological age of (16±0.5 yrs). The research was carried out during a transitional period. The evaluation of body composition and explosive power was determined in the morning hours (10am). One day prior to the evaluation of body composition, the participants had to follow protocol, which required that they not consume food or drink after 10pm. In addition, in the morning hours prior to the testing, the participants did not consume either food or drink. The tests for the evaluation of explosive power were preceded by a standardized warm-up which consisted of running at a moderate intensity (4 min), static and dynamic stretching (4 min), and acceleration (2 min). All of the football players voluntarily agreed to take part in the measurements and did not have any injuries to the locomotor apparatus which might possibly affect the final outcome.

Procedure

The anthropometric variables (Body Height (BH), Body Weight (BW)) were measured according to standard procedures of the International Society for the Advancement of Kinanthropometry (ISAK) as stated in Marfell-Jones, & et al., (2006). Body composition, Body Fat (BF), Low Body Mass (LBS) and Muscle Mass (MM) were determined using the InBody 720 (Aandstad, et al., 2014). To evaluate explosive power, i.e. vertical jumping ability, the following tests were used: the Countermovement jump (CMJ), Countermovement jump free arms (CMJA) and the squat jump (SJ). The countermovement jump test was measured using the Optojump (Glatthorn, et al., 2011). The values of the jump were obtained when the participant was asked to stand in a limited space which is covered by Optojump sensors. From an upright position, at the researcher's mark, the participant, arms 'fixed' at the hips, performs a semi-squat and from that position attempts to jump as high as possible. The mistake that occurs during the performance is that the hands move from the hips. The Countermovement jump free arms is a test which also evaluates the explosive power of the lower extremities and differs only in the fact that during this test the arms are 'free', need not be 'fixed' to the hips, and could provide an additional impulse during take-off. It was also measured using Optojump sensors (Glatthorn, et al., 2011). The final test for the evaluation of the explosive power of the lower extremities is the squat jump. The test procedure requires the participant to assume an initial position in a semi-squat, hands on hips. At the researcher's mark, the participant takes

off from the starting position and performs a vertical jump. The values of the jump are recorded on a screen using Optojump sensors (Glatthorn, et al., 2011).

Statistical analysis

All of the data compiled during the research were processed using descriptive and comparative statistics. In terms of descriptive statistics, for each variable the measures of central tendency and measures of dispersion were calculated: means (Mean), minimal values (Min), maximal values (Max), range (Range), standard deviation (Std. Dev.), while to determine the distribution, Skewness and Kurtosis were calculated. In terms of comparative statistics, discriminant parametric procedures were used, a one-way analysis of variance, ANOVA, and the Post Hoc test which was used to determine the differences in relation to player position. To determine the connection between body composition and explosive power of the lower extremities, a correlation analysis was used. To process the data, the statistical package for personal computers IBM SPSS software was used (v17.0, IBM Corporation; Armonk, NY, USA).

RESULTS

Table 1 presents the descriptive parameters of the football players of various ages and levels of competition. The analysis of the results confirmed that the juniors were more dominant in terms of explosive power, on all the tests, which is linked to their age and the point of achieving peak explosive power. Average values on the tests of explosive power were noted among the juniors, which can also be seen in the maximal recorded values, so that we can conclude that the linear relationship between explosive power and the age of the football players is evident.

Table 1. Basic statistical parameters of the football players

Variables	Age	Mean	Std. Dev.	Range	Min	Max	Skewness	Kurtosis
BH	Cadets	176.71	6.254	22.2	164.4	186.6	-.063	-1.068
(cm)	Juniors	176.69	8.101	34.1	158.9	193	-.091	.321
BW	Cadets	65.77	8.756	32.1	51.2	83.3	.351	-.764
(kg)	Juniors	68.48	8.765	35	52.4	87.4	.159	-.387
CMJ	Cadets	31.82	4.150	15.3	24.5	39.8	.067	-.601
(cm)	Juniors	33.71	3.474	16.1	24.3	40.4	-.416	.964
CMJA	Cadets	38.03	4.465	16.4	30	46.4	.000	-.797
(cm)	Juniors	40.04	5.188	24	28	52	.065	.805
SJ	Cadets	30.60	3.659	13.1	23.8	36.9	.059	-.659
(cm)	Juniors	32.11	3.582	19.6	22.6	42.2	.217	2.739
BF	Cadets	11.69	3.551	18.2	6.1	24.3	1.869	5.939
(%)	Juniors	11.71	2.671	9.1	6.8	15.9	-.366	-1.025
LBM	Cadets	57.84	7.553	25.4	45.1	70.5	.212	-1.121
(kg)	Juniors	60.36	7.320	28	46.1	74.1	.328	-.378
MM	Cadets	32.61	4.450	15.1	24.9	40	.187	-.104
(kg)	Juniors	34.24	4.321	16.9	25.9	42.8	.329	-.354

Similar average values were noted for the variables BH and BF, while the juniors had greater average values for the variables BW, LBM and MM. The analysis of the symmetry of the results of the junior football players enabled the formation of the distribution frequency with a statistically negative asymmetry for the variable (BH), while for the other variables there are no significant deviations from normal distribution. In the case of junior football players, a statistically negative asymmetry was noted for the variables (BH, CMJ, BF). In terms of homogeneity, there is a leptokurtic and platykurtic curve among the football players of both age categories.

Table 2. Pearson's correlation, cadets

Variables	CMJ	CMJA	SJ	BF	LBM	MM
CMJ	1	.937**	.951**	-.043	.221	.222
CMJA		1	.905**	-.099	.209	.215
SJ			1	-.147	.120	.122
BF				1	-.091	-.095
LBM					1	.999**
MM						1

**p<0.01

Table 3. Pearson's correlation, juniors

Variables	CMJ	CMJA	SJ	BF	LBM	MM
CMJ	1	.823**	.853**	-.472*	-.247	-.238
CMJA		1	.781**	-.408*	-.205	-.198
SJ			1	-.467*	-.290	-.278
BF				1	.137	.146
LBM					1	.998**
MM						1

**p<0.01; *p<0.05

The values of the connection between the parameters of explosive power (CMJ, CMJA, SJ) and the values of body composition are shown in tables 2 and 3 for the cadet and junior football players. No statistically significant connection between the variables of explosive power and variables of body composition were noted for the cadets, while in the case of the juniors, the BF showed a statistically significant, moderate, negative connection with the tests CMJ (r=-.472), CMJA (r=-.408) and SJ (r=-.467). To determine the statistically significant differences between player positions in terms of explosive power and body composition, the one-way analysis of variance, ANOVA, was used (Table 4). An analysis of the results in table 4 indicated that there are statistically significant differences between the football players for the variables LBM (p<0.031) and MM (p<0.033).

Tabela 4. Differences in the anthropometric characteristics and explosive power of the football players - Anova, Post Hoc

Variables	Position				Anova	
	GK	DF	MF	FW	F	p
CMJ	29.50±6.78	33.71±4.02	32.67±3.44	32.46±4.50	.774	.515
CMJA	35.85±8.27	40.04±5.15	38.66±4.75	39.45±4.80	.536	.660
SJ	29±5.37	32.22±4.37	31.33±3.28	30.70±3.22	.623	.604
BF	13.05±0.21	12.10±4.44	11.58±2.53	11.78±1.94	.184	.906
LBM	62.85±2.19	60.22±6.80	56.38±6.29*	64.70±9.52	3.236	**.031**
MM	35.80±1.55	34.08±3.99	31.84±3.70*	36.68±5.75	3.164	**.033**

Note: Goalkeeper – GK; Defender – DF; Midfielder – MF; Forward – FW. *Midfielder vs Forward p<0.01

Following the analysis of the results of the Post Hoc, the differences in the explosive power and body composition among football players of various ranks of competition were presented in table 4. Statistically significant differences were noted for body composition between the midfielders and forward players for the variables LBM and MM.

DISCUSSION

The obtained results of the correlation for the cadets indicate that there is no statistically significant connection with body composition. However, among the juniors, the percentage of body fat indicates a statistically significant connection with the tests of explosive power. In the research of Silvestre, et al., (2006), the values of the vertical jump indicate a statistically significant connection with the percentage of body fat. Similar results were obtained by the authors Stuempfle, Katch, & Petrie (2003), who determined that the values of the correlation range from 0,52 to 0,70. Better results in explosive power of the lower extremities and body composition were achieved by juniors in comparison to cadets.

Differences in terms of positions on the team and the variables of explosive power and body composition indicate a statistically significant difference only between the forward players and midfielders (Table 6), for two parameters of body composition, muscle mass and lean body mass. In the work of Silvestre, et al., (2006), it was concluded that midfielders have a lower percentage of body fat and higher values of lean body mass compared to the forward players. In addition, the research of Lago-Peñas, ReyCasáis & Gómez-López (2014) indicates that midfielders have somewhat lower values of the percentage of body mass compared to forward players. The research of Lago-Peñas, et al., (2011) indicated that midfielders have lower levels of percentage of body fat, but no statistically significant differences were determined.

CONCLUSION

This research indicates that there is a statistically significant connection between the variables for the percentage of body fat and the tests of explosive power only in the case of the juniors, while for the remaining variables and the cadets, no connections were determined. The results indicate that it could

be assumed that the increase in the percentage of body fat has a negative impact on the physical fitness of athletes. When it comes to the differences based on the positions on the team, there was no great and significant difference in the values of explosive power and body composition among the football players. The recommendations and conclusions of the paper are that further research, in order to obtain as precise results as possible, should analyze a greater number of variables of body composition. Furthermore, the recommendation is that, in addition to the tests of explosive power of the lower extremities, tests of speed, agility and endurance also be included.

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DIFFERENCES IN THE AGILITY OF FEMALE FOOTBALLERS IN RELATION TO THE TEAM POSITION

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ABSTRACT

A game of football is characterized by richness and variety of movement. High level of motor skills is a basic prerequisite for a quality and effective display of technique and tactics in football (Joksimović, 2008). The aim of this paper is to determine the differences in the agility of female footballers in relation to the player position. The sample consisted of 20 female footballers aged 17 to 20. The sample of measuring instruments consisted of a three-test battery (T-test, Zigzag and Slalom). A T-test for independent samples was used to determine differences between groups of subjects. Based on the obtained results, it can be concluded that there are no statistically significant differences in agility between female footballers at different positions in a team.

Key words: agility, football, women, motor skills.

INTRODUCTION

Football (Eng. *football, derived from words foot* and *ball*) is one of the most popular sports of today, widespread in almost every continent. It can be played by people of all ages and genders. Football is often referred to as "the most important unimportant thing in the world" (Avramović, 2014). Today, over 240 million people in more than 200 countries around the world are actively engaged in football (Hillis, 1998).

Due to the speed at which the game is played, the complexity of movement in it, the conditions in which it takes place and the active interference of opponents, in order to achieve a favorable sports result, it is necessary for players to have a high level of motor skills, a high level of intellectual abilities and a favorable structure of personality traits" (Špirtović, Aćimovic & Joksimović 2012, 391). As a complete sport with a wide variety of possible movements, football is regarded as a complex sport (Malacko, 2000).

A game of football is characterized by richness and variety of movement. A high level of motor skills is a basic prerequisite for a quality and effective display of technique and tactics in football (Joksimović, 2008). Modern football is characterized by dynamism and constant increase in the speed of the game, and the motor skills that most influence the speed of the game in football and limit the footballer's movement ability are explosive power, speed, agility and endurance (Pivovarniček, Pupiš, Tonhauserova & Tokárová, 2013).

Agility represents the synthesis of almost all the motor skills an athlete possesses (Verstegen & Marčelo, 2010). It is defined by motor tasks that consist of fast running with frequent changes in direction of movement (Jovanović, 1999). The ability to stop quickly and change direction is an obvious example of a physical ability that provides the conversion of classic speed to specific speed in almost all sports (Kremer & Gomez, 2010). In literature of various authors, explosive power, agility and speed are often found in the same context as velocity - explosive properties (*In English* SAQ - speed, agility and quickness. (Milanović, 2004).

METHODS

The sample of subjects

The sample of subjects in this study consisted of FC Mašinac female footballers who are actively engaged in the training process. A total of 20 female players, 17 years of age ± 6 months participated in this study. The subjects were divided into three groups with respect to the player position. The first group consisted of forward players, the second

group included centrals (midfielders) and the third group consisted of defense players.

The sample of measuring instruments

The sample of measuring instruments in this study consisted of a battery of three agility assessment tests (T-test, Zigzag, Slalom).

Statistical data processing

In order to obtain relevant results, statistical procedures appropriate to the subject of the survey were used. Descriptive statistics results were presented for each variable. A T-test for independent samples has been used to determine differences between the groups of subjects. Data have been processed using the statistical program *SPSS* 22, with a significance level of 0.05.

Description of the Agility Assessment Tests

T-test

Equipment: four cones, tape, computerized photocell system.

Task: Cross the path between the four cones (A, B, C and D) placed in the shape of a letter T in the shortest possible time (Figure 1). The subject starts at cone A, sprints to cone B and touches the cone with their right hand. Then, they shuffle sideways to cone C and touches it with their left hand. They use the same kind of movement to reach cone D and touch it with their right hand, then again to cone B touching it with the left hand. The last stage is done by running backwards to cone A. A computerized photocells system for measuring time is set at the start and the finish.

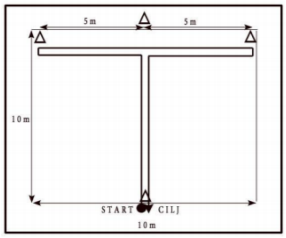

Figure 1. T-test for agility assessment
http://www.brianmac.co.uk/tdrill.htm

Zigzag

Equipment: five cones, computerized photocell system.

Test: Subjects run 20 m at maximum speed, changing direction by 100 at every 5 m. The computerized photocell system for measuring time was set at the start and the finish - perpendicular to the direction of the subjects' movement (Figure 2).

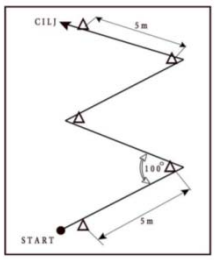

Figure 2. Zigzag test for agility assessment
https://www.topendsports.com/testing/tests/zigzag.htm

Slalom

Equipment: two flags, six cones, computerized photocell system.

Task: Six cones were placed between the two flags, 20 m apart. The first at a distance of two meters, and each next at a distance of three meters. The subjects should cross the path between them as soon as possible. A computerized photocells system for measuring time is set at the start and the finish.

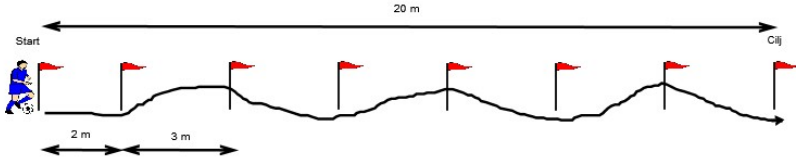

Figure 3. Slalom test for agility assessment
https://www.researchgate.net/figure/Diagram-of-the-slalom-dribble-test-course-Key-cone-n-timing-gate_fig1_26331807

RESULTS

Table 1. Descriptive statistics

Variable	N	Range	Min	Max	Mean	St.Dev.	Skewness	Kurtosis
T-test	20	2.91	10.84	13.75	12.43	.78	-.608	.014
Zigzag	20	1.77	6.83	8.60	7.75	.47	-.134	-.574
Slalom	20	2.16	7.35	9.51	8.77	.48	-1.480	3.180

Legend: **N**-number of subjects; **Range**-span; **Min**-minimal value; **Max**-maximal value; **St.Dev**-standard deviation; **Skewness**-*Skjunis*; **Kurtosis**-*Kjurtosis*

Table 1 shows the basic statistical parameters of agility. Twenty subjects participated in the study. The T-test achieved a mean score of 12.43 and a standard deviation of .78. The results of this test are normally distributed as can be seen based on the values of skewness and kurtosis.

The Zigzag test achieved a mean score of 7.75 and a standard deviation of .47. The results of this test are normally distributed, which we can see based on the value of skewness and kurtosis.

The Slalom test achieved a mean score of 8.77 and a standard deviation of .48. The results of this test are normally distributed, which we can see based on the value of skewness and kurtosis.

Differences in values on the T-test between the players relative to the position on the team have been tested by the T-test for independent samples. The results are shown in the table below.

Table 2. – Results of agility on T-test

Variable	Group	N	Mean	Std. Deviation	Sig.
T-test	Defense	6	12.58	.790	.810
	Midfielders	7	12.18	.759	
T-test	Defense	6	12.58	.790	.929
	Forward	7	12.55	.865	
T-test	Midfielders	7	12.18	.758	-.911
	Forward	7	12.55	..865	

Legend: **N**-number of subjects; **Mean –** mean value; **St.Dev**-standard deviation; **Sig –** significance level

Table 2 shows the results of the T - test for independent samples. Based on the results of the T - test for independent samples, it can be concluded that there is no statistically significant difference in the values of agility in relation to the position on the team.

Table 3. – Results of agility on Zigzag test

Variable	Group	N	Mean	Std. Deviation	Sig.
Zigzag	Defense	6	7.96	.303	.081
	Midfielders	7	7.69	.557	
Zigzag	Defense	6	7.86	.303	.204
	Forward	7	7.73	.550	
Zigzag	Midfielders	7	7.69	.313	.801
	Forward	7	7.73	..680	

Legend: **N**-number of subjects; **Mean** – mean value; **St.Dev**-standard deviation; **Sig** – significance level

Table 3 shows the results of the Zigzag test for independent samples. Based on the results of the T - test for independent samples, it can be concluded that there is no statistically significant difference in the values of agility in relation to the position on the team.

Table 4. – Results of agility on Slalom test

Test	Group	N	Mean	Std. Deviation	Sig.
Slalom	Defense	6	8.73	.464	.562
	Midfielders	7	8.82	.313	
Slalom	Defense	6	8.73	.464	.676
	Forward	7	8.76	.680	
Slalom	Midfielders	7	8.82	.313	.384
	Forward	7	8.76	..680	

Legend: **N**-number of subjects; **Mean** – mean value; **St.Dev**-standard deviation; **Sig** – significance level

Table 4 shows the results of the Slalom test for independent samples. Based on the results of the T - test for independent samples, it can be concluded that there is no statistically significant difference in the values of agility in relation to the position on the team.

DISCUSSION & CONCLUSION

The experimental sample of this study consisted of the female football players from the club "Mašinac" from Niš (n = 20). The subjects were divided according to their position on the team into defense (n = 6), midfielders (n = 7) and forward (n = 7). The differences in agility were compared with the position on the team.

In Table 2, based on the results obtained on the T-test, in relation to the position on the team, it can be concluded that there is no statistically significant difference between the players in relation to the position on the team (p> 0.05).

In Table 3, based on the results obtained on the Zigzag test, in relation to the position on the team, it can be concluded that there is no statistically significant difference between the players in relation to the position on the team (p> 0.05).

In Table 4, based on the results obtained on the Slalom test, in relation to the position on the team, it can be concluded that there is no statistically significant difference between the players in relation to the position on the team (p> 0.05).

The fact that there was no statistically significant difference between players in different positions on the team in any application of the Agility Assessment Test only confirms previously conducted research on this and similar topics (Taşkin, 2008.; Swapan, Nabanita, & Parthasarthi, 2010.; Milanović, Daly, Trajković & Sporiš, 2011.; Lago – Penas, Rey, Casais & Gomez – Lopez, 2014). In the work of Haugen et al. (Haugen et al., 2012), the results showed statistically significant differences in speed in favor of forward female players relative to midfielders and goalkeepers, while in agility and explosive power, no statistically significant differences were observed between different player positions. Lockie et al. (Lockie et al., 2016), who addressed the same topic, also did not find statistically significant differences in agility relative to player position.

However, some researchers have come up with different results. Goral et al. conducted a study showing that there were statistically significant differences in agility in favor of midfielders and goalkeepers in the Illinois Test, in the t-test midfielders had statistically better results than goalkeepers, but comparing with other player positions, no statistically significant differences were observed. Gil, Ruiz, Irazusta, & Irazusta (2007), after conducting a research, concluded that midfielders had statistically significantly better results than players in other positions.

This research has been conducted to identify differences in the agility of female footballers in relation to player position on the team. Twenty female footballers from the football club Mašinac from Niš participated in the research.

Based on the obtained and analyzed statistical results, it can be concluded that there are no statistically significant differences in the agility of the female footballers in relation to the position on the team. It is the fact that a large number of researchers whose papers are available on the Internet were based on finding the mentioned differences on the sample of football players. Such data can be partly justified by the fact that there are still more male than female footballers in the world. This research could serve as an incentive for the authors to direct their future research on this or similar topics towards female subjects. Further and more detailed examination would certainly make a huge contribution to this sport which is increasingly popular among women.

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DIFFERENCES IN THE PRECISION OF PERFORMING THE TECHNICAL ELEMENT - OVERHEAD PASSING SKILL OF DIFFERENT AGE VOLLEYBALL PLAYERS

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ABSTRACT

The aim of this study was to investigate the differences in the precision of performing the technical element of overhead passing skill of volleyball players of different ages. The study involved 60 male respondents, divided into two age groups. The first group consisted of respondents aged 15 to 17 years, and the second group consisted of respondents aged 17 and a half to 19 years. The measurements are carried out at the club "VGSK" in Veliko Gradiste. The study used a group of tests that were designed to determine the motor ability (precision) of a volleyball player in conducting of a given technical element. Based on the data it can be concluded that the differences between the older and the younger group of respondents regarding the passing the ball into the wall circle (t - value = -4.838, df. = 58, Sig. <.01) are statistically significant. In other words, there is a difference in the accuracy of overhead passing between the older and younger groups, with the older group (Mean = 13.73, Std. = 2.83, Std. Err = .52) performing better on this test than the younger group (Mean = 9.34, Std. = 4.08, Std. Err = .74). On the other hand, the results indicate that there is no statistically significant difference (t - value = -1.532, df. = 58, Sig. > .05) between the older and the younger group of respondents when it comes to the Elevational precision of overhead passing skill from the base position. Also, there is no statistically significant difference with respect to age (t – value = -1.478, df. = 58, Sig. > .05) when looking at the results of a test that measures the Elevational precision of jumping overhead passing skill.

Keywords: technique, cadets, juniors

INTRODUCTION

Volleyball is a very attractive, interesting, complex and dynamic sports branch, with the rapid transfer of actions from one side of the field to the other, in which teams strive to win by scoring more points, by successfully attacking or outsmarting opponents. Physical development and improvement of motor skills are significant components that can be affected by programmed physical exercise, is training. Technical and tactical requirements in many sports disciplines include frequent changes of direction in the frontal and sagittal plane, different types of jumps, among them jumps characteristic of a particular sport branch (Nešić, 2009). These characteristics require adequate preparedness and high performance in relation to sports technique, tactics and basic and specific physical preparation, since there are a large number of jumping techniques depending on the specificity of the sports field (Zatsiorsky & Kraemer, 2006).

Modern volleyball requires from all players a high level of general motor skills, as well as specific characteristics - characteristic of volleyball and certain playing positions (Borras et al., 2011). Players must be prepared to perform every technical and tactical element perfectly. In the course of its development, volleyball has perfected and improved throughout its segments. Modern gameplay requires the player to master the elements of the technique perfectly (performing movements as rationally as possible in order to solve certain tasks).

In order for volleyball players to reach the stage for maximum results, they must go through certain transformational processes (Tomić i Nejić, 2004). The specific place in volleyball is occupied by specific motor skills, that is, the technique that the player needs to work through to contact with the ball, as

well as in the game itself. In order to be able to successfully participate in the volleyball game, one must have a certain degree of knowledge of the specific elements of the game and the technique in competitive conditions. In volleyball, technique has a central place and reflects directly on the result. Along with the application of the elements of the technique, the game requires a good knowledge of tactics - both individual and group and team. One can not imagine a top-notch volleyball player who is not prepared to perform every technical and tactical element perfectly. In order to achieve this, it is necessary, first of all, to have adequate, optimal physical fitness, as a foundation for all movement manifestations on the volleyball court. During the learning, adoption or perfect execution of these elements, maximum care must be taken so that they can be performed as quickly, vigorously and accurately as possible.

Precision is the ability to effectively hit an external object with a guided and / or ejected projectile (Sekulić i Metikoš, 2007).

Based on the phenomenological approach and cognition, precision can be divided into:

- • Precision shooting - ejecting a projectile along a curve to hit a target;
- • Targeting precision - the ability to hit the target by guiding the projectile to the target of the missile.

In multiple sports, e.g. in volleyball, the precision of aiming and shooting is manifested at the same time. The volleyball player first hits the ball with his hand, and then hits the desired part of the pitch with that ball.

The aim of this study was to investigate the differences in the precision of performing the technical element of overhead passing of volleyball players of different ages. Therefore, the basic tasks of the work was to test the precision of overhead passing skill of the younger and older age group.

METHODS

Subjects

In this research participated 60 male volleyball players. For the purposes of this research, respondents were divided into two categories, by age. The younger group consists of respondents aged 15 to 17 years, - youth while the older group consists of respondents from 17 and a half to 19 years, - youth. The measurements are carried out at the club "VGSK" in Veliko Gradiste.

Procedure

The instrument will consist of two parts, general and special. The general section will contain the basic demographic information of the respondents such as age and category of candidates. A special part of the instrument will consist of a series of tasks that the respondent has to complete over a period of time. The tasks are grouped according to the technique that the respondent is required to complete, which include the use of hands and fingers in performing ball techniques. The following tests were applied for precision: **1) Overhead passing in a circle on the wall** - *Instrument:* 35 cm diameter hoop and volleyball ball. *Assignment:* Respondent stands 2 m. from the wall, where the hoop is fixed at a height of 243 cm (from the floor to the bottom edge of the hoop), and after precise throwing of the ball above the head, by repeatedly passing the ball, he tries with his fingers to pass the ball for as long as possible into the set target on the wall. The test is repeated 3 times and the best value is taken. *Rating:* The result is the number of consecutive passes of a ball in a circle on a wall over a period of 30 seconds. *Note:* If the ball hits the edge of the hoop or outside the hoop, and if the subject comes closer than the intended distance, counting is stopped. Time is measured with a stopwatch. **2) Elevational precision of overhead passing skill from the base position** - *Instrument:* volleyball net and volleyball ball. *Assignment:* Two concentric circles are drawn on the playground, smaller 100 cm in diameter and 200 cm larger. The center of the circle is 4.5 m away from the center line. The respondent on the opposite side of the field is also 4.5 m away from the net. He should throw the ball over his head, and pass it over the net into a smaller circle. *Rating:* The hit in the central circle is calculated by four points, the line - three points, the outer circle - two points, the outer circle line - one point, and the missed point. The target shooting task was repeated ten times and the best result is taken. **3) Elevational precision of jumping overhead passing skill** - *Instrument:* volleyball net and volleyball ball. *Assignment:* The respondent stands at a distance of 2 m. from the net. He should throw the ball high above and in front of him, and in the maximum jump, with his fingertips he will pass the ball across the net, shooting at a smaller circle indicated on the base of the field. *Rating:* The hit in the central circle is calculated by four points, the line - three points, the outer circle - two points, the outer circle line - one point, and the missed point (maximum 40 points). Respondent has ten attempts. The task is repeated three times and the best result is taken. More detailed explanation of the test could be found in Gabbett, Georgieff, Anderson, & Cotton (2006).

Variables

- Dependent – overhead passing skill
- Independent – age

Statistical data processing

The SPSS program (IBM SPSS Statistics 23) was used for detailed statistical analysis. The arithmetic mean (Mean) and standard deviation (Std.) are shown for the dependent variable included in this research, and the range of minimum and maximum values. The difference between the arithmetic means of the two groups (older and younger groups) of the subjects on the dependent variables examined was determined by applying the parametric test (T-test for independent samples).

RESULTS

Precision of overhead passing skill

Table 1 – Generally descriptive statistics

Generally descriptive statistics									
	N	**Min**	**Max**	**Mean**	**Std.**	**Skew**	**Std. Err**	**Kurt**	**Std. Err**
Age	60	1.00	2.00	1.5000	.50422	.000	.309	-2.070	.608
POOPS	60	6.00	26.00	14.0833	4.66611	.439	.309	-.590	.608
EPOOPSFBP	60	2.10	3.80	2.9700	.40560	-.388	.309	-.248	.608
EPOJOP	60	2.10	3.70	2.9817	.34370	-.321	.309	.164	.608

Legend: **POOPS** - Precision of overhead passing skill (overhead passing in a circle on the wall); **EPOOPSFBP** - Elevational precision of overhead passing skill from the base position; **EPOJOP** - Elevational precision of jumping overhead passing skill; **N** - number of participants; **Min** - minimun; **Max** - Maximum; **Mean** - arithmetic mean; **Std.** – standard deviation; **Skew** - Skewness; **Std. err** - standard error; **Kurt** – kurtosis.

Table 2 – Descriptive statistics for younger group

Younger group descriptive statistics									
	N	**Min**	**Max**	**Mean**	**Std.**	**Skew**	**Std.Err**	**Kurt**	**Std. Err**
Age	30	1.00	1.00	1.0000	.00000	.	.	.	.
POOPS	30	6.00	19.00	11.8333	3.43495	.633	.427	-.455	.833
EPOOPSFBP	30	2.10	3.50	2.8800	.42621	-.582	.427	-.917	.833
EPOJOP	30	2.10	3.60	2.9233	.37479	-.435	.427	-.272	.833

Legend: **POOPS** - Precision of overhead passing skill (overhead passing in a circle on the wall); **EPOOPSFBP** - Elevational precision of overhead passing skill from the base position; **EPOJOP** - Elevational precision of jumping overhead passing skill; **N** - number of participants; **Min** - minimun; **Max** - Maximum; **Mean** - arithmetic mean; **Std.** – standard deviation; **Skew** - Skewness; **Std. err** - standard error; **Kurt** – kurtosis.

Table 3 – Descriptive statistics for older group

Older group descriptive statistics									
	N	**Min**	**Max**	**Mean**	**Std.**	**Skew**	**Std.Err**	**Kurtosis**	**Std.Err**
Age	30	2.00	2.00	2.0000	.00000	.	.	.	.
POOPS	30	7.00	26.00	16.3333	4.69287	-.054	.427	-.564	.833
EPOOPSFBP	30	2.20	3.80	3.0600	.36916	.072	.427	-.164	.833
EPOJOP	30	2.40	3.70	3.0400	.30468	.156	.427	.274	.833

Legend: **POOPS** - Precision of overhead passing skill (overhead passing in a circle on the wall); **EPOOPSFBP** - Elevational precision of overhead passing skill from the base position; **EPOJOP** - Elevational precision of jumping overhead passing skill; **N** - number of participants; **Min** - minimun; **Max** - Maximum; **Mean** - arithmetic mean; **Std.** – standard deviation; **Skew** - Skewness; **Std. err** - standard error; **Kurt** – kurtosis.

The precision of overhead passing skill with respect to age

This section will outline the differences between the older and younger group of respondents with respect to the precision of overhead passing skill, for each test separately.

Table 4 - Differences between the older and younger group of respondents in terms of precision of overhead passing skill

	Descriptive statistics					T - test		
Test	**Age**	**N**	**Mean**	**Std.**	**Std. Err**	**t-value**	**df.**	**Sig.**
POOPS	Younger group	30	9.34	2.83	.52	-4.838	58	.00**
	Older group	30	13.73	4.08	.74			
EPOOPSFBP	Younger group	30	2.56	0.40	.07	-1.532	58	.13
	Older group	30	2.71	0.33	.06			
EPOJOP	Younger group	30	2.58	0.33	.06	-1.478	58	.14
	Older group	30	2.71	0.35	.06			

Legend: **POOPS** - Precision of overhead passing skill (overhead passing in a circle on the wall); **EPOOPSFBP** - Elevational precision of overhead passing skill from the base position; **EPOJOP** - Elevational precision of jumping overhead passing skill; **N** - number of participants; **Mean** - arithmetic mean; **Std.** – standard deviation; **Std. err** - standard error; **t – value -** Value of t-statistics; **df.** - Number of degrees of freedom; **Sig.** - Significance level (p> .05 no statistically significant difference; * p <.05 there is a statistically significant difference - a lighter criterion; ** p <.01 there is a statistically significant difference - a stricter criterion)

DISCUSSION

Previous research has mainly dealt with the effects of training on the accuracy of volleyball players (Delextrat & Martinez, 2014; Krističević, Madić & Krakan, 2016) so this research provides new information on the differences between younger and older volleyball players. The results obtained are significant for the study of the motor skills space, and especially for the further study of the ability of precision volleyball players.

Analysis of the difference in the precision of overhead passing skill between the older and younger group of subjects

Based on the data presented in Table 4, it can be concluded that the differences between the older and the younger group of respondents regarding the passing the ball into the wall circle (t - value = -4.838, df. = 58, Sig. <.01) are statistically significant. In other words, there is a difference in the accuracy of overhead passing between the older and younger groups, with the older group (Mean = 13.73, Std. = 2.83, Std. Err = .52) performing better on this test than the younger group (Mean = 9.34, Std. = 4.08, Std. Err = .74).

On the other hand, the results in Table 4 indicate that there is no statistically significant difference (t – value = -1.532, df .= 58, Sig. > .05) between the older and the younger group of respondents when it comes to the Elevational precision of overhead passing skill from the base position. Also, there is no statistically significant difference with respect to age (t -value = -1.478, df. = 58, Sig. > .05) when looking at the results of a test that measures the Elevational precision of jumping overhead passing skill.

CONCLUSION

This research aimed at precision, one of the key motor skills that will greatly depend on the success of volleyball players. A specific problem was related to the realization of precision through clearly defined and metrically valid tests, characteristic of the space of the technical and tactical structure of volleyball. The task was to determine the degree of correlation of motor tasks with the main components defined as potential factors of the investigated space in volleyball players.

The main, unifying task of this research was to determine a statistically significant difference in motor skill precision between younger and older volleyball players. It was confirmed that, in general, volleyball players of the older age group were more successful in the applied tests for the precision because they achieved better results.

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Physical Education

THE RELATION OF THE RESULTS IN MOTOR ABILITY TESTS AND THE SUCCESS IN ACQISITION OF GENERAL EDUCATIONAL KNOWLEDGE OF YOUNGER SCHOOL STUDENTS

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ABSTRACT

Introduction: Body movement-exercise is a daily need and Physical Education lessons have a positive influence on intellectual work of students. Physical Education is basic part of educational work, without which there is no survival and development of the civilization. In younger school age classes, Physical Education is realised as a class education and in some schools in the fourth year as a subject education. The goal of the research was to determine the relation of the results in motor ability tests and the success in school subjects for younger age students.

Methods: The research has transversal character, and it was realised in the second term of 2018/2019 school year in primary school "Jovan Jovanovic Zmaj" in Svilajnac, Serbia. The research involved 60 second grade students, divided into two sub samples in relation to gender: the sub sample of 30 boys age 8 (± 6 months) and the sub sample of 30 girls age 8 (± 6 months). All pupils were healthy on the day of testing and they had written consent of their parents and from the school principal. For the evaluation of motor abilities five tests of Eurofit battery were applied: Plate tapping – EFTA, Sit – and - reach – EFPS, Standing broad jump _EFSK, Handgrip test – EFZG, and 10x5m shuttle run – EFAG. The tests were performed in the sports hall during regular PE lessons. The PE teachers with the experience did the evaluations from previous tests, so that one test was measured by the same teacher. The success of the pupils was measured by the grades at the end of the second school term from the following subjects: Serbian language, English language, Mathematics, The World around us, and Physical Education. In the processing of the data acquired by empirical tests, apart from descriptive statistics for the evaluation of statistically significant differences, in the processing of the data Pearson coefficient of correlation was applied as well as partial correlations and T-test for small independent samples.

Results: On the basis of the results of motor abilities and the success from the subjects we can see statistically significant differences only in Sit-and-Reach and they are in favour of the girls (p=0.000). For general knowledge statistically significant differences exist only in English language (p=0,0013) and they are in favour of girls. There was significantly moderate negative correlation between the successes in the test Plate tapping –EFTA and the Serbian language marks for boys. Between the results achieved in the tests of motor abilities and academic success of the girls, there were no statistically significant correlations. Additional analysis which considered the age indicates that is influenced statistically significant differences in 10x5m shuttle run (r = 0,523, p=0,003). On the basis of negative moderate correlation it can be stated that for boys by their age the success is raised on this test. For girls negative moderate correlations were determined between their age and the test results. Plate tapping – EFTA (r=0,450, p=0,013), 10x5m shuttle run – EFAG (r = 0,381, p=0,038) and Standing broad jump –EFSK (r=0,401, p=0,028). In relation to younger girls, the older ones have more success in these tests. When the influence of age is controlled, for boys there were statistically significant relations of Serbian language grades and the test results. Plate tapping (r=0,464, p=0,011) Standing broad jump –EFSK (r=0,423, p=0,022) and Mathematics grade with the results in tests Standing broad jump (r=0,358, p=0,056). For girls there was only statistically significant correlation of Serbian language grade and the test result 10 x 5 m shuttle run (r=0,367, p=0,050).

Discussion and conclusion: The results on the motor ability tests are not significantly related to the subjects which boys and girls study. Additional analyses indicated the significance of the age on the manifestation of motor abilities. By the use of partial correlations and by the control of age, for boys some correlations were determined between the grades from Serbian language and the test results Plate tapping and Standing broadg jump, as well as between the Mathematics grades and Standing broad jump. For girls border values were determined between Serbian language and the results on the test 10 x 5 m shuttle run. The variability of the grades in the first three years of primary school is very small, so it is more difficult to get statistically significant correlations of the grades

from the subjects and the results on the motor ability tests. Based on this it can be stated that the grade from the subjects is desirable to apply only in scientific research with older school age students.

Key words: relation, motor abilities, grade, younger school age

INTRODUCTION

Motor development of a child implies the development of large and fine motoric, which begins in early childhood. The large motoric involves the abilities of performing movements by activation of larger muscles or groups of muscles, which a child mostly does by head, arms, legs, feet or by the whole body. Fine motoric involves the abilities of the use of the smallest muscles of the body in order to perform precise movements. It is closely related to coordination "eye-arm". It is proved that intellectual abilities depend on a number of synapses (connections between neurons, i.e. nerve cells). The biggest number of synapses, over 70%, is formed until the seventh year of life. Until the age of 12 95% of synapses is formed, and later, until the end of life, it rejuvenates 1-2% of synapses.

Piaget thinks that sensomotoric development has a key role in early cognitive development of children. According to his theory of a child's development, motor abilities contribute to active research of environment. It often happens that children do not have enough concentration for lessons, that they are tired, sleepy or moody etc. Because of this, it is good to find ways, which contribute to the improvement of teaching process by raising the level of concentration of the students. Physical exercise, with certain healthy nourishment and enough quantity of rest, has a big influence on the improvement of working abilities of students. As it has been previously stated, breathing is improved during physical exercise by which larger quantity of oxygen is inhaled in organism, which contributes to the improvement of brain functioning and general health. By this, the student's concentration is improved. Physical exercise enhances the students' mood, which has significance in work and in personal satisfaction in the relation with other students. By playing, the students are taught tolerance and creation of good interpersonal relationships. Physical education lessons influence intellectual work of students, and they do not spoil their working ability during next lessons. By this, there is no need that Physical education lessons have a special timetable during the day (Berkovic, 1971).

The persons who are disabled in mental development have connection between intellectual and motor functioning in relation the children without these problems and it is connected with coordination, speed and explosive strength(Orlic, Cvetkovic & Jaksic, 2010). The differences in motor abilities in relation to cognitive abilities comes from the supposition that the inferiority of the persons with smaller cognitive abilities is seen in solving complex motor tasks, probably because of the lower level of integrity CNS, which influences the speed of information flow, or conduciveness of nerve fibres. Complex motor tests have bigger connection with cognitive abilities, i.e. they are on higher level which includes cognitive processes, while the process of performing simple motor tests is on the lower elementary level, where the participation of intellectual processes is on minimum. The results are in accordance with the theory of integral development, according to which emotional, motor and intellectual development are closely related.

Gligorovic et al. (2011) indicate the significance of perceptive motor functions for the development of the abilities, which are precondition for acquiring of academic skills. Younger school age represents very sensitive time for the development of children's motor skills, so it is very important not to miss this period (Popovic et al., 2012), In the process of performing very complex motor tasks the cognitive functioning is also involved , whose influence raises with the rising of the level of complexity of motor tasks, which indicates significant relationships between motor and cognitive abilities of the students (Gadzic, Zivanovic & MIlojevic, 2011).

Nurbaks (2006) also denotes significant positive connection between motor abilities and academic success, i.e. cognitive development and he recommends enrichment and improvement of physical education programme and teaching techniques with the goal of improvement of motor and working abilities of students in order to make direct and positive effect on the development of intellectual abilities of the students,

On the basis of all previously said, we started from the hypothesis that motor abilities significantly influence success in general school subjects for younger school age pupils. Motor abilities are manifested trough the results on motor tests and the success in general school subjects is manifested by the grades in the end of the second term. The goal of this research was to determine the relation of the results on motor ability tests and the success in general school subjects for younger school pupils.

RESULTS

Based on the results in Table 1 we can see the values of boys and girls in motor ability tests. The boys have achieved better results on average in Hand tapping for 74 tithes, in Sit- and- reach the girls achieved on average better results with 5,41cm, in Standing broad jump for 1,24 cm, in Handgrip test for 47,6 tithes and in 10 x 5 m shuttle run for 11,87 tithes the better result was achieved by the boys. Statistically significant difference exist only for the variable Sit–and-reach for boys and girls with the level of statistical significance p=0,000 and it is in favour of the girls.

Table 1. Motor abilities of boys and girls

Test	Sex	N	Min	Max	AS	SD	df	t	p
EFTA	*Boys*	30	126	287	179,73	30,39	58	-0,936	0,353
	Girls	30	139	251	187,13	30,86			
EFPS	*Boys*	30	7	27	17,03	5,20	58	-4,143	**0,000****
	Girls	30	10	33	22,50	5,02			
EFSK	*Boys*	30	102	163	131,17	15,89	58	0,269	0,789
	Girls	30	88	174	129,93	19,50			
EFZG	*Boys*	30	60	907	387,47	252,04	58	0,784	0,436
	Girls	30	40	751	339,87	216,88			
EFAG	*Boys*	30	207	296	240,43	22,92	58	-1,977	0,053
	Girls	30	205	327	252,30	23,58			

Legend: *EFTA – Plate tapping; EFPS – Sit-and-reach; EFSK – Standing broad jump; EFZG – Handgrip test; EFAG –10 x 5 m shuttle run; N – number of pupils; Min – minimum; Max – maximum; AS – mean value; SD – standard deviation; df – the level of freedom; t – T-test value; p – the level of statistical significance; * statistical significance p<0,05; ** statistical significance p<0,01.*

Table 2. The success of boys and girls in general school subjects

Test	Sex	N	Min	Max	AS	SD	df	t	p
SRP	*Boys*	30	2	5	4,43	0,82	51,113	-1,108	0,273
	Girls	30	3	5	4,63	0,56			
ENG	*Boys*	30	3	5	4,43	0,57	54,018	-2,561	**0,013***
	Girls	30	4	5	4,77	0,43			
MAT	*Boys*	30	2	5	4,57	0,68	58	-0,602	0,550
	Girls	30	3	5	4,67	0,61			
SON	*Boys*	30	2	5	4,67	0,66	58	-0,941	0,351
	Girls	30	4	5	4,80	0,41			
FIZ	*Boys*	30	5	5	5,00	0,00	/	/	/
	Girls	30	5	5	5,00	0,00			

Legend: *SRP – Serbian language; ENG – English language; MAT – Mathematics; SON – The World around us; FIZ – Physical education; N – Number of students; Min – minimum; Max – Maximum; AS - mean value; SD – standard deviation; df – the level of freedom; t – T-test value; p – the level of statistical significance; * statistical significance p<0,05; ** statistical significance p<0,01.*

The thing that surprises is the average better success in four subjects for girls in relation to the boys and the same success with an average grade 5,00 for the boys and the girls in Physical Education. In Serbian language the average success of the girls is better for 0,2, in English language for 0,34, in Mathematics for 0,1 in The World around us for 0,13. Better grades of the girls influences statistically significant differences only between average results of grades in English language with the level of statistical significance p=0,013 and it is in favour of the girls. Since they all have fives in Physical Education, the grade in Physical Education was excluded from further analyses (Table 2).

Table 3. The relation of motor abilities and the success in general school subjects of boys and girls

Test	Sex	SRP	ENG	MAT	SON
Plate tapping (EFTA)	*Boys*	**-0,405***	-0,037	-0,216	-0,104
	Girls	-0,094	-0,260	0,001	0,299
Sit-and-reach (EFPS)	*Boys*	0,345	0,123	0,151	0,013
	Girls	-0,068	0,008	0,011	0,135
Standing broad jump (EFSK)	*Boys*	0,348	-0,054	0,250	0,111
	Girls	0,141	0,253	0,004	-0,276
Handgrip test (EFZG)	*Boys*	0,023	-0,185	0,095	0,160
	Girls	0,175	0,241	0,154	0,073
10 x 5 m shuttle run (EFAG)	*Boys*	-0,130	0,237	0,048	0,019
	Girls	-0,278	-0,306	-0,273	0,032

An average negative correlation was determined for both sub samples and only for the boys between the success in the Plate tapping test – EFTA and the grade from the subject Serbian language. The examinee is more successful if in short period of time ends Plate tapping test, while higher subject grade in Serbian language indicates better success, so that on the basis of the direction of the correlation it can be stated that better success on Plate tapping test - EFTA indicates higher grade in Serbian language. Between the results of other tests of motor abilities and academic success, there were no statistically significant correlations (Table 3).

Table 4. The relation of motor abilities and common success in general school subjects of boys and girls

Test	SRP	ENG	MAT	SON
Plate tapping (EFTA)	-0,250	-0,086	-0,102	0,064
Sit-and-reach (EFPS)	0,224	0,214	0,113	0,109
Standing broad jump (EFSK)	0,235	0,075	0,117	-0,056
Handgrip test (EFZG)	0,062	-0,049	0,111	0,114
10 x 5 m shuttle run (EFAG)	-0,143	0,079	-0,082	0,053

Legend: *SRP – Serbian language; ENG – English language; MAT – Mathematics; SON – The World around us; * statistical significance p<0, 05; ** statistical significance p<0, 01.*

For the research of the relation of the results on tests of motor abilities and common success, in general school subjects of boys and girls the coefficient of Pearson's linear correlation was used (Table 4). The values indicate that there is no statistically significant connection of the results on tests of motor abilities with an average grade in Serbian language, English language, Mathematics and The World around us. Thus additional analyses were done.

Table 5. The relation of the results of boys and girls on motor ability tests and average grades in general school subjects

Test	Average grades (*boys*)	Average grades (*girls*)	Average grades (the whole sample)
Plate tapping (EFTA)	-0,243	-0,025	-0,122
Sit-and-reach (EFPS)	0,198	0,016	0,196
Standing broad jump (EFSK)	0,212	0,046	0,121
Handgrip test (EFZG)	0,036	0,193	0,074
10 x 5 m shuttle run (EFAG)	0,031	-0,262	-0,040

By the study of the relation of the results on motor ability tests and average grade from the subject Serbian language – SRP, English language – ENG, Mathematics – MAT and The World around us – SON for boys and girls, as well as on the whole sample there were no statistically significant differences. By comparing of the age of boys and girls there were differences in age expressed in months. The boys were on average 103, 40 and the girls were on average 101, 27 months old, which indicates the difference of 2, 13 months in favour of the boys (Table 5).

Table 6. The relation of the age of boys and girls and their results on motor ability tests

Age	EFTA	EFPS	EFSK	EFZG	EFAG
Boys	-0,291	0,016	0,360	0,166	**-0,523****
Girls	**-0,450***	-0,225	**0,401***	0,238	**-0,381***
The whole sample	**-0,385****	-0,227	**0,371****	0,219	**-0,494****

The only statistically significant connection between the age of the boys and the test results of motor abilities was determined on the test 10 x 5m shuttle run _EFAG 9r=0,523, p=0,003). Based on negative average correlation, it can be stated that for boys the success on this test raises with the age. For girls negative average correlations were determined between the age and the test results Plate tapping – EFTA 9r=0,450, p=0.013). 10 x 5m shuttle run – EFAG 9r=0.381, p=0,038) and Standing broad jump – EFSK 9r=0,401, p= 0,028). IN relation to younger girls, the older ones have more success in these tests.

On the level of the whole sample, the results significantly correlate with the age on the test Plate tapping - EFTA (r=-0,385, p=0,002), Standing broad jump – EFSK (r=-0,371, p=0,004) and 10 x 5 m shuttle run – EFAG (r=-0,494, p=0,000). The direction and the level of correlation determine the results, which were described on the sub sample level (Table 6).

Table 7. The relation of motor abilities and academic success of boys and girls with the control of age influence

Test	Sex	SRP	ENG	MAT	SON
Plate tapping (EFTA)	Boys	**-0,464***	-0,117	-0,298	-0,166
	Girls	-0,183	-0,269	-0,020	0,184
Sit-and-reach (EFPS)	Boys	0,350	0,131	0,158	0,017
	Girls	-0,106	0,019	0,002	0,069
Standing broad jump (EFSK)	Boys	**0,423***	0,037	**0,358***	0,190
	Girls	0,223	0,257	0,022	-0,170
Handgrip test (EFZG)	Boys	0,044	-0,151	0,135	0,195
	Girls	0,220	0,237	0,168	0,162
10 x 5 m shuttle run (EFAG)	Boys	-0,229	0,131	-0,077	-0,088
	Girls	**-0,367***	-0,312	-0,312	-0,102

When the influence of age was controlled on the sample of boys, i.e. when partial correlations were applied, there was significant connection of the subject Serbian language - SRP and the results on the tests of Plate tapping - EFTA (r=0,464, p=0,011) and Standing broad jump - EFSK (r=0,423, p=0,022). Better grades in the subjects Serbian language - SRP are connected with better results on the tests Plate tapping - EFTA and Standing broad jump – EFSK. Correlations of the grades in Mathematics – MAT and Standing broad jump – EFSK have border value (r=0,358, p=0,056), which means that pupils who have better grades in Mathematics have better success in Standing broadjump.

When the influence of age was controlled on the sample of girls, border negative values were determined in subject Serbian language – SRP and the results on the test 10 x 5 m shuttle run – EFAG (r=0,367, p=0,050). It means that better results of the girls in Serbian language – SRP is connected with the success in the test 10 x 5 m shuttle run – EFAG (Table 7).

Table 8. The relation of motor abilities and common success of boys and girls in general school subjects with the control of age influence

Test	SRP	ENG	MAT	SON
Plate tapping (EFTA)	**-0,346***	-0,184	-0,176	-0,036
Sit-and-reach (EFPS)	0,194	0,175	0,082	0,055
Standing broad jump (EFSK)	**0,325***	0,168	0,188	0,040
Izdržaj u zgibu (EFZG)	0,103	-0,003	0,150	0,179
10 x 5 m shuttle run (EFAG)	**-0,264***	-0,028	-0,182	-0,083

When the age influence was controlled on the whole sample there were statistically significant values of correlation in Serbian language – SRP and the results in the tests Plate tapping – EFTA (r=0,346, p=0,007), Standing broad jump – EFSK (r=0,325, p=0,012) and 10 x 5m shuttle run – EFAG (r=0.264, p=0,044), which means that better success

of pupils is in Serbian language – SRP, connected with better success on these three tests (Table 8).

DISCUSSION

The connection of motor abilities and cognitive characteristics has always attracted attention of many researchers, where in many studies the connection of these two notions was done. There are not many studies in Serbia with this type of research and especially those dealing with motor abilities and success in general school subjects on samples of younger school age pupils. Five motor tasks from Eurofit battery and success in five subjects at the end of the second school term were parameters based on which the following relation of the results was determined. For the five researched tests, the boys achieved better results on average in four tests than girls, while the girls achieved on average better results in the test Sit-and-reach and the difference in mean value influenced statistically significant differences with the level of statistical significance of p=0,000.

The girls have better success on average in general school subjects in four subjects, but statistically significant difference was stated only between average results in English language with the level of statistical significance p=0,013. The teachers should think about the grades in Physical Education. All the girls and the boys have fives in Physical Education and all studies several decades backwards indicate the fall of motor abilities of schoolchildren. Sport technical knowledge is very poor, pupils do not acquire the minimum of educational demands from athletics, gymnastics and sport games. The evaluation of motor abilities is not done at the beginning and at the end of a school year, so that there are no parameters, which would influence planning, and programming of Physical education teaching for a certain grade. The development of the problems of Physical education teaching dates from the first organised systems of Physical education and that is for example, the lack of organised and planned work in preschools and in first years of primary school, which represents one "of the weakest bonds of the complex process of school Physical education and teaching" (Konstatinovic, 1981).

The biggest problem is that teachers and professors of Physical education do not follow plan and programme for a certain age, the bigger problem are not held lessons or exchanged with other subjects, usually with Mathematics, which is a kind of punishment. The lessons themselves , even if they are held, do not allow high quality work because of bad material technical conditions and then several classes are in a gym or in open school courts without proper surveillance or organised work (Markovic, 2016). The biggest mistake is the grading, fives for all students; these grades just cover bad work, i.e. negligence of Physical education teaching,

Moderate negative correlation was determined only for boys regarding both sub samples between the success in test Plate tapping = EFTA and the grade in Serbian language. By the coefficient of Pearson linear correlation there was no statistically significant connection of the results in motor ability tests with the grades in Serbian language, English language, Mathematics and The World around us. Because of that additional analyses were done which indicated that the boys are on average older 2, 13 months in relation to the girls. Statistically significant connection between the age and the results for boys on the motor ability test was only stated in Shuttle run. For the girls the negative moderate correlations between the age and the test results were achieved for Plate tapping and 10 x 5 m shuttle run, which indicates that older girls have more success on these tests and positive correlation between the age and the results on the test Standing broad jump.

When the influence of age is controlled on the sample of the boys, i.e. when partial correlations are applied, there were significant correlations of the subjects Serbian language and the results on the tests Plate tapping and Standing broad jump (better grades in Serbian language are connected with more successful results on the tests Plate tapping and Standing broad jump). Beside these values, the other ones indicate better result in Standing broad jump which is influenced by better grade in Mathematics. The girls age is connected with better result in Serbian language and it is connected with better result in Punt running 10 x 5 m. When the whole sample was controlled by the age factor there were statistically significant values of the correlation of the grades in Serbian language and the results in the tests Plate tapping, Standing broad jump and 10 x 5m shuttle run.

CONCLUSION

The goal of this study was to determine the relation of the results on motor ability tests and the success in general school subjects in the second grade of primary school. Additional analyses indicated the significant influence of the age on motor ability manifestation. By the use of partial correlations and by the age control for boys the correlations were determined between the grades in Serbian language and the results on tests Plate tapping and Standing broad jump and grades in Mathematics and Standing broad jump. For girls border values were determined between the grades

in Serbian language and the results on the test 10 x 5 m shuttle run. Based on the results the basic hypothesis form that we started (*that motor abilities significantly influence the success in general school subjects for boys and girls of younger school age*) is partially stated. Most pupils have the grade 4 or 5 from all subjects. It is considered that there would be more correlation if the grades vary more. The variability of the grades in the first three years of primary school is very small, so it is harder to get statistically significant correlation of the grades of general school subjects and the results in tests of motor abilities. On the basis of the stated it can be said that the grade foe general school subject in scientific research is desirable to notice only in older school age groups.

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VISUAL-MOTOR INTEGRATION AND COORDINATION IN PRESCHOOL CHILDREN AGED 4 TO 7 YEARS

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ABSTRACT

The study was conducted with the aim of determining relations between visual-motor integration and coordination in children aged 4 to 7 years who were divided into two subsamples. Visual-motor integration of graphomotor type was assessed by the use of the Visual-Motor Integration Test (VMI Test), while coordination was measured by the use of the Backward Obstacle Course motor test. The obtained findings confirmed a statistically significant correlation between the observed dimensions at the level of motor manifestations in the subsample aged 4 to 6 years as well as in in the subsample aged 6 to 7 years. This implies the possibility of common mechanisms responsible for motor control of both fine motor skills and gross motor skills. Further research is suggested to identify possible neurological mechanisms underlying different motor skills.

Keywords: fine motor skills, motor abilities, motor control

INTRODUCTION

Motor skills and motor abilities development represent an important question in the research field of human ontogenetic development. In this regard, kinesiological science is predominantly occupied with development of gross motor skills. Studies on fine motor skills still remain inadequately represented. This is particularly seen for examining mechanisms in the background of fine motor skills and fine motor control. Moreover, the imposed question refers to relations between fine motor skills and gross motor skills from the aspect of motor control as well from the aspect of motor manifestations.

Previous results are not consistent. Although most studies indicate that the processes of fine motor and gross motor development take place separately (De Barros, Fragoso, de Oliveira, Cabral Filho & de Castro, 2003; Rezende, Beteli & dos Santos, 2005), others indicate a connection between them (Bonifacci, 2004).

Although the aforementioned studies point to the relationship of the observed motor skills, the question remains whether a common neurological base mechanism of fine and gross motor skills exists. In order to address this question, it is necessary to analyse neurological processes underlying both fine and gross motor manifestations.

One of the most important developmental processes in the field of fine motor skills is the process of visual-motor integration. It represents a process of neuro-muscular synchronization, or a process of coordination of information from visual receptors and muscular effectors, with the aim of achieving precision while performing motor activities (Bavčević, 2015). The above-mentioned process is directly manifested in coordination of the eyes and the hands that allow fine manual activities, e.g. graphomotor type activities (Cornhill & Case-Smith, 1996; Maki, Voeten, Vauras & Poskiparta, 2001; Tseng & Chow, 2000; Weintraub & Graham, 2000). Accordingly, the question arises whether there is connection between visual-motor integration and motor control on the level of the whole-body movement.

The aim of this study was to analyse relations between the visual-motor integration degree and motor coordination.

METHODS

Subjects

The sample of participants in this research included 36 male and female preschool children

divided in two subsamples. The first group included 20 subjects aged 4 to 6 years, while the second group included 16 children aged 6 to 7 years. All subjects were healthy and without any psychophysical aberrations. All subjects included in the experiment had a written parents'/guardians' consent after they had been introduced to the aim and procedures of the research. Research has been conducted in Universal sport academy "Sparta", City of Split, Croatia in September 2019.

Procedure

Visual-motor integration of the subjects was assessed by the use of the Visual-Motor Integration Test (VMI Test). It evaluates visual-motor integration of graphomotor type. The VMI test (T. Bavčević & D. Bavčević, 2015) is a paper-pen type of instrument. It consists of two parallel lines with the equidistance of 1.5 cm forming a 178.5 cm long path on an A4 size paper. The task of the subject was to connect the dots from the beginning to the end of the path by drawing a line without interruptions and without touching borders of the path as quickly as possible. The line was drawn with the dominant hand by using a B-2B pencil. Time required for solving the test was measured in seconds. The number of errors included every interruption of the line drawn as well as touching the borders of the path. Final result of the VMI Test was calculated as a sum of the time required for solving the task and all errors multiplied by two. The VMI Test was solved once by each subject.

Motor coordination was evaluated by the use of the Backwards Obstacle Course motor test (MPN). This obstacle course was 10 meters long between the start and finish lines. The first obstacle was vaulting box base and top (Height = 50 ± 2cm), positioned 3 m after the start line and the second one was vaulting box pallet unit positioned vertically on its longer side 6 m after start line. The task was to complete the course as fast as possible by running backwards on all fours looking through legs and crossing over the first and trough the second obstacle. The test was repeated three times.

Statistical analysis

The obtained results were subjected to descriptive analysis including calculating arithmetic mean, minimum and maximum result, standard deviation (SD), coefficient of asymmetry (α3), and coefficient of skewness (α4). Normality of data distribution was tested by the use of the Kolmogorov-Smirnov Test (KS-Test) with a possibility of an error at the significance level of 0.05 as a critical value. Relations between the level of visual-motor integration and motor coordination were determined by the application of correlation analysis and the Pearson linear correlation coefficient was calculated (r). The obtained data were processed by the use of the Statistica software package (SPSS 13.3).

RESULTS

Tables 1 and 2 show parameters of descriptive statistics and results of the Kolmogorov-Smirnov Test for the normality of data distribution for the VMI Test variables (VMI time, VMI errors, VMI) and Backward Obstacle Course test (MPN) for both subsamples of participants respectively.

Table 1. Descriptive statistics parameters and the KS-Test – the subsample of 4 to 6-year-olds

	Mean	SD	Min	Max	α3	α4	Max d
VMI time	47.72	14.26	28.70	85.75	1.07	1.06	0.183
VMI errors	10.10	6.66	0.00	26.00	0.71	0.48	0.146
VMI	67.77	19.04	42.85	110.09	0.58	-0.28	0.136
MPN	19.58	4.78	12.22	28.69	0.07	-1.12	0.134

Max d = 0.294

Comparative analysis of mean results and respected standard deviations showed that standard deviations did not exceed 1/3 of the respective mean value in VMI nor MPN variable. The values of skewness coefficients in both variables showed a symmetrical distribution of data. The kurtosis coefficient showed a regular dispersion of data with a slight platykurtic distribution tendency in MPN results.

The normality distribution test showed that maximum deviations between the empiric and theoretic relative cumulative frequency (max d) did not exceed the critical value of the KS-Test in neither VMI nor MPN variable. These results confirmed normal data distribution for both variables.

Table 2. Descriptive statistics parameters and the KS-Test – the subsample of 6 to 7-year-olds

	Mean	SD	Min	Max	α3	α4	Max d
VMI time	39.60	15.13	22.69	82.19	1.77	3.35	0.281
VMI errors	4.81	5.21	0.00	23.00	3.14	11.27	0.298
VMI	49.22	23.45	34.88	128.19	2.89	9.25	0.312
MPN	11.97	3.00	6.68	18.89	0.63	0.58	0.169

Max d = 0.328

Comparison of means and respected standard deviation implied an increased heterogeneity of data in the VMI variable in which standard deviation exceeded 1/3 of the mean value. In the MPN variable standard deviation value was lower than 1/3 of the mean value thus confirming homogenous distribution. Skewness value for the VMI variable showed a positive asymmetry thus implying a shift of the results to the lower range of values while the increased kurtosis showed an increased leptokurticity of distribution. Values of skewness and kurtosis for the MPN variable confirmed both symmetrical and mesokurtic distribution of data.

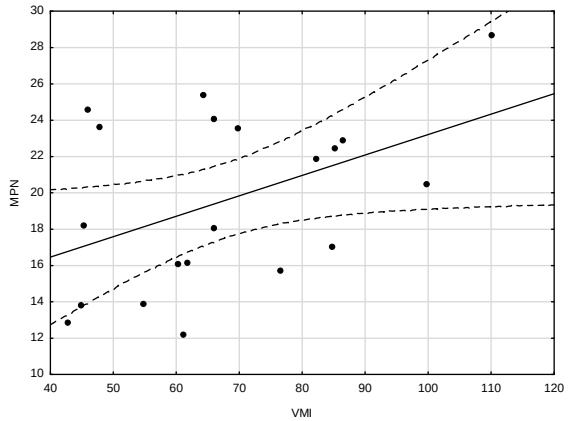
Results of the KS-Test confirmed normality of distribution for both VMI and MPN variable, while maximum deviations between the empiric and theoretic relative cumulative frequency (max d) did not exceed the critical value of the KS-Test.

Table 3 shows results of the correlation analysis between the subsample of 4 to 6-year-olds and subsample of 6 to 7-year-olds. A graphical representation of the above results is given in graph 1 and graph 2.

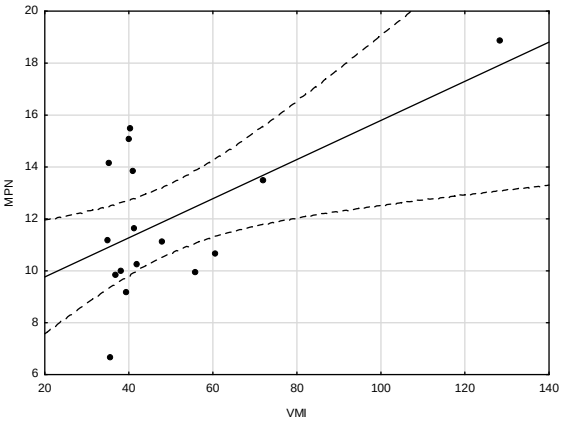
Table 3. Correlation analysis – VMI vs MPN

	Subsample 4 to 6-year-olds		Subsample 6 to 7-year-olds	
	VMI	MPN	VMI	MPN
VMI	1.00		1.00	
MPN	0.45	1.00	0.59	1.00
	r^2=0.20		r^2=0.35	

Results of the correlation analysis confirmed statistically significant positive correlation between visual-motor integration (VMI) and Backward Obstacle Course (MPN) for both subsamples of subjects. The value of Pearson correlation coefficient for the subsample of subjects aged 4 to 6 years was r=0.45 which squared showed a common variance of the variable of r^2=0.20 or 20%. In the subsample of subjects aged 6 to 7 years, the coefficient of correlation was r=0.59 or squared r^2=0.35 meaning the observed variables shared 35% of common variance.



Graph 1
Scatterplot – VMI vs MPN,
the subsample of 4 to 6-year-olds



Graph 2
Scatterplot – VMI vs MPN,
the subsample of 6 to 7-year-old

DISCUSSION

The findings confirmed statistically significant relations between the degree of visual-motor integration and coordination in both subsamples. The values of the observed variables were positively correlated, indicating that in the analysed subsamples visual-motor integration and coordination were a subject to the same or related neurological mechanisms.

It can be stated that at the level of motor manifestation both graphomotor activities and coordination manifesting as reorganisation of movement stereotype indicate a significant level of correlation. However, this does not allow us to make a definitive conclusion regarding the existence of common control mechanisms underlying fine motor skills and gross motor abilities, and therefore skills. The research findings for subjects at this age leave this possibility open, but they also raise other important questions. The first refers to the ontogenetic dynamics of the development of particular dimensions, which may or may not retain the same source mechanisms in the function of time. The second issue is the detection of all relevant neuro-motor mechanisms resulting in motor control on the level of fine and gross motor skills.

The obtained findings are in line with the results of Bonifacci (2005). The author examined correlation between visual-motor integration, gross motor skills and perceptual abilities in a sample of 144 primary-school pupils aged 6 to 10 years. The study confirmed a significant difference in the degree of visual-motor integration between children with high and low gross motor skills. The difference in the level of perceptual skills and intellectual abilities was not noted.

However, other studies suggest that the development of fine motor skills and gross motor skills takes place separately (Darrah, Senthilselvan & Magill-Evans, 2009; Darrah, Hodge, Magill-Evans & Kembhavi, 2003; Darrah, Redfern, Maguire, Beaulne & Watt, 1998; Rosenbaum, 2006; Souza et al., 2010).

Accordingly, there is a need to further explore motor control of both fine and gross motor skills. Special attention should be paid to the study of the neurological mechanisms underlying various motor manifestations.

CONCLUSION

The study results confirmed the significant correlation between visual-motor integration of the graphomotor type and coordination on the motor manifestation level. Such findings imply the possibility of common mechanisms of motor control responsible for fine motor skills as well as gross motor skills.

In order to investigate this possibility, further research is needed in this area, in particular those aimed at identifying the neurological basis of fine and gross motor skills.

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RELATIONS OF PHYSICAL FITNESS, INTELLECTUAL MATURITY, ACADEMIC ACHIEVEMENT AND AGE OF SPECIAL ELEMENTARY SCHOOL STUDENTS: GENDER DIFFERENCES

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ABSTRACT

Mind and body are never independent in modern human's approach to education. It has been fairly well established that the total development of an individual is a result of a complex interaction among heredity, environment, and maturation. While educators speak in terms of motor, social, emotional, or intellectual development, the interrelationship and interaction among these processes' is complex. Physical educators have alluded to this positive relationship for years without much research support. Studies attempting to evaluate the relationship of motor function and cognitive function are of three major tip's: (1) those correlation studies in which statistical comparisons are made between the academic or mental score and the perceptual motor scores, (2) those which evaluate the academic attributes when specific programs of motor skills are conducted, and (3) those studying the motor and mental development of adolescents. Movement and manipulative routines have long been employed in physical activity programs for those classified as intellectually deficient. The basic purpose of this study was to determine the significance of the relations between motor development, and intellectual maturity (performance) in Secondary school students with special needs. The total sample of 77 subjects of both genders (51 males and 26 females) was included in the study. A battery of Physical Fitness Tests (PFT) for the evaluation of motor development was applied, comprising nine different tasks (including running, jumping, throwing and climbing) for the estimation of explosive strength, running speed, agility and endurance of participants. Study Results were processed using descriptive statistics, ANOVA, and CORREL Methods. It was established statistically significant between gender difference (p=.001) in 7 of 9 components for the estimation of motor development (PFT), with discriminative coefficient (up .000 to .037) in favor of male sample of participants. Special interest for this study was stated in regard of the relationship estimation among variables for assessment of chronological age (AGE), academic achievement (SCSS), intellectual maturity (IQ) and motor development (PFT) of Special Elementary School Students (male and female), using Pearson's, Kendall's, and Spearman's Correlations Coefficient (r). In Special Elementary school boys relations are established between IQ and SCSS (,257) Kendall's, and between Physical Fitness Test- Z and SCSS (,351) Spearman's. At the low level of significance was established Pearson's Correlation Coefficient (0.205) between AGE and Physical Fitness Z score, as well as between AGE and IQ with negative sign (-0.234), and IQ and SCSS (0.272). In Special Elementary school girls relations are established between IQ and SCSS: .527 - Pearson's coefficient, .417 - Kendall's coefficient, and .538 - Spearman's coefficient. Physical *Fitness Test - Z-* value has not established any kind of correlation with others variables.

Keywords: special physical education, physical-fitness-test, intellectual maturity, academic success, age and gender differences

INTRODUCTION

In many world countries experts pay a high attention to solution of questions of the health state of population and search factors close connected with it. At present time experts face the difficult transition period and looking for the main factors and determinants of relations between physical fitness and appropriate health state and life success in some anthropological segments.

Mind and body are never independent in modern human's approach to education. It has been fairly well established that the total development of an individual is a result of a complex interaction among heredity, environment, and maturation. While educators speak in terms of motor, social, emotional, or intellectual development, the interrelationship and interaction among these processes' is complex. Physical educators have alluded to this positive relationship for years without much research support. Studies attempting to evaluate the relationship of motor function and cognitive function are of three major tip's: (1) those correlation studies in which statistical comparisons are made between the academic or mental score and the perceptual motor scores; (2) those which evaluate the academic attributes when specific programs of motor skills are conducted; (3) and those studying the motor and mental development of children and adolescents.

The concept of the integrated development or the interrelationship between motor and intellectual abilities has served as the foundation of a number of theories of child development and of learning. The learning of motor skills requires total physical and intellectual involvement for greatest efficiency. It has been assumed by many that the learning and the performance of motor skills are closely related to intelligence.

Rethazi & Keeton (1998) have provided the study on the Kaufman Assessment Battery for Children (K-ABC) in the assessment of learning disabled (LD) children. The authors of the K-ABC assert that, in addition to a discrepancy between learning potential and academic achievement, learning disability is characterized by poor sequential relative to simultaneous processing skills. The study was designed to determine whether the K-ABC could discriminate between learning disabled and normal children on the basis of these characteristics. Sample of 43 LD pupils up 7 to 12 years of age and 20 normally achieving children of similar age were administered the K-ABC. Results indicated that, for both the LD and the normal children, scores on the Sequential Processing Scale were significantly lower than on the Simultaneous Processing Scale. In addition, the discrepancy between Simultaneous and Sequential scale scores was similarly distributed in both groups. The LD group scored lower and the normal group higher on the Achievement Scale than on the Mental Processing Composite. The results, therefore, indicated that the K-ABC differentiated LD from normal children in terms of Achievement relative to MPC scores; however, it failed to reveal a unique profile pattern related to simultaneous vs. sequential processing skills for the LD group.

Mehrens & Clarizio (1993) have provided a selective review on Curriculum-based measurement: Conceptual and psychometric considerations. This review of published literature and research critically examines the conceptual and psychometric problems associated with curriculum-based measurement (CBM) as they relate to eligibility decision making and programming for special education. It is concluded that although CBM can provide a useful supplement in assessing and remediating academic difficulties, it suffers from many of the criticisms leveled at traditional assessments as well as some unique limitations of its own. It is concluded that CBM, to be of most value, needs to be part of a larger systematic psycho-educational assessment program rather than a replacement for it.

Humphrey (1972) provides study on the use of motor activity learning in the development of science concepts with slow learning fifth grade children. This study compared the motor activity technique of learning, using physical education activities, with traditional ways of developing science concepts with fifth grade slow learning children. Two groups of ten children each were equated on the basis of pretest scores. Both groups were taught by the same classroom teacher. One group was taught through motor activity learning and the other by traditional procedures. Both groups were retested after a two-week teaching period, and again after a three-month extended interval. The difference in the post-test scores favored the motor activity learning group ($p=.01$; $t=4.33$). The difference in the extended interval test also favored the same group ($p=.001$; $t=6.37$). Using the differences in test scores as criteria for learning, the children in the motor activity learning group learned and retained significantly more than those in the traditional group.

Barona & Faykus (1992) have provided research on Differential effects of socio-cultural variables on special education eligibility categories. The influence of socio-cultural factors (ethnicity, socioeconomic status, father absence, and family size) on special education eligibility was examined for three ethnic groups. A multiple regression procedure was used to analyze the data on 300 students referred for

evaluation and found to be either not eligible for services or eligible for services as mentally retarded or learning disabled. Results indicated that only socioeconomic status and ethnicity made a significant contribution to the prediction of all three groups. Individually, father absence and family size did not contribute to the prediction of special education eligibility. Results of this study suggest that legislative mandates to control for socio-cultural factors in the determination of special education eligibility have been only partially successful.

Bracken & Fagan (1998) have provided a study on Abilities assessed by the K-ABC mental processing subtests: The perceptions of practitioners with varying degrees of experience. Eighty practitioners with varying levels of experience in the administration of the Kaufman Assessment Battery for Children (K-ABC) were asked to complete a K-ABC Abilities Matrix to indicate their perceptions of the specific abilities assessed by each of the ten K-ABC Mental Processing subtests. The practitioners' responses were compared to the perceptions of the K-ABC authors, and, in roughly half of the judgments, a majority of the practitioners agreed with the test authors, while the remaining judgments constituted majority disagreements. The practitioners associated additional psycho-educational abilities or skills that had not been identified previously by the K-ABC authors, with several of the K-ABC subtests.

Auxter, Pyfer, Zittel, & Roth (2010) have been made observations in deficiencies' in motor, intellectual, and social development in the same individual. This has suggested the possibility of the impairment of one behavior being related to the impairment of other developing behaviors. Movement and manipulative routines have long been employed in physical activity programs for those classified as intellectually deficient**.**

The basic purpose of this study was to determine the significance of age and gender differences in motor and mental development, intellectual maturity and educational achievement in upper elementary school students with disabilities. Additionally, of special interest in this study was to determine the relationships between established levels of motor abilities, recalculated to *Z* score, intellectual maturity, year of age and the school success with the scope of gender differences.

METHODS

Subjects

A cohort sample of upper elementary classes (aged up 11-12 to 15-17 years), was derived from the *global* sample of children, attending local Special Elementary School, in an urban area of the city of Niš, which represents the whole sample of pupils in these age groups in the school selected. The sample included children with intellectual disabilities in a wide range of socio-economic backgrounds and reflect the population of children attending special schools in this region. They completed Test of Physical Fitness (TPF) after Fjørtoft, Pedersen, Sigmundsson, & Vereijken (2003). Two subsamples of 77 students of both gender (51 boys, 26 girls) were included in the study and were assessed also with additional indicators: chronological age of participants, academic achievement, and intellectual/mental development, considered as of special interest for these study.

Procedure

Physical Fitness Test (PFT) aims to provide a reliable, objective quantification of children's physical fitness levels (Fjørtoft et al., 2003; Haga, 2008). It consists of activities that are included in most children's everyday play activities and has nine test items: three based on jumping; two on throwing; one on climbing, and three on running. This battery is applicable for the participants with low motor competence, as were considered those with intellectual disabilities. The test battery is simple to set up and is not time demanding. The nine test items are:

1) Standing broad jump (StBJ). The child starts with his or her two feet in parallel behind a starting line, one shoulder width apart. Upon a signal, the child swings their arms backwards and forwards, and jumps with both feet simultaneously as far forward as possible. Test item score (best of two attempts) is the distance between starting line and landing position (in centimeters).

2) Jumping with the two feet a distance of 7m as fast as possible (2S7m). Test item score (best of two attempts) is time needed to cross the distance (in 1/10 seconds).

3) Jumping a distance of 7m on one foot (child chooses preferred foot) as fast as possible (1S7m). Test item score (best of two attempts) is time needed to cross the distance (in 1/10 seconds).

4) Throwing a tennis ball with one hand (child chooses preferred hand) as far as possible (TenB). The child stands with the contra lateral foot in front of the ipsilateral foot. Test item score (best of two attempts) is distance thrown (in meters).

5) Pushing a medicine ball (1kg) with two hands as far as possible (Med). Starting position is with feet parallel to each other, shoulder width apart, with the ball held against the chest. Test item score (best of two attempts) is distance achieved (in meters).

6) Climbing wall bars, crossing over two columns to the right, and down the fourth column as fast as possible (Clmb). Each column of the wall bars was 255-cm high and 75-cm wide. Test item score (best of two attempts) is time needed for the test item (in second).

7) Shuttle run (10X5). Test item score is time needed to run 10×5 m (in seconds).

8) Running 20m as fast as possible (R20m). The child starts in a standing position. With a procedural error, performance is interrupted and the test item repeated. Test item score is time needed to run the distance (in seconds).

9) Reduced Cooper test (MCT6). The child runs/walks around a marked out rectangle measuring 9×18m (the size of a volleyball field) for 6 min. Both running and walking are allowed. Test item score is distance covered in 6 min (in meters).

Three additional variables of special interest for this study are: chronological age (AGE) of upper Elementary school children (re-count at the end of the school year and provided in month), educational/academic achievement/school success (SCSS) of upper Elementary school children at the end of the school year and provided in points/grade-marks (real numbers with two decimals as the grades: 5– excellent, 4– very good, 3– good, 2– satisfactory/sufficient, 1– unsatisfactory/insufficient), and mental/Intellectual maturity (IQ), which was provided by the School officials in charge (principal of the school), school psychologist and social worker.

Statistical analysis

Basic and Descriptive Statistics: *Mean* and *Standard Deviation (SD)* as the most commonly used descriptive statistics; *Minimum* and *Maximum* values are very important when it is of special interest to detect potential inaccuracies in data entry, especially with small samples study design.

Data reduction and analysis: In order to express the child's total performance on the Physical Fitness Test as one score, a total score was calculated by using SPSS version 10.0 for Windows**.** Test item scores were transformed into standardized score (***z*-**scores) from the mean of the whole sample. Higher z-scores indicate higher performance on the tasks. The total test score for each child was defined as the average ***z*** score in all test items successfully performed by that child. **Correlate Bivariate:** This test examines relationships between two or more variables. It is important to be clear whether the test for the relationships or the differences between the variables needs to be done in the study. The *Pearson* coefficient (r) is used when there are parametric data and the *Spearman's* or *Kendall's* coefficient when there are non-parametric data. When there are several variables the correlation matrix can be particularly large, because it will include the correlations between all possible combinations of the variables. However, in some cases a researcher may be interested in some specific correlations only. For example, examining the relationship of the motor performance with several different indicators: chronological age, educational success and intellectual maturity, which is of special interest in this study. Standardized ***z*-**scores were used for the correlation analysis only.

Research management

The study was carried out in accordance with the Declaration of Helsinki. Prior to the gathering the data, the School Council and the parents were presented with the written information about the nature of the study. This was followed by signing the written permission from the participant's representative (PE teacher) prior to their child's involvement in the study. The assessments of physical fitness took place in the school gym hall during the time-tabled PE session for each particular class, with test protocol in accordance with the TPF manual. Each test item was explained and demonstrated before the child started. Each test item was performed twice, except for tests of running. During the tests assessment the children needed to wear suitable clothing. All the children in the sample voluntarily completed the measurements (during the period of two months, May, 7th – Jun, 10th, 2011) at the end of the Elementary School Year.

RESULTS

A low level of statistically significant correlation was established between chronological age (AGE) and Physical Fitness Z score (r=0.205), as well as between AGE and Intellectual maturity (IQ) with negative sign (r=-0.234), and IQ and academic achievement (r=0.272) (Table 2.1).

Table 1. Descriptive statistics of Special Elementary upper graders

Variables	Boys (n=51)		Girls (n=26)	
	Mean	SD	Mean	SD
AGEM	174.961	20.117	175.885	21.970
IQ	3.843	1.541	4.077	1.809
SCSS	3.764	.843	4.076	.935
Z	8.529E-02	1.981	.134	2.508

Legend: **AGE** –chronological age of participants, presented in months; **IQ** – intellectual maturity up 1 to 9 (1-considered as moderate impairment (IQ: 48 and less), and 9- considered as average level of intellectual maturity (IQ: 90-109); **SCSS** – school success, presented in decimal marks; **Z** - Physical Fitness Test (Z value).

Table 2.1 Values of Pearson's coefficient (boys)

Variables	Pearson Correlations	AGE	IQ	SCSS	Z
AGE	Correlation Coefficient	1.000	**-.234***	-.120	**.205***
	Sig. (2-tailed)	.	.099	.403	.148
	Sum of Squares and Cross-products	20233.922	-362.314	-101.563	409.331
	Covariance	404.678	-7.246	-2.031	8.187
IQ	Correlation Coefficient	**-.234***	1.000	**.272***	-.151
	Sig. (2-tailed)	.099	.	.053	.291
	Sum of Squares and Cross-products	-362.314	118.745	17.698	-22.988
	Covariance	-7.246	2.375	.354	-.460
SCSS	Correlation Coefficient	-.120	**.272***	1.000	-.122
	Sig. (2-tailed)	.403	.053	.	.394
	Sum of Squares and Cross-products	-101.563	17.698	35.550	-10.187
	Covariance	-2.031	.354	.711	-.204
Z	Correlation Coefficient	**.205***	-.151	-.122	1.000
	Sig. (2-tailed)	.148	.291	.394	.
	Sum of Squares and Cross-products	409.331	-22.988	-10.187	196.124
	Covariance	8.187	-.460	-.204	3.922

**Correlation is significant at 0.05.*

Table 2.2 Values of Kendall's coefficient (boys)

Variables	Pearson Correlations	AGE	IQ	SCSS	Z
AGE	Correlation Coefficient	1.000	-.186	-.059	.136
	Sig. (2-tailed)	.	.084	.557	.162
IQ	Correlation Coefficient	-.186	1.000	**.275***	-.068
	Sig. (2-tailed)	.084	.	.012	.524
SCSS	Correlation Coefficient	-.059	**.275***	1.000	-.084
	Sig. (2-tailed)	.557	.012	.	.396
Z	Correlation Coefficient	-.060	-.027	-.021	1.000
	Sig. (2-tailed)	.319	.675	.733	.

**Correlation is significant at 0.05.*

Table 2.3 Values of Spearman's coefficient (boys)

Variables	Pearson Correlations	AGE	IQ	SCSS	Z
AGE	Correlation Coefficient	1,000	,136	-,068	-,084
	Sig. (2-tailed)	,	,162	,524	,396
IQ	Correlation Coefficient	,167	1,000	**-,241***	-,086
	Sig. (2-tailed)	,240	,	,088	,551
SCSS	Correlation Coefficient	-,084	**-,241***	1,000	**,351***
	Sig. (2-tailed)	,558	,088	,	,012
Z	Correlation Coefficient	-,122	-,086	**,351***	1,000
	Sig. (2-tailed)	,394	,551	,012	,

**Correlation is significant at 0.05.*

Significant *Kendall's Correlation Coefficient* (0.275) was estimated between Intellectual maturity (IQ) and academic achievement (SCSS) in *Boys sample* of participants (Table 2.2), and *Spearman's Correlation Coefficient* (.351), between Intellectual maturity (IQ), and academic achievement (SCSS),

with the negative sign (-0.241) and at the low level of probability (Table 2.3).

Table 3.1 Values of Pearson's coefficient (girls)

Variables	Pearson Correlations	AGE	IQ	SCSS	Z
AGE	Correlation Coefficient	1.000	-.044	-.070	-.017
	Sig. (2-tailed)	.	.831	.732	.934
	Sum of Squares and Cross-products	12066.654	-43.769	-36.203	-23.407
	Covariance	1.000	-.044	-.070	-.017
IQ	Correlation Coefficient	-.044	1.000	**.572****	**-.233***
	Sig. (2-tailed)	.831	.	.002	.252
	Sum of Squares and Cross-products	-43.769	81.846	24.188	-26.418
	Covariance	-1.751	3.274	.968	-1.057
SCSS	Correlation Coefficient	-.070	**.572****	1.000	-.132
	Sig. (2-tailed)	.732	.002	.	.519
	Sum of Squares and Cross-products	-36.203	24.188	21.880	-7.766
	Covariance	-1.448	.968	.875	-.311
Z	Correlation Coefficient	-.017	**-.233***	-.132	1.000
	Sig. (2-tailed)	.934	.252	.519	.
	Sum of Squares and Cross-products	-23.407	-26.418	-7.766	157.295
	Covariance	-.936	-1.057	-.311	6.292

**Correlation is significant at 0.05.*

***Correlation is significant at 0.01.*

Table 3.2 Values of Kendall's coefficient (girls)

Variables	Pearson Correlations	AGE	IQ	SCSS	Z
AGE	Correlation Coefficient	1.000	-.021	.030	-.041
	Sig. (2-tailed)	.	.892	.839	.774
IQ	Correlation Coefficient	-.021	1.000	**.417***	-.138
	Sig. (2-tailed)	.892	.	.007	.355
SCSS	Correlation Coefficient	.030	**.417***	1.000	-.069
	Sig. (2-tailed)	.839	.007	.	.637
Z	Correlation Coefficient	-.041	-.138	-.069	1.000
	Sig. (2-tailed)	.774	.355	.637	.

**Correlation is significant at 0.01.*

Table 3.3 Values of Spearman's coefficient (girls)

Variables	Pearson Correlations	AGE	IQ	SCSS	Z
AGE	Correlation Coefficient	1.000	-.026	.040	-.072
	Sig. (2-tailed)	.	.899	.846	.728
IQ	Correlation Coefficient	-.026	1.000	**.538****	**-.200***
	Sig. (2-tailed)	.899	.	.005	.326
SCSS	Correlation Coefficient	.040	**.538****	1.000	-.071
	Sig. (2-tailed)	.846	.005	.	.732
Z	Correlation Coefficient	-.072	**-.200***	-.071	1.000
	Sig. (2-tailed)	.728	.326	.732	.

**Correlation is significant at 0.05.*

***Correlation is significant at 0.01.*

Significant Pearson's Correlation Coefficient (r=0.572) was estimated between intellectual maturity (IQ) and academic achievement (SCSS) at the probability level of significance p=.01, and between intellectual maturity (IQ) and Z score of Physical Fitness test a low Pearson's Correlation Coefficient with negative sign was established (-0.233) (Table 3.1).

Significant Kendall's Correlation Coefficient (0.417), and Spearman's Correlation Coefficient (0.538) between Intellectual maturity (IQ) and academic achievement (SCSS), at the same probability level of significance (p=.01) (Table 3.2 and 3.3, respectively).

Low Spearman's Correlation Coefficient with negative sign (-0.200) was established between Physical Fitness Test (Z value) and Intellectual maturity (IQ) in girls sample (Table 3.3).

STUDY LIMITATIONS AND CONCLUSION

Despite the contribution regarding the relationship of physical fitness to academic

achievement, in the sample of boys, several limitations of the study warrant mention. First, as discussed, student motivation may account for a portion of the variance explained in the relationship between physical fitness and academic performance. Second, the utilization of field-test measures of physical fitness, although administered by researchers, have a restricted evaluation of fitness in children. However, a field test was chosen to examine the relationship between fitness and cognition in an externally valid setting, and allowed for a greater understanding of the relationship between the various components of fitness, rather than only aerobic fitness. Finally, the sample was not random, and therefore the findings from this study may not be generalized to other populations.

The cross-sectional design of the present study clearly limits the conclusions that can be drawn, and one cannot attribute causation to any of the observed relationships. For example, this study cannot infer that an increase in physical activity, as part of a school program, would necessarily improve children's general educational achievement. The observed weak relationship between physical activity and academic achievement may be attributable to children with higher levels of motor competence having the confidence necessary to participate in physical activities.

Academic performance tends to decline for many youth, particularly females, during adolescence. The findings of this study suggest that participation in physical activities, and especially vigorous physical activities, may help some youth traverse this difficult period. Alternatively, it may be that many youth face barriers to participation, and that it is mainly those with strong self-esteems that participate. Either way, the results call for measures that would increase access to physical activities for all adolescents, and especially females.

The finding that higher levels of physical activity had relatively small effects on academic achievement is consistent with the findings of previous cross-sectional and longitudinal studies. However, our measure of physical activity provides only a rudimentary account of the quality and quantity of students' physical activity. In addition, our measures had strengths and limitations. Academic achievement was not assessed through a standardized test, in regard to avoid any potential rater bias that might have been introduced while academic achievement had been based on ratings by classroom teachers.

These research results are relevant for the evaluation of the various segments of the anthropological status of children such as chronological age (AGE), sufficient physical fitness (Z value) and academic achievement (SCSS) in individual with intellectual disabilities (IQ), as these factors are important contributors to their health and well-being. In addition, studies quantifying changes in academic performance resulting from the implementation of physical fitness/activity programs during various stages of childhood and adolescence should be conducted. In ABSTRACT, this study demonstrated that physical activity had a positive, trivial relationship with academic achievement. The study suggests that the relationship between physical activity and academic achievement is weak. For some children, physical activity may be indirectly related to enhanced academic performance by improving physical health and self-esteem.

General conclusion, derived from results of this study, provided within Special Education Students in upper level of Elementary School children (fifth to eighth graders) do not support a consistent link between specific components of Physical Fitness Tests, recalculated to Z- score, and common indices of academic achievement, such as average of various educational subjects' marks. Moreover, when separate analyses were conducted to examine differences between boys and girls, the relationship between academic achievement (SCSS) and Z- score was more evident in boys sample, then in girls sample (with low level of significance) with negative sign. Correlations are established between chronological age (AGE) and academic performance (SCSS), and intellectual maturity (IQ) and academic performance (SCSS). Physical Fitness Test Z value has not established any significant correlation with other variables. Future research in this area should focus on understanding the mechanisms supporting this association.

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DEVELOPMENT OF VISUAL-MOTOR INTEGRATION IN PRESCHOOL CHILDREN AGED 4 TO 7 YEARS

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ABSTRACT

The study was conducted with the aim of determining differences in the degree of visual-motor integration between preschool children of different age. Measurements were using the Visual Motor-Integration Assessment Test (VMI Test) on a sample of 36 subjects aged 4 to 7 years, divided into two subsamples; one sample included 20 children from 4 to 6 and the other 16 children from 6 to 7 years. A statistically significant difference was observed among the subsamples in the degree of visual-motor integration using the T-Test. Hereditary as well as environmental factors, such as programmed kinesiological activities and graphomotor exercises in the preschool system are possible causes for the noticed differences. In conclusion, further research of the above mentioned processes is recommended with a particular emphasis on the detection of neurological mechanisms responsible for visual-motor integration.

Keywords: fine motor skills, graphomotor skills, ontogenetic development

INTRODUCTION

One of the most important segments in the study of human ontogenesis is visual-motor integration which represents an extremely significant role in the development of a child. Visual-motor integration is defined as a process of motor system coordination providing information received through vision. The result of this process is a possibility of performing fine motor activities. Visual-motor integration represents a process of neuro-muscular synchronization or coordination of information from visual receptors and muscular effectors with the aim of executing precise motor activities (Bavčević, 2015).

Most frequently the term visual-motor integration refers to coordination of eyes and a hand or is fist muscles to be more specific which enables precise manual activities. This complex process includes at the same time visual perception and coordination of eyes and a hand (Beery, 1989). Visual-motor skills require abilities of turning visual perception into motor function and they include motor control, motor precision, motor coordination and psycho-motor velocity (Sanghavi & Kelkar, 2005).

Visual-motor integration is a part of ontogenetic development of a child and it represents a quite significant scientific question in the field of kinesiology and especially in kinesiological education. Numerous studies indicate the importance of visual-motor integration in the process of growth and development (Decker, Englund, Carboni & Brooks, 2011; Lin, Luo, Wu, Shen & Sun, 2015). During human life, visual-motor abilities grow fast till the period of middle adolescence, they weaken through the period of maturity and they rapidly decrease in the late years of life (Decker, 2008). Results of this study are contradictory with the statements that visual-motor development ends in late childhood. During ontogenetic development both sex and age are predictors for better results in aiming tasks and tracing skills (Flatters, Hill, Williams, Barber & Mon-Williams, 2014). Numerous studies show that visual-motor integration is in relation to writing skills (Cornhill & Case-Smith, 1996; Maki, Voeten, Vauras, & Poskiparta, 2001; Weintraub & Graham, 2000).

The aim of this research is to analyse ontogenetic development of visual-motor integration in children aged 4 to 7 years.

METHODS

Subjects

The research was conducted at the Sparta Universal Sports Academy, City of Split, Croatia in September 2019 and it included 36 children. Subjects were divided into two subsamples, 20 children aged 4 to 6 years and 16 children aged 6 to 7 years. All subjects were healthy and without any psychophysical aberrations. All subjects included in the experiment had a written parents'/guardians' consent after they were introduced to the aim and procedures of research.

Procedure

The subjects were assessed by the use of the Visual-Motor Integration Test (VMI Test). This test evaluates visual-motor integration of graphomotor type. The VMI Test (T. Bavčević & D. Bavčević, 2015) is a paper-pen type of instrument. The Visual-Motor Integration Test (VMI) consists of two parallel lines with spacing of 1.5 cm between them, drawn on an A4 size paper. Drawn lines form a path consisting of a total of 59 segments. The spacing between the starting dot and the final dot is 178.5 cm. The task was to draw a line with a pencil within the path from the starting point to the final point as fast as possible. Interruption of the line or drawing the line outside the path was considered to be an error. The final result of the test was calculated by adding a number of errors multiplied by two to the time necessary for finishing the test. The VMI Test was repeated once by each child..

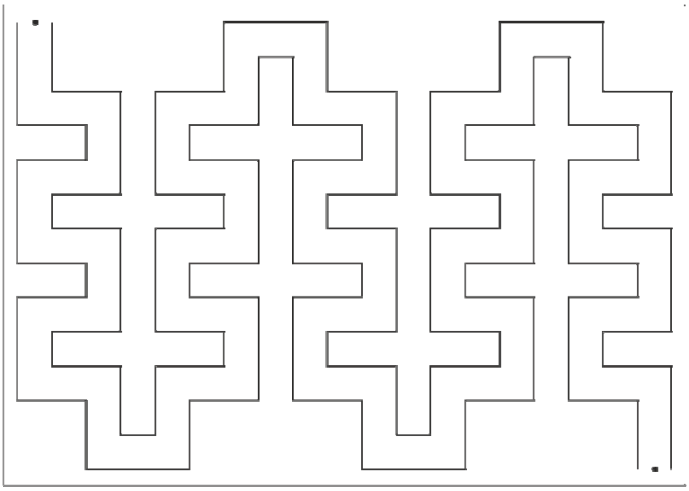

Figure 1. Graphic representation of the VMI Test (T. Bavčević & D. Bavčević, 2015)

Statistical analysis

The obtained results were subjected to descriptive analysis including calculating arithmetic mean, minimum and maximum result, standard deviation (SD), coefficient of asymmetry (α3), and coefficient of skewness (α4). Normality of data distribution was tested by the use of the Kolmogorov-Smirnov Test (KS-Test) with a possibility of an error at the significance level of 0.05 as a critical value.

Differences between components of the VMI Test were analysed by the use of the T-Test thus calculating the t value (t) and the level of significance (p).

The obtained data were processed by the use of the Statistica software package (SPSS 13.3).

RESULTS

Table 1 shows descriptive parameters and results of the Kolmogorov-Smirnov Test for the normality of data distribution for the VMI Test variables (VMI time, VMI errors, VMI) for both subsamples.

Table 1. Descriptive statistics parameters and the KS-Test

	Subsample 4 to 6 years (Max d = 0.294)						Subsample 6 to 7 years (Max d = 0.328)					
	Mean ±SD	Min	Max	α3	α4	Max d	Mean ±SD	Min	Max	α3	α4	Max d
VMI time	47.72 ±14.26	28.70	85.75	1.07	1.06	0.183	39.60 ±15.13	22.69	82.19	1.77	3.35	0.281
VMI errors	10.10 ±6.66	0.00	26.00	0.71	0.48	0.146	4.81 ±5.21	0.00	23.00	3.14	11.27	0.298
VMI	67.77 ±19.04	42.85	110.09	0.58	-0.28	0.136	49.22 ±23.45	34.88	128.19	2.89	9.25	0.312

Comparative analysis for the subsample of children aged 4 to 6 years showed homogenous distributions for all variables as standard deviations were lower than 1/3 of the respective mean values. The values of skewness confirmed a symmetrical distribution and the kurtosis values indicated mesokurtic distributions for all variables. The results of the KS-Test for the subsample of children aged 4 to 6 years confirmed a normal distribution of data for all variables because maximum deviations between the empiric and theoretic relative cumulative frequencies (max d) did not exceed the critical value of the KS-Test.

In the subsample of children aged 6 to 7 years the comparison of means and standard deviations show increased heterogeneity of data in the variables VMI time and VMI. In these cases, standard deviations exceeded 1/3 of the respective mean values. The increased skewness values confirmed a positive distribution asymmetry for all tree variables thus impaling the result shift to the zone of the lower values. The kurtosis values showed an increased concertation of the results thus creating leptokurtic distributions for all variables. The KS-Test confirmed a normal distribution for all variables in the subsample of children aged 6 to 7 years.

Table 2 shows results obtained by the use of the T-Test between the subsample of children aged 4 to 6 years and the subsample of children aged 6 to 7 years.

Table 2. The T-Test results for the subsamples

	Mean Subsample of children 4 to 6 years	Mean Subsample of children 6 to 7 years	t	p
VMI time	47.72	39.60	1.65	0.11
VMI errors	10.10	4.81	2.60	0.01
VMI	67.77	49.22	2.62	0.01

In order to determine the significance of means difference between the subsample of children aged 4 to 6 years and the subsample of children aged 6 to 7 years, a series of T-Tests was applied. The obtained results showed statistically significant differences between the two subsamples for the variables VMI errors and VMI. By analysing the respective mean values it was obvious that older subjects needed less time for solving the test although it was not statistically significant. They also made less errors obtaining better overall results.

DISCUSSION

The study results confirmed a statistically significant difference in the degree of visual-motor integration in children aged 4 to 6 and children aged 6 to 7 years respectively. The above findings suggest a strong developmental momentum of visual-motor integration during the investigated childhood period. The obtained findings are in line with the previous studies that define the preschool period as one of the most important periods in the development of visual-motor integration and graphomotor skills (Decker, Englund, Carboni & Brooks, 2011; Lin, Luo, Wu, Shen & Sun, 2015).

Accordingly, the question arises regarding the relationship between hereditary and environmental factors responsible for the process of visual-motor integration in children. The answer most likely lies in the interrelation of the above factors. Namely, the preschool period is a life period that is developing rather dynamically. At this stage there is a strong development of all anthropological characteristics

(Findak, 2003). It is also possible to assume that the process of visual-motor integration is aided by the exercise process, both by spontaneous children's activity and organized exercise. In addition, in the preschool system, especially during the year before starting school, children participate in various graphomotor activities. As previous studies show, such activities contribute significantly to the development of visual-motor integration (Flatters, Hill, Williams, Barber & Mon-Williams, 2014).

The findings of this study are in accordance with the above mentioned since the children aged 6 to 7 years achieved significantly better results in the field of graphomotor skills than the younger respondents. The above points to the conclusion about the importance of the observed life period in the process of growth and development, and thus impose the need for further research of ontogenetic process in the field of visual-motor integration.

CONCLUSION

The study confirmed the importance of preschool age in the process of visual-motor integration in children. During this period there is a significant increase in these skills and the causes could be found in both hereditary and environmental factors.

This raises additional questions regarding the importance of both the learning and exercising process, i.e. programmed kinesiological activities aimed specifically at stimulating and developing visual-motor integration. Therefore, the focus of scientific research work needs to be further focused on studying these developmental processes, especially with the aim of detecting neurological mechanisms responsible for the process of visual-motor integration.

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PHYSICAL DEVELOPMENT AND MOTOR ABILITIES OF PRIMARY SCHOOL BOYS

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ABSTRACT

In order to determine differences in motor abilities and basic anthropometric characteristics, 185 elementary schools pupils of the fourth and fifth grade age from 11-12 years from the autonomous region Vojvodina participated. A battery of 5 basic anthropometric measurements (body height, body weight, muscle mass, body fat, body mass index), 6 motoric tests and a short survey were assessed to the sample.

Based on the research results, we conclude that boys who are involved in regular organized sports activities have better motor abilities than boys who do not train. A statistically significant difference was found in the sit-ups tests, plate hand tapping, standing long jump and shuttle run 10x5m test, all for the benefit of boys involved in sports, which is the result of continuous work in sports clubs. Also, based on the results of anthropometric measurements and body mass index, we conclude that boys involved in spme sports have higher body height, lower body fat, lower body mass and greater muscle mass than boys who do not practice any sport.

Keywords: body mass index, motor ability, pupils 11-12 years

INTRODUCTION

Considering the quality of life importance in the context of increasing hypokinesia and obesity in the population of elementary school pupilss, a study was conducted to identify differences in motoric abilities and anthropometric characteristics of boys who are involved in different sports and those who do not participate in any sports activities.

Morphological-anthropological characteristics are used as indicators to assess nutritional status, central obesity, and health risk (Mikalački et al. 2014).

Living conditions, social status, diet, physical activity, as well as genetic predisposition are just some of the factors that influence an individual's body composition. Based on the body structure of an individual, one can gain an impression of a lifestyle that includes both good and bad habits, and reflects on the structure of the body, giving it a kind of personal characteristic (Korovljev et al., 2009; Maksimovic and Milosevic, 2008).

Body height and weight are the basic and most important indicators of growth, development, health and maturity of an organism, and indirectly, the living conditions of individuals (Berar, 2005).

Basic motor skills are not acquired spontaneously during the graduation process (Hardy et al. 2010). With this in mind, appropriate movement activities should be structured and implemented to encourage the development of basic motor abilities.

Knowledge of growth and development regularities, as well as the morphological and functional - physiological changes that occur in childhood are essential for all those who direct children to physical activity. It is well known that physical exercise, well selected and dosed, can be a stimulating factor in growth and development, but excessive and/or age inappropriate physical activity can have a negative effect (Mishigoj-Durakovic, 2008).

Engaging in physical activity at an early age, especially with the support and encouragement of parents, teachers and others, enables the creation of positive attitudes towards physical activity and the establishment of appropriate habits and value systems (Djordjic and Bala, 2006).

Physical characteristics investigations of preschool and school-age children are not rare. Many authors from different perspectives have explored the importance of physical activities and sports sections for young people and their positive impact on proper growth and development. Halashi et al. (2018) compared the body composition and the speed of gypsy children with their agemates from Vojvodina autonomous region, where the results

indicate that these children have a higher percentage of body fat and lower motor skills than the control group. The subject of research by Grujić (2016) is motor and morphological characteristics of young handball players tested by the Eurofit battery of tests, which indicates the importance of the development of motor skills in handball and sports in general.

METHODS

Sample

The sample consisted of 185 elementary school boys aged 11 - 12 years. Whole sample was divided into two groups. First group, 90 of them, are boys who do not conduct any sports, and second group, 95 of them, are boys who have been conducting sports for more than a year.

Measurement procedure and instruments

Measurement of physical development and testing of boys' motor abilities were performed in physical education halls in Novi Sad in May and June 2019. The testing was conducted by physical education professors employed by the Provincial Institute for Sport and Sports Medicine.

Body height (BH) measurements were performed with an anthropometer according to Martin with an accuracy of 0.1 cm. Body mass was measured by bioelectrical impedance (BIA) with an accuracy of 0.1 kg. The determination of body composition was performed by the Inbody 230 apparatus, which operates on the basis of bioelectrical impedance (BIA). BIA analysis is a fast, non-invasive, and relatively inexpensive method for evaluating body composition, in both field and clinical settings.

The following variables were obtained in determining the body composition: body mass index (kg / m2), muscle mass (kg), body fat percentage (%) and body fat mass (kg). Testing of motor abilities was performed by selecting and following the instructions of the test battery (according to the "EUROFIT" model of test battery prescribed by the Council of Europe Sports Development Committee (Council of Europe, 1993). The following tests were selected: seat and reach (cm) to assess hip flexibility, sit-ups (n) to assess repetitive abdominal muscle strength (30 seconds), plate tapping (s) to evaluate segmental velocity (25 double touches), standing long jump (cm) to evaluate explosive muscle strength of leg extensions (2 tries), shuttle run 10x5 meters to assess agility and speed running, and hand-grip (kg) to estimate the static strength (force) of fingers flexors (both hands, we take better result).

Statistical analysis

Descriptive statistics were used to process the basic descriptive variables of physical development and physical ability. T-test is used for comparing two independent groups of boys. The analysis of the obtained data was done with the help of the open source statistical processing software GNU PSPP version 1.0.1.

RESULTS

Table 1 shows the results of for variables of physical development and motor abilities in boys who do not conduct any sports. Results distribution was determined using Skewness and Kurtosis. Skewness values indicate a relatively normal distribution, and a positive sign tells us that the number of good results is large. The measured values of the sit-ups test based on the values of Skewness (-1.29) and Kurtosis (6.57) indicate that most of the values achieved are concentrated around poor results.

Table 1. Descriptive statistics in boys who are not involved in any sports

Variable	N	JM	AS	MIN	MAX	SD	Skew	Kurt
Body height	*90*	*cm*	*153,74*	*138,50*	*173,30*	*8,04*	*,30*	*-,45*
Body weight	*90*	*kg*	*48,29*	*29,70*	*87,10*	*13,23*	*,98*	*,57*
Muscle mass	*85*	*kg*	*19,21*	*12,60*	*29,00*	*3,85*	*,55*	*-,26*
Fat mass	*85*	*kg*	*12,24*	*2,30*	*37,00*	*8,35*	*1,27*	*,75*
Body mass index	*85*	*kg/m²*	*20,01*	*13,60*	*30,90*	*4,02*	*,98*	*,28*
Seat and reach	*89*	*cm*	*13,92*	*1,00*	*34,00*	*6,78*	*,46*	*,18*
Sit-ups	*89*	*n*	*20,62*	*2,00*	*29,00*	*3,69*	*-1,29*	*6,57*
Plate tapping	*90*	*s*	*13,28*	*9,98*	*18,19*	*1,63*	*,59*	*,53*
Standing long jump	*89*	*cm*	*160,40*	*90,00*	*230,00*	*28,43*	*-,15*	*-,22*
Shuttle run 10x5m	*88*	*s*	*22,52*	*18,29*	*28,34*	*1,97*	*,60*	*,28*
Hand-grip	*86*	*kg*	*19,47*	*9,00*	*41,00*	*5,89*	*,95*	*1,36*

Legend: N-research sample number, J.M.-unit, AS-arithmetic mean, MIN-minimal results, MAX-maximal results, SD-standard deviation, Skew- *Skewness distribution*, Kurt- *Curvature coefficient Kurtosis*

Body height of boys not involved in sports is in the range (138.5-173.30cm) and body weight (29.70-87.10kg).

Table 2 shows the results of descriptive statistics for variables of physical development and motor skills in group of boys who have been involved in sports for more than a year. The Skewness and Kurtosis values shown indicate that the normal distribution of the data of this sub-sample, except for the achieved values of the Standing long jump test, which are weak and concentrated around the small achieved values, Kurtosis (3.76).

Table 2. Descriptive statistics of boys who are involved in sports

Variable	N	JM	AS	MIN	MAX	SD	Skew	Kurt
Body height	*95*	*cm*	*155,75*	*130,50*	*186,00*	*9,90*	*,23*	*,16*
Body weight	*95*	*kg*	*47,30*	*29,00*	*82,30*	*10,78*	*,77*	*,36*
Muscle mass	*91*	*kg*	*19,94*	*11,40*	*31,60*	*4,21*	*,63*	*,31*
Fat mass	*91*	*kg*	*10,01*	*3,00*	*28,10*	*5,81*	*1,00*	*,27*
Body mass index	*91*	*kg/m²*	*19,22*	*14,10*	*30,20*	*3,10*	*,82*	*,63*
Seat and reach	*95*	*cm*	*14,52*	*,00*	*28,00*	*6,51*	*-,17*	*-,51*
Sit-ups	*93*	*n*	*23,77*	*9,00*	*32,00*	*3,68*	*-,52*	*1,80*
Plate tapping	*94*	*s*	*12,66*	*9,61*	*16,56*	*1,38*	*,40*	*-,14*
Standing long jump	*93*	*cm*	*171,38*	*60,00*	*210,00*	*23,98*	*-1,25*	*3,76*
Shuttle run 10x5m	*91*	*s*	*21,21*	*17,90*	*25,01*	*1,50*	*,30*	*-,13*
Hand-grip	*92*	*kg*	*20,22*	*10,00*	*42,00*	*5,08*	*,94*	*2,66*

Legend: *N-research sample number, J.M.- unit, AS-arithmetic mean, MIN-minimal results, MAX-maximal results, SD-standard deviation, Skew-* Skewness distribution*, Kurt-* Curvature coefficient Kurtosis

Table 3. T-test variables of physical development and motor abilities of the respondents

Variable	respondents	N	AS	SD	*Lev p*	*F*	*p*	*MD*
Body height	*1*	*90*	*153,74*	*8,04*	*,076*	*3,19*	*,132*	*-2,01*
	2	*95*	*155,75*	*9,90*				
Body mass	*1*	*90*	*48,29*	*13,23*	*,193*	*1,71*	*,576*	*,99*
	2	*95*	*47,30*	*10,78*				
Muscle mass	*1*	*85*	*19,21*	*3,85*	*,422*	*,65*	*,232*	*-,73*
	2	*91*	*19,94*	*4,21*				
Fat mass	*1*	*85*	*12,24*	*8,35*	*,006*	*7,87*	***,043***	*2,23*
	2	*91*	*10,01*	*5,81*				
Non-fat body mass	*1*	*85*	*35,84*	*6,46*	*,401*	*,71*	*,254*	*-1,17*
	2	*91*	*37,01*	*7,07*				
Seat and reach	*1*	*89*	*13,92*	*6,78*	*,945*	*,00*	*,545*	*-,59*
	2	*95*	*14,52*	*6,51*				
Sit-ups	*1*	*89*	*20,62*	*3,69*	*,518*	*,42*	***,000***	*-3,16*
	2	*93*	*23,77*	*3,68*				
Plate tapping	*1*	*90*	*13,28*	*1,63*	*,236*	*1,41*	***,006***	*,62*
	2	*94*	*12,66*	*1,38*				
Standing long jump	*1*	*89*	*160,40*	*28,43*	*,065*	*3,44*	***,005***	*-10,97*
	2	*93*	*171,38*	*23,98*				
Shuttle run 10x5m	*1*	*88*	*22,52*	*1,97*	*,015*	*5,98*	***,000***	*1,31*
	2	*91*	*21,21*	*1,50*				
Hand-grip	*1*	*86*	*19,47*	*5,89*	*,218*	*1,53*	*,362*	*-,75*
	2	*92*	*20,22*	*5,08*				

Legend: 1-boys not involved in sport, 2- boys involved in sport for more that 1 year, *N-number of respondents,* AS-arithmetic mean, SD-standard deviation, Lev p-Levele statistical significance coefficient, F-samples relation, p-level of statistical significance of univariate analysis of variance, MD arithmetic means differences

Body height of boys involved in sports is in the range (130.50-186.00cm) and body weight (29.00-82.30 kg). Respondents average values of body weight and body height study (Tables 1 and 2) are within the expected limits and values for the examined age (Gajević, 2009).

By looking at table no. 3, where by the t-test we tried to determine the differences in the tests of motor abilities and physical development on level of statistical significance ($p < 0.05$) we conclude that in all motor tests boys who train are better but statistically a significant difference was found in body fat assessment ($F = 7.87$, $p = 0.043$), where higher body fat values were observed in children not engaged in sports activities, statistically significantly better results were achieved by boys involved in sports with more than one year in Plate tapping ($F = 1.41$, $p = 0.00$), Standing long jump ($F = 3.44$, $p = 0.01$) and Shuttle run 10x5m ($F = 5.98$, $p = 0.00$).

DISCUSSION

Motor abilities of primary school pupils have often been the subject of research in physical culture. Various authors have explored motor skills of pupils from various aspects. (Gadžić, Marković, 2014) investigated differences between boys and girls of sixth grade elementary schools in some motor skills and morphological characteristics, while Badrić et al (2012) explored the trend of development of motor skills of pupilss from 5 to 8th class.

The results of this study are in line with the study by Buisic et al (2013), who tested 4th grade pupils in Standing long jump (AS 156.21cm) among other tests. Doder et al. (2010) aim to determine the status and differences in the physical development and physical abilities of primary school children in grades 1-8 from the AP Vojvodina region by applying the "Eurofit" battery of tests to compare Serbia and some other European countries. The sample consisted of 704 pupils (384 boys and 320 girls) from Novi Sad. Comparing the results of our study with this, better results were achieved in the following tests: Hand-taping (AS = 13.28s non-athletes, 12.66s athletes> 14.31s pupils 11 years, 12.94s pupils 12 years), Standing long jump (160.40 cm non-athletes, 171.38 cm athletes> 160.33 cm pupils 11 years). When it comes to agility, better results in the 10x5m shuttle run test compared to the Doder survey were achieved by boys who have been involved in sports for more than a year (21.21s> 22.49s), while boys not involved in sports activities weaker (22.52 <22.49s 11 years old). In the sit-ups test, better are pupils involved in sports (23.77> 21.07 11 years old).

The results show us that the importance of playing sports is undoubtedly great, especially when it comes to this age of children, bearing in mind that the sensitive stages of motor skills development for particular abilities end or continue in this period of life.

CONCLUSION

Physical activity, regardless of age, is treated as health-related behavior that can have a beneficial effect on all aspects of the health and overall children development (Halashi et al. 2018).

Generally speaking, the results of previous and present research conclude that boys involved in sports for more than one year, ages 11-12, have a higher level of motor skills and lower body fat than boys who are not involved into a particular sport. In the study of differences between physical abilities and development of elementary school students aged 11 and 12, it was found out that statistically significant differences in motor space were found in the examined sample: repetitive abdominal muscle strength (sit-ups test), alternative movement speed (plate tapping), explosive legs strength and agility (shuttle run 10x5m test), as well as the amount of body fat, for the benefit of boys involved in sports. The reasons for such results are found in the continuous work in sports clubs on the development of tested physical abilities and physical development, that is, the physical composition of the body of young athletes.

A comparison of two studies Ivanović, B. (1996) and this study in 2019 indicates an increasing negative tendency for weight gain, which may be an indicator of the onset of young people obesity. The data from our research that almost 50% of tested children do not engage in any kind of sports activities, with lack of everyday movement and a modern way of life, are certainly a wake-up call for all participants, institutions dealing with children, education and sports.

The results of this research should serve parents and teachers to confirm the importance of playing sports in poor health habits prevention, as well as to raise awareness of the sports and sports activities positive impact on the comprehensive physical development of children.

Obtained statistically significant differences in motor abilities that are more or less susceptible to changes through the training process are the result of continuous work of children in sports clubs. The impact of regular training activities on those abilities that are dominant in the sports sector is obvious.

Physical activity and children development, is conditioned by a number of factors, and certainly the

social environment at school and the environment in which children grow up have a major impact on children's activity in general.

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CORRELATION BETWEEN MORPHOLOGICAL CHARACTERISTICS AND MOTOR SKILLS IN PRIMARY-SCHOOL STUDENTS FROM THE SEVENTH AND EIGHTH FORM

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ABSTRACT

The sample consisted of 88 male students from the seventh and eighth primary-school forms from the city of Split. In order to achieve tasks and objectives of Physical Education, it is necessary to determine the current state of the subjects. The research was conducted during Physical Education classes in order to determine the correlation of morphological characteristics and motor skills. The implementation of canonical correlation analysis between a set of morphological characteristics and set of motor skills where obtained by the canonical correlation coefficient of 0,631, with the forms of the test statistics $\chi 2 = 56,226$ while the degrees of freedom were 18. Correlation between the set of morphological and motor variables was statistically significant as the empirical significance level of the canonical correlation coefficient was less than 0,05. The percentage of the set of morphological variables explained in variables of motor skills was 19,481%, and the percentage of the set motor variables explained in variables of morphology was 11,535%. Only the first extracted canonical pair is statistically significant ($p = 0,000$), unlike the other two canonical pairs ($p > 0,05$). The largest eigenvalue had the first canonical pair (0,398). The first canonical factor was determined by the anthropometric body height and the variable MPR. Such canonical factor could be interpreted as a flexibility factor. This study offers an insight into correlation of morphological characteristics and motor abilities. The obtained results show relationship between the characteristics and skills. Such findings might represent a foundation for planning and programming in the immediate kinesiological practise.

Keywords: primary school, male students, Physical Education, canonical correlation analysis

INTRODUCTION

Determining the current state of the student as an individual, as well as of the group as a whole, enables the teacher to directly control his work and to programme and implement the planned contents in a quality manner in order to achieve the set goals. Findak, Metikoš and Mraković (1992) argued that in order to achieve the achieve tasks and objectives of Physical Education, it is necessary to determine the current state of children at the beginning of the school year due to work programming and at the end of the school year due to the analysis of work performance. Marijan Jozić and Hrvoje Đurak (2012) conducted a study on the relationships between motor abilities and morphological characteristics in the seventh and eigthth-form students. The study was conducted on a random sample of schoolchildren with the aim of obtaining the latest information on the level of utilization of certain elements from the official programme. Of the total number of canonical correlations, only the first canonical pair was statistically significant. The results showed that there was a significant correlation between morphological dimensions and motor abilities. The morphological structure of the body greatly influenced results in tests for motor skills in primary-school students. Kinesiological education uses an appropriate kinesiometric monitoring system for anthropological features for younger school age, so there are great opportunities for monitoring and following students in Physical Education (Findak, Metikoš, Mraković, Neljak, 1996; Prskalo, 2003). The described system was standardised (Findak et al., 1996). Therefore, the aim of this research was to determine the correlation

between the set of variables for assessing morphological dimensions and the set of variables for assessing motor skills in the seventh and eighth-form students during the Physical Education classes.

METHODS

Subjects

The sample consisted of 88 male pupils from the seventh and eighth forms from *Mertojak* and *Bol* primary schools in Split. A total of 45 subjects were seventh-form students and the remaining 45 were eight-form students. All subjects were measured within the same time period during the Physical Education classes. The criterion for students to be a part of the sample was to attend Physical Education regularly and to be fully healthy.

Procedure

The battery of tests consisted of:

- A sample of morphological variables for assessing anthropometric characteristics consisted of a set of three variables: ATV (anthropometric body height), ATT (anthropometric body weight) and AOP (anthropometric forearm circumference).
- A sample of motor variables for assessing motor skills consisted of a set of six motor tests (variables): MTR (hand-tapping), MSDM (standing long jump), MPOL (backward obstacle course), MPT (sit-ups), MPR (sit-and-reach) and MVIS (hanging endurance).

The data were collected within the framework of measurements taken during Physical Education classes using standardized measuring instruments with verified and satisfactory metric characteristics (Norms–Findak et al., 1996).

Statistical analysis

The data were processed using the STATISTICA 12 software package. Descriptive statistics parameters (arithmetic mean, minimum and maximum, standard deviation, coefficient of variation, skewness, kurtosis, and K-S test) were calculated, as well as canonical correlation analysis between the set of morphological characteristics and the set of motor skills (coefficient of canonical correlation eigenvalue, test statistic value, degrees of freedom, and significance level).

RESULTS

Table 3 shows the results of descriptive statistics for variables of morphological characteristics (arithmetic mean, minimum and maximum, standard deviation, coefficient of variation, skewness, kurtosis, and K-S test).

Table 3. Results of descriptive statistics for variables of morphological characteristics.

	Arit. Mean	Min	Max	Std. Dev.	Coef. Var.	Skew.	Kurt.	K-S test
ATV	165,236	148,000	183,500	7,005	4,240	0,230	0,251	p > .20
ATT	55,864	38,500	86,500	8,150	14,590	0,524	1,242	p > .20
AOP	22,542	19,000	27,500	1,721	7,635	0,667	0,548	p > .20

ATV - anthropometric height, ATT - anthropometric body weight, AOP - anthropometric forearm circumference

Table 4 presents the results of descriptive statistics for variables of motor skills (arithmetic mean, minimum and maximum, standard deviation, coefficient of variation, skewness, kurtosis, and K-S test).

Table 4. Results of descriptive statistics for variables of motor skills

	Arit. Mean	Min	Max	Std. Dev.	Coef. Var.	Skew.	Kurt.	K-S test
MTR	31,000	25,000	36,000	2,528	8,155	-0,009	-0,608	p > .20
MSDM	188,807	160,000	232,000	16,831	8,914	0,588	-0,181	p < .15
MPOL	13,117	8,110	18,200	2,073	15,805	-0,062	-0,312	p > .20
MPT	42,034	31,000	54,000	5,165	12,288	0,234	-0,254	p > .20
MPR	61,614	47,000	91,000	8,798	14,280	0,985	1,465	p < .20
MVIS	38,034	6,500	103,000	16,074	42,264	0,921	2,054	p > .20

MTR (hand-tapping), MSDM (standing long jump), MPOL (backward obstacle course), MPT (sit-ups), MPR (sit-and-reach) and MVIS (hanging endurance).

Table 5 shows the results of the canonical correlation analysis between the sets of morphological characteristics and the set of motor skills (canonical correlation coefficient, eigenvalue, test statistic value, degrees of freedom, and significance level).

Table 5. Significance testing of extracted canonical pairs by using the χ2 test

	Canonical correlation coefficient	Eigenvalue	The value of test statistics	df	p
0	0,631	0,398	56,226	18	0,000
1	0,381	0,145	14,605	10	0,147
2	0,145	0,021	1,739	4	0,784

0 – first canonical pair, 1 – second canonical pair, 2 – third canonical pair

Applying the canonical correlation analysis between the set of morphological characteristics and motor abilities resulted in canonical correlation coefficient of 0.631 with the test statistics value χ2 = 56.226 and the degrees of freedom of 18. The correlation between the set of morphological and motor variables was statistically significant since the empirical level of significance for the canonical correlation coefficient was p = 0.000. The percentage of the set of morphological variables explained by motor variables was 19,481% and the percentage of the set of motor variables explained by morphology variables was 11,535%.

Only the first extracted canonical pair was statistically significant (p = 0.000) unlike the other three canonical pairs (p> 0.05). The first canonical pair had the highest eigenvalue (0.398), meaning that 39.8% of the variance of the first canonical pair was explained by the correlation between the first canonical factor of morphological variables and the first canonical factor of motor variables.

Using Table 6 we can see the correlations between the morphology variables and the canonical factors and conclude which variable mostly correlates with the significant canonical pair. In this case, it is the variable ATV - anthropometric height, because it is numerically closest to number 1.

Table 6. Correlation matrix of canonical factors and morphology variables (Root 1 - first canonical factor, Root 2 - second canonical factor, Root 3 - third canonical factor)

	Root 1	Root 2	Root 3
ATV	0,802	-0,581	-0,140
ATT	0,217	-0,887	0,407
AOP	0,139	-0,959	-0,245

ATV - anthropometric height, ATT - anthropometric body weight, AOP - anthropometric forearm circumference

The first canonical factor of the morphological set was mostly determined by the variable ATV (the correlation coefficient was 0.802). The second canonical factor of the morphological set was mostly determined by the variable AOP (the negative correlation coefficient was -0,959), while the third canonical factor of the morphological set was mostly determined by the variable ATT (the correlation coefficient was 0.407).

Table 7 shows correlations between motor variables and canonical factors, leading to a conclusion which variable mostly correlates with its significant canonical pair. It is the variable MPR – sit-and-reach, for the same reason as in the previous table, that is, it is numerically closest to number 1.

Table 7, Correlation matrix of canonical factors and motor variables

	Root 1	Root 2	Root 3
MTR	0,547	-0,311	-0,096
MSDM	0,594	-0,323	-0,297
MPOL	-0,393	-0,585	0,679
MPT	0,117	0,372	-0,173
MPR	0,647	0,452	0,563
MVIS	-0,286	0,354	-0,047

MTR - hand-tapping, MSDM - standing long jump, MPOL - backward obstacle course, MPT – sit-ups, MPR - sit-and-reach and MVIS - hanging endurance

The first canonical factor of the motor set was mostly determined by the MPR variable (correlation coefficient was 0.647), the second canonical motor set factor was determined mostly by the MPOL variable (the correlation coefficient is negative and equals to -0.585, but in general the variable MPOL was inversely scaled because a smaller numerical result means a better overall result), and the third canonical motor assembly factor was again

determined mostly by the variable MPOL (correlation coefficient was 0.679).

DISCUSSION

The first canonical factor could be flexibility, and since the variables ATV and MPR have a positive correlation coefficient with the first factor, we conclude that the higher results for the body height, i.e. the longitudinality of the skeleton, the better the result for the variable MPR. We can logically assume, in addition to the results obtained, that higher students also have bare more flexible due to the fact that longitudinality of the skeleton, especially of the upper extremities, can greatly improve the result of this test. We have to pay particular attention to the fact that these are the students from the seventh and eighth primary-school forms, that is, male students in the period of puberty, and this fact can additionally explain the obtained results. Thereby, two peers may be completely different during this period of life. Accelerated growth begins at the age of 10 for girls and at the age of 12 for boys (Kosinac, 2011). Therefore, the phenomenon of growth in its sense implies quantitative changes, it is caused by the enlargement and multiplication of cells and the intercellular substance, and is reflected in changes in the shape of the body, the so-called morphological maturation (Mišigoj-Duraković 2008). This is further evidence why subjects with higher anthropometric height have a better score in the pre-inclination test, but the anthropometric height may not always have an impact on the test. We also need to consider that some students may be involved in sports where flexibility is being developed. Of course, this ability is developed during training in all sports, but it also depends to what extent do coaches pay it any significance or attention. While in some sports it is certainly much more developed, such as gymnastics, wrestling, judo, etc., it is important to emphasize that this is a group of entities that are in the development phase. But it's also important to emphasise that the development of height both in children athletes and non-athletes follow the same regularities. (Prskalo, 2004). For example, it would hardly be possible to observe the older population in such manner. The question is what measures of anthropometric characteristics, and at the same time, the results of tests to test the motor skills, of globally all measured entities from the data matrix would be obtained after puberty. Although the second and third factors are not statistically significant, further research could certainly prove their significance, but the question is whether the same variables would have the highest correlation with canonical factors. Since these are significant factors that are not significant, they cannot be interpreted as there is no need to.

CONCLUSION

After testing and statistical processing and interpreting the data, it was determined that there was a statistically significant correlation between morphology and motor skills in 88 male students of seventh and eighth grades of elementary schools. Using the canonical correlation analysis, only the first extracted canonical pair was statistically significant and the other two were not. The first canonical factor could be flexibility; is most determined by anthropometric body height and the MPR variable, and we conclude that the higher the anthropometric body height, the better the result in the MPR variable. Given that the population consists of seventh- and eighth-grade elementary school male students, some of whom had reached puberty, some had not, it is logical that students with greater upper extremity longitude can reach further outstretched than students with lower upper extremity longitude. Also, the overall anthropometric height should be taken into account. (when it comes to the older population, we could hardly look at it this way). Since the second and third canonical factors are not statistically significant, they are neither proven nor need to be interpreted, but further research could certainly prove it, for example with a larger sample of respondents. Findak (2001) states that it is certain that Physical Education classes must be implemented methodically, rationally and safely. Accordingly, the results can be of great use to coaches and teachers of physical education for better planning and programming the training cycles and the teaching process, guidance, control of individual level of training, monitoring of growth and development, development of basic and specific motor skills, control of the realization of teaching and in general the entire teaching of physical education.

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CHANGES IN MORPHOLOGICAL CHARACTERISTICS UNDER THE INFLUENCE OF PHYSICAL EDUCATION EXTENDED CLASSES PROGRAMME

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ABSTRACT

The research was conducted aiming to determine quantitative changes in morphological characteristics of high school students under the influence of extended classes programme. The respondents' sample consisted of 51 male students from "Gemit-Apeiron" High School Centre in Banja Luka, between 15 to 18 years of age. The whole sample was divided into two groups through random selection, an experimental group (N=25) and control group (N=26). In accordance with the set goal, 17 variables of morphological characteristics were applied in the research, as well as the body mass index (BMI). Canonical discriminant analysis was applied to determine global quantitative changes in morphological characteristics of high school students under the influence of extended classes.

Analysing the results of canonical discriminant analysis, it can be seen that the respondents in experimental group with whom the extended classes programme was implemented had statistically significant global quantitative changes in morphological characteristics. The resulting changes are especially evident in reduction of subcutaneous adipose tissue (adipose tissue has a negative sign, which means reduction), which is essentially the main task and primary goal of applied kinesiology activity programmes through extracurricular activities of students in accordance with their developmental stages.

Key words: changes, morphological characteristics, students, extended classes.

INTRODUCTION

Identification and determining changes of transformational treatments under the influence of regular physical training classes and various programmes of extracurricular and out-of-school organizational work forms are always important for obtaining valid information on their effects. Physical education is a teaching-pedagogical process in which physical exercises and other necessary teaching aids and methods are applied in a planned and organized manner aiming at comprehensive preparation of young people in accordance with general educational goals.

Morphological characteristics are the characteristics responsible for growth and development of the human body. Based on previous research, it has been established that morphological space is four-dimensional, consisting of longitudinal dimensionality of the body, transverse dimensionality of the body, circular dimensionality and body mass and subcutaneous apidose tissue (Kurelić, Momirović, Stojanović, Šturm, Radivojević and Viskić-Štalec, 1970; Malacko and Rađo, 2004). Research on the student population supports the conclusion that longitudinal measures develop intensively at that age (Burzan, 1984; Bilić, 2001; Ramadanović, 2005), that is, that the development of longitudinal measures is influenced by transformational treatment process (Kosinac, 1999; Bonacin, Blažević and Katić, 2002; Bajrić et al., 2016; Bajrić et al., 2018), but also by programmed physical education classes (Stanković, 2002; Bajrić et al., 2018; Klojčnik, 1979). Furthermore, it has been observed that the changes are taking place, in addition to those already mentioned, in the direction of reducing subcutaneous adipose tissue, when it comes to extended organized physical activity (Pelemiš and Stević, 2009; Nićin and Lolić, 2011).

The main objective of this research is to determine quantitative effects in the changes of morphological characteristics by a specially defined work programme of extended classes with various contents enabled by physical education classes in experimental group respondents compared to the control group, among high school students between 15-18 years of age.

WORK METHOD

The respondents' sample

The research was conducted on a sample of 51 male respondents, students of High School 'Gemit' from Banja Luka, between 15 to 18 years of age, non-selected and through random selection divided into two groups, experimental (EG = 25) and control (CG = 26). The control group (CG = 26) performed physical education classes according to the existing High School Curriculum, two school hours per week. The experimental group (EG = 25) worked according to the existing High School Curriculum, two school hours per week and additionally, two school hours per week (once a week two school hours), according to the planned work programme for school sections, and in the preparatory part of extended classes and specially selected body shaping exercises, during a four months period.

The variables sample

The variables sample for assessing morphological characteristics and body composition consisted of *variable for assessing longitudinal body dimensionality* (body height - AVISTJ, arm length - ADUŽRU, leg length - ADUŽNO), *variable for assessing transverse body dimensionality* (ankle width - AŠIRSZ, knee joint width - AŠIRZK), *variable for assessing circular dimensionality and body weight* (body weight - ATEŽTJ, abdominal circumference - AOBTRB, mean chest circumference - ASROGK and body mass index - BMINDX), *variable for subcutaneous adipose tissue* (abdominal skinfold ANATRB, back skinfold ANALEĐ, biceps skinfold - ANABIC, triceps skinfold - ANATRI, lower leg skinfold - ANAPOT) and *variable for body composition assessment* (basal metabolism - BAZMET, total fat - UKUMAS, visceral fat - VISMAS, muscle mass - MIMASA).

Description of the research

Morphological characteristics of the respondents were measured in accordance with the International Biological Programme guidelines (IBP, Mišigoj-Duraković et al., 1996) and protocol requirements for determining body composition. An apparatus (scale) based on bioelectrical impedance was used for assessment of body mass and body composition.

The work of the experimental group students in regular physical education classes was carried out according to the anticipated high schools Curriculum. Annual work plan for the high school first and second grades is 72 hours and has been worked out according to the monthly plans. In addition to the regular physical education classes, an experimental work programme of extended classes (extracurricular activity) was carried out with the experimental group students, which was implemented with additional two school hours per week as per the sports sections programme for a period of four months. The main differences that distinguish the experimental programme from the current 'standard' programme anticipated by the high schools Curriculum are as follows: the work according to the work plan and programme of a certain sport branch section, the scope and interpretation of teaching content and teaching in the experimental group were 'burdened' with additional exercise hours, shaping exercises, divided into three groups, 18 exercises per hour, with 10 repetitions. The classes were delivered by physical education and sports teachers.

Statistical processing of the data

Canonical discriminant analysis was applied to determine global quantitative changes in morphological characteristics for both respondent groups. Discriminant analysis in the research was used to determine if there was a statistically significant difference between the initial and final measurements, and then to determine which morphological variables contributed the most to the established difference, that is, group discrimination. Statistical programme SPSS12 and statistics 7.0 were used to process the obtained data at the initial and final measurements of morphological characteristics in the experimental and control group respondents.

RESULTS AND DISCUSSION

In this research, in order to determine global quantitative differences between the initial and final measurements of experimental and control group respondents in the space of morphological characteristics and motor skills, the following values were calculated by the discriminant analysis: Eigenvalue - square of discrimination coefficient, Canonical R - coefficient of canonical correlation, Wilk's lambda - separation (discriminative strength), Chi-Square - Statistical significance of each variable, df - degrees of freedom, Sig. - a possible error in rejecting the hypothesis where the actual value of canonical correlation equals zero.

Differences between the initial and final situations of quantitative effects of experimental treatment in the morphological characteristics space of the experimental group are shown in Tables 1 to 4. First, the Box test determined statistical significance of global quantitative changes in the morphological characteristics space (Table 1). Table 2 shows the squares of discrimination coefficient (Eigenvalue), canonical correlation coefficients (Canonical R), Bartlett test values (Wilk's lambda), the size of the Chi Square test (Chi-Sqr), degrees of freedom (df), and the error probability sign (Sig.) at rejecting the hypothesis that the actual value of canonical correlation equals zero. One significant discriminant high intensity function (CR = 69.6%) was obtained, showing in which correlation is the set of data on the basis of which discriminant analysis of the obtained results was performed. Results of the discriminant strength of anthropometric measures were given by the Wilk's-lambda test (.516), so the differences between the initial and final measurements in the morphological characteristics space of the experimental group are significant (Sig. = .049) because the size of the Chi Square test has a high value (Chi-Sqr = 26.504). Overview of the results presented in Table 3 shows that the biggest contributors to the discriminant function are the following variables: body weight (ATEŽTJ), body height (AVISTJ), leg length (ADUŽNO), mean chest circumference (ASROGK), biceps skinfold (ANABIC) and triceps skinfold (ANATRI).

Based on the correlations with the discriminant function (structure of the discriminant function, Table 4), thus with the variable that differentiates the initial from the final measurement to the maximum, it can be observed that the body height test (AVISTJ) is the most responsible for the changes that occurred, followed by the body weight measurement tests (ATEŽTJ), visceral fat (VISMAS), lower leg skinfold (ANAPOT) and back skinfold (ANALEĐ). Based on the obtained results, it can be concluded that the aforesaid anthropometric measures influenced the obtained effects caused by the applied extended classes programme, but the influence of biological growth and development should not be neglected. Based on standardised centroids, the effects of extended classes programme influence on morphological characteristics of the experimental group respondents in terms of reduction of subcutaneous adipose tissue (adipose tissue has a negative sign, which means reduction) are noticed. In this direction, morphological characteristics of the students should be influenced in accordance with their stages of development.

Table 1. The Box test of statistical significance of the experimental group morphological characteristics changes

VAR00019	Rank	Log Determinant
1.00	18	124.193
2.00	18	129.629
Pooled within-groups	18	137.172

Box's M		500.081
F	Approx.	1.755
	df1	171
	df2	7345.252
	Sig.	.000

Table 2. Isolated discriminant function significance

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.940[a]	100.0	100.0	.696

Test of Function(s)	Wilks' lambda	Chi-square	df	Sig.
1	.516	26.504	18	.049

Table 3. Matrix of the discriminant function standardized coefficients

	Function
	1
ATEŽTJ	.768
AVISTJ	.755
BAZMET	.033
BMINDX	-.298
UKUMAS	-.432
VISMAS	-.244
MIŠMAS	.081
ADUŽRU	.098
ADUŽNO	-.594
AŠIRSZ	.308
AŠIRZK	-.141
AOBTRB	-.058
ASROGK	.644
ANATRB	.232
ANALEĐ	-.278
ANABIC	-.499
ANATRI	.426
ANAPOT	-.318

Table 4. Isolated discriminant function structure matrix

	Function
	1
AVISTJ	.466
ATEŽTJ	.432
VISMAS	-.251
ANAPOT	-.239
ANALEĐ	-.214
ANATRI	-.189
ADUŽRU	-.170
UKUMAS	-.160
ANATRB	-.149
BMINDX	-.144
MIŠMAS	.124
AŠIRSZ	.113
ADUŽNO	-.112
AOBTRB	.085
AŠIRZK	-.073
ANABIC	-.054
BAZMET	-.015
ASROGK	-.005

Table 5. The groups centroids' positions

	Function
VAR00019	1
1.00	.969
2.00	-.932

Based on the results of canonical discriminant analysis, it can be concluded that there are statistically significant global quantitative effects (global quantitative changes) in the morphological characteristics of the experimental group respondents. The resulting changes are most likely caused by the combination of biological growth and development supported by physical education classes, but also by the programmed content of extended classes.

Differences between the initial and final situations of global quantitative effects in the morphological characteristics space of the control group are shown in Tables 6 to 9. First, the Box test checked whether there was a statistical significance of global quantitative changes in the morphological characteristics space of the control group respondents and whether there was a justification for entering into the analysis of the discriminant analysis results. Provided that the Box test does not

show any statistical significance, further analysis will not be performed as there is no justification for that.

Table 6 shows the squares of discrimination coefficient (Eigenvalue), canonical correlation coefficients (Canonical R), Bartlett test values (Wilk's lambda), the size of the Chi Square test (Chi-Sqr), degrees of freedom (df), and the error probability sign (Sig.) at rejecting the hypothesis that the actual value of canonical correlation equals zero. No significant discriminant function was obtained, that would show in which correlation is the set of data on the basis of which the discriminant analysis of the obtained results was performed.

Results of the canonical discriminant analysis indicate that under the influence of 'standard' physical education programme planned on the basis of the current curriculum, there were no statistically significant global changes in morphological characteristics of the control group respondents, with whom the defined programme of extended classes as an extracurricular school work was not implemented.

Based on the obtained results of the canonical discriminant analysis, it is evident that 'standard' physical education work programme planned by the current curriculum has insufficient effectiveness on the change of those morphological characteristics that actually may be affected by such programmes (reduction of subcutaneous adipose tissue), as seen in the experimental group that was subjected to the extended classes programme.

Table 6. The Box test of statistical significance of the control group morphological characteristics changes

VAR00019	Rank	Log Determinant
1.00	18	125.572
2.00	18	124.193
Pooled within-groups	18	130.952

Box's M		291.352
F	Approx.	1.008
	df1	171
	df2	7072.091
	Sig.	.458

Table 7. Isolated discriminant function significance

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.283[a]	100.0	100.0	.470

Test of Function(s)	Wilks' lambda	Chi-square	df	Sig.
1	.779	9.727	18	.940

Table 8. Discriminant function standard coefficients

	Function
	1
ATEŽTJ	-.375
AVISTJ	-.008
BAZMET	-.494
NDX	.449
UKUMAS	1.236
VISMAS	.545
MIŠMAS	2.947
ADUŽRU	.246
ADUŽNO	1.146
AŠIRSZ	.246
AŠIRZK	.415
AOBTRB	.904
ASROGK	.023
ANATRB	.919
ANALEĐ	.427
NABBIC	1.332
ANATRI	-1.253
ANAPOT	.519

Table 9. Isolated discriminant function structure matrix

	Function
	1
ANATRB	.415
AVISTJ	-.335
BMINDX	.252
ANAPOT	.188
ANABIC	.153
VISMAS	.099
ATEŽTJ	-.070
UKUMAS	.056
ASROGK	-.033
ANATRI	-.032
BAZMET	-.030
AŠIRZK	.021
ADUŽNO	-.006
AOBTRB	.005
ADUŽRU	-.005
ANALEĐ	.005
MIŠMAS	-.003
AŠIRSZ	-.001

Table 10. The groups centroids' positions

	Function
VAR00019	1
1.00	.521
2.00	-.521

The obtained results support earlier research that extended classes of physical education may cause changes in morphological characteristics (Selmanović, 2007; Hodžić, Ejup, Hadžiahmetović and Ferić, 2010; Ademović, 2013).

CONCLUSION

Obtained results indicate that the experimental group respondents with whom the extended classes programme was implemented had statistically significant global changes in applied morphological variables. The most significant changes in the research space are evident in the skinfold variables, that is, in reduction of subcutaneous adipose tissue, which is essentially the primary task and desired goal of extended classes applied programmes through extracurricular student activities. Contribution of other variables to the quantitative changes of the discriminant function is relatively small. Obtained significant changes are most likely caused by the combination of biological growth and development supported by physical education classes, as well as by the programmed contents of extended classes. In the control group of respondents who worked under the 'standard' physical education curriculum, the resulting changes were of lower intensity and were not statistically significant at the global level. The reasons for this should certainly be sought in the lower total workload and intensity in physical education classes in comparison to the experimental group that had additional engagement through extended classes. However, disregarding weaker effects of the changes in the control group than in the experimental group, positive effect of physical education classes in schools cannot be disputed.

This is why the authors believe that greater effects of transformations in morphological characteristics of students can be expected only if regular physical education classes are combined with other forms of extracurricular content, thus practically rounding up the positive effects of teaching in schools. Results of this research may be useful for physical education teachers as a guide how and in which direction it is possible to perform transformations in morphological characteristics of students under the influence of defined programmes in curricular and extracurricular work forms. Furthermore, the results of the research can serve as a basis for future research that will also cover other anthropological characteristics of students (motor skills, cognitive abilities, conative characteristics and social status), thus obtaining more valid information on anthropological characteristics of students and the possibility of their transformation.

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SCHOOL SPORT, PHYSICAL EDUCATION CLASSES AND ACADEMIC PERFORMANCE: A BRIEF REVIEW

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ABSTRACT

Introduction: The aim of this review was to determine whether participation in physical education classes and school sports has a positive effect on academic achievement, motor skills and participation in physical activity. Moreover, the aim of this paper was to formulate some conclusions based on previous research, but also to come up with new information related to the assumption that physical education and school sports significantly influence academic achievement of students.

Methods: The literature was searched by terms that reflected exposure of interest (e.g., physical education classes, sport, and physical activity), academic performance (e.g., grade point average, grades, standardized test scores and course grades, assessment of concentration, memory, and classroom behaviour), as well as methods (experimental, systematic reviews and meta-analyses).

Results and Discussion: The results of this review showed that physical education and school sports have a positive impact on the examined phenomena.

Conclusion: There is some compelling evidence to suggest that physical activity can improve attention and arousal in children, which may indirectly contribute to academic achievement. Some authors point out that there may be a short improvement in attention after physical activity, but that long-term improvement in academic achievement as a result of stronger physical activity is not well substantiated. Regardless of the mechanisms that affect academic development, the implication is that daily physical education should be introduced from the first day of school, without the consequences of endangering academic development. Moreover, there is a valid claim that aspects of aerobic fitness may be globally related to the academic performance of pre-adolescents.

Keywords: School sports, Physical education, Physical activity, Academic performance.

INTRODUCTION

When thinking about school sport, we have to keep in mind that it is a separate segment of sport, and at the same time it is a link between two important areas of physical culture (physical education and sport). It contains the characteristics of both areas, but the priority is given to the characteristics of physical education. School sport should be treated as a segment of the school curriculum Savić (2014). School sport, in essence, contains the characteristics of the training process, but not in the form of elite sport. Its importance is reflected through competition, but the outcome is not a primary goal. These are the determinants of school sport, which could be beneficial to educational process (Savić, 2014). Moreover, an important goal concerns the long lasting interest in sports, which can contribute to engaging in sports or recreational activities throughout one's life (Okely, Booth, & Patterson, 2001; Savić, 2014; Vanreusel et al., 1997; Yang, 1997). The trends of modern life, as well as the times we live in, and the fact that children are not physically active, school sports and physical education are of great importance for their development and progress (Savić, 2014).

There a few research focused on the relations between physical activity in physical education classes and academic achievement among students (Castelli, Hillman, Buck, & Erwin, 2007; Sibley & Etnier, 2003; Strong et al., 2005; Taras, 2005; Tomporowski, Davis, Miller, & Naglieri, 2008; Stewart G Trost, 2007; Stewart G. Trost et al., 1997; Francois Trudeau & Shephard, 2005; François Trudeau & Shephard, 2008). Physical education classes and school breaks are ideal conditions in which the basic motor movements, physical activity and fitness could be developed (van Beurden et al.,

2003), while on the other hand, contributing to one of the primary goals of the education, which is to promote academic achievement (Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001).

There are many more questions that need to be answered, which are questions about the link between academic achievement, physical education, physical activity in school, and sports. In one of their studies, Eccles, Barber, Stone, & Hunt (2003) emphasize that it is evident that we know enough about the programs that are most likely to have a positive impact on the development of children and adolescents. This previous statement indicates that there is evidence to support that academic achievement, physical fitness and children's health will not be improved by limiting time devoted to physical education classes, physical activity at school, and sports programs. Academic achievement can, in theory, be enhanced using biological and psycho-sociological modes (Van Praag, 2008), and a reciprocal link between them is possible and probable.

Furthermore, more research is needed to understand the mechanisms behind the potential effects of physical activity on academic achievement. Some suggestions are also related to elucidating the effects associated with physical activity on neurotrophic brain factor and other cellular and molecular mechanisms, exploring the potential mediating role of psychological parameters, and enhancing understanding of the potential role of social belonging and support in improving academic achievement. Adding additional physical education and school sports classes to the curriculum results in the potential of positive improvement in academic achievement. Thus, the aim of this brief review was to determine whether engaging in physical education teaching and school sport has a positive effect on academic achievement.

METHODS

To locate research of studies on engagement in physical education classes and school sports and academic performance, searches of the following electronic databases took place up to September 2019: Web of Science, Medline, PubMed, Cochrane Library, and Kobson. The literature was searched by terms that reflected exposure of interest (e.g., physical education classes, sport, and physical activity), academic performance (e.g., grade point average, standardized test scores and course grades, attention assessment scales, memory, and classroom behaviour), as well as methods (experimental, systematic reviews and meta-analyses). Papers were selected for detailed analysis if they met the following inclusion criteria: 1. were experimental and review papers; 2. reported on the relationship between physical activity, and academic performance; 3. were based on school-aged children or adolescents, without physical and mental health limitations.

RESULTS AND DISCUSSION

This brief review included forty papers that are closely related to the subject of this research.

Most students attend public schools, so it is believed that educational institutions are the most important drivers of increased physical activity. Although there is objective concern for increasing public health, the fact is that opportunities to involve more students in school sports activities are significantly reduced (Pellegrini & Bohn, 2005), and that obesity rates are increasing (McKenzie & Kahan, 2004; Pellegrini & Bohn, 2005; Services, 2000). Students who exhibited a greater degree of physical fitness scored better on standardized reading and math tests to a greater extent. Specifically, aerobic fitness in particular is positively correlated with overall academic achievement, while muscle strength and flexibility are poorly correlated (Castelli et al., 2007). The results from aforementioned study indicate that physical fitness is positively related to academic achievement. Accordingly, the school should allow students to be physically active and physically fit, especially at the elementary school level. Transversal studies of the relationship between academic achievement and physical fitness, as well as academic achievement and physical activity have had different results, from low but positive effects (Dwyer et al., 2001; Education, 2001; Sallis, Prochaska, & Taylor, 2000). to trivial, negative correlations (Tremblay, Inman, & Willms, 2000).

Etnier et al. (1997) conducted a meta-analysis, which was related to the association between physical activity and cognitive ability, and concluded that potential changes in cognitive ability may originate from physiological mechanisms that are dependent on aerobic fitness. Better aerobic fitness was associated with changes in neurocognitive function (Hillman, Castelli, & Buck, 2005), because children with greater physical fitness displayed a more efficient neuroelectric profile compared to children with poorer physical fitness when performing a stimulus discrimination task. Students with better physical fitness were also more effective in measures of behavioral response time to stimuli and response accuracy, most likely resulting from greater allocation of intentional resources of working memory (Kramer & Hillman, 2006). The authors emphasized the need to understand the effects of physical activity, not only at the behavioral,

but also at the cellular, functional, and morphological levels. Several studies have addressed the linkage of brain functions that may be the hidden cause of the influence of physical activity on cognitive achievement (Chaddock-Heyman et al., 2013; Chang, Tsai, Chen, & Hung, 2013; Hillman et al., 2014; Kamijo et al., 2011). The conclusions reached by the authors relate to the fact that, after participating in an experimental study of physical activity, serve as evidence for a more efficient use of the neural resources responsible for executive functions, which is reflected in the improvement of neuronal activity in areas of attention, and working memory functions (Chaddock-Heyman et al., 2013; Chang et al., 2013; Hillman et al., 2014; Kamijo et al., 2011). Based on this knowledge, Chaddock-Heyman et al. (2013) stated that physical activity research can result in the involvement of prefrontal brain parts, which is similar to adult engagement, which is important for aspects of executive function.

On the other hand, there are frequent concerns of parents about the less time their children spend learning and doing homework. Sharif & Sargent (2006)argue that parents should reconsider the amount of time their children spend watching TV and playing computer games, rather than engaging in physical education, physical activity, or school sports. The more time spent on television resulted a deterioration in school success (Sharif & Sargent, 2006). One Canadian study found that time devoted to physical activity had positive correlations with the time spent reading by school-age children (Feldman, Barnett, Shrier, Rossignol, & Abenhaim, 2003). Parents who are interested in the health and academic success of their children should keep in mind that the increased occurrence of various metabolic pathologies, such as obesity and type 2 diabetes, that occur earlier, is most affected by a sedentary lifestyle (Datar & Sturm, 2006). Such pathologies can potentially adversely affect academic achievement, but this is an area that needs to be explored more (Taras, 2005). In a recent article, obese girls who were younger than eight years of age did not score worse after taking into account the variable related to socioeconomic status and education, but girls who were overweight had behavior such as arguing and fighting, as well as some symptoms of depression, such as loneliness and sadness (Judge & Jahns, 2007). Some authors believe that participation in physical education classes is likely to increase if real grades are given for physical education, especially in secondary schools. Particularly in girls, participation is reduced if the grade from the physical education does not count to GPA (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998; Anderssen, 1993; Van Wersch, Trew, & Turner, 1992). Yin & Moore (2004) emphasize that the level of class non-attendance in adolescents of both sexes is reduced by participating in school sports. Another problem that needs to be addressed is the diversity of physical education offerings (Marshall & Hardman, 2000), extracurricular sports activities, and other physical education programs (Cohen, Taylor, Zonta, Vestal, & Schuster, 2007). Particular attention should be pointed to schools with low socio-economic standards. School sport would attract more students if emphasis were placed on its educational potential rather than its competitive character. Moving away from new goals would be prevented by monitoring, thus avoiding moving away from an economic goal and ensuring maximum positive impact such as academic achievement and long-term physical activity. The current emphasis on a limited number of team sports needs to be changed to provide opportunities for students who are interested, as well as having the necessary skills for other sports ventures and adventures that would attract more students.

CONCLUSION

There is some compelling evidence to suggest that physical activity can improve attention and arousal in children, which may indirectly contribute to academic achievement. Some authors point out that there may be a short improvement in attention after physical activity, but that long-term improvement in academic achievement as a result of stronger physical activity is not well substantiated. Regardless of the mechanisms that affect academic development, the implication is that daily physical education should be introduced from the first day of school, without the consequences of endangering academic development. Moreover, there is a valid claim that aspects of aerobic fitness may be globally related to the academic performance of pre-adolescents. It has also been observed that while there is little direct instruction in life skills within school sports and physical activity in general, students are generally active producers of their own experiences that support their own development. Participation in inter-school sports competitions is a relatively strong predictor of involvement in sports activities in adulthood. Future research should further explore the link between physical activity in the school environment and students' academic achievement depending on gender, race, ethnicity, or level of education and socio-economic status. Research should be developed in consultation with educators and be linked to disciplines such as biology, psychology and kinesiology.

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Physical Activity and Health

CONNECTION BETWEEN PHYSICAL ACTIVITY AND OBESITY IN CHILDREN AND ADOLESCENTS

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ABSTRACT

The period of puberty and the subsequent adolescent period are recognized as a particularly vulnerable time for the development of obesity due to sexual maturation and in many individuals a simultaneous decrease in physical activity. In order to determine the degree of correlation between physical activity and obesity in children and adolescents, we conducted a study review using Internet browsers in available sports science journals. The results and conclusions of studies conducted in recent decades show that the incidence of obesity is epidemic in many parts of the world, and the best way to prevent it is through regular physical activity and moderate-intensity exercise that burns fat and preserves muscle and other non-fat tissues. The positive energy balance of increased caloric intake and their inadequate consumption due to inactivity is a leading cause of overweight in children and adolescents. These studies show that physical activity plays a significant role not only in the development of obesity, but also in the future way of living and maintaining psycho - social health. Although physical activity does not lead to rapid weight loss, in combination with diet it facilitates maintenance of the achieved therapeutic effect. Treatment with controlled diet and exercise leads to significant changes in morphological characteristics in children and adolescents with increased body mass.

Keywords: physical activity, exercise, obesity, children.

INTRODUCTION

The need to exercise and combat obesity are key topics that need to be addressed today. Therefore, each of us should be aware of the importance of regular physical activity in the prevention of obesity. This is especially important in a time of accelerated technological advancement in which children neglect physical activity and increasingly turn to computers, cell phones and other advances in modern civilization. This means that obesity, which is caused by the imbalance between caloric intake and consumption, is most often due to the modern lifestyle (Lakka & Bouchard, 2005). It is defined as being overweight due to an increase in body fat beyond a measure considered normal for gender, age and body type (Kahrovic, Radenkovic, Muric, Milic, & Spirtovic, 2017). The puberty period and subsequent adolescent period have been recognized as a particularly vulnerable time for the development of obesity due to sexual maturation and in many individuals a concurrent decrease in physical activity (Hills, Andersen, & Byrne (2011).

Since physical activity is a very important factor in the prevention of childhood overweight, the task for us adults is to prepare and educate children and young people to participate in daily physical activity. It is an important regulator of body mass and the most natural way to consume energy, which has become very limited in developed countries due to technological advances. That is why many universities in the world organize study programs that provide knowledge and skills related to the implementation of physical activity programs.

Many studies have addressed the link between physical activity and obesity (Biddle, Whitehead, O'Donovanm, & Nevill, 2005; Daley, 2002; Beunen, Lefever, Philippaerts, Delvaux, & Thomis, 2004; Telama, Yang, Hirvensalo & Raitakari, 2006) and show that the children who exercise regularly have a positive attitude towards exercise when they grow up and become mature. However, some studies indicate that levels of physical activity decline with age (Biddle et al., 2005; Corbin, Pangrazi, & LeMasurier, 2004; Norman, Nutter, Ryan, Sallis, & Calfas, 2006), and that is the most common cause of obesity in period of adolescence and after maturation. In addition to physical inactivity and an

unhealthy diet such as fast food, which is increasingly consumed by children, it causes obesity to take on epidemic proportions and significantly increase the risk of cardiovascular and other diseases (Fegal, Carroll, Ogden, & Johnson, 2002).

In order to determine the degree of correlation between physical activity and obesity in children and adolescents, which was our primary goal, we reviewed studies of available journals in the field of sports sciences. The method of work was to collect literature data and analyze the results and conclusions reached by the authors of the review studies.

METHODS

Literature data collection was performed using search engines (Google Scholar, KoBSON, PubMed) from available sports science journals using keywords: physical activity, exercise, obesity, children. The literature review included more than 50 studies, of which more than one half dealt with the correlation between physical activity and overweight of children and adolescents. Systematization of studies was performed according to the criterion of the effects of exercise programs on the weight of children and adolescents. The data processing method is descriptive because the study authors used different exercise programs and measurements were made with different measuring instruments, which made it impossible to compare the results with other methods.

RESULTS

As is known, the buildup of fat in the abdomen is associated with an increased risk of many diseases. Studies have shown that the way fat is distributed is directly related to the health side effects of the body. Scientists have even shown a clear correlation between waist and hip circumference and health risk factors. The findings of the aforementioned studies indicate that the pear-shaped type of fat distribution is healthier than the apple type, that is, it is less risky to have excess weight on the hips and thighs than in the waist, ie the abdomen (Wickelgren, 1998). Studies show that the accumulation of fat in the abdomen, which gives the body an apple appearance, increases the risk of heart disease and diabetes (Ziegler & Filer, 2000). Although the concept of apple and pear body structure can be used to describe the distribution of adipose tissue in both children and young people, it is increasingly recommended that children only calculate waist circumference, which is associated with increased amount of fat in the abdomen and increased health risk. Thus, waist circumference can be a useful indicator of malnutrition in children and adults, which can be easily obtained (Katzmarzyk, Srinibasan, Chen & Malina, 2004). In addition, analyzes found that children with a waist circumference above the 90th percentile (age, gender, and ethnicity) were at increased risk of disease and comorbid conditions. Those children with a large waist circumference are at increased risk of disease (Fernandez, Redden, Pietrobelli, & Allison, 2004).

Eating habits are also an important factor in weight control. The American Center for Disease Control and Prevention states that over the past two decades, the number of overweight young people has more than doubled (Ogden, Carrol, Curtin, Lamb, & Flegel, 2010). There is a widespread belief among the people that a fat baby is a healthy baby. However, excessive diet in the first years of life stimulates the development of larger and more numerous fat cells that can stimulate a higher appetite. This can also happen in an age of intense growth and development, when obesity can also develop (Malina & Bouchard, 1991). The study of morphological characteristics of elementary school students showed that the incidence of moderately obese children is highest among the youngest school-age children and the lowest among seventh and eighth-grade students (Kisic-Tepavcevic, Jovanovic, Kisic, Nalic, 2008).

Research shows that the risk of obesity in children is much higher when parents are obese, meaning that the genetic factor plays a significant role in the development of obesity. Obesity has its root in genetics, as has been pointed out by some older studies on single and twin twins that grew up in different environments (Struncard, Foch, & Hrubec, 1986). However, in one study (Esparza, Fox, Harper, Schulz, Valencia, & Ravussirt, 2000), the level of physical activity played a significant role in preventing the development of obesity in a population with a genetic predisposition. Considerable impact of fast food intake on the development of obesity in this population was also observed.

The authors Sallis & Glanz (2006) found a link between obesity and the conditions in which children live. Obesity is lower and the level of physical activity of children is much higher in urban areas with well-constructed sidewalks, bicycle lanes and off-road traffic. They suggest that removing barriers of this kind would promote physical activity and a healthy lifestyle. They also note that the large supply of fast food, the inaccessibility of fresh fruits and vegetables, as well as the increase in the portion of food contribute to the epidemic of obesity greatly. Numerous studies (Ewing, Schmid, Killingsworth, Zlot, & Raudenbush, 2003; Sallis, Floyd, Rodríguez, & Saelens, 2012) support the link between obesity and

the built environment, as well as the availability of sports facilities, although research of this kind is still in its infancy . The positive impact of physical activity on children's health was also recognized by the World Health Organization, which in 2004 adopted the Global Strategy for Physical Activity and Health, as well as the Resolution on the Promotion of Health and Healthy Lifestyle (http://www.savremenisport.com). It is encouraging and may be important to improve the treatment outcomes of obesity and comorbid conditions by investigating the effects of exercise or physical activity in pediatric obesity treatment (Epstein & Goldfield, 1999). Several recent studies have found that the health risk of an obese person who regularly engages in physical activity is no greater than that of people with an ideal body mass index who are physically inactive (Haskell, Lee, Pate, Powell, Blair & Franklin, 2007).

DISCUSSION

The frequent migration of prehistoric people and the struggle for survival forced them to be physically active, but things have changed dramatically since. Initially, these changes were slower, but the pace of these changes, with the rapid technological advances in recent decades, has accelerated significantly, making us a sedentary and obese population. Today, children travel to school by car or their parents take them by car. At home, they spend more and more time at their computer, on their cell phones, or in front of their TVs. The consequence of such a modern lifestyle is reduced movement, which has led to an increase in obesity twice in the past few decades and more than three times among adolescents (Ogden, Flegal, Caroll & Johnson, 2002). Overweight youth are more likely to become overweight adults, and children who become obese by the age of eight will have a more severe form of obesity as adults (Ferraro, Thrope, & Wilkinson, 2003). According to the researchers, the main cause of the obesity epidemic is the continuing decrease in daily calorie consumption, which does not adequately reduce caloric intake (Hili & Melanson, 1999). This mismatch of food intake with lower energy needs applies to both children and adults. People tend to reduce their activity as they get thicker. Those overweight children are less active than their peers in sports games. A person who was active in childhood and became obese in later years would be more physically active in older age than a person who was obese in childhood. This means that physical inactivity due to excess weight entails greater physical inactivity, which contributes to weight gain. Therefore, it is suggested that as a prevention of childhood obesity and adolescence, physical activity should be enhanced, and in no case a diet that could have adverse health effects. (Watts, Jones, Davis & Green, 2005).

An increase in obesity in children and adolescents occurs at the same time as exercise time decreases, and children who are not physically active become physically inactive adults, so it is necessary to work on developing physical activity habits in children. The promotion of different types of physical activity plays a very important role in creating habits that contribute to the preservation and improvement of the health of children and young people. In this regard, preschool and school institutions should develop and implement programs to raise the level of physical activity. Although physical education students need to be aware of all the risks that a sedentary lifestyle entails, they must also be aware of the many beneficial effects of regular physical activity and exercise throughout their lives. It is especially important to emphasize the benefits of exercising in the time we live. In order to solve the problem of lack of physical activity, it is necessary for every child in primary school to be physically active every day for 45 minutes, which will lead to changes in habits that will reduce the obesity rate in children. In this regard, it is important to break the practice of changing physical education classes to mathematics, computer science or mother tongue, which is often the case, especially in the lower grades of elementary school. In America, for example, due to a lack of obesity prevention policies, obesity rates have increased in 37 states over the past year, and no obesity decline has been reported in any country (Levi, Winter, St.Laurent & Segal, 2008). Physical activity, even without reducing caloric intake, is a very effective method of reducing the risk of chronic diseases, regardless of obesity (Ross, Freeman & Janssen, 2000).

CONCLUSION

The main objective of the study was to determine the degree of correlation between physical activity and obesity in children and adolescents. To determine the impact of the implementation of physical activity programs on obesity in these age categories, we reviewed the literature data of available journals. The results and conclusions of a number of studies done in recent decades show that the incidence of obesity is epidemic in many parts of the world, and the best way to prevent it is through regular physical activity and moderate-intensity exercise that burns fat and preserves muscle and other non-fat tissues. The positive energy balance of increased caloric intake and their inadequate

consumption due to inactivity is a leading cause of overweight in children and adolescents.

These studies show that physical activity plays a significant role not only in the development of obesity, but also in the future life and preservation of psycho-social health. Regular physical activity in both sexes is associated with a lower percentage of adipose tissue in the overall body composition. Differences in the amount of adipose tissue in the body structure between the physically active and the physically inactive are smaller in boys than in girls. In addition, the authors agree that physical activity is an integral part of non-medical obesity therapy. Although physical activity does not lead to weight loss, the use of dietary diets makes it easier to maintain the achieved therapeutic effect. The treatment controls the results and through physical exercise leads to significant changes in morphological characteristics in obese children. This would mean that we can use them to keep our children's weight within normal limits and maintain healthy health, we must include them in appropriate physical activity programs and take more care in their food choices. The combination of regular physical activity and a healthy diet is by all means the best possible solution and a winning combination.

The authors also conclude that the level of physical activity in children declines with age, and the reason for this is mainly the biological changes that occur at puberty and which, in a way, determine the level of physical activity of boys and girls during this developmental period. They propose the implementation of the planned physical education curriculum, with the exclusion of absenteeism and sports activities that are required to be performed by professional rather than trained staff.

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EFFECTS OF PHYSICAL ACTIVITY ON FITNESS ABILITIES AND BONE DENSITY IN POSTMENOPAUSAL WOMEN

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ABSTRACT

Osteopenia and osteoporosis are characterized by low bone mineral density and they represent a risk of fracture in humans. The most common occurrence of osteoporosis is in postmenopausal women. Bone loss occurs faster if there is no load on the bone. The aim of this study is to determine, on the basis of the analyzed studies, the effects of individual exercise programs on fitness (FS) and bone density (BD) in postmenopausal women. The study includes 33 closely related studies. The search is limited to papers published between 2000 and 2019. Most studies have measured bone density in the lumbar spine, hip, proximal femur, distal tibia, and forearm. The most commonly treated fitness abilities are muscle strength, flexibility, body balance and cardiorespiratory endurance (VO2MAX). The shortest duration of the program was six weeks (Roghani et al, 2013) and the longest was 12 years (Kemmler et al, 2012). All the studies obtained results that showed an increase in fitness abilities among women who were covered by the exercise program compared to the control groups. Exercise in the form of walking, jogging and moderate intensity three to five times a week is the best effect. This can increase bone density, especially in the lumbar spine and the entire hip.

Keywords: osteoporosis, physical activity, bone density, postmenopausal women, prevention.

INTRODUCTION

Osteopenia and osteoporosis are conditions characterized by low bone mineral density and bone mineral content, with an increased risk of fracture (Gonzalo-Encabo et al., 2019). The consequences of osteoporosis fractures are severe disability, loss of independence, chronic pain and increased mortality. The skeleton, like all other tissues, undergoes changes throughout life, the so-called remodeling process. Remodeling is a dynamic process in which there is a balance between resorption (which takes place with the help of osteoclasts) and bone formation (which takes place with the help of osteoblasts). Aging disrupts the process of bone remodeling, meaning that bone formation is much less expressed than bone resorption (Vuksanovic, Djurica & Zerajic, 2008). Most cases of osteoporosis are reported in postmenopausal women. Postmenopausal osteoporosis occurs when bone mineral density is more than two and a half standard deviations below the average (-2, 5) of young and healthy women. Research in the US shows that 20 percent of women, between four and six million, over 50 years of age, suffer from osteoporosis. The same research shows that as many as 35 to 50 percent (12 to 15 million) have reduced bone density, that is, post-menstrual osteoporosis affects approximately one in three women and is expected to increase in the coming years (Gonzalo-Encabo et al., 2019). Developing bones are much better responsive to mechanical stress and physical activity than mature bones. This indicates that early childhood exercise may be an important factor in the prevention of osteoporosis in later life. (Obradovic et al, 2009). It is also important to note that the quality of bone achieved by exercise cannot be permanently maintained unless supported by physical activity later in life. After the age of 40, bone mass decreases by about 0.5% per year, regardless of gender or race. The most intense loss of bone mineral density occurs in women in the first few postmenopausal years due to a sudden loss of the antiresorptive effect of estrogen. In the late postmenopausal age, women lose bone density at the same rate as men of their age. Studies have shown a beneficial effect of

physical activity on reducing bone mineral density loss in adulthood (Kemmler et al., 2010; Von Stengel et al., 2011).

Bone loss occurs faster if there is no load on the bone. The problem for the elderly is that they can hardly continue activities that would provide adequate workload to maintain bone mass. Adapted physical activity, of moderate to medium intensity, in women between the ages of 65 and 75 can lead to an improvement in muscle strength, which will also lead to an improvement in bone quality (Bošković et al, 2013). Healthy bone requires regular exercise and physical activity, avoiding a sedentary lifestyle. Unless the bones are under exertion and physical activity. Exercises with load (self-weight) and resistance exercises are effective for increasing bone density, and aerobic exercises increase balance and functional muscle activity, thereby reducing falls (Vujasinovic-Stupar, Radojcic & Nenadic, 2007). Regular physical activity of women in adulthood and old age is very important for maintaining the optimal ratio of body composition components, maintaining lean body mass, musculature and bone, muscle strength and strength, as well as contributing to the primary and secondary prevention of chronic diseases (Mishigoj-Durakovic & Durakovic), 2009).

The aim of this study is to determine, on the basis of the analyzed studies, the effects of individual exercise programs on fitness abilities (FS) and bone density (BD) in postmenopausal women.

METHODS

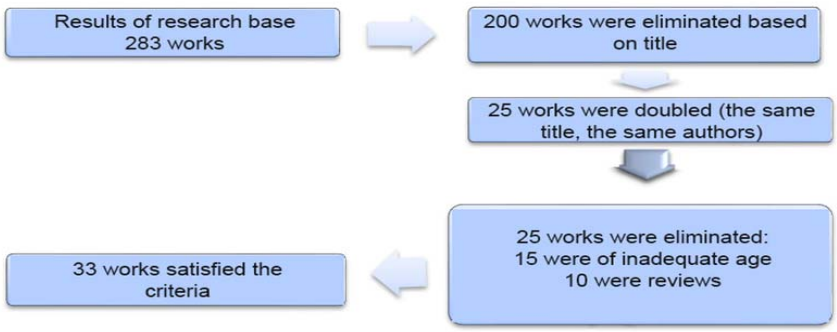
The descriptive method and theoretical analysis were used to collect, classify and analyze the targeted research. The literature was collected through a search of the Internet, as well as available papers in the Google Scholar, Kobson and PubMeb database. The search was limited to papers published between 2000 and 2019. Supplementary literature in the form of textbooks was also used. The keywords used in the search are: osteoporosis, physical activity, bone density, postmenopausal women and prevention. References from all papers were reviewed to find more studies that addressed this topic. The first condition for accepting the papers is to test the bone density, the second is to test the physical abilities and the third is that the sample of the subjects is postmenopausal women.

Subjects

The study included 33 closely related studies. At the beginning of the search, 283 references were identified that responded to some of the criteria, but immediately 200 titles were eliminated based on the title and another 50 were eliminated based on other criteria (Figure 1). Each study was presented according to the following parameters: Sample of subjects (number of subjects, age and health status) and experimental program (number of groups, number of subjects per group, place of measurement of MGK, treated FS, effects of exercise on MGK and effects of exercise on FS). The number of participants varied considerably from survey to survey, with the smallest number of participants being 18 in the research of Kemmler, Engelke, Weineck, Hensen & Kalender, 2003, and the largest number being 400 in Gonzalo-Encabo et al., (2019) researches. The youngest respondent was 40 years old (Going et al, 2003) and the oldest was 88 years old (Iwamoto et al, 2005). In 14 studies, the women were diagnosed with osteoporosis, in 8 with osteopenia and 10 studies tested the postmenopausal healthy women.

Procedure

Figure 1. The process of downloading the data



RESULTS

Table 1. Chronological-table review of the collected and analyzed researches

Research, author, year	Sample of respondents		Experimental treatment				
	Number Age Zd. status	Number of groups	Place of measurement BMD	Exercise program and duration	Treated FS	Effects of exercise on BMD	Effects of exercise on FS
Chien (2000)	N=43, 48-65, Osteopenia	1En=22 1Kn=21	BMD of the spinal column (L2-L4) and right cervical femuri	walking on a treadmill with an intensity of more than 70% VO2max in 30 minutes, ten minute stepping exercises for 24 weeks.	flexibility, muscular strength and endurance, body posture and cardiorespiratory fitness.	BMD of the lumbar (L2-L4) as well as the femoral neck increased in the exercise group 2.0% 6.8% (P <0.05), while in the control group there was a decrease in MKG 2.3%	Quadriceps strength, muscular endurance and VO2max increased significantly in the exercise group, while none of the given fitness parameters improved in the control group.
Iwamoto (2001)	N=35, 53-77, Osteoporosis	1Kn = 201E n = 8 exercised 2 years 1En = 7,exercised 1 year, one year rest	BMD of lumbar spine	daily brisk walking and gymnastic exercises 2 years	/	an increase in BMD in the lumbar spine, in groups that exercised for a year and two years	/
Asikainen (2002)	N=116, 48-63, Healthy women	4En=21, 21,18,21 1Kn=40	/	walking five times a week with the following intensity (% VO2MAX) and energy consumption (kcal number per week): E1 group 55% / 1500kcal; group E2 45% / 1500 kcal; group E3 55% / 1000 kcal; group E4 45% / 1000 kcal for 24 weeks	aerobic fitness (VO2MAX),	/	Heart rate for standard submaximal exercises decreased by 4 to 8 beats per minute in all groups Walking (for a period of 24 weeks) of moderate intensity from 45% to 55% VO2MAX, with a total energy consumption of 1000 to 1500 kcal per week can improve VO2MAX and body posture
Carter (2002)	N=80, 65-75, Osteoporosis	1En=50 1Kn=30	/	2 times a week moderate or high intensity exercises, 20 weeks	static balance, dynamic balance, knee extension strength	/	Static balance improvement, dynamic balance and knee extension strength
Uusi-Rasi (2002)	N=126, Average age 67.6 years. Healthy women	4E	MGK distal end and axial part of radial bone	1E walking twice a week 2E walking once a week 3E walking once a week with less	Muscle strength, dynamic balance, body balance and cardio-pulmonary fitness abilities	Physical activity has a positive effect especially on tibia which is a weight carrier, there was no positive effect on	Women who were physically active compared to those who were inactive showed better results in fitness abilities

			and tibia	intensity. 4E inactive		radial bone	
Going (2003)	N=320 40-65, Healthy women	2Kn=70, 73 2E n=86,81	BMD of cervical bone, trochanteric region and lumbar spine	aerobics exercises, carrying and lifting exercises under supervision three times a week, 12 months	/	BMD in certain regions can improve aerobics with exercise, carrying and lifting exercises in important skeletal parts	/
Jessup (2003)	N=18, Average age 69years, Healthy women	1En=9 1Kn=9	BMD of hip and lumbar spine	strength and walking training, stair climbing and weight training with a vest with weights, a thirty-two-week program (three times a week for 1 hour)	balance, strength and dexterity	Significant improvement in densities in the bones of the femoral neck, there was no enhancement in the lumbar spine	Significant improvement in balance and strength, there was no improvement in dexterity
Kemmler (2003)	N=100 55.1 ±3.4years) osteopenia	1En=59 1K41	BMD of the lumbar spine and the whole hip	2 times a week in a group and 2 times a week alone at home. Exercise endurance, jumping, training and stretching	maximum isometric power, maximum oxygen uptake (VO2max)	BMD increased significantly in the lumbar spine of participants in the exercise group, and decreased in participants in the control group. There is no difference in the hip and neck of the femur	Significant improvement in maximum isometric power and VO2max.
Papaioanno (2003)	N=60, Average age 60 years Osteoporosis	1En=30 1Kn=30	BMD in the lumbar spine and neck of the femur	60 minutes, three times a week: stretching, strength and aerobics exercises, 12 months	Muscle strength, body balance and cardio-pulmonary fitness abilities	There was no improvement in bone density	Significant improvement in balance
Uusi-Rasi (2003)	N=164 50-60, Healthy women	4E	MGK of lumbar spine, distal tibia, cortical bone	Progressive Jumping Exercises; 2) only 5mg of alendronate; 3) placebo and progressive jumping exercises; 4) took placebo for 12 months	Leg extensor muscle strength, dynamic balance and cardiopulmonary ability	There was no effect on bone mass in the lumbar spine and neck of the femur, significant statistical results in the distal tibia	increase in leg extensor muscle strength, dynamic balance and cardiopulmonary capacity
Chan (2004)	N=132 Average age 54.3, Healthy women	1En=67 1Kn=6	BMD lumbar spine, proximal femur, distal tibia	Tai Chi Chi Chuan (TCC) Exercises 45 min each day, 5 days a week 12 months	/	Bone density loss in both the TCC group and the control group in all measured parts of the bone skeleton of the subjects, but the percentage loss was significantly lower in the TCC group	/

Kemmler (2004)	N=83, 48-60, Osteop enia	1En=50 1Kn=33	BMD of lumbar spine, proximal femur and forearm	Twice a week group exercises and twice individual: endurance exercises, jumping, strength, flexibility, 26 months	Maximum strength and cardiovascular abilities	BMD increased significantly in lumbar spine, trabecular bone and cortical bone and whole hip	Significant improvement in maximal strength and cardiovascular capacity
Teoman (2004)	N=81, Averag e age 51 yrs. Healthy women	1En=41 1Kn=40	/	Walking, vertical jumps, balance test, side bending	Strength, endurance, flexibility and balance	/	Statistically significant change in strength, endurance, flexibility and balance in the exercise group
Verschuer (2004)	N=70 58-74, Healthy women	1En = 25 (VCT) full body vibratio n 1E n = 22 (VSO) resistan ce exercise 1Kn = 23	BMD of the hip	VCT- static and dynamic knee extension exercises on a vibrating base.VSO knee-extension dynamic outages and leg extensions, moderate and strong intensity, three times a week, 24 weeks	isometric and dynamic muscle strength	Vibration training improved the BMD of the hip. No differences in hip MGK were observed in members of the exercise groups or those in the control group who had the same age as the women who exercised.	Vibration training improved isometric and dynamic muscle strength
Yamazaki (2004)	N=50, 49-75, Osteop enia osteopo rosis	1En=32 1Kn=18	MGK of lumbar spine (L2-L4)	Walking, with an intensity of 50% of the maximum oxygen intake for one hour, where more is done at least 4 times a week for 12 months	/	MGK lumbar scores increased in the exercise group compared to the control group	/
Englund (2005)	N=48, 66-87, Healthy women	1En=24 1Kn=24	Full body BMD	The program lasts 50 minutes and consists of a combination of aerobics exercises, strength training and balance and coordination exercises, 12 months	strength, balance, coordination, aerobic ability	BMD improved significantly with the experimental group	Significant improvement in strength, balance, and aerobic ability
Iwamoto (2005)	N=50, 55-88. osteopo rosis	1En=25 1Kn=25	BMD of lumbar spine	Whole-body vibration exercises using the Galileo machine once a week for 4 minutes, 12 months	/	There was no difference in groups	/

Kemmler (2005)	N=78 Average age 55.1, osteopenia	1En=48 1Kn=30	BMD of lumbar spine, hip, calcaneus forearm	65 to 70 minutes, 1) warm-up and endurance exercises, 2) jumping exercises, 3) strength exercises, 4) stretching exercises.4 repetitions weekly for 38 months	Maximum isometric and dynamic power, maximum oxygen uptake (VO2max)	Improvement of BMD in the lumbar spine (0.7% and 3.0%) in the femoral neck	The maximum isometric power increased significantly with the case, while, except in one case. One maximum repetition (1 RM) was significantly increased for all measured parts. The V˙ O2max of the GZV group increased significantly during the study.
Stengel (2005)	N=53, 49-75, Healthy women	1E strength training (GS) and 1E fitness training group (GK).	BMD in the lumbar spine, proximal femur and distal forearm	Progressive workout with exercise, gymnastics and 2 workouts at home for 12 months	/	Exercise exercises are more effective than strength exercises in preventing bone loss in postmenopausal women.	/
Asikainen (2006)	N=134, 66-87, Healthy women	1En = 46 continuous walking 1E n = 43 groups with divided walking during the day 1Kn = 4	/	One or two high-speed bouts and moderate resistance exercises	Lower extremity muscle strength, balance, walking ability	/	Improved lower extremity muscle strength and reduced walking time, but there was no improvement in balance. Two walking sessions per day significantly lessened lower limb problems in the walking interruption group than in the constant walking group.
Hongo (2007)	N=80, osteoporosis	1En=42 1Kn=38	/	Low intensity back exercises, 4 months	Isometric muscle strength of the back extensor, spinal motility	/	Low-intensity back muscle strengthening exercises have the effect of improving the quality of life and strength of the extensor muscles in the back of patients with osteoporosis.
Karinkanta (2007)	N=149 70-78, osteopenia	3E, VO=37,VSR=37,KOMB=38 1K,KG=37	BMD of proximal part of femur, tibia	1) with resistance exercises (VO), 2) with balance jumping exercises (VSR), group 3) combined resistance and jumping exercises (COMB) and 4 as control (KG)	Extensor forces of leg muscles, dynamic balance	There were no significant differences in BMD between groups in the proximal femur. Increase in MKG tibia.	Self-reported physical function increased in the KOMB group and decreased in the KG group; the average difference between the groups was 10%. The mean increase in the extensor force of the leg muscles was higher in the VO and COMB groups compared with the KG group. Dynamic balance improved in the VSR group and the KOMB group
Madureira (2007)	N=60, 49-75, Osteoporosis	1En=32 1Kn=34	/	Balancing exercises: one-hour and group training each week and one-on-one exercises at home	balance, mobility and frequency of decline	/	All results were significantly better with the intervention group compared with the results of the control group

Bergstrom (2008)	N=112, 45-65, osteoporosis	1E n=59 1Kn=52	BMD was measured in the hip area and lumbar spine	Three repetitions of a thirty-minute walk and two repetitions of one-hour physical activity per week	Upper and lower extremity muscle strength, balance, torso and walking ability	The BMD hip increased in the E group and decreased in the K group; the BMD in the lumbar spine did not increase.	Improving upper and lower extremity muscle strength, trunk and walking ability
Brentano (2008)	N=28, 50-60 osteoporosis	1En = 9 Power Exercise 1E = 10 Circular Exercise 1K = 9	BMD in the hip area and lumbar spine	strength exercises and circular exercise 24 weeks	Strength, cardiorespiratory fitness	There was no improvement	Strength exercises and circular exercise have a positive effect on postmenopausal women's muscle strength, muscle activation and cardiorespiratory fitness
Hourigan (2008)	N=98 41-78 osteopenia	1En=42 1Kn=56	BMD proximal femur and lumbar spine	Balance test, power test (quadriceps, adductors, abductors and external hip rotators and torso extensors, 20 weeks	Balance and strength	There was an increase in BMD in the exercise group	The exercise group performed significantly better in balance (measurements of unilateral and bilateral body movement, lateral reach and hip muscle strength (abductors, adductors and external rotators), quadriceps and trunk extensors
Kemmler (2010)	N=246, Osteoporosis	1En=123 1Kn=123	BMD Lumbar spine	multifunctional exercise program with special emphasis on exercise intensity, 18 months	/	It significantly improves BMD in older women and lowers the risk of falling.	/
Bergland (2011)	N=89, 60-84, osteoporosis	1E n=49 1Kn=40	/	Maximum Walking Speed (MBH), Up and Go Time Limit Test (TUG), Functional Reach Test, 3 Months	Balance and mobility	/	There was an improvement in mentioned abilities in women with osteoporosis
Von Stengel (2011)	N=108, 65,8, osteoporosis	1En = 36 rotational vibration (RV) 1En = 36Vertical vibration (VV) 1Kn = 36 Wellness Program (WP)	MBD was measured in the hip and lumbar spine	1) RV 12.5 Hz, 12 mm, three times a week for 15 minutes each, including dynamic squat exercises; 2) VV to be exact 35 Hz, 1.7 mm, the same three times a week for 15 min; and 3 (KG), namely, two blocks of 10 repetitions of low intensity stretching exercises. 12 months	Power and strength	Improvements in MGK in the lumbar spine in both vibrational groups, MKG neck results increased in both RV and VV groups, and remained stable in KG.	Both vibrational groups improved the results of maximum leg extension strength

Kemmler (2012)	N=85, 45-65 osteopenija	1En=41 1Kn=44	BMD je merena u lumbalnom delu kičmei proksimalnom delu femura	učesnice vežbaju dva puta nedeljno u grupi i dva puta nedeljno kod kuće,skakanje ,trčanje,vežbe otpornosti,aerobne vežbe 12 godina	/	Poboljšanje u BMD	/
Roghani (2013)	N=36 41-78 osteoporosis	1En = 15Aerobic, 1E group wearing vest with weights n = 10 1kn = 11	body fat percentage, bone biomarkers, alkaline phosphatase (ALP) important for bones	1E aerobics group, 18 repetitions of walking on the treadmill, three times a day for 30 minutes each, 1E same but carrying weights. 6 weeks	Balance	The results showed that the two programs stimulate bone consolidation and reduce bone breakdown in postmenopausal women	that exercising when wearing a vest with weights has a significant effect on improving balance
Gonzalo (2018)	N=400 50-74	1En-high-intensity aerobics 1E-moderate-intensity aerobics	Total bone mineral density	High aerobics and moderate intensity aerobics 12 months	/	High intensity exercise women had higher bone mineral density than women with moderate intensity exercise	/
Pei-An Yu (2019)	N=80 45-85 osteopenia	N = 40 1E = 40 aerobic dance 1K = 40	Proximal femur, lumbal spine	Aerobic dance 24 weeks	Strength, Balance, Flexibility, Cardiovascular Endurance, Agility	Exercise women had a statistically significant improvement in bone density (femoral neck) than non-exercise women	Statistically significant difference in strength, endurance and agility in the experimental group

The youngest respondent was 40 years old (Going et al, 2003) and the oldest was 88 years old (Iwamoto et al, 2005). Most often, there were one experimental and one control group in the studies. There were two E groups and one K group in six studies (Iwamoto, Takeda, Sato & Uzawa, 2005; Verschuer et al, 2004; Asikainen et al, 2006; Brentano et al, 2008; Von Stengel et al, 2011 and Roghani et al , 2013). One study was with two E and two K groups (Going et al, 2003). There were four studies with more than two E groups (Asikainen et al, 2002; Uusi-Rasi, Sievänen, Pasanen, Oja, & Vuori, 2002; Uusi-Rasi et al, 2003; Karinkanta et al, 2007). The experimental groups included groups in which women practiced some physical activity, if there are more experimental groups then different types of physical activity intensities are involved. The control groups did not engage in any activity. Most studies have measured bone density in the lumbar spine, hip, proximal femur, distal tibia, and forearm. Only one study measured whole-body bone density (Englund, Littbrand, Sondell, Pettersson, & Bucht, 2005). The most commonly treated fitness (physical) abilities are muscular strength, flexibility, body balance and aerobic fitness (VO2MAX). Regarding the length of the program, the shortest duration was six weeks (Roghani et al, 2013) and the longest was 12 years (Kemmler et al, 2012). Most often, the program lasted for 12 months and it is a period in which it could be assessed whether physical activity affects the fitness and bone density of postmenopausal women.

Exercise program, intensity and frequency of exercise

The exercise programs are mostly aerobic exercises, and the most common forms of exercise are walking, running, jumping, climbing stairs, strength exercises and more. The intensity of exercise went from low to moderate as well as high intensity. Chan et al (2004) found that Tai Chi Chuan exercises for 45 min every day affected bone density in women, and found that these exercises reduced the percentage of bone loss. Verschuer et al., (2004) and Iwamoto (2005) examined how the whole body vibration, using a vibrating pad and the Galileo machine, affects bone density and fitness abilities in postmenopausal women and concluded that this improved isometric and dynamic muscle strength as hip bone density. Exercise sessions in the

research varied from once a week (Iwamoto, Takeda & Ichimura, 2005; Madureira, 2007;) twice a week (Carter et al, 2002; Uusi-Rasi, Sievänen, Pasanen, Oja, & Vuori, 2002; Kemmler et al. al, 2003; Kemmler et al, 2004; Kemmler et al, 2012), three times a week (Going et al, 2003; Jessup, Horne, Vishen & Wheeler, 2003; Papaioannou et al, 2003; Verschuer et al, 2004). four times a week (Yamazaki et al, 2004; Kemmler et al, 2005), while other studies had group exercise and exercise at home, as well as the researches that had exercise programs five times a week. The exercise sessions lasted 30-60 minutes per day.

Effects of physical activity on bone density

When it comes to the lumbar spine, most researches have examined the impact of physical activity on this part of the human body. The results showed that physical activity can prevent bone density loss as well as increase in bone density in the lumbar spine. However, there have been a few studies where no improvements have been made (Jessup, Horne, Vishen & Wheeler, 2003; Papaioannou et al, 2003; Uusi-Rasi et al, 2003; Bergstrom et al, 2008; Brentano et al, 2008). Stengel et al (2005) concluded that fitness exercises are more effective than strength exercises in preventing bone loss in postmenopausal women, especially in the lumbar spine.The next most commonly tested part of the human body is the hip and the neck of the femur, and the results are different: bone density has increased in eight studies (Chien et al, 2000; Jessup, Horne, Vishen & Wheeler, 2003; Kemmler et al, 2004; Verschuer et al, 2004; Kemmler et al, 2005; Bergstrom et al, 2008; Hourigan et al, 2008; Pei-An Yu, 2019). Other studies (Kemmler et al, 2003; Uusi-Rasi et al, 2003; Karinkanta et al, 2007) that measured hip and femur did not improve, there was no difference in bone density between the physical activity groups and inactive groups.

Physical activity has a positive effect on the weight bearing tibia; all studies (Uusi-Rasi et al, 2002; Uusi-Rasi et al, 2003; Chan et al, 2004; Karinkanta et al, 2007) that have tested the previously mentioned, received the same result.

With regard to forearm bones, there is no increase in MGK in any study (Uusi-Rasi et al, 2002; Kemmler et al, 2004; Kemmler et al, 2005; Stengel et al, 2005;) that addressed the density of these bones.

Effects of physical activity on fitness abilities

When it comes to the impact of physical activity on the fitness abilities of postmenopausal women, the most commonly tested abilities are VO2MAX, balance, strength, a great deal of the research has shown that physical activity produces positive results, i.e. statistically significant increases in the tested abilities. All studies obtained the results in which there was an increase in fitness abilities in women covered by the exercise program compared to the control groups, and the research (Asikainen et al, 2002) with the following exercise program should be noted: walking five times a week, 24 weeks with the following intensity (% VO2MAX) and energy consumption (kcal per week): group E1 55% / 1500kcal; group E2 45% / 1500 kcal; group E3 55% / 1000 kcal; group E4 45% / 1000 kcal, and the results showed that heart rate at standard submaximal exercises decreased by 4 to 8 beats per minute in all groups. Walking (over a period of 24 weeks) of moderate intensity from 45% to 55% VO2MAX, with a total energy expenditure of between 1000 and 1500 kcal per week can improve VO2MAX body posture in postmenopausal women. In addition to moderate intensity, the authors (Chien et al, 2000) examined walking on a treadmill at an intensity of over 70% of maximal oxygen uptake (VO2max) for 30 minutes, and also came to positive results in the experimental group. In all studies, there were improvements in abilities, except in one (Jessup et al, 2003) where dexterity was not improved and in the other (Asikainen et al, 2006) where balance did not improve.

DISCUSSION

The loss of bone mass is significantly accelerated with the onset of menopause, so it is necessary to start with a specific exercise program in order to slow down the process. Most of the studies in this paper have proven that certain physical exercise programs slow down this process. The most common form of exercise is walking at a moderate or high intensity. What exercises best influence the prevention of bone density loss was examined by one study (Stengel et al, 2005), the results of which showed that fitness exercises were far more effective than strength exercises. When it comes to postmenopausal women's fitness abilities, one study (Asikainen et al, 2002) examined the minimum intensity that will improve aerobic fitness, and found that it is walking at a moderate intensity of 45% to 55% VO2MAX.

In the case of one study (Brentano et al, 2008), the results showed that strength and circular exercise for 24 weeks did not increase bone density or prevent loss of bone but it had a very effective effect on the strength and cardiorespiratory system of women in postmenopausal period. The reason for this may be that it is a short period of time to achieve good bone density results, and that, as mentioned above, fitness training is much more effective than

strength training. The one-year progressive jumping exercises had no effect on bone density in the lumbar and hip, only in the distal part of the tibia in women, but made great success with regard to strength and cardiopulmonary ability (Uusi-Rasi et al , 2003, Pei-An Yu, 2019). All studies received the same results regarding the effect of FA on postmenopausal women's fitness abilities, there were statistically significant differences between control and experimental groups, from those programs that lasted the shortest time to those whose experiment lasted for many years. Only the magnitude of the statistical significance is different, it is larger for those with a longer program duration.

While the situation with the effects of FA on bone density in women is different. The minimum time to get the proper effects is 12 months, with an adequate exercise program, i.e. aerobics (in the form of walking, running, etc.), however, if during these 12 months attention is paid only to strength exercises, the effect will not be achieved in that period. The best effect is achieved by exercising five times a week, but with the appropriate exercise program as mentioned above, the effect can also be achieved by exercising three times a week for a period longer than one year.

CONCLUSION

Postmenopausal period carries with itself certain problems that women encounter. Bone loss is one of these problems. Based on the results of the studies analyzed in this paper, physical activity can contribute to solving particular problems. Physical activity can prevent further decrease in bone density caused by special bone cells of osteoclasts, and it can also increase bone density. Exercise in the form of walking, jogging and moderate intensity three to five times a week is the best effect. This can increase bone density, especially in the lumbar spine and the entire hip. Based on the existing researches, what is the best for increasing the tibia density is the progressive jumping exercise. When it comes to postmenopausal women's fitness abilities, any form of exercise that lasts for a year or more has led to statistically significant improvements in the cardiorespiratory system, as well as body balance (which is very important in women diagnosed with osteoporosis), with positive results in both isometric and statistical strength. In addition to exercising with a particular program, it was also found (Verschuer et al, 2004; Iwamoto et al, 2005) that using a vibrating pad and a Galileo machine can affect bone density and fitness abilities in postmenopausal women and that in particular it increases isometric and dynamic muscle strength.

A recommendation to increase bone density and fitness abilities at the same time is a program that lasts 50 minutes, five times a week, and consists of a combination of aerobics, strength training and balance and coordination exercises, with a training period not shorter than 12 months.

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THE ROLE OF DIFFERENT TYPES PHYSICAL ACTIVITY IN OBESITY TREATMENT

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ABSTRACT

Obesity is a global health problem and one of the greatest public health challenges of today. The treatment of obesity is complex and implies a multidisciplinary approach. Physical activity is an important segment of obesity treatment. Recent literature data suggest a correlation between weight loss and health benefits, as well as a decrease in the risk of coronary artery disease, atherosclerosis and hypertension,all of which are directly responsible for the death of obese people. The aim of the review article was to consider the effects of various forms of physical activity in the treatment of obese persons.The literature data whose aim was to evaluate the effects of aerobic exercise, highintensity interval exercise, and resistance training were taken into consideration. The paper studied scientific research data that monitored the effect of combined exercise, aerobic exercise and resistance training on weight loss reduction.

Keywords: aerobic exerise, resistance training, high intensity interval exercise, obesity, treatment.

INTRODUCTION

Obesity is a global health problem and one of the biggest public health challenges of today. It was declared a global epidemic about fifteen years ago (WHO, 2000), and the number of newly ill is on a constant rise. The latest statistics show that the number of the obese has nearly tripled since 1975. In 2016, there were more than 1.9 billion overweight adults, while 650 million were classified as obese. In 2016, 13% of the world's adult population was obese while 39% of the population was overweight(WHO.Obesity and Overweight Fact Sheet Accessedat:http://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.)According to statistics, obesity is a more common cause of death than malnutrition, which is worrying and certainly an alarm for public health policies to promote healthy lifestyles, prevention and treatment of this disease.

Being overweight is a significant risk factor for the development of other diseases such as respiratory diseases, kidney disease, musculoskeletal diseases, gastrointestinal diseases and psychological problems.

Obesity is associated with numerous and significant health problems. It triggers a number of metabolic disorders. As BMI increases, the risk of developing two or more associated diseases increases (Hunter, D. J & Reddy, K. S, 2013).

The treatment of obesity is complex and involves a multidisciplinary approach and the involvement of professionals of different specialties. Treatment includes dietary regimen, behavioral therapy, medical treatment, surgical treatment (in extreme cases) and programmed physical activity.

Obesity treatment should be comprehensive,primarily aimed at reducing excess weight, maintaining the achieved therapeutic effect while preventing weight gain. Treatment must also include consideration of existing risk factors and comorbidities in order for the treatment to produce satisfactory results.

Physical activity in the treatment of obesity

Physical activity, aerobic exercise in particular, should be a part of the treatment of body weight regulation, as it increases energy expenditure and plays an important role both in weight loss and in maintaining it. Increased physical activity reduces the risk of developing cardiovascular disease not only by affecting the reduction of adipose tissue, but also by having a beneficial effect on glycoregulation, blood pressure and general health (Petrović-Oggaino, Damjanov, Gurinović&Glibetić, 2010).

Another benefit of exercise is that in addition to reducing body fat, it prevents muscle mass loss, a common occurrence in weight loss.A correlation has been found between physical activity and mood enhancement due to the secretion of various hormones and humoral factors such as endorphins, dopamine and serotonin, which are also referred to as happiness hormones in literature. Obese individuals are advised to increase their physical activity gradually, ensuring not to injure themselves. One needs to start with less demanding activities such as housework, gardening and walking. A physician should be consulted for any serious physical activity such as collective and individual sports.The American Heart Association (AHA) and the American College of Sports Medicine recommend a rising load test followed by an ECG (stress test or load test) for anyone with a defined health problem (heart, lung, or metabolic disease) and for all men over the age of 45 and women over 55 who want to take up active training.

DIFFERENT TYPES OF PHYSICAL ACTIVITY IN THE OBESITY TREATMENT

Aerobic exercise

Aerobic exercise involves a continuous and rhythmic activation of large muscle groups, namely activities such as walking, running, cycling and swimming. In practical terms, this implies maintaining a moderate to strong intensity exercise inone's own estimation over a long period of time. Today, obese individuals are advised to do aerobic exercise 5-7 days per week, with each training session lasting between 45 and 60 minutes so that the total exercise time per week is at least 150 minutes long (Donnelly et al., 2009).This recommendation refers to the minimum amount of exercise time required to maintain health, not weight loss. It is advised that individuals who want to lose weight or prevent their weight gain over an extended period of time should extend their exercise time to 200-300 minutes per week (Jakicic et al., 2001). For most individuals, this means burning over 2000 calories per week (or over 400 calories per workout). This practically means that most people would have to walk or run 1.6 km to consume 100 calories, which in food is the same as one piece of bread or four full tablespoons of sugar.Based on this recommendation, it is clear that obese individuals need intense aerobic training in order to lose weight, or those who have lost weight to maintain the desired weight. However, weight loss resulting from aerobic exercise can vary greatly, partly due to individual differences in total energy expenditure for a given amount of exercise and partly due to a compensatory change in dietary calorie intake.

In the studies examining weight change in response to the use of recommended aerobic exercise in accordance with currently validguidelines, most subjects showed only modest weight loss, whereas some did not lose weight at all. For example, in the Inflammation and Exercise Study (INFLAME) (Church et al., 2010) (129 subjects), 4 months of aerobic exercise training resulted in only minimal weight loss (-0.4 kg), which was no different from a control group that was not subjected to any physical exertion.Similar to the study above, the Dose Response to Exercise in Women (DREW) study (Church, Earnest, Skinner & Blair, 2007)analyzed weight loss in response to aerobic exercise training in accordance with public health guidelines for postmenopausal women (464 subjects) over a 6-month period. Despite achieving a percentage of exercise adherence, the researchers did not notice any significant changes in weight (-2.2 kg).Interestingly, the authors of the study showed that weight loss was still minimal even when aerobic exercise was applied in 150% of public health recommendations (-0.6 kg). The study "Targeted Risk Reduction Intervention through Defined Exercise " (STRRIDE) (Kraus et al., 2002) (84 subjects), examined the interaction between the amount and intensity of exercise, over 6 months of exercise, using and analyzing exercise combinations: (1) a small amount of moderate -intensity exercise, (2) a small amount of high intensity exercise, or (3) a large amount of high intensity exercise.Regardless of exercise intensity, weight loss was the least achieved when performing small amounts of exercise (moderate intensity: -0.6 kg, strong exercise intensity: -0.2 kg); Although weight loss is greater asthe exercise volumeincreases, total weight loss is still minimal (-1.5kg). In the study "Diabetes Aerobic and Resistance Exercise" (DARE) (Sigal et al., 2007), (251 subjects), a statistically significant weight loss was observed after 22 weeks of aerobic exercise in the group of subjects with type 2 diabetes, compared with the control group that did not undergo any resistance training, although the weight loss was also minimal this time (-0.74kg).It is important to emphasize that these studies represent the best research basis for evaluating changes in weight by performing aerobic exercise, as they include a large sample of either obese subjects or subjects on the verge of obesity, they include supervised exercise sessions to ensure high exercise adherence, confirm high adherence rates, include a control group to compare changes in weight as well as controlled factors such as complementary changes in diet.Overall, overweight or obese people who want to lose weight only through aerobic exercise (ie

without a complementary change in diet, such as reduced calorie intake) can expect weight loss in the 'no weight loss to 2kg loss' range (loss of 0% -3% body weight) if they adhere to the training program in accordance with the current recommendations. With this in mind, clinical practitioners should alert their patients, and trainers should clarify to their clients, that the chances of significant weight loss at this level of training without reducing calorie intake are very unfavorable.An important limitation to existing data in this area is that sufficiently comprehensive long-term studies (1 year) and time studies are not currently available.

In the literature there are certain studies carrying out supervised aerobic exercise training that shows significant weight loss without reducing caloric intake. However, these cases involve prescribed exercises at levels which far exceed the minimum amount of exercise recommended in accordance with public health guidelines. In a study, an 8% weight loss was achieved in obese individuals after only 12 weeks of aerobic exercise without changing their eating habits.The recommended training in this study translated to energy expenditure of 700 calories per workout, for an individual weighing about 90kg is equivalent to a light bike ride of 2 hours or, shown in food, the same calories are contained in a cheeseburger and a medium serving of French fries. In another study (Ross et al., 2000), overweight premenopausal women (BMI> 27kg / m2) underwent aerobic exercise training for 14 weeks with an energy expenditure of 500 kcal / workout, resulting in weight loss of 6.8%.Moreover, in a study conducted by Donelly et al (Donnelly et al., 2009), a weight loss of 5.3% was observed in obese men after 16 weeks of aerobic exercise training with an energy expenditure of 2000 kcal / week, which is, in terms of the recommended calorie intake for an average woman, equivalent to an all-day abstinence from food intake. Also, in this study, women who participated in the program did not experience significant weight reduction (-0.7 kg), and although any potential weight gain was prevented, this was not the case in the non-exercising control group (+2.9 kg).Considering all of the above, it is concluded that it is possible to achieve clinically substantial weight loss through aerobic exercise without reducing calorie intake, but the amount of exercise performed must be significantly higher than the currently recommended level,and the fact that the results are likely to be variableshould also be taken into account. For general population and the average obese person, this type of exercise is unlikely to be either practical or sustainable.

High-Intensity Interval Exercise

High-intensity interval exercise, also known as high-intensity interval training or HIIT training, involves repeating a series of high-intensity exercises between which either low-intensity exercise is performed or there are rest intervalsof different recovery time. Training periods can range from 5 to 8 minutes with recovery time varying in length, with a total training duration of between 20 and 60 minutes.

The most obvious advantage of high-intensity exercise is the shorter amount of time it takes to consume the right amount of energy. This is an important issue because with proper energy expenditure, weight loss is the same as in moderate exercise lasting 300 minutes per week or vigorous exercise for 200 minutes per week.Interestingly, Ross and colleagues (Ross, Hudson, Stotz, & Lam, 2015) observed differential changes in body fat distribution after high-intensity training as opposed toaerobic exercisetraining. After 24 weeks of application of the high intensity exercise program, waist circumference decreased by 4.6 cm (between 6.2 and 3.0 cm) compared to a decrease in volume by 3.6 cm (between 5.1 and 2.2 cm) with aerobic training of the same duration.Taking into account that a reduction in waist circumference of 5cm is associated with a 9% reduction in mortality risk, these data are of even greater clinical importance. Furthermore, apart from the increased energy expenditure, the increaseof exercise intensity can have additional health benefits (Gillen &Gibala, 2014).

Resistance Training

Resistance training is primarily designed to improve muscular ability by engaging a muscle or muscle groups (using weights, weight machines, bodyweight training equipment, resistance bands, medicine balls, and even ordinary household products).It should be pointed out thatfollowing the proper technique is of vital importancefor resistance trainingso as to ensure avoiding injury, that is, for most non-practitioners it is necessary to perform these exercises under professional guidance and supervision. Exercise instructions vary depending on whether hypertrophy, muscle strengthening, or strength and endurance are the intended outcome.Resistance training should be an important part of any exercise program because it is associated with many of the health benefits of exercise, such as preventing sarcopenia (loss of muscle mass) and maintaining bone mineral density, which are associated with aging and lack of physical activity. (Winett&Carpinelli, 2001). However, resistance exercise is often neglected in terms of maintaining optimal weight. In general, there is little data to show that only resistance training promotes weight loss.In a study conducted by Church et al. (Church et al., 2010), nine months of resistance training did not lead to significant changes in weight compared to the

non-exercising control group, which seems to be a consistent conclusion of many other studies as well (Sigal et al., 2007). Although resistance exercises may not lead to advances in weight loss as such, these exercises contribute to weight loss and increased muscle mass. Thus, obese individuals who undergo resistance training may not experience significant weight loss, but may expect improvements in body composition and appearance (McGuigan, Tatasciore, Newton & Pettigrew, 2009).

The effect of the combination of aerobic and resistance training in the treatment of the obese

There are several randomized trials aimed at examining the effects of a combination of these two types of training in weight reduction compared to the effects of each of these types of training individually in the treatment of the obese. Available data indicate that the effect of combined exercise in the treatment of obesity was similar to the effect in patients treated with aerobic exercise. HEART-D (Sigal et al., 2007; Church et al., 2010) and DARE (Ross et al., 2000) trials have shown that the combination of these two types of exercise in obese individuals with type 2 diabetes contributes to better glycemic control than aerobic exercise.

CONCLUSION

Recommendations regarding physical activity in the treatment of obesity should be used in the context of individual needs, goals and abilities. In this respect, the type, duration and intensity of physical activity that would be used in the treatment of obesity should be carefully evaluated in accordance with the individual approach. It is important to devise an exercise program for the individual so that, in addition to achieving sustainable weight loss, theywould permanently adopt healthy lifestyle habits to profit from the wide range of health benefits of physical activity.With all of the above in mind, it should be emphasized that lifestyle changes, which include adopting healthy dietary habits, certainly produce better results in the treatment of obesity than just regularexercise. In addition to the general diet and physical activity guidelines in the treatment of obesity, it should be pointed out that there is no universal approach to the problem with proven positive health effects. And for this reason, it is an imperative that all recommendations regarding physical activity are individually tailored to the needs, health, and lifestyle changes that each individual wants to achieve in the future.

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KINANTHROPOLOGICAL ANALYSIS OF THE CORE

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ABSTRACT

The term core is most commonly used to refer to the trunk, or more precisely, for the lumbar region. The stability of the lumbar region, or more reather the lumbar part of the spinal column, is crucial for creating the foundation for the movement of the upper and lower extremities, for supporting the load and protecting the spinal cord and nerve originating from it. The muscles of the core act as a bridge between the cranial and caudal parts of the body, transferring kinetic energy to the upper and lower limbs. The development of core strength to improve the efficiency of sports technique has been a controversial issue that has yielded different results. The purpose of this study was to investigate a number of papers that theoretically, empirically and experimentally address the problems of the muscular system, which is nominated by the term "core", considering the functional and morphological status, as well as the relationship between core stability and athletic competence.

Keywords: Core stability, Core strenght training, Core exercise principles, Trunk muscle, Lumbar spinal stabilization, Lumbar pain.

INTRODUCTION

The musculature of core acts as a bridge between its caudal and cranial parts of the body, between the upper and lower extremities. In biomechanical terms, this muscular whole provides dynamic and kinematic aspects of the human locomotion, including maintaining the balance or stability of the body in its various positions. Some studies have shown a link between core stability and increased incidence of injury (Akuthota, Ferreiro, Moore, & Fredericson, 2008; Akuthota & Nadler, 2004; Desai, & Marshall, 2010; Sung, Yoon, & Lee, 2010; Smith, Nyland. Caudill, Brosky, & Caborn, 2008; Peate, Bates, Lunda, Francis, & Bellamy, 2007; Panjabi, 2003). Topological positioning and functional incorporation are the reasons for labeling this muscle whole with the term "core" (Akuthota, 2008; Akuthota & Nadler, 2004; Fitzgerald, Ake, & Snyder-Mackler, 2000; McGill, Grenier, Kavcic, & Cholewicki, 2003; Myer, Ford, & Hewett, 2004; Myklebust, Engebresten, Braekken, Skjolberg, Olsen, & Bahr, 2003).

The promotion of knowledge about this muscular whole, 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 life of today. In this context, in the form of a review paper, this text deals with defining the morphological and functional status of this muscle region.

The goal of this review was to determine the structure, functional and morphological status of the muscles that make up the nucleus of the body, analyzing scientific journal articles.

METHODS

The focus of this research is a number of jurnal articales that deal both theoretically and experimentally and empirically with the problem of the muscular system, which is termed the core (Akuthota, 2008; Akuthota & Nadler, 2004; Fitzgerald, Ake, & Snyder-Mackler, 2000; McGill, Grenier , Kavcic, & Cholewicki, 2003; Boyle, 2004; Jeffrey, 2007; Cook, 2003; Santana, 2001; Willardson, 2007; Verstegen & Williams, 2004).

The databases that were used were cobson, pubmed and google scholar. Search was conducted by keywords: core stability, core strenght training, core exercise principles, trunk muscle, lumbar spinal stabilization, lumbar pain.

RESULTS

Morphological status

The core of the human body's musculature acts through the thoracolumbar fascia as a "private back belt". Muscle transverse abdominais has a significant effect in the medial and posterior parts of the thoraco-dorsal fascia (Sapsford, 2000). In addition, the deep part is closely connected to the lumbar-spinal processes via the posterior layer. In fact, the thoracic-back fascia serves as a “hoop” around the trunk (McGill, 2001), which provides, previously mentioned, a kinetic link between the lower and upper extremities (Akuthota et al., 2008). With core muscle contraction, the thoracolumbar fascia also functions as a proprioceptor - providing feedback on trunk positioning (Akuthota & Nadler, 2004).

Two types of muscle fibers makes the body core: slow twitch fibers and fast twitch fibers. Slow twitch fibers form the primary local muscular system (deep muscle layer). These muscles are shorter in length and are suitable for controlling the intersegmental movement 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. Multifidus has been found to atrophy in individuals with chronic lumbar pain (Akuthota & Nadler, 2004). On the other hand, fast twitch muscle fibers form the global muscular system (the superficial layer of muscle). These muscles are long and play a role in large polygons - allowing them to produce large amounts of torque and overall movement. Key global muscles include the levator scapulae, the outer obliques, rectus badominis, and quadratus lumborum - considered by McGill (2003) to be the main stabilizer of the spine.

However, the abdominal muscles are vital components of the core. The transverse abdominal muscle attracted particular attention with its stabilizing effects. It has fibers that extend horizontally (except for the lowest positioned lower fibers, which follows the fibers of the inner oblique abdominal muscle), creating a band around the abdomen. Insertion of the lower abdomen creates isolated activation of TrA. Clinical research has shown that, in healthy individuals, TrA and multifidus are activated 30ms before shoulder and upper extremity 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). The inner obliques and the TrA work together to increase the intra-abdominal pressure acting over the thoracic fascia, thus creating a pressure around the trunk, similar sa the hoop. Increased intra-abdominal pressure has been shown to increase 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 only engage 5-10% of their maximal voluntary contraction to stiffen and stabilize the spinal segments (Akuthota et al., 2008; Grenier & McGill, 2007).

The pelvic floor musculature is vital for all functional activities and plays a key role in stabilizing the hips and pelvis while walking (Akuthota et al., 2008). Poor endurance and delayed activation of the muscles of the hip extensor (gluteus maximus) and of the abductors (gluteus medius) were first observed in people with lower back pain and other musculoskeletal conditions, such as, for example, ankle sprain (Leeton, Ireland, & Willson, 2004). The Iliopsoas is only one blind flexor in the lumbar spine (Akuthota et al., 2008; Sapsford, 2000). However, it has the potential to exert strong pressure on the lumbar discs. In activities that promote maximal loin contraction of the psoas, such as in the exercise of full flexing of the trunk, it can exert a load on an L5-S1 disk equal to a weight of 100 kg (Akuthota et al., 2008; Sapsford, 2000). Shortening of the hip flexors (iliopsoas) can cause lower back pain by increasing pressure on the lumbar discs.

The diaphragm serves as a lid or roof on the muscle box of the core, and the pelvic floor muscles as the bottom. Diaphragm contraction increases intra-abdominal pressure, contributing to spinal stability. The pelvic floor muscles coactivate with contraction of the transverse abdominal muscle (Hewett, Torg, & Boden, 2000). In one study (Akuthota et al., 2008), people with sacroiliac pain were shown to have impaired involvement of the diaphragm and pelvic floor muscles. Thus diaphragmatic breathing techniques and pelvic floor activation can be an important part of a basic core strengthening program.

Functional status

The stability of the core and the depending factors

Similar terms used to describe body core stability are: lumbar stabilization, dynamic stabilization, motor control (neuromuscular training), neutral spinal control, muscular fusion (synchronization), trunk stabilization, core strengthening, lumbopelvic stabilization (Akuthota & Nadler, 2004; Bliss & Teeple, 2005). All of these concepts are incorporated into our definition of core stability. 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 (Liemohn, Baumgartner, & Gagnon, 2005; Panjabi, 2003; Smith, Nyland, & Caud, 2003;

Smith, Nyland, & Caud; Caud Caborn, 2008; Willson, Dougherty, Ireland, & McClay, 2005). Stability (often referred to as ligament integrity around the wrist) is the ability to maintain proper posture and/or control of segment movement and general movement (Cook, 2003). Cook (2003) emphasizes that stability is the ability to control force or movement. In most cases, stability is a precursor to power (Cook, 2003). The stability of any system represents the ability to limit displacements and maintain the integrity of the structure (Willson et al., 2005). Clinically and practically, these definitions lack a tangible, functional perspective that translates into principles for the practical application and assessment of core stability in active, sporting populations (Bliven & Anderson, 2013). Several authors (Bliven & Anderson, 2013; Akuthota & Nadler, 2004; Colston, 2012; Kiesel, Plisky, & Butler, 2011) have proposed a more functional perspective for describing the core as the basis of the kinetic chain responsible for the more efficient transfer of torque and force torque between the lower and upper extremities for global motor tasks of daily living.

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 while dynamic stability is pronounced during dynamic activities. Dynamic activities are those that cause disturbances in the center of gravity in response to muscle activity (Bliss & Teeple, 2005). Dynamic stabilization refers to the ability to use strength and endurance in a functional way through all planes of motion, despite changes in the center of gravity (Bliss & Teeple, 2005).

According to the group of authors (Akuthota, Ferreiro, Moore, & Fredericson, 2008), the system for maintaining spinal stability consists of the following interacting elements:

- Neuromuscular control (neural elements)
- Passive subsystem (bone and ligamentous elements
- Active subsystem (muscle elements)

In order for stability to be optimal, all three elements must contribute and complement each other. The contribution of passive elements results from the interaction of mechanical loading on bone architecture and soft tissue compliance (Wilson et al., 2005). Compared to the active muscle component, the contribution of passive elements in stability is quite small. For example, the *in vivo* lumbar spine can withstand compressive loads > 6,000 N during daily functional activities and successfully maintain stability (Wilson et al., 2005). However, without active support, 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 (Akuthota et al., 2008; Kibler, Press, & Sciascia, 2006; Wilson et al. , 2005). The active, muscular elements of the core contribute to the stability of the system through three mechanisms: intra-abdominal pressure, compressive forces, and rigidity of the hip and trunk muscles (Wilson et al., 2005). The contribution of intra-abdominal pressure to core stability is considered to be a consequence of abdominal muscle activity. Although this assumption is often true, studies show that increased intra-abdominal pressure can be achieved without abdominal muscle activity. Specifically, simultaneous contraction of the diaphragm and pelvic floor muscles increase intra-abdominal pressure and increase global stiffness (Wilson et al., 2005). So the active, muscular components of this system are critically important.

However, spine stability depends not only on muscle strength, but also on an adequate nerve impulse that informs the central nervous system (CNS) of the interaction between the body and the environment, provides constant feedback and enables refinement of movement (Akuthota et al., 2008). Lack of optimal coordination in the core musculature can lead to a decrease in movement efficiency and compensation patterns, causing deformations, unnecessary stresses, and thus creating a predisposition for various injuries (Akuthota et al., 2008; Akuthota & Nadler, 2004). Therefore, motor learning can be just as important as strengthening the core muscles. Stabilization requires a neutral spine position (Bliss & Teeple, 2005), as well as the ability to move through that position in a controlled manner. A neutral spine is usually, but erroneously, synonymous with a straight back position. A neutral spine is not a single fixed 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 stability of the core requires immediate changes by the central nervous system in order to obtain appropriate combinations of muscle activation and intensity of muscle recruitment for stiffness (ie stability) as well as the need for systemic mobility (Akuthota & Nadler, 2004; Bliven & Anderson, 2013; Escamilla , Lewis, Bell, Bramblet, Daffron, Lambert, Pecson, Imamura, Paulos, & Andrews, 2010; Kibler et al., 2006; Smith, Nyland, Caudill, Brosky, & Caborn, 2008; Willson et al., 2005).

Stability of the core musculature and sports competence

The development of core stability to improve sports performance has been a controversial issue in the bibliography. The core refers to the muscles that

surround the hips, pelvis, and lower back. Thus, core stability functionally maintains the neutral position of the pelvis while simultaneously protecting the lumbar spine (Stanton, Reaburn, & Humphries, 2004). This may be important in terms of spread injury, but research has found different results regarding the relationship between core stability (Abt, Smoglia, Brick, Jolly, Lephart, & Fu, 2007; Nesser, Huxel, Tincher, & Okada, 2008; Nesser & Lee , 2009) and core-related programs (Myer, Ford, Brent, & Hewitt, 2006; Stanton, Reaburn & Humphries, 2004; Thompson, Cobb, & Blackwell, 2007; Tse, McManus, & Masters, 2005). The core muscles are thought to play an integral role in the process of kinetic energy transfer from the trunk to the extremities (Abt, et al., 2007; Tse, et al., 2005). Weak core musculature coupled with strong limb musculature can lead to fatigue and insufficient force generation, which can be detrimental to many aspects of sports performance or exercise (Nesser, Huxel, Tincher, & Okada, 2008; Nesser & Lee, 2009; Tse, et al , 2005). To assess the role of core musculature in sports performance, studies have examined the correlations between different measures of core musculature and athletes' performance in cycling, American football, and soccer (Abt, et al., 2007; Nesser, et al., 2008; Nesser & Lee , 2009). Additional studies have 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). However, the present research lacks significant and consistent results. They focus primarily on aspects of stabilization and endurance of the core musculature when aiming to determine its effect on sports performance (Abt, et al., 2007; Meyer, et al., 2006; Nesser et al., 2008; Nesser & Lee, 2009 ; Sato & Mokha, 2009; Nikolienko et al., 2011; Stanton, et al., 2004; Tse, et al., 2005). Measures used to evaluate the core musculature may not evaluate its role in energy transfer during sports performance (Cowley, Fitzgerald, Sottung, & Swensen, 2009; Cowley & Swensen, 2008; Nesser, et al., 2008; Nesser & Lee, 2009 ; Tse, et al., 2005) due to 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 et al. 2009) using tests specifically targeting the core. In addition, core musculature may not play as big a role in sports performance as is commonly thought.

In one study, a group of researchers (Nikolenko et al., 2011) aimed to investigate the relationship between two dynamic strength tests and measures of sports performance. Twenty healthy, recreationally active, men who had at least six months of experience in workout training participated in the study. Respondents were tested over three days. On the first day they were theoretically familiar with all the tests (where their height and body weight were also measured). The second day was tested by a 40-yard sprint (Nesser et al., 2008; Nesser & Lee, 2009), a s shuttle run (Nesser et al., 2008; Nesser & Lee, 2009), a vertical jump and a 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): Front abdominal power throw and side abdominal power throw.

While most of the performance variables in this study (Nikolienko et al., 2011) were found to have no significant correlation with the two core tests, the 1 RM back squat 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 deliberately activates thrunk flexors, including m. rectus abdominus and hip flexors like m. psoas major and m. rectus femoris, which can also be activated during the back squat (Nikolienko et al., 2011). So, in this case, the increased 1 RM of the back squat and the test of throwing the medicine out of the supine position the result can be attributed to the greater strength of the hip flexors. The purpose of this study was to determine the relationship between two dynamic strength tests and measures of sports performance. There were moderate correlations between the 1 RM back squat and the power of the anterior abdominal throw. No other significant correlations were found. This could mean that the core, as measured by these specific strength tests, lacks specificity or does not contribute to significant sporting performance as measured in this study. This is not to say that these trunk muscles were not used or activated during other performance tests, but perhaps that the muscle activities or movements used in the FAPT and SAPT tests were not specific to the different roles that core musculature plays in different performance tests (Nikolienko et al , 2011).

Although this study (Nikolienko et al., 2011) focused on the component of core muscle strength, the results are similar to those obtained by Nesser and Lee (2009), who determined the relationships between core stability and endurance and different performance variables. They found no significant correlation between core stability tests and any performance variable. These results can be attributed to the specificity of training and testing to determine the role and involvement of core musculature in sports performance. Also, studies conducted by Nikolenko et al. (2011) show a significant lack of core contribution to sports performance, and are similar to those conducted by

Tse et al. (2005). These studies investigated the effectiveness of a core training program on core endurance and various performance measures in sport. Both studies found no significant differences between groups or within the group from initial to 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 properly engage the core muscles.

In order to properly measure the core strength and stability and their role in sports performance, that is, skill-specific tasks (throwing speed, golf club or baseball bat speed, tennis serving speed, etc.) it may be necessary to evaluate (Tse, et al , 2005). Although some previous studies have focused on some sports-related tasks, such as swimming at 100m and 2000m rowing (Tse, et al., 2005), significant results were not found, either because core training protocols were not performance specific or performance tests focused more on cardiovascular fitness and muscle endurance. One study that addressed the specific task and how it was affected by the 8-week training program was the study of Thompson et al. (2007), who analyzed the speed of a stick head in a golfer. They found that the experimental group had an increase in golf club head speed of 4.9%, while that of the control group decreased slightly.

This need, that it is necessary to focus on the specificity of sport, when trying to evaluate the musculature of core and determine its role in sport performance, has also been examined by Kubo, Ohta, Takahashi, Kukidome, and Funato (2007). Magnetic Resonance Imaging (MRI) taken from a wrestler's musculature with results showing that the higher the performance level, the greater the muscle cross-sectional area (CSA) of the trunk flexor muscles. Although a study by Kubo and colleagues (2007) indicates that there is a relationship between muscle cross-section and performance, it does not state how the core contributes to performance. Two basic field tests used in the study by Nikolenko et al (2011) emphasized the core strength component. The lack of significant links between these tests and the various performance tests they used may mean that the basic field tests are not movement specific, or the core plays a small role in performance tests. In recent years, fitness experts and researchers have increasingly emphasized the importance of exercise and training programs to increase core stability (Boyle, 2004; Jeffrey, 2007; Nikolic, 2016). Also, a large number of researchers and clinicians (Wang, Zheng, Yu, Bi, Lou, Jing, Cai, Hua, Wei, Shen, Chen, Pan, Xu, & Chen, 2012) suggest that increased lumbar stabilization is significant in the prevention of sports injury. Therapy that includes exercises to stabilize the body's core is an effective treatment to relieve pain and improve the functional status of patients with chronic lumbar pain in most clinical practices (Hayden, Tulder, Malmivaara, & Koes, 2005). Stability and core strength training has become a kind of fitness trend that has begun to be implemented in rehabilitation and sports medicine programs (Akuthota, Ferreiro, Moore, & Fredericson, 2008). Many studies (Desai & Marshall, 2010; Sung, Yoon, & Lee, 2010) have shown that lumbar stabilization exercises are an important component of rehabilitation. However, stabilization exercises for the core are usually performed by healthy individuals at fitness and recreation centers (Willardson, 2007). This shift toward commercial settings may have stemmed from exercises popularized by the San Francisco Spine Institute (1989) when the concept of "neutral spine" was emphasized in their 1989. manual entitled "Dynamic Lumbar Stabilization Program" (Willardson, 2007). Over the last decade, the roles of physical therapy experts, personal trainers, strength training and fitness have been increasingly intertwined and merged. For example, personal and strength and fitness coaches now receive advertising equipment and advertising catalogs specifically designed for core stability training (Willardson, 2007). Seminars and workshops offered at national conferences have expanded information on the proper use of such training programs and have suggested the benefits of such training. Some authors (Boyle, 2004; Jeffrey, 2007; Cook, 2003; Santana, 2001; Willardson, 2004; Verstegen & Williams, 2004) specifically highlight and promote special equipment for enhancing lumbar stabilization. However, although research in the rehabilitation literature has shown the effectiveness of exercises and training programs to develop core stability in reducing the likelihood and prevention of sports injuries - most in the lower back and lower extremities (Fitzgerald, Ake, & Snyder-Mackler, 2000; McGill, Grenier, Kavcic, & Cholewicki, 2003; Myer, Ford, & Hewett, 2004; Myklebust, Engebresten, Braekken, Skjolberg, Olsen, & Bahr, 2003), relatively few studies have directly examined the benefits for healthy athletes (Schibek, Guskiewicz, Prentice , Mays, & Davis, 2001; Stanton, Reaburn, & Humphries, 2004; Willardson, 2007).

Certain individuals have promoted exercises and programs to improve core stability in sports-competitive and rehadilation conditions with little scientific evidence to support their claims (Boyle, 2004; Jeffrey, 2007; Cook, 2003; Santana, 2001; Willardson, 2007; Verstegen & Williams , 2004). The concept of core stability and how this feature can be trained to increase sports performance has been interpreted differently among practitioners (Willardson, 2007). Furthermore, what distinguishes

stability exercises for the core from other traditional exercise exercises is not yet clearly defined.

CONCLUSION

We talked about the structure, functional and morphological status of the muscles that make up the body's core. The vital purpose of improving the core in this study was to show how it affects the advancement of sports technique and its efficiency. Most studies showing the effectiveness of core stability training have been conducted on untrained individuals or injured athletes for rehabilitation purposes. These studies suggest that it is necessary to incorporate a program to increase 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 included isometric muscle activity, low exercise, and long periods of tension, which may not develop the core stability necessary for athletic performance in healthy athletes.

A new paradigm is needed among personal and fitness coaches in exercise types that are recommended for healthy athletes. Future research focusing on the effects of traditional exercise (e.g. deadlifting, different types of squats, cleans, different types of thrusts and jerks) for core stability will help to create this new paradigm. There is currently no battery of tests to assess core stability in healthy athletes. Therefore, future research should seek to establish a battery of core stability tests incorporating dynamic muscular activity while maintaining relatively high posture loads, consistent with core stability requirements in sports performance.

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DEVELOPMENT OF SPECIFIC DYNAMIC MOVEMENT SKILLS IN PERSONS DIAGNOSED WITH PARAPARESIS ASSOCIATED WITH THE WHEELCHAIR USE – CASE REPORT

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ABSTRACT

Physical exercise has a positive effect on cardiovascular system, motor skills and psychological wellbeing of persons affected with paraparesis. Most of the activities of persons affected are performed in wheelchairs, including physical exercise. Wheelchair use is a specific dynamic activity with characteristics of its own, taught by therapist and physical therapists, and furthermore, if the person who is wheelchair bound has an interest in sports, by coaches of the chosen sport. The purpose of this research – case study, was to determine the development of specific dynamics in persons diagnosed with paraparesis. Examinee with paraparesis, male (185 cm, 75 kg, 32 years) physically active, diagnosed with Spastic Paraplegia which appeared, due to the complications of encephalitis, sepsis and laryngotracheobronchoscopy procedure, 10 years before this research. The following parameters were observed, in particular – wheelchair dynamic movement skills: 5 m sprint, 20 m sprint, 5 m Sprint with dribbling (ball), 20 m sprint with dribbling (ball), Slalom without a ball and Slalom with a ball (dribbling). Examinations were performed before and after an exercise program. The training program lasted 5 days, with 2 training sessions per day, every training session lasted 90 min. The results have showed an improvement in the final assessment in four of the six variables. Further researches of this topic are necessary.

Keywords: wheelchair use, paresis, case report

INTRODUCTION

According to a 2011 World Health Organization (WHO) report, there are over one billion people with disability in the world, and out of that number 110-190 milion people have a severe disability, therefore PWDs[1] make up for 15% of the world's total population (WHO, 2011). In Europe, there is one PWD on every ten people, while the are no accurate and relevant data for Serbia. If the WHO principle is applied, taking that PWDs make up for 10% of the entire population, it could be said that some 800.000 people in Serbia have some form of disability. On the other hand, according to various associations operating in Serbia, the number of 142.168 people comes. The reason we are unable to ascertain the exact numbers is that we cannot obtain data of this kind by means of routine research, but receive accurate information only in the event that PWDs are registered, in employment or else in registers of specific diseases. Also, according to a 2011 WHO report, disability is a more common occurrence among women, the elderly and the poor. Underdeveloped countries have a higher prevalence of disability (WHO, 2011).

The human body is intended for physical activity. It is therefore not surprising that declining of functions is shown in situations of prolonged inactivity. In the last 20 years, lengthy epidemiological and experimental studies have found that inactivity causes illness and premature death. Physical activity strengthens skeletal muscle, tendons and ligaments, and increases bone density (Warburton, Nicol & Bredin, 2006). Self-administered physical activity has the effect of reducing weight and subcutaneous adipose tissue, while in combination with diet programs with reduced energy intake through diet, it is an ideal model in body weight correction (Jakicic, Clark, Coleman, Donnelly, Foreyt et al., 2001). Numerous research authors researching the benefits of physical

[1]Person with disability

activity on people's mental health have argued that physical exercise improves self-confidence, mood, reduces stress and anxiety and improves the quality of sleep (Scully, Kremer, Meade, Graham & Dudgeon, 1998; Fox, 1999; Penedo & Dahn, 2005).

The number of disabled people in the world is growing steadily. There is a great need for their integration in their immediate society, and sports and recreational activities have proven to be the most appropriate way of overcoming this problem (Миленковић & Живановић, 2010).

Sports and exercise are means of secondary rehabilitation and aim to improve the quality of life and psychophysical condition of the entire human organism. Shephard (1988) states that the principles of training, exercise, refinement of physical, technical and tactical elements are quite similar to the methods used by athletes without disabilities. The difference is reflected in the impact of exercise that is more peripheral than general with a focus on the upper extremities and a reduced chance of overtraining. Today, more and more attention is focused towards the design and comfort of wheelchairs, preventing injury and increasing efficiency.

The aim of this study is to determine the effects that wheelchair basketball training has on the development of specific dynamics of wheelchair use in persons with paraparesis.

METHODS

Before and after the application of experimental programme, assessments of selected variables were performed using the following tests (Gil, Yanci, Otero, Olasagasti, Badiola et al., 2015; Marszalek, Kosmol, Morgulec-Adamowicz, Mróz, Gryko et al, 2019): 5 m Sprint, 20 m Sprint, 5 m Sprint with ball, 20 m Sprint with ball, Slalom without the ball, Slalom with the ball.

Subjects

The sample consisted of one respondent diagnosed with paraparesis (185cm, 75kg). The respondent was diagnosed with spastic paraparesis that occurred 10 years ago due to complications of encephalitis and sepsis. Respondent has been physically active, and has been engaged in wheelchair basketball. In the last four months.

Procedure

The initial assessment was held on 24.06.2019. at 7:30 am. Before the assessment, the examinee had training sessions three times a week. After the initial assessment, the examinee took part in the preparation programme of the Serbian National Wheelchair Basketball Team lasting five days (June 27th – July 1st 2019). Training sessions were held twice a day and their primal focus was on technical and tactical preparation while physical fitness was secondary. Each training session lasted 90 min (15 minutes – warming up, 60 min working on technical and tactical preparation and 15 min - cooling down). After returning from the preparations, the respondent did not have a systematic training session for ten days. After a period of active rest, the final assessment was conducted on 10.07.2019. Testing was carried out at 7:30 am, after breakfast, during training session held in the small hall of the Čair Sports Centre. Photocells (Witty, System, Microgate, Bolzano, Italy), basketballs weighing 600 g and training cones were used from the apparatus and props. Each of the tests was performed three times with a one-minute break between each try. The best achieved result of the respondent was taken as a sample.

Statistical analysis

As this is case analysis, statistical data processing will not be necessary.

RESULTS

Variables	Initial assessment	Final assessment
5 m Sprint	2.18	2.21
10 m Sprint	6.45	6.44
SWB 5 m	5.22	5.01
SWB 20 m	8.08	7.69
SWOTB	11.29	11.21
SWTB	15.06	15.12

Legend: 5 m Sprint with ball (SWB 5 m); 20 m Sprint with ball (SWB 20 m); Slalom without the ball (SWOTB); Slalom with the ball (SWTB).

DISCUSSION

Although this research is a review, that is, case study, which is the most basic form of methodological research (Mills, Harrison, Franklin & Birks, 2017) the individual approach is best advised for the topic of specific wheelchair mobility (Zukowski, Hass, Shechtman, Christou & Tillman, 2017) In general, wheelchair propulsion kinematics are of limited interest to researchers (Crespo-Ruiz, Del Arna-Espinosa, & GilAgudo, 2011). Wheelchair use is a specific motion activity taught by occupational therapists and physical therapists (Boninger, Souza, Cooper,, Fitzgerald, Koontz & Fay, 2002), and furthermore, in the event that a wheelchair bound individual is interested in sports, coaching of the chosen sport is taken over by the sport coaches (Vanlandewijck, Theisen & Daly, 2001).

It should be noted that the examinee didn't train after returning from the preparation of the Serbian National Wheelchair Basketball Team, in the period from the preparation day until the day he was tested. On the other hand, when initial assessments were performed, his training sessions were held four times a week, two hours a day. Final results would probably have been even better had testing been done earlier. Also, regarding the somewhat poorer results on the 5m slalom with the ball assessment, we should consider the motion response speed which is quite specific, individually determined and depends on a lot of external and internal factors.

Also, better results are explained by the content of the experimental program that was filled with the of basketball training contents. Specifically, wheelchair basketball, as a sport, is highly dependent on starting and braking in a wheelchair, expressed by numerous stopping and restarting (Seron, de Carvalho & Greguol, 2019).

CONCLUSION

Based on the analysis of the obtained data and considering all circumstances, it is concluded that systematic training improves general and specific dynamics.

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CONNECTION OF BODY COMPOSITION AND CARDIORRESPIRATORY FITNESS IN PHYSICALLY ACTIVE WOMEN

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ABSTRACT

The aim of the study is to determine the correlation between body composition and cardiorespiratory fitness in physically active women.

The sample of subject consisted 50 women of aged from 22 to 25. The sample of participants included in the experiment were students from different faculties of the University of Niš, except the Faculty of Sports and Physical Education in Niš, who belong to the group of physically active women (minimum activity of 3 times per week, 60 minutes each). All subjects were involved in a regular recreational aerobic exercise program with music, and had a minimum of 3 months of regular exercise experience.

Body composition indicators were calculated: Body fat [%] Body fat [kg] Muscle mass [%] Muscle mass [kg] and cardiorespiratory fitness: Systolic ABP [mmHg] Diastolic ABP [mmHg] Pulse at rest [rpm] pulse at load [rpm] VO2max [ml / kg / min] VO2max [L].

The correlation between the body composition and the cardiorespiratory fitness of physically active women was found by canonical correlation analysis.

Keywords: body composition, cardiorespiratory fitness, female students, aerobic exercise

INTRODUCTION

Body composition is an important indirect indicator of "fitness" as well as the general health of the physically active and it changes under the influence of physical exercise (Стојиљковић, 2012). The relative values of muscle, fat, bone and other anatomical components that contribute to a person's overall body weight make up a body composition (Solway, 2013). The American Health Association confirms that body structure is the ratio of fat, muscle, and bone tissue to the entire body mass, while associating body composition with body structure (in anthropometry) as a composition of the human body, represented by the size and grouping of the existing measurable segments it consists of (Ugarković, 2004).

Inactive lifestyles endanger the health and normal functioning of human organs and organ systems. In people who are inactive or slightly physically active, the function of the locomotor, cardiovascular, respiratory and other systems of the organism decreases. We should bear in mind that lower intensity exercises are not effective in enhancing the functional capacity of the organism, moderate intensity exercises are effective, and those of excessive intensity are detrimental to the body (Hollmann, 1992; Hollmann & Hettinger, 2000; Weineck, 2000).

Quality lifestyle and physical activity positively affect our mood, our self-awareness as well as our self-esteem and the reduction of physiological and psychological stress (Berger & Motl, 2001) and other experiences that play an important role in the quality of life.

Young people do not pay attention to their diet during their student days, so fast food, sweets and snacks, coffee and energy drinks are at the forefront of the pyramid of students' nutrition. Obesity is one

of the main problems of modern society around the world.

A group of authors (Terry et al., 2010) investigated overweight, obesity, nutrition and physical activity in 18- to 27-year-old students. They came to the conclusion that more than 69% did not consume enough fruit and vegetables daily, while 67% reported being physically active less than three times a day. Most of them do not meet the requirements for diet and physical activity, hence a logical explanation of why obesity is prevalent to such a great extent.

Intensity, volume and frequency are the most important factors during exercise, so it is important to respect them. A group of authors (Pate et al., 1995; Hickson, Foster, Pollock, Galassi, & Rich, 1985) considered what level of intensity physical exercise should be at in order to have positive effects on the body and gave the following recommendations: 30 minutes of moderate-intensity physical activity at least three times a week, preferably every day of the week. American College of Sports Medicine, recommends physical activity three to five times a week with an intensity of 55/65% to 90% of maximum heart rate, lasting 20 to 60 minutes. The exercise program can be individually selected, the most common motive for women is, first and foremost, health, then improving physical appearance and regulating body fat (Стојиљковић, 1996).

The aim of the study was to determine the correlation between body composition and cardiorespiratory fitness in physically active women.

METHODS

With an aim of obtaining relevant information, adequate procedures have been applied that correspond to the nature of the set subject, the purpose and the tasks of the research.

Subjects

The sample of respondents consisted of 50 women aged from 22 to 25 years. The sample included in the experiment were students from different faculties of the University of Niš (except the Faculty of Physical Education in Niš), who belong to the group of physically active women (minimum 3 hours per week, 60 minutes each) (Mikalački, 2005). All respondents were involved in a regular recreational aerobic exercise program with music, and had a minimum of 3 months of regular exercise experience.

Respondents had to meet the following criteria:

- they are students of a faculty of the University of Niš (except the Faculty of Physical Education),
- they do not have somatic defects or diseases,
- they are not engaged in other organized forms of physical activity other than participation in the recreational program,
- they regularly participate in exercise (three times a week),
- they have voluntarily agreed to participate in the exercise program.

The characteristics of the sample were described by body height, body weight and BMI calculation

Table 1. *Descriptive statistics of basic characteristics of the sample of respondents*

	Mean	Srd.Dev.	Min	Max	Range
Age	23,02	1,87	19,00	28,00	9,00
Body weight	61,02	5,84	50,50	73,50	23,00
Body height	164,64	6,12	157,00	181,60	24,60
BMI	22,54	2,22	19,53	29,50	9,97

Legend: (Mean) - Arithmetic Mean, (Std.Dev.) - Standard Deviation, (Min) -Minimum Value, (Max) -Maximum Value, (Range) -range

Table 1 shows the basic descriptive data of the respondents included in the survey. Based on the results, it can be concluded that the tested group is homogeneous because there are less than 6 standard deviations within the range. It can be stated that the subjects were well-nourished (BMI 22.54 kg / m2), with an average height of 164.64 cm and a body weight of 61.02 kg.

Procedure

Sample of measuring instruments

For the purpose of the research, the tests were applied to estimate:

- indicators of body composition
- cardiorespiratory fitness

Parameters for body composition assessment

Bioelectrical impedance analysis (Bioelectric Impedance Analysis - BIA) was applied to assess body composition. The measurements were made with the TANITA UM-72 Body Fat Monitor (Body Composition Monitor).

Parameters for cardiorespiratory fitness assessment

- Pulse at rest
- Pulse at load
- Systolic arterial blood pressure
- Diastolic arterial blood pressure

- VO2max oxygen consumption (ml / kg / min)

Statistical analysis

The data were processed using Statistica 7.0 (StatSoft.Inc., Tulsa, OK, USA). The significance level is .05.

(1) *Descriptive statistics and distribution*

For all tests, basic parameters of descriptive statistics and distribution were calculated: Arithmetic Mean (Mean), Minimum Value (Min), Maximum Value (Max), Range (Range), Standard Deviation (Std.Dev.)

(2) *Relations*

The correlation between predictors and criteria was determined using canonical - correlation analysis.

RESULTS

The results of the survey are presented in tables. Table 2 shows the results of parameters for the body composition assessment. It can be stated that the tested group is homogeneous because there are fewer than 6 standard deviations within the range. The numerical values shown indicate that the subjects have standard body composition results in terms of the tested parameters.

Table 2. *Descriptive statistics of the body composition assessment of the respondents*

		Mean	Srd.Dev.	Min	Max	Range
Body fat	**[%]**	21,34	4,44	13,70	32,30	18,60
Body fat	**[kg]**	12,40	4,73	4,00	23,70	19,70
Muscle mass	**[%]**	31,93	3,89	22,91	41,88	18,97
Muscle mass	**[kg]**	19,26	2,51	15,35	27,01	11,66

Legend: (Mean) - Arithmetic Mean, (Std.Dev.) - Standard Deviation, (Min) -Minimum Value, (Max) -Maximum Value, (Range) -range

Table 3 shows the results of the parameters for cardiorespiratory fitness assessment. It can be stated that the tested group is homogeneous because there are fewer than 6 standard deviations within the range. It can be stated that all the parameters correspond to the normal values of the tested cardiorespiratory indicators.

Table 3. *Descriptive statistics of cardiorespiratory fitness assessment*

	Mean	Srd.Dev.	Min	Max	Range
Systolic ABP [mmHg]	119,80	7,74	105,00	134,00	29,00
Diastolic ABP [mmHg]	77,42	7,56	60,00	94,00	34,00
Pulse at rest [o/min]	72,96	5,21	60,00	84,00	24,00
Pulse at load [o/min]	158,42	8,01	144,00	175,00	31,00
VO2max [ml/kg/min]	36,66	1,47	33,61	39,31	5,70
VO2max [L]	2,24	0,26	1,76	2,81	1,05

Legend: (Mean) - Arithmetic Mean, (Std.Dev.) - Standard Deviation, (Min) -Minimum Value, (Max) -Maximum Value, (Range) -range

Table 4. *Cross-correlations of body composition and cardiorespiratory fitness of physically active women*

	Systolic ABP [mmHg]	Diastolic ABP [mmHg]	Pulse at rest [o/min]	Pulse at load [o/min]	VO2max [ml/kg/min]	VO2max [L]
Body fat [%]	0,44	0,50	0,16	-0,15	0,16	0,44
Body fat [kg]	0,48	0,47	-0,05	-0,09	0,09	0,41
Muscle mass [%]	-0,25	-0,07	0,14	-0,11	0,11	-0,22
Muscle mass [kg]	0,22	0,36	0,06	-0,03	0,03	-0,01

Legend: statistical correlation significance p <.05

Based on the significant correlation coefficients, it is observed that the percentage of body fat and body fat in kilograms is positively correlated with systolic arterial blood pressure. The percentage of body fat and body fat in kilograms have a significant positive correlation with diastolic arterial blood pressure. The percentage of body fat and body fat in kilograms correlates positively with the oxygen consumption expressed in liters.

Using a canonical correlation analysis, a correlation was found between body composition and cardiorespiratory fitness in physically active women (Table 5).

Table 5. *The coefficient of canonical correlation of body composition and cardiorespiratory fitness in physically active women*

	R	R^2	Chi-sqr.	df	p
0	0,76	0,59	74,52	2	.000
				4	
1	0,70	0,50	35,71	1	.002
				5	
2	0,26	0,07	5,50	8	.702
3	0,22	0,05	2,26	3	.519

Legend: (R) canonical correlation coefficient, (R2) paracanonical factor determination coefficient, (Chi-sqr.) Bartlet's x2test, (df) degrees of freedom, (p) statistical significance

The analysis of the results (Table 5) reveals that the areas of body composition and cardiorespiratory fitness are interrelated with two pairs of statistically significant canonical factors. The first pair of canonical factors explains 59% (R^2 = 0.59) of shared variability, the second pair 50% (R^2 = 0.50) of common variability.

Table 6. *Factor structure of body composition of physically active women*

		Root 1	Root 2
Body fat	**[%]**	0,79	-0,55
Body fat	**[kg]**	0,58	-0,80
Muscle mass	**[%]**	0,03	0,64
Muscle mass	**[kg]**	0,35	-0,10

The analysis of the results (Table 6) shows that on the first isolated canonical factor in the area of body composition the percentage of body fat (0.79) and body fat in kilograms (0.58). the highest projection, with a positive sign. On the second isolated canonical factor in the area of body composition the percentage of body fat (-0.55) and body fat in kilograms (-0.80), has the highest projection, with a negative sign, while the muscle mass in the body structure has a positive projection.

Table 7. *Factor structure of cardiorespiratory fitness of physically active women*

	Root 1	Root 2
Systolic ABP [mmHg]	0,24	-0,61
Diastolic ABP [mmHg]	0,52	-0,40
Pulse at rest [o/min]	0,54	0,53
Pulse at load [o/min]	-0,99	-0,35
VO2max [ml/kg/min]	0,99	0,35
VO2max [L]	0,88	-0,17

Analysis of the results (Table 7) shows that on the first isolated canonical factor in the area of cardiorespiratory fitness the pulse at load (-0.99) has the highest projection, with a negative sign, and the oxygen consumption expressed in milliliters (0.99) and oxygen consumption expressed in liters (0.88) have the positive projection. On the second isolated canonical factor in the area of cardiorespiratory fitness, systolic (-0.61) and diastolic arterial blood pressure (-0.40) have the highest projection, with a negative sign, while the pulse at rest has a positive projection (0.53).

DISCUSSION

Based on the results of the descriptive statistics of the parameters for the body composition assessment, the numerical values shown indicate that the respondents have standard results of the body composition in terms of the tested parameters. An inadequate ratio of food intake and exercise contributes to weight gain. The best results regarding weight loss were obtained in studies that combined restrictive diet and optimal exercise (Bouchard, Despres, & Tremblay, 1993; Stefanick, 1993; Wood, Sefanick, Drion, et al., 1988; Wood, Stefanick , Williams, & Haskell, 1991). Also, people who combined exercise with diet lost weight more effectively.

The results of the cardiorespiratory fitness assessment parameters indicated that the group tested was homogeneous. It can be stated that all parameters correspond to the normal values of the cardiorespiratory indicators tested: Systolic ABP [mmHg] 119.80; Diastolic ABP [mmHg] 77.42; Pulse at rest [rpm] 72.96; Pulse at load [rpm] 158.42; VO2max [ml / kg / min] 36.66; VO2max [L] 2.24. Influenced by systematic exercise of adequate volume, frequency, and intensity, heart rate at rest and on exertion will be slower, the cardiac stroke volume will increase, and the recovery time from exertion will be shortened. Cross-correlations of body composition and cardiorespiratory fitness of physically active women showed that the percentage of body fat and body fat in kilograms was positively correlated with systolic arterial blood pressure. The percentage of body fat and body fat in kilograms are significantly positively correlated with diastolic arterial blood pressure. The percentage of body fat and body fat in kilograms correlates positively with the oxygen consumption expressed in liters. Excessive fat has a negative effect on the load on cardiac function and oxygen uptake by working muscles. Low cardio-respiratory function in youth with high body fat may be a factor for the development of cardiovascular chronic conditions or conditions in a patient later in life and old age as demonstrated by Sharma, Kamal & Chawla (2016). The results show that weight gain correlates with decreased cardiorespiratory fitness and musculoskeletal capacity. The correlation between the body composition and the cardiorespiratory fitness of physically active women was found by canonical correlation analysis. Based on the values of the coefficients, it can be concluded that body composition and cardiorespiratory fitness are associated with two pairs of statistically significant canonical factors. Some studies show that prolonged and intense exercise can cause central cardiovascular adaptation in women, which is evident in older men (McCole, Brown, Moore, Zmuda, Cwynar, & Hagberg, 1997). In both men and women, under the influence of exercise, VO2max is increased, except that the increase in women is a result of arteriovenous oxygen difference (Spina, Miller, Bogenhagen, Schechtman, & Ehsani, 1996).

The factor structure of the body composition of physically active women shows that on the first isolated canonical factor in the body composition area, the percentage of body fat (0.79) and body fat in kilograms (0.58) have the highest projections with the positive sign. On the second isolated canonical factor in the body composition area the percentage of body fat (-0.55) and body fat in kilograms (-0.80) have the highest projection with the negative sign, whereas muscle mass in the body structure has a positive projection. Research findings conducted by Tremblay, Despres, Leblanc, Craig, Ferris, Stephens & Bouchard (1990) have shown that only vigorous exercise can have the effect of reducing skin folds, that is, body fat.

The pulse rate at rest as well as at different loads is much lower in women engaged in recreational activities. Arabmokhtari et al. (2018) concluded that postgraduate students have an ideal body composition, and relatively poor cardiorespiratory fitness.

On the first isolated canonical factor in the area of cardiorespiratory fitness the pulse at load (-0.99) has the highest projection, with a negative sign, and the oxygen consumption expressed in milliliters (0.99) and oxygen consumption expressed in liters (0.88) have the positive projection. On the second isolated canonical factor in the area of cardiorespiratory fitness, systolic (-0.61) and diastolic arterial blood pressure (-0.40) have the highest projection, with a negative sign, while the pulse at rest has a positive projection (0.53). Shazia, Badaam & Deore (2015) reached the conclusion that overweight girls had significantly reduced cardiorespiratory ability compared to girls with normal weight. Bandyopadhyay and Chatterjee (2003) showed that different components of body composition and morphological characteristics were significantly correlated with cardiorespiratory fitness or maximum aerobic capacity (VO2max) in the examined population.

CONCLUSION

A great deal of research indicates the necessity for physical activity. Individuals who regularly have certain forms of physical activity should have qualitatively better values of fitness components compared to those who do not exercise. The most important thing is that the concept of exercise is harmonized and properly dosed so that the effects

are expected. Respondents who exercise regularly are proven to have better parameters of body composition and physical fitness in respect of its quality and quantity.

Based on the conducted research, measurement, data processing and analysis, it can be concluded that "there is a statistically significant correlation between physical composition and cardiorespiratory fitness of physically active women."

Respondents that have a better-quality body composition (less body fat, more muscle tissue ...) also have better parameters in physical fitness indicators (pulse at rest, pulse at load, systolic arterial blood pressure, diastolic arterial blood pressure, oxygen consumption of VO2mah).

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BACK PAIN SYNDROME

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ABSTRACT

Diseases of the lumbar spine manifest as back pain syndrome. Lumbar syndrome implies pain with impaired functioning of the lumbar spine. There are multiple causes of lumbar syndrome, but the underlying cause is the muscle imbalance of the lumbar and abdominal regions. Lumbar syndrome is one of the most common pain syndromes, currently affecting 75-80% of the population, who at some point of their lifetime experience lumbar spine pain.

The sample of respondents included both male and female population who either did or did not engage in sports, of different age categories, from different sports, who were of different training status and age categories. Studies were included if they indicated the presence of back pain syndrome.

The following methods were used in the paper: selection method, descriptive method, systematization method, analyses and syntheses, as well as comparative method.

The study leads to the conclusion that in order to prevent back pain syndrome, which most commonly manifests as lumbar pain syndrome, it is important to implement targeted measures to examine patterns, risk factors and prevent back pain syndrome.

Keywords: back pain syndrome, lumbar syndrome, sport, prevalences

INTRODUCTION

Posture (Lat. Positura – position) is a proper way of holding the body.

Spine (Lat. *columna vertebralis*) is an axial bone column of vertebrates composed of vertebrae. It is positioned in the midline of the upper neck and trunk, forming the basis of the entire skeleton. Due to this, the spine has a static, mechanical and protective role. The human spine consists of 33-34 vertebrae and is located in the midline of the back of the neck and trunk. The cervical spine includes 7 vertebrae, the thoracic spine has 12 and the lumbar spine 5 vertebrae. The first 24 vertebrae are interspaced and are also called the true vertebrae. The remaining 9-10 have grown together to form the sacrum and coccyx and are therefore called false vertebrae. The spine, as a whole, has four sides (anterior, posterior, and two lateral sides) and two ends (upper and lower). It also involves four characteristic curves (cervical, thoracic, lumbar and sacrococcygeal or pelvic curve). The static role of the human spine is reflected in the carrying and transfer of the weight of the upper body to the pelvis and lower limbs. Its mechanical or dynamic role lies in the mobility of its vertebrae, while the protective role of the spine relies on the existence of a spinal canal that protects the spinal cord and other contents. (Obradović, 2002).

The basic configuration of a vertebra depends on its location in the spinal column and its purpose. The largest part of a vertebra is its body, the central part of which is called centrum. The upper and lower surfaces of the vertebral body provide attachment to the intervertebral discs. A vertebral arch is formed in the posterior part of a vertebra, consisting of eleven parts; two pedicles, two laminae and seven processes. The laminae facilitate attachment to the ligaments of the spinal column. There are also pedicle-shaped notches on each vertebra, which form an intervertebral foramina when the vertebrae articulate. These foramina represent exit conducts for the spinal cord nerves. The vertebral body and its arch form a large central vertebral foramen, a sequence of which forms the spinal canal whose role is to enclose and protect the spinal cord from external mechanical influences. Each of the

vertebrae is an irregular bone, the size of which varies depending on the position in the spinal column, the load it bears in posture and the pathological condition (Hadžiselimović, 1986; Warrell, Cox & Firth, 2010; Noble, 1987; Dunphy & Winland-Brown, 2011).

Diseases of the lumbar spine manifest as lumbar syndrome. According to Nedvidek, (Radisavljević, 2001) lumbar syndrome involves pain accompanied by impaired functioning of the lumbar spine, which can often be followed by motor or neurological deficit of the affected spinal nerve. There can be multiple causes of lumbar syndrome, but the underlying one is the muscle imbalance of the lumbar and abdominal regions (Norris & Matthews, 2008). Lumbar syndrome represents one of the most frequent pain syndromes, currently affecting 75-80% of the population who at some point in their lifetime experience pain in the lumbar spine (Nedvidek, 1985; Kelić, 2009; Kaljić, 2011).

Vodanović and Grgurov list around 130 different causes of lumbar pain, including inflammation, neurological diseases, vascular and psychogenic disorders (Vodanović & Grgurev, 2007).

Some authors underline the following as the most frequent causes of chronic lumbar syndrome:

mechanical lumbar pain syndrome 70%; degenerative processes 10%; discus hernia 4%; osteoporosis – compression fractures 4%; spondylolisthesis 2%; traumatic fractures 1%; benign tumours, cancers, metastases 0,7%; ankylosing spondilitis 0,3%; infections 0,1%; non-spinal causes 2% (Wheeler & Murrey, 2005).

One of the major causes of lumbar postural syndrome is also sedentary lifestyle (Vodanović & Grgurev, 2007). Data indicate that in the urban environment the incidence of lumbar pain in people aged 50-59 is 58% in men and 45% in women, and that lumbar syndrome is a frequent cause of work disability in 25% of people under 45 (Novičić, 2000).

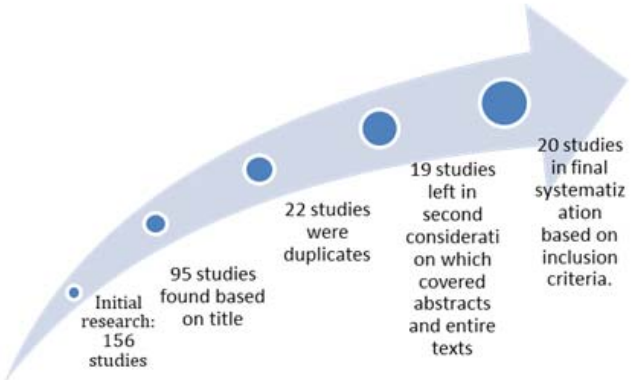
METHODS

The following methods were used in the paper: selection method, descriptive method, systematization method, analysis and synthesis method, and comparative method. Between 2000 and 2019, the following electronic databases were used to research the literature: Google Akademik, Google Scholar, MEDLINE, PubMed, EBSCO, while the key words that were used either independently or in combination included: low back pain, back pain, prevalence, sports activities, sports, team, the pain, as well as the names of different sports. All titles and abstracts were reviewed for potential inclusion in the study. Relevant studies were obtained after a thorough review if they met the inclusion criteria. The criteria for systematization included in the analysis are: epidemiological, longitudinal and transversal, controlled randomized and nonrandomized studies of back pain syndrome in English, Serbian and Croatian.

Subjects

The sample of respondents included a population of male and female practitioners who either did or did not engage in sports, of different age categories, from different sports, who were of different training status and age categories. Studies were included if they indicated the presence of back pain syndrome. The study exclusion criteria were: if they did not consider the presence of back pain syndrome, if they were not in English, Serbian or Croatian.

Graph 1. Presentation of research for studies referring to given subject



RESULTS

Table 1. Presentation of studies

	Participants				Experimental programme	
Name of first author, year	No. of respondents	Age	Sex	Study participants	Examined variables	Results
1. Golik-Perić (2006)	136	18-35	M	Football players	Back pain	Multivariate method of variance identified differences and found that there was a statistically significant difference in terms of subjective feeling of back pain. This provided insight into factors that affect pain in certain regions, dysfunction and weakness in certain muscle groups, and the impact of certain muscle groups on others, as well as disorder in the kinetic chain of the locomotor apparatus of football players.
2. Fett (2017)	4253	20,9 ± 4,8 21,2 ± 2,0	M + F	Elite and non-elite athletes	Height, weight, prevalence of pain 12 months and 3 months	In elite athletes, the prevalence of back pain during lifetime was 88.5%, the prevalence of 12 months was 81.1%, the prevalence of 3 months was 68.3%, and the prevalence of points was 49.0%, compared with 80.7%, 69.9%, 59.0%, and 42.8% respectively in the control group. The 12-month and 3-month prevalence in elite athletes was significantly higher than in the control group. In terms of individual sports, the prevalence of back pain was significantly higher among elite rowers, dancers, fencers, gymnasts, track and field athletes, skaters and shooters, as well as athletes playing water polo, basketball, ice hockey and hockey, compared to the control group. The prevalence of low back pain was significantly lower in elite triathlon athletes. Back pain is a common issue among German athletes. Low back pain seems to be a problem encountered by elite athletes and physically active non-athletes. High training rates for elite athletes and low training levels for physically active individuals can increase the prevalence rate. Specific prevention programs should be in place, especially in high-risk sports. Further studies should investigate the optimal dose-effect relationship of sporting activity for the general population to prevent back pain.
3. Reis (2015)	72	26.7	M	Jujutsu athletes Professional and recreational practitioners	Presence of chronic low back pain and the Quebec Back Pain Disability Scale	Chronic low back pain is present in 80.6% of athletes. Pain was present in 88.9% of professionals and 72.2% of recreational practitioners. In the professional jiu-jitsu group, the mean value of the scale (Quebec Back Pain Disability Scale) was 10 (IQR = 16), while in the recreational group the value was 6.0 (IQR = 12) (p = .001). There was a high prevalence of lower back pain in jujutsu, and professional athletes seem to be at a higher risk of developing chronic low back pain.
4. Jelaska (2014)	80	26	M + F	Tennis players	Pain assessment by means of SEFIP questionnaire. Assessment of pain on a 0-4 Likert-type scale.	In male tennis players, 92.1% of subjects experienced an average pain intensity of 1.60 in one or more body regions. 91.7% of female tennis players reported an average pain intensity of 1.59. The highest incidence of pain was reported in the lower back. Female tennis players were found to have significantly higher pain intensities in the upper and lower back, as opposed to male tennis players. Gathering information on the incidence of pain should be only the first step toward the main goal – prevention, i.e. reducing the number and severity of tennis injuries.
5 Kaljić (2011)	913	25 – 65	M + F	General population	Lumbar pain syndrome and incorrect working posture, different professions	The highest incidence of lumbar pain syndrome is among workmen (268 or 29.35%), followed by clerks (239 or 26.17%), as their work equipment and work activities directly cause the body to be in an incorrect posture. The study found that all patients had inadequate equipment and working posture. Based on the research conducted through the aforementioned variables, it is possible to determine not only the correlation, but also the great influence that inappropriate equipment and incorrect working posture can have on the occurrence of lumbar pain syndrome of discogenic etiology.

6. Noormohammadpou (2016)	1059	23.1 ±3.8	F	Athletes	Various sports, lumbar pain syndrome 12-month period	The prevalence of lumbar pain syndrome within 12 months amounted to 39.0%; in addition, the chronic and acute prevalence of lumbar pain syndrome was 59.7 and 17.8%, respectively. Basketball players (47.9%) and karate practitioners (44.0%) reported the highest prevalence of lumbar pain syndrome in 12 months. Lumbar pain syndrome prevalences in shooters (29.7%) and badminton players (42.4%) were significant as well. The results show that lumbar pain syndrome led to a relatively high rate of absence from training (27.9%) and matches (13.0%). While most of the existing literature regarding lumbar pain syndrome focused on sports with specific requirements to lower back (such as skiing and rowing), many other sports have not been thoroughly studied in this respect. Examining the prevalence of lumbar pain syndrome and related factors in other types of sports, such as martial arts, badminton and shooting can provide better understanding of the incidence of low back pain and provide us with the necessary insight to take effective steps toward its prevention in athletes.
7. Sato (2011)	43.630	7-12	M + F	Athletes Non-athletes	Gender difference, height and weight, body mass index, sports time, lifestyle differences, family history and mental factors, severity of lumbar pain syndrome	The valid response rate amounted to 61.3%. Among 26,766 participants with valid answers, 2,591 suffered from lumbar pain syndrome at the time of the survey and 8,588 had a history of lumbar pain syndrome. In the non-athlete group, 21.3% experienced lumbar pain syndrome, while in the sports group, 34.9% experienced lumbar pain syndrome ($p < 0.001$). The severity of lumbar pain syndrome was significantly higher in the sports group (20.1 vs. 3.2%, $p < 0.001$). The average time spent doing sporting activities was 9.8 hours per week, and the history of lumbar pain syndrome was significantly higher in the group that engaged in sporting activities for a longer time (odds ratio of 1.43 in group 3). The study indicates that sporting activity represents a potential risk factor for lumbar pain syndrome, and that it can increase the risk of lumbar pain syndrome among children and adolescents.
8. Guddal (2017)	7.596	13-19	M + F	Adolescents	Level of physical activity, participation or non-participation in sports	A moderate level of physical activity was associated with decreased likelihood to develop low back pain (OR = 0.75 [95% CI, 0.62-0.91]). Participation in endurance sports was associated with lower chance of developing low back pain (OR = 0.77 [95% CI, 0.65-0.92]), especially among girls. Participation in technical sports was associated with increased prospects of low back pain. Strength and extreme sports have been associated with pain in all regions The study found that a moderate level of physical activity was associated with less pain in the neck and shoulder and low back pain, as well as that engaging in endurance sports can be particularly beneficial. The findings indicate that healthcare professionals should consider the types of sporting activities adolescents participate in during the evaluation of musculoskeletal pain.
9. Kraft (2009)	88	34	M + F	Horseback riders and non-athletes	Evaluation of lumbar disc degeneration, region of intersection of paraspinal muscles, spondylolysis and spondylolisthesis, by means of MRI. Prevalence of disc degeneration between these 2 groups was compared, and relation between low back pain (lumbar pain syndrome), riding discipline, body mass index (BMI), trunk / leg length coefficient, and MRI results was examined.	88% of elite riders (n = 51) had a history of lumbar pain syndrome, as opposed to 33% of non-athletes ($p < .05$). There was no statistical difference in the prevalence of lumbar pain syndrome among different horseback riding disciplines. However, there was a high rate of pathological intensity of the T2 signal of the lumbar intervertebral disc among riders – particularly dressage riders - but there was no significant increase compared to non-athletes. A prior history of lumbar pain syndrome symptoms, riding discipline, BMI, and trunk / leg length ratio were found to have no significant effect on the development of lumbar disc degeneration. Two controls had spondylolisthesis Meyerding grade 1 that was not associated with back pain. Even though riders have a high prevalence of lumbar pain syndrome, the MRI showed no evidence that the cause lies in excessive disc degeneration, spondylolysis, spondylolisthesis, or pathological changes in the paraspinal muscles of the lumbar spine.

10. Perry (2009)	1608	14	M + F	Adolescents	Evaluating relation between back pain in adolescents and fitness, motor competence and body composition.	After multivariate logistic regression analysis, an increased likelihood of back pain in boys was associated with greater aerobic capacity, greater waist circumference, and decreased and higher flexibility. Back pain in girls was associated with greater abdominal endurance, decreased kinaesthetic integration, and decreased and higher reverse endurance. Lower likelihood of back pain was associated with greater bimanual dexterity in boys and higher lower extremity strength in girls. Physical characteristics are usually said to be important risk factors for the development of back pain. Although some factors were associated with adolescent back pain, and they differed between boys and girls, they made only a slight contribution to logistic regression models for back pain. The results suggest that future research should look into the interaction of multiple domains of risk factors (physical, lifestyle, and psychosocial) and subgroups in adolescent back pain, for which different risk factors may be of importance.
11. Pasanen (2016)	400	15,8 ± 1,9	M + F	Young basketball and floorball players	Age, sex, sport and family history of musculoskeletal disorders were estimated to be risk factors for lumbar pain syndrome. Adjustments were made at team level in order to avoid random team-related effects.	44% of basketball players and 62% of floorball players suffered from lumbar pain syndrome in the past 12 months. The prevalence of lumbar pain syndrome in the previous year was significantly higher among floorball players (p = 0,001). In both sports, the prevalence of pain symptoms peaked during the competitive season. Family history of musculoskeletal disorders [OR (odds ratio), 2.02, 95% confidence interval (CI), 1.22-3.34] and older age (OR, 1.22, 95% CI, 1.05-1.41) are associated with lumbar pain syndrome in players. The study confirmed that lumbar pain syndrome is a relatively frequent occurrence and complaint in young team sports players. Target measures need to be in place to examine the causes, risk factors and prevention of lumbar pain syndrome in youth sport.
12. Peacock (2005)	500	28-55	M	Alpine ski instructors	Lifespan and point prevalence were determined by respondents' report concerning their history of low back pain and current back pain.	204 respondents (75% of 272 subjects) reported a history of low back pain. 85 of respondents (31%) reported to currently suffer from back pain. Over 9% of respondents took 10 or more days off work due to back pain. The prevalence of back pain during lifetime was similar to that of the general population. Respondents stated that back pain was greater than in other sports. The high prevalence of back pain in alpine ski instructors can increase costs and reduce income for the employer. Preventive training for this population can reduce the incidence of back pain and reduce the cost for employers and alpine ski instructors.
13. Ong (2003)	31	22-33	M	Olympic athletes	(a)loss of disc signal intensity; (b)loss of disc height; (c) presence of discus hernia.	Disc signal intensity gradually decreased as the disk space increased. It was most commonly noticed at the L5 / S1 level, and in the abnormal group, 36% (n = 11) showed the most degenerative changes. Disc height reduction was also found to be most common at the L5 / S1 level. However, decrease in height was usually only slight. A similar trend of increased prevalence of disc herniation was observed at multiple caudal levels. At the L5 / S1 level, 58% were found to have a disc displacement element, most of which were disc bulges. Disc degeneration defined by the aforementioned criteria has been shown to be significantly more severe in these Olympic athletes. The results suggest that elite athletes have a higher prevalence and greater degree of lumbar disc degeneration than general population.
14. Schulz (2016)	3564	22-35	M + F	Elite German athletes	Frequency, localization, treatment and factors that affect back pain, age, BMI	There were 929 respondents. 514 athletes (55.3%) suffered from back pain in the past 12 months, mostly in lumbar spine (n = 293, 56.1%). The average pain intensity was 5.75 / 10. Exercise affecting relapse and additional workloads (e.g. at workplace) did not increase the intensity of back pain. When athletes were divided into two groups according to the back pain intensity, back pain did not correlate with pain, age or BMI. At least one in ten athletes temporarily suffers from low blood pressure at a level where spine surgery might be the only option for pain relief. Back pain occurs regardless of training that affects relapse and additional stress. Further evaluation is needed to identify factors for avoiding severe back pain in elite athletes.

15. Smoljanović (2008)	3152	18-38	M + F	Elite junior and senior world rowers from 6 continents and 70 countries	Level of risk from injury in relation with number of training sessions	The results of the research confirmed that rowing is a sport with a very low risk of injury in terms of the number of training sessions. Rowers have suffered from 1.75 to 2.25 injuries per rower per 1000 training sessions. Despite the low risk of injury, due to a large number of training sessions, more than 50.0% of elite junior and senior rowers suffer injuries during the rowing season. The most common injuries among top rowers competing in the World Rowing Championships are minor to moderate chronic injuries. The most common localization of all types of injuries in rowing is the lumbar spine and it causes the most absences from training and competition. There was a significant relation between the average number of training sessions per week and a higher incidence of lumbar spine injury in junior and senior rowers. There was a significant relation between the incidence of chronic injuries and the average number of rowing sessions per week for junior and senior rowers. For senior and veteran rowers, the length of rowing training sessions had no effect on the incidence of their acute injuries, while for veteran rowers a small average number of training sessions per week was not associated with the occurrence of their chronic injuries.
16. Koyama (2013)	104	19.7 ±1.0	M + F	Gymnasts	Types of radiological abnormalities and their association with lumbar syndrome	The prevalence of over 1 MRI abnormalities in gymnasts was 47.1% (49/104). The chi-square test showed that the incidence of lumbar disc degeneration and limbus vertebra was significantly higher among gymnasts with lumbar pain syndrome than in gymnasts who did not suffer from it. Using logistic regression analysis to analyse the associated environmental variables, only the lumbar disc and limbus vertebra (OR, 2.70; CI 95%, 1.10–6.66) were selected as a statistically significant variable covering lumbar pain syndrome. The presence of lumbar pain syndrome was assessed using the Osaka City University Test (OCU Test). The incidence of lumbar disc and lumbar vertebra degeneration is a predictor for lumbar pain syndrome in Japanese gymnasts.
17. Okada (2007)	82	20.1 ± 0.9	M	Judoists	Weight classes: Lightweight (n= 29), Middleweight (n = 31) Heavyweight (n = 22).	The prevalence of lumbar pain syndrome in LRA (lumbar radiological abnormalities) categories among lightweight, middleweight and heavyweight classes amounted to 34.5%, 32.3% and 40.9%, respectively. For LRA, the prevalence for the three weight classes was 65.5%, 90.3%, and 90.9%, respectively (middleweight and heavyweight classes showed higher prevalence than lightweight class $p < 0.05$). The prevalence in athletes suffering from lumbar pain syndrome was 50.0%, 100% and 88.9%, respectively for each class (middleweight shows higher prevalence than lightweight class $p<0.05$). The LRA prevalence in athletes not suffering from lumbar pain syndrome in each category was 73.7%, 85.7% and 92.3%, respectively. The prevalence of LRA was almost 90% in middle and heavyweight classes, which is more than in the lightweight class. There was a high coprevalence between lumbar pain syndrome and LRA. However, many judoists not suffering from lumbar pain syndrome had LRA. The presence of LRA may not be directly associated with lumbar pain syndrome.
18. Tsirikos (2001)	32	26-45	M	Jockeys	Clinical and radiographic spine assessment; three consecutive age groups over a period of 13 years were studied	There was a higher incidence of degenerative changes in the spine in jockeys compared to the control group, and it was higher in the older age group for both the lumbar and cervical spine. The results indicate that, apart from a higher risk of direct spinal injury, equestrian sports, especially professional horseback riding, can lead to progressive degeneration of the spine as a result of repeated trauma and increased physical exertion of the spine.
19. Pieper (1998)	64	20-31	M	Handball players	Disproportion between muscles that mostly function as stabilizers (postural muscles)	37% of male athletes reported chronic back issues. Typical distribution of muscle shortening especially of the hamstrings and the iliopsoas and muscle weakness of abdominal and gluteal muscles, erector spinae lumbalis can negatively affect the statics of the pelvic region. The resulting hyperlordosis is augmented by certain training techniques, which can lead to segmental instability of the lumbar spine, thus contributing to chronic back pain.

20. Quinn (1996)	108	18-50	M + F	Horseback riding	Type of saddle Riding habits Horseback riding experience	48% of riders reported to suffer from low back pain, and the incidence is higher in classic saddle (66%) than in Western saddle (23%) users (p <0.001). ***Women had a higher incidence of low back pain than men, 58% to 27%, respectively (p <0.005). When genders were analysed separately to determine the influence of saddle type, men using classic and Western saddle had a 33% and 6% incidence of low back pain, respectively, while women using classic and Western saddle had a 72% and 33% incidence, respectively. The highest incidence of low back pain occurred in users who engaged in riding for more than 15 years (p <0.07).*** The difference in the incidence of low back pain between users of the two types of saddle may be due to the additional comfort, cushioning, postural positioning and stability provided by the design of the deep-seated saddle. The results indicate that, even though deep-seated saddle is not suitable for all equestrian activities, it should be used whenever possible, bearing in mind its potential to reduce the risk of low back pain.

DISCUSSION

Systematized studies were divided into three groups based on the following criteria: back pain in athletes and non-athletes up to 18 years of age, back pain in the population aged over 18, and back pain in the working population.

The following conclusions were made based on the included systematization of the research, whose aim was to examine the presence of back pain syndrome in athletes of different sports and different age categories, non-athletes and working population.

Four studies analysed that back pain syndrome is present in athletes and non-athletes, although the prevalence is higher among elite athletes than mid-level athletes, and the prevalence of back pain is higher during the competitive season. (Sato, Ito, Hirano, Morita, Kikuchi, Endo, & Tanabe, 2011; Pasanen, Rossi, Parkkari, Kannus, Heinonen, Tokola, & Myklebust, 2016; Reis, Dias, Newlands, Meziat-Filho, & Macedo, 2015; Schulz, Lenz, & Büttner-Janz, 2016). They also stated that early selection of young athletes as well as an inappropriate intensity of training carries an increased risk of back pain syndrome, which leads to a conclusion that targeted measures need to be taken to examine patterns, risk factors and prevention of back pain syndrome.

Most authors found that back pain is located in the lumbar spine with the onset of lumbar pain syndrome. (Sato et al., 2011; Pasanen et al., 2016; Noormohammadpour, Rostami, Mansournia, Farahbakhsh, Shahi, & Kordi, 2016; Kraft, Pennekamp, Becker, Young, Diedrich, Lüring, & von Falkenhausen, 2009; Schulz, Lenz, & Büttner-Janz, 2016; Smoljanovic, 2008; Koyama, Nakazato, Min, Gushiken, Hatakeda, Seo, & Hiranuma, 2013; Okada, Nakazato, Iwai, Tanabe, Irie, & Nakajima, 2007; Kalic, 2011).

While some authors have found that the absence of moderate physical activity carries the same risk of back pain syndrome as being an elite athlete in a sport where technique is predominant (Sato et al., 2011; Fett, Trompeter, & Platen, 2017; Reis et al., 2015; Kraft et al., 2009; Ong, Anderson, & Roche, 2003; Schulz, Lenz, & Büttner-Janz, 2016; Smoljanovic, 2008), other group of authors have concluded that physical aerobic activities of moderate volume and intensity are the least likely to lead to back pain syndrome (Guddal, Stensland, Småstuen, Johnsen, Zwart, & Storheim, 2017). They also pointed to the association of physical characteristics in adolescents with the risk of developing back pain.

In the analyzed studies authors believe that inadequate equipment, inadequate conditions, highly repetitive movements and incorrect posture increase the risk of suffering from back pain syndrome (Kalic, 2011; Quinn, & Bird, 1996).

CONCLUSION

From the conducted overview study we can conclude that the risk of developing back pain syndrome is higher in athletes than in non-athletes, increased in the regime of high volume and intensity of physical activity, decreased in the regime of aerobic and moderate physical activity, increased by the early selection of young athletes, increased when performing activities at a highly technical level, due to inadequate equipment, conditions, incorrect body posture and level of repetitiveness of actions, as well as that adolescents' physical characteristics are associated back pain syndrome. Therefore, it can be concluded that in order to prevent back pain syndrome, which most commonly manifests as lumbar pain syndrome, it is important to implement targeted measures for the examination of patterns, risk factors and prevention of back pain syndrome.

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UPPER LIMB COORDINATION: IS THERE ANY DIFFERENCE BETWEEN GENDERS IN MILD INTELLECTULLY DISABLED YOUTH

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ABSTRACT

The aim of this study was to examine the Upper limb coordination status of the young people with mild intellectual disabilities (ID), and to determine if there are any differences between genders. Subjects who participated in this study were 27 adolescents (15 males and 12 females) age 15 to 19 years (17.12±1.24 years) with mild ID attending special school "October 14th " in Nis. Upper limb coordination was tested by seven items of subtest Upper limb coordination up to Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2). Results showed low level of examined motor ability, according to descriptive criteria. There were no statistically significant differences between genders (t (25) = .720, p=.478) in a status of Upper limb coordination. Obtained results indicate the need to improve the Upper limb coordination in this population, as fine motor skill necessary for every day's life and work.

Keywords: mild intellectually disabled, upper limb coordination, BOT-2.

INTRODUCTION

Intellectual disability is characterized by impaired intellectual and adaptive functioning and is defined on the basis of three criteria: sub-average intellectual functioning, significant limitations in adaptive life skills, and manifestation of these two deficits before the age of 18. Approximately 3% of the population meets these criteria (American Association of Intellectual and Developmental Disabilities, AAIDD, 2007). Intellectual disability is known as a general learning disability, while mental retardation is considered as a generalized neurodevelopmental disorder characterized by significant limitations in both intellectual and adaptive functioning, an IQ<70, and deficits in 2 or more adaptive behaviors covering many everyday social and practical skills (American Association on Intellectual and Developmental Disabilities, 2018)

The Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) is a standardized, norm-referenced measure. This test recently was revised and published as the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) (Bruininks & Bruininks, 2005a,b). The BOT-2 is an individually administered measure of fine and gross motor skills of children and youth, 4 through 21 years of age. It can identify motor performance deficits in individuals with developmental coordination disorders (DCD), mild to moderate intellectual disabilities (ID), or high-functioning autism/Asperger's Disorder. It provides a comprehensive assessment of motor skills, making it a useful instrument to a variety of practitioners, specialists, and researches in a variety of settings. While each composite assesses a broad area, each subtest measures an important and specific aspect of functional motor skills and consists of activities that differ in task requirements but involve the same limbs and muscle groups (Bruininks & Bruininks, 2005a).

Coordination is a complex motor ability, which is characterized by compliance of time, space and energy parameters of movement and motion. Coordination consists of: dexterity, agility, balance and precision, abilities that largely depend on the central nervous system. A sensitive period for the development of these motor abilities is in the period from 7 to 12 years in children with typical development (Stojiljkovic, 2003).

Manual coordination composite encompasses control and coordination of the arms and hands, especially for object manipulation. It comprises of Manual dexterity and Upper limb coordination

subtests. Upper limb subtest consists of activities designed to measure visual tracking with coordinated arm and hand movement. Tasks include catching, dribbling, and throwing a tennis ball. The subtests and corresponding composites that assess Manual coordination, Body coordination and Strength and agility skills are especially informative for development adaptive physical education teachers and physical therapists. Although the Upper limb coordination subtest belongs to Fine motor composite, it can be used to screen individuals for adaptive physical education program (Bruininks & Bruininks, 2005a).

Starting with the seminal study by Francis and Rarick (1959) which measured physical fitness and motor proficiency variables, and continuing to the present day, contemporary research continues with further analyses of the population with disabilities by means of cross-cultural comparisons using standardized motor assessments (Rintala & Loovis, 2013). However, such research is still insufficient today.

Maiano, Hue & April (2019) in their systematic review researches about fundamental motor skills in children and adolescents with intellectual disabilities (ID) indicates an insufficient number of them. Only 17 studies met the criterion. Only six of them deal with the fundamental motor skills of adolescents with ID (Zhang, 2005; Frey & Chow, 2006; Elbasan, Atasavun, & Düger, 2011; Jeoung, 2013; Lee & Jeoung, 2016; Jeong, Choi, Yoo & Jeoung, 2017) three of them research adolescents with mild ID (Zhang, 2005; Frey & Chow, 2006; Elbasan et al., 2011). BOT-2 test battery was used in only two studies (Zhang, 2005; Lee & Jeoung, 2016).

Nevertheless, there is a number of studies addressing the motor abilities status of adolescents with mild ID (Van de Vliet, Rintala, Fröjd, Verellen, Van Houtte, et al., 2006; Einarsson, Arngrimsson, Vanlandewijck, & Daly 2011; Blomqvist, Olsson, Wallin, Wester, & Rehn, 2012; Stankovic, Aleksandrovic, & Aleksic-Veljkovic, 2013; Jeong, 2018; Stojanovic, 2018a), or the impact of specific intervention programs on the motor skills of this population (Jankovic-Szymanska, Mikolajczyk, & Wojtanowski, 2012; Wuang, Ho, & Su, 2013; Top, 2015; Stojanovic ,2018b).

Individuals with mild intellectual disability can generally acquire reading, writing, and mathematics skills to the level of grade 3 to 6, often enabling them to hold jobs and live in dependently (Jeong, 2018). Special place in everyday life and most professions has manual dexterity and upper limb coordination. The aim of the present study is to assess the status of Upper limb coordination (as one part of Manual coordination composite) in high school students with mild ID, and to determine if there are any differences between genders.

METHODS

The tasks done for Upper limb coordination subtest (BOT-2) were: 1)Dropping and catching a ball-both hands, 2)Catching a tossed ball-both hands, 3)Dropping and catching a ball-one hand, 4) Catching a tossed ball-one hand, 5)Dribbling a ball-one hand, 6)Dribbling a ball-alternating hand and 7)Throwing a ball at a target. Measuring was conducted in accordance with the standards of the 2008 Helsinki Declaration on the Ethical Principles for Medical Research Involving Human Subjects (WMA, 2011) in sports hall of special school "October 14th" in Nis.

Subjects

The participants comprised a total of 27 high school students- 15 male and 12 female (mean age 17.12±1.24 years, height 169.11±12.04 cm, weight 66.34±15.18 kg, BMI 23.26±4.91 kg/m^2) that attend special school "October 14th" in the city of Nis. All participants, as well as their parents or guardians, gave written consent before measuring. In order to balance sample by the level of intellectual disability, the school psychologist recommended a list of students. Measured subjects have a mild intellectual disability (IQ between 50 and 75). Total mean scores for the students' ages, mass, high and body mass index are described in Tables 1. and 2. for the female and male subjects respectively.

Table 1. Descriptive statistic for female students' general data

	N	Min	Max	Mean	SD
Age (years)	12	15.35	18.39	16.84	1.01
Mass (kg)	12	39.10	78.60	61.16	14.05
High (cm)	12	149.00	173.50	159.67	7.55
BMI (kg/m^2)	12	17.50	34.00	24.08	5.79

Table 2. Descriptive statistic for male students' general data

	N	Min	Max	Mean	SD
Age (years)	15	15.12	19.66	17.33	1.39
Mass (kg)	15	35.30	98.60	70.49	15.22
High (cm)	15	154.00	198.00	176.67	9.32
BMI (kg/m²)	15	16.90	30.40	22.59	4.16

Procedure

Upper limb coordination was determined by seven tasks of Bruininks-Osertsky Test of Motor Proficiency, Second Edition (BOT-2) subtest Upper limb coordination. This subtest consists of activities designed to measure visual tracking with coordinated arm and hand movement . The subtest total point score is obtained by adding the point scores of the individual item that make up subtest. Total point scores were converted in to scale scores, which are gender and age specific norms. BOT-2 gives the opportunity to convert the scale scores into descriptive criteria, and the total point scores to the age equivalent.

Statistical analysis

Obtained data were analyzed using statistical package SPSS 20.0. Arithmetic means (Mean) and standard deviation (SD) were calculated for all variables obtained in this study. Due to the small sample size, the Shapiro-Wilk Test (with the significance level set at p>.05) was used to assess the data normality in distribution. To determine differences between groups t-test for independent samples was used (Pallant, 2005). The significant level up to .05 (p<.05) is accepted as statistical significance for result differences between two groups.

RESULTS

The results of the descriptive statistical analysis for the subtest Upper limb coordination scale (standardized) and total point scores are presented in Table 3. There are results for the normal distribution of scale scores (Shapiro-Wilk test) for female and male subjects separately, too.

Table 3. Descriptive statistics for the subtest of Upper limb coordination scale and total point scores (BOT-2)

Variable	Gender	N	Min	Max	Mean	SD	Shapiro-Wilk (p)
ULCS	**Girls**	12	6.00	12.00	7.75	2.05	.013
	Boys	15	4.00	9.00	7.27	1.44	.092
	The whole sample	27	4.00	12.00	7.48	1.72	
ULCT	**Girls**	12	26.00	36.00	30.58	3.68	
	Boys	15	16.00	35.00	30.20	5.29	
	The whole sample	27	16.00	36.00	30.37	4.58	

Legend: ULCS-upper limb coordination scale (standardized) point score; p>.05; ULCT- upper limb coordination total point score

Table 4. The differences in the results for Upper limb coordination subtest between male and female subjects (independent t-test)

Variable	t	df	p
ULCS	.720	25	.478

The results for Shapiro-Wilk test indicated that the variable ULC (upper limb coordination) has normal distribution for the boys (p>.05), but not for girls (p<.05).

Table 4. presents the results of the t-test for independent samples. The results indicate that are no statistically significant differences between genders in variable ULC, at the significant level p<.05 (Mean=7.27, SD=1.44 in male subjects; Mean=7.75, SD=2.05 in female subjects; t (25) = .720, p=.478).

DISCUSSION

The purpose of this study was to determine the status of Upper limb coordination and find is there any difference between boys and girls with mild intellectual disabilities. The results showed that there are no statistically significant differences between genders in assessed motor ability. According to Bruininks & Bruininks (2005a) study subtest Upper limb coordination has an average

scale score value 7.80 for mean and 3.80 for standard deviation in the intellectually disabled sample age 5 to 21 years. This is result similar to obtained in the present study (Mean=7.48, SD=1.72).

Considering this fact, the results were compared with the standardized values for the age and gender adequate ones. The obtained results show that the Upper limb coordination status of many subjects is below average according to descriptive criteria. Very few girls have an average score, while very few boys have well-below score. According to the criteria of calendar age equivalent, the results are also worrying- they fit to values for children aged six to ten years.

Previous researches on this subject sample indicated that there were no statistically significant differences between the genders in either Balance (Stankovic, Aleksandrovic, & Aleksic-Veljkovic, 2013) or Bilateral coordination (Stojanovic, 2018a). The status of all motor skills tested so far has also been shown to be low or extremely low.

Jeong (2018) examined the motor skills of young people with intellectual disabilities. BOT-2 was used in this study, too, while the subjects were boys with mild and borderline intellectual disabilities (aged 17.90±2.10 for mild ID and 17.00±2.60 for borderline ID vs. 17.33±1.39 in present study). Looking at the total point scores for the Upper limb coordination subtest, similar results were obtained (27.00±10.40 for mild ID boys and 29.30±10.00 for borderline ID boys vs. 30.20±5.25 for mild ID boys in present study).

Within BOT-2, the Upper limb coordination motor ability is evaluated as one of the subtests that, together with Manual dexterity, make a composite Manual coordination. Wuan., Ho, & Su (2013) studied the occupational therapy home program effects on motor abilities of children with intellectual disabilities. They found that 20-week occupational therapy home program has statistically significant influence on improving the Manual coordination composite (p=.020).

Observing an experimental exercise program effects on the motor abilities of young people with mild intellectual disabilities, Stojanovic (2018b) found that there was a statistically significant difference in one of the two Upper limb coordination subtest variable selected for the BOT-2 short form that was used (Dribbling a ball-alternating hand, p=.048).

Top (2015) researched ten-week swimming program effects on motor proficiency of mild intellectually disabled adolescents using BOT-2 battery. Although no statistically significant difference in Upper limb coordination was shown after the exercise program, a limit value was obtained (p=.051).

Therefore, there are studies that show that the Upper limb coordination, as well as other motor skills, can be affected. Finally, these individuals are less proficient than their normally developing peers at initiating and executing movements, exhibit poor performance on tasks requiring upper-limb speed and accuracy, have longer reaction times, and exhibit greater variability in response speed when choices are provided or when the demand for accuracy is high (Bruininks & Bruininks, 2005a).

CONCLUSION

Based on the obtained results, it can be concluded that the status of Upper limb coordination in mild intellectually disabled adolescents is low. Any research about the motor skills of children and adolescents with mild intellectual disabilities contributes to new knowledge about this population, which can be empowered to function independently with adequate insight and intervention. Knowing and improving the status of Upper limb coordination is of utmost importance, since in special schools in Serbia young people with mild ID are educated for professions such as: hairdresser, locksmith, weaver, and welder.

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Sport Medicine and Physiology

SECULAR TREND OF NUTRITIONAL STATUS OF PREPUBESCENT SCHOOL CHILDREN: A PILOT STUDY

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ABSTRACT

Secular trend of nutritional status is one of the important public health markers which could provide an insight into the complex interaction between growth and the environment. The aim of the present pilot study was to identify the differences in the nutritional status of prepubescent school children over a period of ten years.A total of 100 boys, aged 9–10 years, took part in the pilot study. Measurements were performed during September 2008 and again during September 2018. The percentile and z-score for weight, height and body mass index for the chronological age were used to estimate the nutritional status, and the results were also compared with current standards for growth and nutrition of the World Health Organization. The results show that there is no statistically significant difference in the nutritional status of prepubescent school children over a ten years' period. The average values of the nutrition parameters in both measurements are within the range below +1 SD and below the 85th percentile, which indicates normal nutritional status. A comparison of the results shows the absence of statistically significant differences between the two measurements. Although the results of the pilot study differ from the previous studies performed in Serbia and indicate, moreover, that no secular changes can be observed, we believe that continuous monitoring of the nutritional status using standardized methodology is nevertheless necessary. One of the aims of continuous monitoring of the nutritional status is the identification of metabolically healthy obese children. The significance is reflected in the fact that in these individuals treatment results were different, including a markedly better therapeutic impact of physical exercise compared to other obese individuals.

Key words: secular trend, nutritional status, prepubescent children, obese children.

INTRODUCTION

A secular trend or secular change in anthropology denotes the process leading to gradual change of average physical measurements of the human body from generation to generation. Secular trend in growth is a marker of public health, providing an insight into the interaction between growth and the environment (Fudvoye & Parent, 2017). Overweight in childhood is a significant prognostic factor for overweight in adulthood (Freedman, Mei, Srinivasan et al., 2007). Furthermore, overweight in the preschool and school-age population is associated with a significantly higher risk of overweight as early as adolescence (Nader, O'Brien, Houts et al. 2006). Overweight, pre-obesity and obesity, with a wide range of metabolic complications, especially type 2 diabetes mellitus (t2dm) and other components of the metabolic syndrome in the population of children and adolescents is a significant public health problem. People in the third decade of life are ten times more likely to be overweight and obese if they were overweight as adolescents. The process of atherosclerosis in the obese youth has been shown to start in adolescence, and the incidence of risk factors for childhood cardiovascular disease influences the incidence of cardiovascular disease in adulthood (Baker, Olsen & Sorensen, 2007). Due to the pandemic of obesity in the youth population, today's children may be the first generation to live shorter than their parents (Olshansky, Passaro, Hershow et al., 2005).

The observed trend of rising prevalence of obesity leads to an increase in the risk of associated endocrinological, metabolic, cardiovascular,

respiratory and other health disorders in the population of children and adolescents. The association between abdominal obesity, glucose tolerance disorders, dyslipidemia and hypertension as known risk factors for cardiovascular disease and t2dm is referred to as metabolic syndrome (Alberti, Zimmet & Shaw, 2005). The results of previous studies indicate that the process of atherosclerosis in young people, especially the obese ones, begins as early as childhood and is directly related to the degree of obesity and the presence of metabolic syndrome. Early recognition and treatment of children with metabolic syndrome and preventative measures are crucial in the reduction of risk for early cardiovascular and other obesity complications (Nader, O'Brien, Houts et al., 2006). When obese children or adolescents experience a decrease in insulin sensitivity, obesity and insulin resistance together contribute to the onset of metabolic syndrome. However, not all obese children have metabolic syndrome or other metabolic complications of obesity. They are referred to as "metabolically healthy obese", since they have preserved insulin sensitivity, normal blood pressure and glucose homeostasis, and have no dyslipidemia, liver steatosis, inflammatory and immunological disorders (Karelis, 2008). As a part of the favorable metabolic profile, they have preserved insulin sensitivity, have no dyslipidemia, have normal glucose homeostasis, normal blood pressure and a lower percentage of visceral adipose tissue (Bluher, 2010).

The aim of the present pilot study was to identify the differences in the nutritional status of prepubescent school children over a ten years' period.

METHODS

Subjects

A total of 100 boys, aged 9–10 years, were enrolled in the pilot study. Measurements were conducted during September 2008 on a sample of 50 boys, and again during September 2018, also on a sample of 50 boys. Children were recruited from the same elementary school in a central community of the city of Niš, Serbia. The groups consisted of intact classes, in order to repeat the same procedures with the previously collected unpublished data. Body height was measured using the anthropometer GPM 101 (GPM GmbH, Switzerland), in accordance with the standardized procedure (World Health Organization, 2008). The results of the measurements were accurate within 0.1 cm. Body weight was measured by electronic scale (Tefal, France), in accordance with the standardized procedure (World Health Organization, 2008), with an accuracy within 0.1 kg. The school authorities confirmed that research complied with ethical principles guiding scientific research on human subjects. Parental/guardian consent was obtained at each assessment time point. The measurements were conducted in the same order both times, using the same equipment and performed by the same investigators.

Procedure

The percentile and z-score for weight, height and body mass index (BMI) for the chronological age were used to estimate the nutritional status, and the results were also compared with current standards for growth and nutrition of children and adolescents of the World Health Organization (WHO). However, for BMI-for-age the recommended cut-offs for overweight and obesity are not the same as in adults. For children 5-19 years, the +1 SD in the WHO reference (equivalent to the 85th percentile) coincides at 19 years with the adult cut-off of BMI=25 kg/m^2, which is the cut-off for overweight. Similarly, the +2 SD (equivalent to the 97th centile) coincides at 19 years with the adult cut-off of BMI=30 kg/m^2, which is the recommended cut-off for obesity. Consequently, the +3 SD cutoff will be considered severely obese (corresponding to a BMI of above 35 kg/m^2). For leanness and severe leanness the cut-offs are -2 and -3 SD, respectively. All percentile and z-score values were obtained using the "WHO AnthroPlus"software (World Health Organization, 2009).

Statistical analysis

Descriptive statistics (means) was calculated for all experimental data. The Kolmogorov-Smirnov test of normality was performed on all variables, and all the data were normally distributed. Independent t-tests were conducted, and no significant difference was present between the two measurements for all variables.

RESULTS

Table 1. Average age, weight, height and body mass index of subjects.

Variables	Age (months)	Weight (kg)	Height (cm)	BMI (kg/m^2)
2008. (n=50)	114	34,4	139,1	17,8
2018. (n=50)	113	34,8	139,4	17,9

Table 2. Percentile and Z-score for weight, height and body mass index in relation to age of the subjects.

Variables	Height-for-age		Weight-for-age		BMI-for-age	
Values	**Percentile**	**Z-score**	**Percentile**	**Z-score**	**Percentile**	**Z-score**
2008.	78,1	0,77	71,3	0,56	74,4	0,65
2018.	81,4	0,89	75,7	0,7	76,7	0,73

The obtained results show that the average values of the nutrition parameters in both measurements are within the range below +1 SD and below the 85th percentile, which indicates normal nutritional status. A comparison of the results shows the absence of statistically significant differences between the two measurements.

DISCUSSION

The results of the pilot study showed that there was no statistically significant difference in the nutritional status of prepubescent school children over a ten years' period. In both measurements, the chronological age was below 120 months, which made it possible for us to compare the obtained values with the reference ones, since the reference weight-for-age was not available after the age of ten, since pubertal growth could already have begun.

According to the data of the Ministry of Health of the Republic of Serbia (MZRS) in 2006, the prevalence of pre-obesity in children and adolescents was 11.6% and obesity 6.4% (MZRS, 2007). According to the results of the Serbian Population Health Survey in 2013: more than a quarter (28.2%) of children and adolescents aged 7-14 years were over-nourished, of which 14.5% of children were overweight (BMI ≥ 85th percentile) , and 13.7% were obese (BMI ≥ 95th percentile) (MZRS, 2014). Given the small number of subjects in our pilot study, pre-obese and obese children were not observed separately.

Although the results of the pilot study differ from the previous studies conducted in Serbia and in addition indicate that no secular changes can be observed, we believe that continuous monitoring of the nutritional status by standardized methodology is nevertheless necessary. One of the aims of continuous monitoring of the nutritional status of young children is the identification of metabolically healthy obese children. Namely, the prevalence of metabolically healthy in the population of obese adults is over 40% (Ortega FB, Lee DC, Katzmarzyk et al., 2013). Higher birth weight, as well as early childhood or adolescence obesity, are associated with greater levels of insulin sensitivity. People with higher insulin sensitivity are thought to have an earlier onset of obesity due to excessive caloric intake, while in insulin-resistant individuals, weight gain has been slowed down in part due to less insulin sensitivity. These individuals, who are more prone to metabolic disorders later in life, need a longer period of increased caloric intake to become obese. Despite the lower incidence of t2dm and other metabolic disorders, the overall mortality of metabolically healthy obese patients corresponds to the mortality in the obese population (Mongraw-Chaffin, Foster, Anderson et al, 2018). Therefore, it is understood that in metabolically healthy obese people a treatment is needed to reduce weight, as well as in other obese individuals. Various expertly planned and programmed trainings conducted by qualified individuals can serve as an initial step in encouraging children and adolescents to increase confidence in their physical abilities and to be physically active, which can further on create the habit of regular physical activity, increase muscle strength and improve the quality of life.

To the best of our knowledge, our pilot study is one of the few studies in Serbia that examined prepubescent children using the up-to-date methodology for child growth assessment. On the other hand, the present study had several limitations as well. Small sample size of studied subjects and the inclusion of children from the central community of the city were the most prominent shortcomings of this pilot study. Future research should cover a significantly larger number of children, which should be sampled in accordance with the demographics of schools in central urban areas, urban suburbs and rural areas to gain a more realistic insight into their nutritional status.

CONCLUSION

Application of the contemporary methodology and standardized procedures for measuring and processing of data are the necessary prerequisites

for monitoring the nutritional status of prepubescent school children. A series of public health measures need to be taken to improve the level of health awareness in Serbia regarding the importance of early recognition and treatment of childhood obesity. The importance of identifying metabolically healthy obese is reflected in the fact that in these individuals treatment results were different, including a markedly better therapeutic impact of physical exercise compared to other obese individuals.

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THE EFFECTS OF AN AEROBIC EXERCISE PROGRAM ON THE BODY COMPOSITION OF ATHLETES (A REVIEW STUDY)

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ABSTRACT

Regular and systematic aerobic training has numerous and varied influences on health-related fitness levels (HRF), especially the status of the cardiovascular system, body composition, mineral content, and bone density (Asikainen, Kukkonen-Harjula, & Miilunpalo, 2004). Training activities based on oxidation energy processes dominate aerobic training, and enable the replenishing of expended energy by transporting oxygen to the periphery of the locomotor apparatus. Energy sources during aerobic training include carbohydrates and fats. Based on existing research, we can conclude that aerobic training has a positive influence on body composition. That is, the application of aerobic training has a positive influence on the decrease in body fat percentage, increase in muscle mass, and decrease in body mass. The obtained results have indicated that aerobic training is equally effective among participants of various ages, and that these effects do not depend on gender.

Keywords: aerobic exercise, body composition, effect, impact

INTRODUCTION

Our diet and amount of physical activity directly impact the health-related fitness status of adults and children (Mitić, 2011; Ortega et al., 2013; Diethelm et al. 2014). Due to the fact that the greatest part of the world's population is physically inactive, physical activity is considered to be a public health issue, and not just that of an individual. Low levels of VO2max can be recognized as one of the most important and frequent risk factors for the emergence of various cardiovascular diseases and the increase in the incidence of premature death (Škof, Milić, & Fabjanič, 2010).

There is incontrovertible proof that regular physical activity is effective in the primary and secondary prevention of several chronic conditions and premature death (Warburton et al., 2006). Based on the reports of the World Health Organization physical inactivity is a health risk factor along with smoking, obesity, and hypertension (Mitić, 2001). Hypokinesis, stress and obesity are the most frequent causes of premature death and the onset of chronic incommunicable diseases to which neither children nor the young are immune, as a result of which physical-motor abilities do not follow the intense physical growth of children and the young (Kurelić, 1971).

The widely accepted scientific definition of physical activity determines it as any kind of bodily movement set in motion by the skeletal muscles which results in calorie consumption (Caspersen, Powell, & Christenson, 1985).

A great many studies have indicated the positive influence of aerobic physical activities on fitness levels and body composition (Bassulk, 2003; Kostić, Đurašković, Miletić & Mikalački, 2006). Regular and systematic aerobic training has numerous and varied impacts on health related fitness (HRF), especially the status of the cardio-vascular system, body composition, body mineral content, and bone density (Asikainen, Kukkonen-Harjula, & Miilunpalo, 2004).

Aerobic training includes activities dominated by oxidation energy processes which enable the replenishment of expended energy through oxygen transport to the periphery of the locomotor apparatus. The energy sources for aerobic training include carbohydrates and fats. Blood rich in oxygen is pumped from the heart into the muscles. The muscles use oxygen to provide energy for work. Through aerobic activity, the body can use the oxygen more effectively. Aerobic activities include running, cycling, rowing, walking, etc. Actually, any

type of exercise which engages large muscle groups, increases the heart rate, breathing and body temperature, is said to have the features of aerobic training.

All successful coaches use at least some kind of diagnostic tools to test and evaluate athletes in order to design the training process. One of the more significant segments of the diagnosis of the fitness levels of athletes is the morphological functional testing, which provides information on the body composition and general endurance of the athletes.

Body composition represents the unity of the basic components of the human body, and includes: total body water (TBW), lean body mass (LBM) and the density component (D). Body composition is significantly related to physical exercise and changes under the influence of exercise; thus it represents an important indirect indicator of "fitness", but also the overall health of the athlete (Stojiljković, Mitić, Mandarić, & Nešić, 2012).

The fat component of the body chemically speaking consists of the so-called "essential" and "non-essential" fat. "Essential" fat consists of lipids which remain in the body during fasting, and actually make up 2 to 5% of the non-fat body component. "Non-essential" or reserve fat is found in subcutaneous tissue, in the abdominal cavity, and yellow bone marrow. This fat is spent, that is, it is stored during fasting, or fattening. The fat-free body component consists of muscles, bones, and internal organs, and includes the "essential" component of fat tissue (Macura, 2012).

METHODS

In order to compile samples of current research on the effects of aerobic exercise programs on the body composition of athletes, the following electronic databases were searched: PubMed, SCIndeks, PEDro, J-GATE, SCIndes, DOAJ and Google Scholar. When searching the databases, the following key words were used: aerobic exercise, body composition, effect, impact. The identified abstracts and complete texts were then read and analyzed. The analysis was carried out by one of the authors and the studies were evaluated in detail based on certain set criteria: that the experimental research included individuals which are involved in sport; and that participants were included in the testing to determine body composition.

The experimental studies which met the set criteria were then analyzed and presented based on the following parameters: references (the author and year of publication), sample of participants (total number of participants and subgroups), components of body composition which were analyzed, the sports discipline the participants were taking part in, the age of the participants, the tests which were used to determine body composition, and the research results (Appendix 1).

The exclusion criteria for the studies were: studies including participants who did not take part in sport; experimental research carried out on participants who did not take part in aerobic exercise; review studies; studies not published in English or Serbian (Figure 1).

RESULTS

A total of 15 studies were analyzed as part of this overview. The studies analyzed in this overview included 466 participants of both genders.

Two of the 15 studies included participants of both genders (Myong-Won, et al., 2015; Smith, et al., 2013). In those two studies, the total number of participants was 77, 32 of whom were women and 45 of whom were men.

Five of the 15 studies included only female participants (Carbuhn, et al., 2010; Carling, et al., 2014; Lesinski, et al., 2017; Sedano Campo, et al., 2009; Zahedmanesh, Zafari, & Zahedmanesh, 2013). In those five studies, the total number of participants was 154.

In the remaining 8 studies the participants were only males (Carvalho, Mourão, & Abade, 2014; Castelli Correia de Campos, et al, 2013; Jurimae, et al., 2015; Koundourakis, et al., 2014; Krivokapić, 2007; Manna, La Khanna, & Dhara, 2011; Ostojić, et al., 2009; Sotiropoulos, et al., 2009). The total number of participants in these studies was 235.

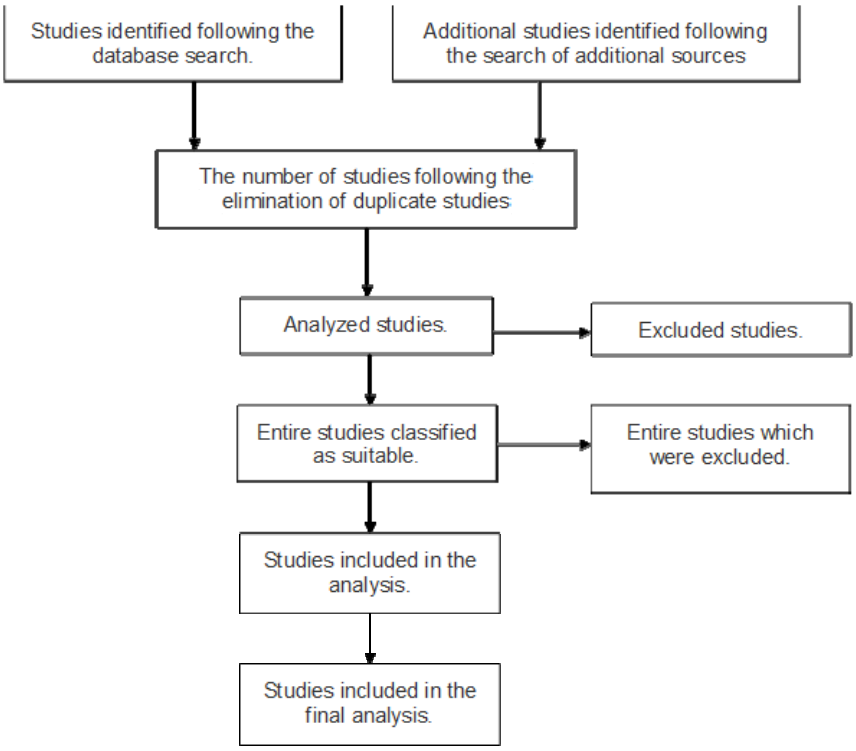

Figure 1: A prism diagram

In 7 of the 15 studies, the research did not include participants who took part in football (Carbuhn, et al., 2010; Carvalho, Mourão, & Abade, 2014; Jurimae, et al., 2015; Krivokapić, 2007; Myong-Won, et al., 2015; Smith, et al., 2013), while in the remaining 8 studies the research included participants who did (Burke, Gollan, & Read, 1986; Carling, et al., 2014; Koundourakis, et al., 2014; Lesinski, et al., 2017; Manna, La Khanna, & Dhara, 2011; Ostojić, et al., 2009; Sedano Campo, et al., 2009; Sotiropoulos, et al., 2009; Zahedmanesh, Zafari, & Zahedmanesh, 2013).

In 3 of the 15 studies the age of the participants was not defined (Carbuhn, et al., 2010; Koundourakis, et al., 2014; Smith, et al., 2013). In 4 of the 15 studies no means of defining body composition were defined (Carvalho, Mourão, & Abade, 2014; Koundourakis, et al., 2014; Lesinski, et al., 2017; Manna, La Khanna, & Dhara, 2011). The average age of the participants ranges from 15,3 ± 0,5 (Lesinski, et al., 2017) to 27,33 ± 5,5 (Castelli Correia de Campos, et al., 2013).

The components of body composition which were analyzed include percentage of muscle mass, body mass, percentage of fat tissue, the body mass index, and the lean body mass index. In only one study was lean body mass analyzed (Castelli Correia de Campos, et al., 2013). The participants were also all males, with an average age of 27,33 ± 5,5, who took part in football. Also, only one study analyzed the body mass index (Zahedmanesh, Zafari, & Zahedmanesh, 2013).

In 8 of the 15 studies the impact of aerobic training on body mass was analyzed (Castelli Correia de Campos, et al., 2013; Koundourakis, et al., 2014; Krivokapić, 2007; Myong-Won, et al., 2015; Ostojić, et al., 2009; Sedano Campo, et al., 2009; Sotiropoulos, et al., 2009; Zahedmanesh, Zafari, & Zahedmanesh, 2013).

In 7 of the 15 studies the impact of aerobic training on the percentage of body fat was analyzed (Carbuhn, et al., 2010; Carling, et al., 2014; Carvalho, Mourão, & Abade, 2014; Castelli Correia de Campos, et al., 2013; Jurimae, et al., 2015; Smith, et al., 2013; Zahedmanesh, Zafari, & Zahedmanesh, 2013).

In 6 of the 15 studies the impact of aerobic training on muscle mass was analyzed (Carbuhn, et al., 2010; Carvalho, Mourão, & Abade, 2014; Jurimae, et al., 2015; Lesinski, et al., 2017; Manna, La Khanna, & Dhara, 2011; Myong-Won, et al., 2015).

In 5 of the 15 studies the impact of aerobic training on fat tissue mass was analyzed (Krivokapić, 2007; Manna, La Khanna, & Dhara, 2011; Ostojić, et al., 2009; Sedano Campo, et al., 2009; Sotiropoulos, et al., 2009).

	Study (year of publication)	Sample of participants	Sports activities / age	Components of body composition	Means of estimating body composition	Research results	Conclusion
1	Carbuhn, A.F. (2010)	F 67	Softball, basketball, volleyball, swimming and athletics / X	PM MM	X-ray absorptiometry (DEXA)	Softball: PM <7%; MM >4%; Basketball: PM <11%; MM >4%; Volleyball: unchanged Swimming: MM >2,5%; Athletics: PM <7%; MM >3,5%;	The research indicated that the training had a positive impact on the decrease in the percentage of body fat and increase in muscle tissue. It was also indicated that the same effect was not noted for each sport.
2	Carling, C. (2010)	F 30	Football / average age 24,4 ± 4,1	PM	Harpenden skinfold caliper (British Indicators Ltd, Luton, UK)	A decrease in the percentage of fat tissue was noted.	This type of physical activity leads to a decrease in the percentage of body fat.
3	Carvalho, A. (2014)	M 12	Handball / average age 21,6 ± 1,73	PM MM	X	The percentage of fat tissue decreased by 16,4 %, and fat tissue mass by 15,7%. Muscle mass increased by 2,1%.	The training process had a positive influence on the decrease in fat tissue as well as the increase in muscle tissue.
4	Castelli Correia de Campos (2013)	M 6	Football / average age 27,33 ± 5,5	PM TM TMBM	skinfold Harpenden digital scales	TM Prior to (77.08 ± 7.73 kg) following (76.16 ± 8.38 kg) PM Prior to (16.84 ± 4.97%) following (15.96 ± 4.54%) TMBM Prior to (63.81 ± 3.23kg) following (64.87 ± 3.67kg).	This testing indicated that aerobic training did not lead to statistically significant changes in the PM, TM and TMBM.
5	Jurimae, J. (2015)	M 20	Rowing / average age 19,0 ± 2,9	PM MM	DEXA (Hologic Inc., Waltham, MA, USA).	PM (r = -0,56) MM (r = -0,50)	Physical activity among rowers influences the decrease in the percentage of body mass and increase in muscle mass.
6	Koundourakis, N. (2014)	M 55	Football / X	TM	X	An increase in body mass and percentage of body fat was noted.	It was determined that a period of 6 weeks without training leads to an increase in body mass and percentage of body fat.
7	Krivokapić, D. (2007).	M 32	Swimming / from 18 to 19	TM MMT	Procedure according to Mateigki	A significant decrease in body mass and fat tissue was noted when comparing the values from the initial and final measurements.	Aerobic swimming training has a positive impact on the decrease in body mass and fat tissue.
8	Lesinski. M. (2017)	F 17	Football / average age 15,3 ± 0,5	MM	X	Muscle body mass increased ($2.50 \leq d \leq 3.39$; $p < 0.01$).	This type of physical activity has a positive impact on the increase in muscle mass.
9	Manna, I. (2011)	M 30	Football / (from 16 to 19)	MM MMT	X	A significant increase in muscle mass was noted ($P < 0.05$) and a decrease in body fat ($P < 0.05$).	Aerobic training influences the decrease in body fat and increase in muscle mass.
10	Myong-Won, S. (2015)	M 22 F 12	Taekwondo / (from 18 to 21)	TM MM	dual X-ray absorptiometry (DXA, Hologic QDR-4500, USA)	TMM decreased from 11.4±2.28% to 9.9±1.50% TMZ decreased from 23.2±3.58% to 21.2±3.09% No significant changes were determined for muscle mass.	It was noted that the training process had a significant impact on the reduction in body fat, irrespective of the gender of the participants.
11	Ostojić, S.M. (2009)	M 22	Football / (from 18 to 25)	TM MMT	foot-pad bioelectrical impedance analyzer (BF-662W, Tanita Corporation, Japan)	Body mass and body fat decreased significantly following a six-week program.	The training process had a significant impact on the decrease in body fat and body mass.

12	Sedano Campo, S. (2009)	F 20	Football / average age 22.8± 2.1	TM MMT	Holtain (British Indicators, Ltd.)	No statistically significant change in body mass and fat tissue occurred following the application of the program.	The training process did not have a significant impact on the changes in body mass and fat tissue.
13	Smith, M. (2013)	M 23 F 20	Crossfit / X	PM	plethysmography device (Life Measurements) Instruments, Concord, CA, USA)	A decrease in PMM, with a reduction from 22,2% to 18%, and in PMZ from 26,6% to 23,2%	The application of the CrossFit training process has a positive influence on the decrease in body mass among participants of both genders.
14	Sotiropoulos, A. (2009)	M 58	Football / average age 24.4 ±2.97	TM MMT	Harpenden skinfold caliper (John Bull, British Indicators, Ltd., West Sussex, United Kingdom	Both groups (the experimental and control) showed signs of an increase in body mass but also fat body mass. The increase was more significant in the control group which did not take part in any activities.	It was concluded that the absence of aerobic training, does not lead to a decrease in body weight and the percentage of fat tissue in body composition.
15	Zahedmanesh, F. (2013)	F 20	Swimming / age from 20 to 25	TM BMI PM	Jackson and Polack skin folds Equation Quetelet index	TM prior (68.4 ± 5.6 kg) following (61.5 ± 5.4 kg) BMI prior (25.2 ± 2.1 $kg.m^{-2}$) following (23.4 ± 2.2 $kg.m^{-2}$) PM prior (22.1 ± 3.5 %) following (20.2 ± 2.3 %)	The results of this study have indicated that 8 weeks of combined swimming training including aerobic and anaerobic swimming training, based on the main training of progressive load, led to a significant decrease in body mass, the body mass index, and percentage of body fat.

DISCUSSION

The studies which included participants who took part in football analyzed the impact of aerobic training on body composition, and also the impact of its absence.

The application of aerobic training resulted in a decrease in body weight, increase in body mass, as well as a decrease in body fat. The results obtained in the analyzed studies indicate that regular systematic aerobic training has a positive impact on body composition, which was also indicated by Asikainen et al. (2004).

Based on the age of the participants included in all the studies, which vary significantly, it could be concluded that aerobic training has an equal impact on body composition for all age categories. However, a study carried out by Castelli Correia de Campos et al. (2013) which included male participants who take part in football, with an average age of 27,33 ± 5,5, indicated that aerobic training did not have a statistically significant impact on the percentage of fat, body mass, as well as lean body mass. The participants in this study were at the same time the oldest group of participants compared to the samples included in other studies. This result can be explained by a decrease in the impact of aerobic training on body composition with an increase in the average age of the participants. However, we must take into consideration the fact that only 6 respondents took part in the study.

In the study carried out by Carbuhn et al. (2010) a difference was noted depending on the sport the participants are involved in. Based on the obtained data, we can conclude that basketball, when compared to softball, swimming, and athletics, has the greatest impact on the decrease in the percentage of body fat by as much as 11%. The greatest impact on the increase in muscle mass was determined for softball and basketball, while in the case of participants who took part in volleyball, no statistically significant changes in the percentage of body fat or muscle mass were determined.

Based on the data regarding the gender of the participants, it can be concluded that in the analyzed studies, aerobic training has an equal impact on body composition, irrespective of gender.

In addition to the great number of studies which included participants involved in football, there were 3 studies in which the participants took part in swimming. Aerobic swimming training sessions proved to have a positive impact on body composition. Krivokapić carried out a study in 2007 which involved male participants, who were swimmers, while Zahedmanesh et al. (2013) carried out a study involving female participants who took part in swimming, and both reached the conclusion

that swimming had a positive influence on the decrease in body mass.

Krivokapić analyzed fat tissue mass, while Zahedmanesh et al. analyzed the percentage of fat of the participants. In both cases aerobic swimming training led to a decrease both in the percentage of fat, and fat tissue mass.

In addition, handball and rowing have a positive impact on the decrease in the percentage of fat and increase in muscle mass. Jurimae et al. (2015) analyzed the impact of aerobic rowing training on muscle mass and percentage of fat, while Carvalho et al. (2014) tested handball players with the same goals in mind.

The only combat sport that was included in the analyzed studies is taekwondo. Myong-Won (2015) et al. carried out a study which included participants of both genders, aged 18 to 21. The research indicated that this type of physical activity has a positive impact on the decrease in body fat, but there is no statistically significant impact on the change in the muscle mass of the participants.

Also, the studies which dealt with the influence of the absence of aerobic training have indicated that such an absence leads to an increase in body mass, decrease in muscle mass, and an increase in percentage of fat.

CONCLUSION

Based on the existing studies, we can conclude that aerobic training has a positive impact on body composition. That is, the application of aerobic training has a positive impact on the decrease in the percentage of body fat, increase in muscle mass, and decrease in body mass. The obtained results have indicated that aerobic training is equally effective in the case of participants of various ages, as well as participants of both genders. However, research has indicated that the impact on participants involved in various sports is not equal. Based on the analyzed studies, it was determined that basketball has the greatest impact on body composition when compared to swimming, volleyball, athletics, and softball. In certain studies it was pointed out that the absence of aerobic activities has a negative impact on body composition. In the absence of aerobic training, an increase in body mass and percentage of fat is noted, as well as a decrease in muscle mass.

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Interdisciplinary

THE REACTION STYLE IN CONFLICT SITUATIONS AS A COPING STRATEGY DURING ADAPTATION OF PHYSICAL EDUCATION TEACHERS

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ABSTRACT

The aim of the study is to establish the typical style of reaction in conflict situations of physical education and sport teachers as a preferred coping strategy during their professional adaptation and to analyze the influence of factors such as gender, age and pedagogical experience on this process. A complex methodology, at the center of which is the psychological testing with the help of a Questionnaire for self-evaluation over the style of coping with conflict Thomas-Kilmann Conflict Mode Instrument-TKI has been applied. The characteristic features of the five possible behavior styles of the teacher have been outlined. The pedagogical advisability of each of them has been explained. A comparative analysis of the quantitative results has been made, providing information for the degree of expressiveness of the different scales of possible coping strategies. From the carried out analysis it has been established that the age and length of the pedagogical experience of the analyzed teachers are not an essential factor for their reactions style, while the factor of gender has a significant influence, demonstrated by the values of Contingency Coefficient. The main conclusion is that physical education teachers should be prepared to understand and accept philosophically the inevitability of conflict situations and to be able to respond correctly, which is inherently a part of its current pedagogical adaptation.

Keywords: physical education, conflict, physical education teacher, coping strategy, reaction/responce style.

INTRODUCTION

As each sphere of professional activity, pedagogy is also influenced by the processes which are taking place in society during the respective part of its development. The pace of economic development, the dynamics and the instability of the social environment, people's mobility along with the multicultural interactions, the profile of the modern students and a multitude of other circumstances raise the expectations toward the adaptability of physical education teachers in concern with their professional realization. Without a doubt, on one hand the teacher has to answer the expectations of pedagogy work and society by developing and refining himself, and on the other hand – he has to safeguard his health, emotional stability and inner equilibrium. Thus studying and researching the mechanisms and the regularities of pedagogy adaptation of physical education teachers is a current scientific problem, which has an important part in managing human resources in today's society. One of these mechanisms is the appropriate reaction to conflicts which are an invariably present in the professional activity of pedagogy specialists.

Conflicts in their nature are a peculiar mental phenomenon related to interpersonal and group relations. Any disagreement or argument can escalate into a conflict. In general, a person enters a conflict situation when from their point of view the fairness is violated, their self-esteem is affected, or when something is done in a way which they believe is incorrect. Conflict situations are comprised of the participants and the object of the conflict, that is, the reasons for the opponents to have entered the confrontation. In this case, according to D. Neverkovich (2006), conflict can be examined from different positions:

- From the point of view of the objectives, the conflict reflects the human desire to protect an idea, principle, action, etc.
- From the perspective of interpersonal relationships, the conflict is a disruption of these relationships at an emotional or behavioral level.

Conflict, respectively the conflict situation, is distinguished with its specifics, the most characteristic of which are: complexity, heightened emotionalism, related mostly with negative experiences, great importance for the individual person, individual style for finding the solution of the conflict, marked impact on the behavior of the individual and the relationships between people.

As a part of human relations, conflicts are also present in the workings of the school as an educational institution and reflect on the business and personal relationships in the professional environment. Their contradictory influence is presented in the following:

- The conflict situation most often has a negative influence over the quality of the pedagogy activity which is conducted in conditions of emotional discomfort and mental tension.
- The positive side of the conflict is connected to that it is a signal of problems in the social climate and steps for it to be eliminated should be taken.

As practical experience demonstrates, the contemporary world the physical education teacher is very often involved in some sort of a conflict taking place in school – either as a participant, or as an arbiter who has to regulate the arisen difficult situation. Obviously, the strategy and tactic of his behavior in such a situation, finding and selecting the optimal solution play a very important part, firstly in avoiding the stress and bettering the mental atmosphere, secondly in regulating the behavior of certain people and, finally in establishing and maintaining his own authority. That is one of the key moments of the professional adaptation, regardless of the age and experience which the teacher already has in life.

To adapt adequately towards the conditions of the environment, in which the conflict takes place, each teacher applies their coping strategy, which depends on:

- *Subjective factors – age, gender, individual mental characteristics: character, temperament, purpose, interests, motivation, self-esteem, anxiety, etc.*
- *Objective factors – the nature of the conflict, personal experience and maturity, belonging to a smaller and bigger society (ethnic and social circles), certain working conditions in the educational environment, number of students, colleague environment, etc.*

In the psycho-pedagogical sciences adaptation has different aspects, which one way or another are connected with the main definition of the word and mean adjusting (from Latin: adaptatio). It is necessary to mention that according to the scientific interpretations there is a difference between the concepts of adjusting and adaptation. In the first case, people accept passively the conditions of the situation and adapt to them as best as they can. In the case of adaptation, people are being active by acquiring and applying various ways and strategies for dealing with the features of the environment, including arisen problems or difficulties.

Coping or coping strategy is the main concept of the theory and studies of the adaptation, stress and health. It is used to mark conscious strategies for coping with stress and other events that raise anxiety (Lazarus, 1966). According to M. Georgiev (Georgoev, 2011 c. 31-32) coping mechanisms are an "individual way of interacting with the situation in accordance to its logic, significance in the person's life and his mental abilities. "

The practical point of the coping strategy lies in fact that teachers has to adapt as best as they can towards the requirements of a particular situation, which makes it possible for them to control and balance it. The main task here for "coping" is to ensure and maintain: the physical and mental health; personal authority' the satisfaction of the professional activity and social relations carried out.

The purpose of the study is to determine the typical style of reaction in conflict situations of physical education students as a preferred coping strategy during their professional adaptation and to analyze the influence of factors such as gender, age and pedagogical experience on this process.

METHODS

The study carried out in the beginning of 2019 has the elements of an ascertaining experiment. Participants in it are 142 physical education teachers (78 man and 64 women) from central and northeast Bulgaria.

With the intent of solving the posed aim, the contingent of study has been conditionally distributed in groups as following:

- According to their age :three groups (A, B, C)

A – up to 35 years; B – from 36 to 50 years; C – over 55 years

- According to the length of their pedagogy experience: three groups (1, 2, 3).

1 group–up to 5 years; 2 group. – from 6 to 20 years; 3 group. – over 20 years

- According to gender: men and women (m, f)

Procedure

A complex methodology has been applied, which includes: Theoretical-logical analysis and synthesis

by literary sources, psychological testing and numerical statistical analysis. Data has been processed with the program package SPSS, version 19.

In relation to the examination of the aspects of professional adaptation of physical education teachers a psychological testing has been made to determine the response style as coping strategy that is applied in conflict situations. K. Thomas-R. Kilmann questionnaire for self-assessment style to deal with conflict has been used (Thomas-Kilmann Conflict Mode Instrument -TKI). It has been adapted and standardized for Bulgarian usage by D. Kutlev (2004)

The personal questionnaire consists of 30 statements, each of which has two alternative responses as opportunities for interpersonal conflict behaviour. The person under examination must choose one of the two statements, which is more in principle consistent with his behaviour in conflict situations. The assessment of behaviour in interpersonal conflicts is based on the two-factor theory K. Thomas and R. Kilmann on conflict resolution styles. According to it, the behavior of the individual can be in two dimensions:

1) Assertiveness (from English. assert – confident and forceful behavior) – The extent to which a person tries to declare, validate, enforce and satisfy his or her own opinion and interests.

2) Cooperation – The extent to which a person tries to comply and satisfy the interests of the other party in the conflict.

From the combination of the low and high degrees of these two lines of behavior, based on 12 arguments according to the largest sum of points on one of the five scales is determined the most preferred form of social behavior.

There are five possible ways to react and tackle conflict situations – rivalry, cooperation, compromise, avoidance and adaptation.

RESULTS AND DISCUSSION

According to data pertaining the general characteristic of the research contingent, the average age of teachers was 43.33 years (Min=24; Max=65; SD=12,06).

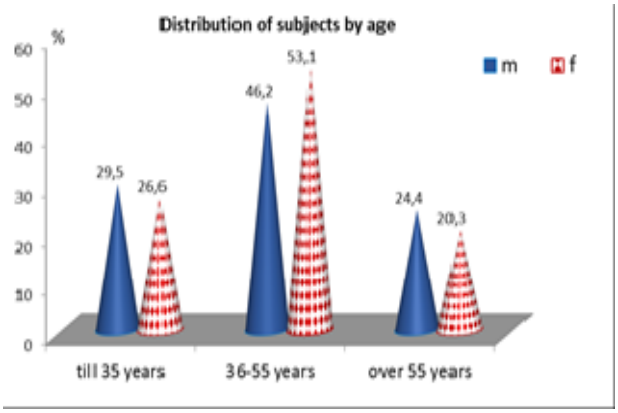

Fig. 1

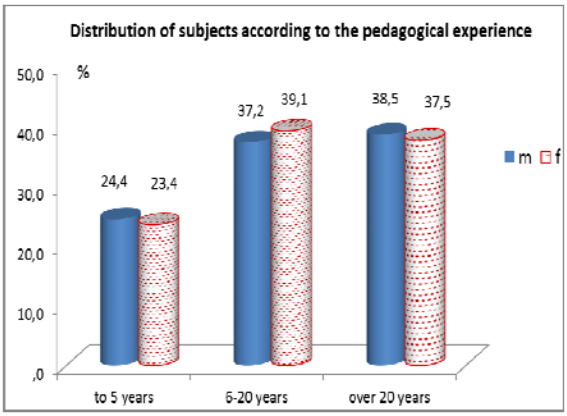

Fig. 2

The highest proportion of teachers is aged 36 – 55 years in both men and women (Fig.1).

In terms of working experience, the picture is identical (Fig. 2). The average of the pedagogical experience is 16.87 years (Min=1; Max=42; SD=12,04). This is not accidental, as the length of the pedagogical experience is a strong correlation with the biological age (r=,919; **Correlation is significant at the 0.01 level (2-tailed).

These findings are relevant in the analysis of pedagogical adaptation of teachers in conflict situations from the point of view that their value system and attitudes to work are formed in conditions of another social and economic formation. At the beginning of his career, under the current legal framework, everyone was required to have an appointment without facing the fierce competition in the labour market that exists now. Moreover, it is assumed that the teachers of this group have a significantly greater stability of the working position due to the accumulated work experience, the established career with higher professional qualification degree.

In terms of quantitative results that provide information on the degree of expression of preferences in a set scale, the data in the table 1 show that there is no statistically significant difference between the group of men and the women's group.

Table 1 Comparative analysis of the results, informing about the degree of expression on the different scales of possible digging strategies

№	Style of conflict response	Unit	Group	Mean	SD	d	t	α
1	**RIVALRY**	points	m	2,92	2,30	0,22	0,51	**0,614**
			f	2,70	2,88			
2	**COOPERATION**	points	m	5,68	1,84	0,37	1,07	**0,285**
			f	5,31	2,23			
3	**COMPROMISE**	points	m	7,84	1,79	- 0,66	2,12	**0,036**
			f	8,50	1,88			
4	**ESCAPE**	points	m	7,46	2,75	-0,09	0,20	**0,840**
			f	7,55	2,17			
5	**ADAPTATION**	points	m	6,04	2,15	0,49	1,57	**0,119**
			f	5,54	1,42			

The conflict situations experienced in pedagogical practice are a prerequisite for tension and sometimes a source of stress in physical education and sports teachers. Overcoming them requires a lot of tact and pedagogical skill. By preserving their personal dignity and the dignity of the other participants in the created situation, the teacher applies a particular coping strategy as a behavior. The characteristics and pedagogical appropriateness of the five main styles of behaviour are the following:

1. ***Rivalry (competition)*** **–** This is a strategy in which the style of conduct is characterised by an aspiration to satisfy, above all, its own interests, and the respondent party to be forced to accept the unilateral solution to the problem. This style can only be effective if the pedagogue is authorized with certain authority and rights. Knowing that his approach and decision in the given situation are correct, he insists on them. In personal relations, rivalry as a style of behavior is not recommended because it can repel and cause alienation in people.

2. **Cooperation** – at the heart of this strategy, which is almost always fruitful, is the willingness of the teacher to reach a solution that satisfies the interests of both parties in the conflict. There is an enduring interest and diligence in cooperating with other participants in the conflict (students, colleagues, parents, administration). This coping strategy is not particularly effective when the parties to the conflict have any hidden requests because it makes it difficult to identify the source of frustration.

3. **Compromise** – it is characterized by the fact that each of the parties makes a certain retreat from their own interests, therefore in the general decision there is only partial satisfaction for each of them. This coping strategy is particularly relevant in cases where the interests of both parties are mutually exclusive and then the compromise becomes the only option for resolving the conflict. The compromise as a reaction style differs from cooperation, as the conflict situation is solved only partially and more superficially.

4. **Escape** (leaving the conflict) – This strategy has a withdrawal from resolving the problem that caused the conflict situation or its active suppression. There is no aspiration to satisfy our own interests and willingness to cooperate. In some cases, exiting the conflict does not mean escaping from the problem, but only a temporary withdrawal, so as not to deepen or intent it to decide later.

5. Escape (leaving the conflict) **–** This strategy has a withdrawal from resolving the problem that caused the conflict situation or its active suppression. There is no aspiration to satisfy our own interests and willingness to cooperate. In some cases, exiting the conflict does not mean escaping from the problem, but only a temporary withdrawal, so as not to deepen or intent it to decide later.

In Fig. 3. the relative share of each style of the five possible digging strategies for conflicts is presented visually.

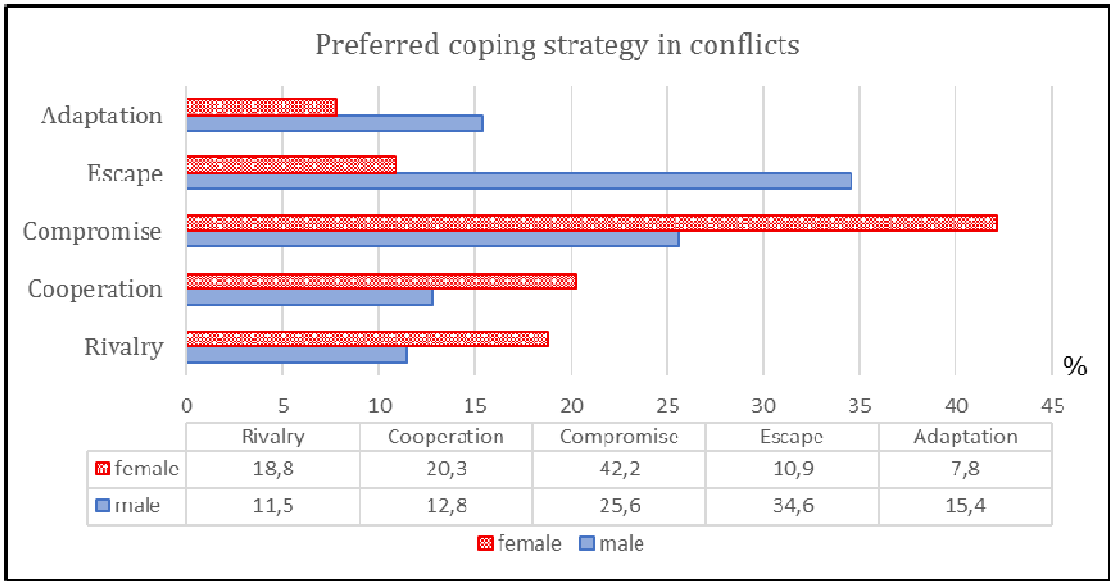

Figure 3

Analyzing the preferences of physical education teachers and sport-digging style in conflicts according to the gender factor is logically justified. On the one hand, the profession sets the same requirements for everyone regardless of their gender and gives it an equal chance of expression. On the other hand, the natural nature of man and woman and the ensuing social roles that everyone performs in life, quite naturally reflect also in pedagogical activities. In addition, both sexes take different changes and react differently with their own style of adaptation behaviour.

In this sense, the results reflected in Fig. 3, are completely regulat. The relative share of women who chose the compromise strategy (42.2%) was quite large and significantly higher than that of men (25.6%).

Surprising is the fact that in the studied teachers the largest is the relative share of those who choose the escape strategy (34.6%). We assume that men do not always take a firm stance in the conflict to avoid possible troubles that can cause problems of a professional and socio-economic nature. The explanation can also be sought in that they wisely withdraw from it and wait to blow over or decide at a convenient time.

It is also interesting that women who choose rivalries are more (18.8%) than men(11.5%), despite it being in their nature to compete with each other. We believe that the experience of women in active sports-competing activity is at the heart of this coping strategy.

The differences found are evidence, which is confirmed by Contingency Coefficien, that gender is a factor of reliable importance in the selection of the coping style by physical education and sports teachers (table 2).

Table 2 Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	,312			,004
Interval by Interval	Pearson's R	-,249	,080	-3,044	,003[c]
Ordinal by Ordinal	Spearman Correlation	-,267	,080	-3,276	,001[c]
N of Valid Cases		142			

a. Not assuming the null hypothesis.] b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on normal approximation.

In-depth analysis of the results of the applied methodology (Thomas-Kilmann Conflict Mode Instrument-TKI) includes the identification and influence of the factors of age and pedagogical experience on the investigated phenomenon. We consider them as separate, as the range of groups (A, B, C) and (1, 2, 3) does not overlap completely. This is because in some teachers the entire internship is not only pedagogical, because they have worked

outside the education area for a certain period or have been unemployed.

According to the Contingency Coefficient values applicable to signs in nominal scales, it can be concluded that both men and women do not have a statistically significant correlation between the style of the coping strategy in a conflict situation and the factors Pedagogical experience (table 3) and the Teacher age group (table 4).

Table 3 Symmetric Measures

Sex			Value	Approx. Sig.
male	Nominal by Nominal	Contingency Coefficient	,284	,553
	N of Valid Cases		78	
female	Nominal by Nominal	Contingency Coefficient	,320	,504
	N of Valid Cases		64	

Table 4 Symmetric Measures

Sex			Value	Approx. Sig.
male	Nominal by Nominal	Contingency Coefficient	,358	,177
	N of Valid Cases		78	
female	Nominal by Nominal	Contingency Coefficient	,326	,471
	N of Valid Cases		64	

CONCLUSION

In carrying out a professional activity, teachers of physical education and sport inevitably face various conflicts in the school environment. A key point for resolving the conflict is the timely and accurate application of a coping strategy as a style of behavior. It was found from the diagnostics that the age and duration of teacher training was not an essential factor in terms of their usual response style. However, it is largely dependent on the gender factor of the persons surveyed.

All this leads to the conclusion that the FCS teacher should be prepared to understand and accept the philosophical inevitability of the conflict situations and to be able to react correctly, which is inherently a part of its current pedagogical adaptation.

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DIFFERENCES IN VISUAL REACTION TIME IN CHILDREN AND ADOLESCENTS INVOLVED IN OPEN SKILL SPORTS

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UDC 796.01-053.6

ABSTRACT

The aim of this paper is to define differences in visual reaction time in relation to age and the type of the presented visual task. The sample in this research consisted of a total of 120 participants of which 52 boys and 68 girls. The sample was divided into the following subsamples in relation to the age of the participants: <= 9, 9-12, 12-15, 15+ years. It was determined that mean simple visual reaction time (SRT) was at the level of 177.75±22.98, 171.58±20.76, 157.42±26.59 and 143.38±18.96 ms, respectively. Mean go/no-go reaction time (GNRT) was at the level of 298.47±54.31, 272.95±49.07, 242.09±68.23 and 216.89±33.71 ms, respectively. Mean choice reaction time (CRT) was at the level of 378.58±67.83, 336.47±59.00, 291.11±67.35 and 257.70±41.13 ms, respectively. Results of ANOVA have shown that these differences were statistically significant at a general level for all three types of reactions (SRT – F=11.770, p=0.000, GNRT – F=10.053, p=0.000, CRT – F=17.466, p=0.000) and Tukey HSD test has revealed statistically significant partial differences. This research has confirmed previous findings regarding differences in visual reaction time in different RT tasks and in relation to the age of the participants involved in open skill sports. The presented results reflect the processes of development and maturation of neuro-visual, cognitive and motor potential of the human body during childhood and adolescence.

Keywords: children, adolescents, reaction time, development, reaction time task

INTRODUCTION

When considering the manifestation of human reactions capabilities, whether those most simple ones that are generally rare in sport activities and human everyday life, or those more frequent and more complex that integrate multiple layers of neurocognitive structures and mechanisms, we can only evaluate ones performance based on reaction time, i.e. the time elapsed between the presentation of the sensory stimulus and the subsequent behavioral response (Shelton & Kumar, 2010). Reaction time is a measure of the speed of the perceptual and neurocognitive system, and it represents the time required for perception and possible evaluation and programming of an adequate response to the presented stimulus. Simple reaction time refers to the situation where there is only one possible response to only one possible stimulus which is known in advance while go/no-go and choice reactions represent a maximally fast motor response in a situation of uncertainty, i.e. a situation where the presentation of an alternative stimulus, or stimuli, is a realistic possibility (Schmidt & Lee, 1998).

The previous efforts in the research of reaction time involved different scientific fields including psychology, motor control, and sport. The interdisciplinary interest for this phenomenon resulted with a large body of knowledge that indicates significant differences in visual reaction time are related to several important factors such as gender, intelligence, practice, type of stimulus, physical activity, handiness and of course age (Ando, Kida, & Oda, 2002, 2004; Dane & Erzurumluoglu, 2003; Der & Deary, 2006; Fontani, Lodi, Felici, Migliorini, & Corradeschi, 2006; Marković & Dopsaj, 2018; Nakamoto & Mori, 2008;

Nettelbeck, 1980; Welford, 1977). Apparently, reaction time shortens from infancy into the late 20s and then gradually increases with aging. This age effect seems to be more marked for complex reaction time tasks (Kosinski, 2008), and possible reasons for this can be related to the information processing speed, attention and other factors (Fontani et al., 2006; Haibach, Reid, & Collier, 2011).

Although conceptually different, volleyball and karate are both open skill sports that require a high level of reactivity (Fontani et al., 2006), and in this context, reaction time can be considered a significant determinant of performance (Vences de Brito & Silva, 2011). Also, the ability to notice and extract relevant information in conditions of time and space constraints can most certainly present a qualitative difference in performance (Heirani, Vazini Taher, Soori, & Rahmani, 2012; Mori, Ohtani, & Imanaka, 2002; Müller & Abernethy, 2012).

The aim of this paper is to define differences in visual reaction time in relation to age and the type of presented visual reaction task in children and adolescents involved in open skill sports. The findings will further contribute to a better understanding of the development and maturation of neuro-visual and cognitive potential for rapid reactions thus widening the fundus knowledge in this area of sports science.

METHODS

This research was transversal and non-experimental. All data sampling was performed using field testing method, by application of specially designed reaction time testing software developed in LabView 2012 software surroundings. The system recorded reaction time with 1 ms precision (Marković & Dopsaj, 2018; Marković, Valdevit, et al., 2019).

Subjects

The sample in this research consisted of a total of 120 subjects, of which 52 boys and 68 girls. The overall sample was divided into the following subsamples in relation to age of the participants: <= 9 years (M = 8.34±0.36 years, N = 12), 9-12 years (M = 10.46±0.76 years, N = 40), 12-15 years (M = 13.57±0.83 years, N = 37), 15+ years (M = 16.82±1.06 years, N = 31). All subjects were members of the Volleyball team "DIF Belgrade" and Karate team "Čukarica" and were involved in regular training to the extent available for their age category. 107 participants were right-handed and 13 were left-handed. All participants included in this research were healthy, had normal or corrected to normal vision and had no neuromuscular disorders.

Procedure

The testing was performed on multiple sessions during the period of February – March 2019. All testing sessions were conducted in the morning hours between 9:00 and 11:30 AM. The testing procedure was thoroughly explained and demonstrated to all subjects, who were then further familiarized with the testing procedure and equipment by performing multiple trial attempts. The testing of visual reaction capabilities included three types of reaction tasks: reactions on a simple stimulus (SRT), reactive – go/no-go reactions (GNGRT) and choice reactions (CRT). For any type of reaction, the test consisted of a random number of stimulus presentations until completion of 10 successful trials. For each trial, the visual stimulus was presented on a laptop screen in a randomized time interval between 2 and 7 s. The performing subject had to react as quickly as possible by pressing the mouse button with the corresponding finger of their dominant hand. Reaction time lower than 100 ms was discarded as an error, and was substituted by an additional trial. Subjects were instructed to avoid any strenuous physical activity prior to testing and did not perform any type of warm-up. The study was conducted in accordance with the postulates of the Declaration of Helsinki and was approved by the Ethics Committee of the University of Belgrade Faculty of Sport and Physical Education.

Variables

The following variables were used in this research: SRT – Simple Visual Reaction Time, GNGRT – Go No-Go Reaction Time, CRT – Choice Reaction Time. For all variables, reaction time result was calculated as a mean of 3 trials with the shortest reaction time. The achieved result was expressed in ms.

Statistical analysis

For the purposes of this paper, all raw data was subjected to descriptive statistical analysis in order to define the basic indicators of central tendency (Mean), data dispersion – Standard deviation (SD) and Coefficient of variation (cV%), and results span indicators – Minimum (Min.), Maximum (Max.) and Range (R). Normality of the distribution of the results was determined by the application of the Shapiro-Wilk goodness of fit test. General differences between age groups in relation to respective variables were determined by the application of univariate analysis of the variance

(ANOVA). Partial differences were determined using Tukey HSD post hoc tests. The level of statistical significance was defined based on criterion p≤0.05 (Vincent, 2005). All data analyses were conducted using statistical software packages Microsoft Excel 2013 and IBM SPSS v23.

RESULTS

Table 1. Descriptive statistics for the simple (SRT), go/no-go (GNGRT) and choice (CRT) visual reaction time variables in relation to the age category of the participants

Descriptive Statistics							
Age <= 9							
	N	Mean	SD	cV%	Min	Max	R
SRT	12	177.75	22.98	12.93	147.67	216.00	68.33
GNGRT	12	298.47	54.31	18.19	206.00	388.33	182.33
CRT	12	378.58	67.83	17.92	259.00	521.33	262.33
Age 9 - 12							
	N	Mean	SD	cV%	Min	Max	R
SRT	40	171.58	20.76	12.10	134.00	220.67	86.67
GNGRT	40	272.95	49.07	17.98	174.00	369.33	195.33
CRT	40	336.47	59.00	17.53	218.67	464.67	246.00
Age 12 - 15							
	N	Mean	SD	cV%	Min	Max	R
SRT	37	157.42	26.59	16.89	110.67	215.67	105.00
GNGRT	37	242.09	68.23	28.18	153.67	435.67	282.00
CRT	37	291.11	67.35	23.14	181.67	489.33	307.67
Age 15+							
	N	Mean	SD	cV%	Min	Max	R
SRT	31	143.38	18.96	13.23	114.67	194.33	79.67
GNGRT	31	216.89	33.71	15.54	163.00	285.00	122.00
CRT	31	257.70	41.13	15.96	182.33	341.33	159.00

Table 2. Results of the Shapiro-Wilk goodness of fit test in relation to the type of visual reaction task and the age category of the participants

Tests of Normality						
	Age <= 9			**Age 9 - 12**		
	Shapiro-Wilk			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SRT	0.940	12	0.501	0.963	40	0.211
GNGRT	0.957	12	0.739	0.984	40	0.825
CRT	0.976	12	0.961	0.982	40	0.771
	Age 12 - 15			**Age 15+**		
	Shapiro-Wilk			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SRT	0.961	37	0.213	0.945	31	0.112
GNGRT	0.903	37	**0.003**	0.950	31	0.158
CRT	0.962	37	0.234	0.984	31	0.919

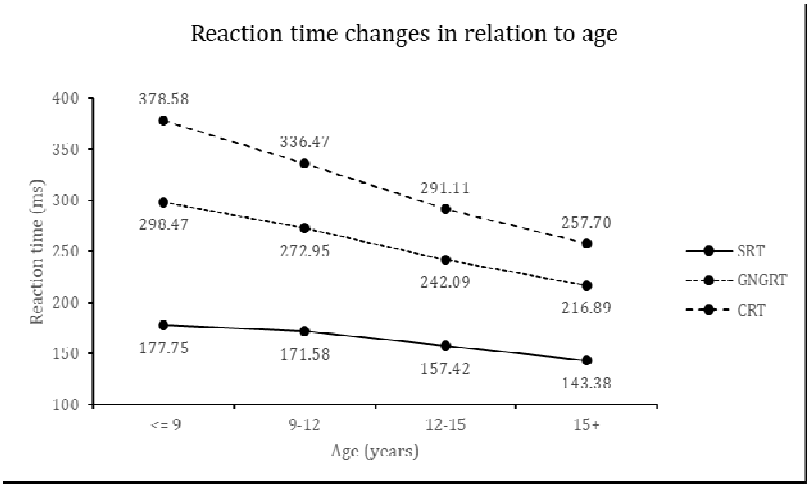
Table 3. Results of the Univariate Analysis of the Variance (ANOVA) in relation to the type of visual reaction

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
SRT	Between Groups	17916.762	3	5972.254	11.770	**0.000**
	Within Groups	58859.223	116	507.407		
	Total	76775.985	119			
GNGRT	Between Groups	85285.098	3	28428.366	10.053	**0.000**
	Within Groups	328030.676	116	2827.851		
	Total	413315.774	119			
CRT	Between Groups	180862.800	3	60287.600	17.466	**0.000**
	Within Groups	400408.741	116	3451.799		
	Total	581271.541	119			

Table 4. Results of the Tukey HSD post hoc test in relation to the type of visual reaction task and the age category of the participants

Multiple Comparisons							
Dependent Variable			Mean Difference	Std. Error	Sig.	95% CI	
						Lower Bound	Upper Bound
SRT	**<= 9**	**9 - 12**	6.175	7.414	0.839	-13.151	25.501
		12 - 15	20.327	7.483	**0.038**	0.820	39.833
		15+	34.374	7.658	**0.000**	14.411	54.337
	9 - 12	**<= 9**	-6.175	7.414	0.839	-25.501	13.151
		12 - 15	14.152	5.138	**0.034**	0.759	27.545
		15+	28.199	5.390	**0.000**	14.148	42.249
	12 - 15	**<= 9**	-20.327	7.483	**0.038**	-39.833	-0.820
		9 - 12	-14.152	5.138	**0.034**	-27.545	-0.759
		15+	14.047	5.485	0.056	-0.250	28.344
	15+	**<= 9**	-34.374	7.658	**0.000**	-54.337	-14.411
		9 - 12	-28.199	5.390	**0.000**	-42.249	-14.148
		12 - 15	-14.047	5.485	0.056	-28.344	0.250
GNGRT	**<= 9**	**9 - 12**	25.522	17.503	0.466	-20.102	71.146
		12 - 15	56.382	17.666	**0.010**	10.333	102.431
		15+	81.580	18.080	**0.000**	34.452	128.707
	9 - 12	**<= 9**	-25.522	17.503	0.466	-71.146	20.102
		12 - 15	30.860	12.129	0.058	-0.758	62.477
		15+	56.058	12.725	**0.000**	22.889	89.226
	12 - 15	**<= 9**	-56.382	17.666	**0.010**	-102.431	-10.333
		9 - 12	-30.860	12.129	0.058	-62.477	0.758
		15+	25.198	12.948	0.215	-8.553	58.949
	15+	**<= 9**	-81.580	18.080	**0.000**	-128.707	-34.452
		9 - 12	-56.058	12.725	**0.000**	-89.226	-22.889
		12 - 15	-25.198	12.948	0.215	-58.949	8.553
CRT	**<= 9**	**9 - 12**	42.117	19.338	0.136	-8.290	92.523
		12 - 15	87.475	19.518	**0.000**	36.599	138.351
		15+	120.884	19.975	**0.000**	68.816	172.952
	9 - 12	**<= 9**	-42.117	19.338	0.136	-92.523	8.290
		12 - 15	45.359	13.401	**0.005**	10.427	80.290
		15+	78.768	14.059	**0.000**	42.122	115.414
	12 - 15	**<= 9**	-87.475	19.518	**0.000**	-138.351	-36.599
		9 - 12	-45.359	13.401	**0.005**	-80.290	-10.427
		15+	33.409	14.305	0.096	-3.880	70.698
	15+	**<= 9**	-120.884	19.975	**0.000**	-172.952	-68.816
		9 - 12	-78.768	14.059	**0.000**	-115.414	-42.122
		12 - 15	-33.409	14.305	0.096	-70.698	3.880

Figure 1. Differences in reaction time in relation to the age category and the applied reaction time task



DISCUSSION

The results of the descriptive statistical analysis have shown that the coefficient of variation (%cV) of the results for the SRT variable range from 12.10 to 16.89% (Table 1). Determined values of the same statistic range from 15.54 to 28.18% for the GNGRT variable and from 15.96 to 23.14% when considering the CRT (Table 1). The results of the Shapiro-Wilk goodness of fit test have shown that the assumption of normality of the distribution of the results was violated only for the results of GNGRT when considering the age 12-15 years (W=0.903, p=0.003). For all other conditions, i.e. combinations of age category and type of reaction task it was determined that the results were normally distributed, p>0.05 (Table 2). On the basis of the aforementioned, it can be concluded that the obtained results are generally normally distributed and have a high level of homogeneity, which makes them representative in terms of further scientific processing and interpretation (Perić, 2003).

It was determined that mean simple visual reaction time (SRT) was at the level of 177.75±22.98, 171.58±20.76, 157.42±26.59 and 143.38±18.96 ms, for the subsamples of age <= 9, 9-12, 12-15, 15+ years, respectively (Table 1). Results of ANOVA have shown that, on a general level, differences in SRT in relation to age groups are statistically significant (F = 11.770, p = 0.000) (Table 3). Multiple comparisons using Tukey HSD test have determined statistically significant differences in SRT between group <=9 and groups 12-15 and 15+ (Mean Diff. = 20.327, p = 0.038 and Mean Diff. = 34.374, p = 0.000, respectively) as well as between group 9-12 and groups 12-15 and 15+ (Mean Diff. = 14.152, p = 0.034 and Mean Diff. = 28.199, p = 0.000, respectively) (Table 4). For the GNGRT it was determined that reaction time was 298.47±54.31, 272.95±49.07, 242.09±68.23 and 216.89±33.71 ms, for the subsamples of age <= 9, 9-12, 12-15, 15+ years, respectively (Table 1). A statistically significant effect of age on GNGRT at the p = 0.000 level with an F value of 10.053 was determined using ANOVA (Table3). The results of post hoc tests (Tukey HSD) have shown that statistically significant differences in GNGRT exist between groups <=9 and 12-15 (Mean Diff. = 56.382, p = 0.010), <=9 and 15+ (Mean Diff. = 81.580, p = 0.000) as well as between groups 9-12 and 15+ (Mean Diff. = 56.058, p = 0.000) (Table 4). Similar to the SRT and GNGRT the reaction time required for choice reactions (CRT) decreased as a function of the age category. The determined values of CRT at the level of 378.58±67.83, 336.47±59.00, 291.11±67.35 and 257.70±41.13 ms, were determined for groups of age <= 9, 9-12, 12-15, 15+ years, respectively (Table 1). Results of ANOVA have shown that, on a general level, differences in SRT in relation to age groups are statistically significant (F = 17.466, p = 0.000) (Table 2). Based on the results of Tukey HSD post hoc test it was determined that statistically significant partial differences in CRT exist between groups <=9 and 12-15 (Mean Diff. = 87.475, p = 0.000), <=9 and 15+ (Mean Diff. = 120.884, p = 0.000), 9-12 and 12-15 (Mean Diff. = 45.359, p = 0.005) and groups 9-12 and 15+ (Mean Diff. = 78.768, p = 0.000) (Table 4).

The present study further confirms the previous findings that indicate a general shortening of reaction time in different tasks during childhood and adolescence. When compared with the available scientific literature which indicates that mean simple reaction time (SRT) on a visual stimulus is approximately 190-200 ms (Kosinski, 2008; Marković & Dopsaj, 2018; Marković, Vučković, & Janković, 2019; Milošević, 2002) the present study has determined somewhat shorter reaction times which can be attributed to the differences in the applied methodology, and was consistently found for other reactions tasks, i.e. GNGRT and CRT. However, the results on SRT and CRT are very similar to those found by Coşkun et al. (2014). The presented results indicate an apparent trend of SRT shortening with age (Figure 1) which is in line with the previous findings (Coşkun et al., 2014; Kosinski, 2008), although this seems more accentuated during puberty. The ability to repress an unsuitable response and to react only in the presence of an adequate stimulus, measured using GNGRT (Fontani et al., 2006) is being gradually developed during childhood and adolescence. The shortening of GNGRT over age categories found in this study was nearly constant (30ms per age category) and is shown in Figure 1. The same applies to the CRT task where the reaction time decreased approximately 40 ms per age category. Very similar values of the obtained results and the determined differences between age categories confirm the result of previous research (Coşkun et al., 2014) conducted on karate athletes., i.e. that reaction time differences are significant when comparing children and adolescents.

This research has confirmed previous findings regarding differences in visual reaction time in different reaction time tasks and in relation to the age of the participants involved in open skill sports. The presented results reflect the processes of development and maturation of neuro-visual, cognitive and motor potential of the human body during childhood and adolescence, which are certainly accentuated by regular physical activity and training.

CONCLUSION

This paper is aimed to define differences in visual reaction time related to age category and the type of the presented visual reaction task, i.e. differences in simple (SRT), Go/no-go (GNGRT) and choice (CRT) reaction time in children and adolescents involved in open skill sports. The sample in this research consisted of a total of 120 participants of which 52 boys and 68 girls and was further divided into 4 subsamples in relation to the age of the participants: <= 9, 9-12, 12-15, 15+ years. Mean simple visual reaction time (SRT) of 177.75±22.98, 171.58±20.76, 157.42±26.59 and 143.38±18.96 ms, was determined for the respective subsamples. Mean go/no-go reaction time (GNRT) of 298.47±54.31, 272.95±49.07, 242.09±68.23 and 216.89±33.71 ms, was determined for the <= 9, 9-12, 12-15, 15+ subsamples, respectively. For the same subsamples, the determined mean choice reaction time (CRT) was at the level of 378.58±67.83, 336.47±59.00, 291.11±67.35 and 257.70±41.13 ms, respectively. Results of ANOVA have shown that these differences were statistically significant at a general level for all three types of reaction tasks (SRT – F=11.770, p=0.000, GNRT – F=10.053, p=0.000, CRT – F=17.466, p=0.000) and Tukey HSD test has revealed statistically significant partial differences ($p<0.05$) for between groups of age <=9 and 9-12 and groups of age 12-15 and 15+ for SRT, GNGRT, and CRT. This confirms previous findings regarding differences in visual reaction time in different RT tasks and in relation to the age category. Although the presented results generally reflect the processes of development and maturation of neuro-visual, cognitive and motor potential of the human body during childhood and adolescence further research is necessary in order to determine the effects of regular involvement in open skill sports on reaction capabilities of children and adolescents.

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DIFFERENCES BETWEEN THE PROFESSIONAL AND THE AMATEUR FOOTBALL PLAYERS IN THE PERCEPTION OF COACHING BEHAVIOR

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ABSTRACT

The aim of this study was to investigate the differences between professional and amateur football players in the perception of coaching behavior. The sample included 75 football players, 50 professional rankings (Mean age 23.58 ± 3.55 years) and 25 amateur rankings (Mean age 24.00 ± 3.74 years) who had voluntarily participated in the research. The main data collection tools have included the personal information form and the Leadership Scale for Sport. The data was analyzed by way of SPSS 20.0 and, more specifically, by means of descriptive statistics and T-test for the small independent samples. The findings have reveaed that along all the dimensions of the questionnaire there was a statistically significant difference at the level of r <.005, except in the case of the Instruction scale, where the difference was at the level of r <.05. The sample has shown that athletes have different perceptions of the coach behavior, which can be further indicative of the coaches of professional and amateur competitive rank having a different approach to athletes training.

Keywords: instructiveness, democratic and autocratic behavior, social support, positive feedback

INTRODUCTION

The relationship between a coach and an athlete is a very complex phenomenon that can be affected by many variables. Furthermore, this relationship can significantly influence the development of athletes and their sport career (Gesualdo 2011; Jurko, Tomljanović, & Čular, 2013). The attitudes held by an athlete and a coach resemble a two-way street. Therefore, it is very important to examine how an athlete experiences or evaluates the coach and the coach's behavior. Individual and team sports set different expectations for coaches and athletes, their relationship included. The way athletes notice their coaches' behaviors affect everyone included as well as the sport achievements themselves which is influenced by a number of psychological variables (attitudes, emotions, goals) (Aleksic Veljkovic, Djurovic, Dimic, Mujanovic, & Zivcic Markovic 2016).

Both the atmosphere and the overall relationship between the athletes in the team are associated with coach leadership. They depend on whether the coach is focused on improving the performance of the athletes in a variety of physical training segments, or the focus is solely on the result, i.e. to win a competition or a game (Aleksic Veljkovic et al. 2016). The findings of the previous studies on the topic reveal that the coach behavior aimed at improving the performance of athletes has been evaluated higher by the athletes in the individual sports. The individual sports coaches provided more instructions to the athletes concerning the overall performance - sport and organization activities underlying their skills, techniques, and tactics, more precisely. Also, the individual sport athletes showed greater appreciation for the coaches' concern for the welfare of the athletes, resulting, in turn, in the creation of a positive environment and interpersonal relationships (Kenow & Williams, 2016; Murray, 2006). Results show that the behavior of a coach related to the reinforcing athlete reinforcement and recognition, and the rewarding, of good performances has been rated more in the case of individual sports. One of the findings of Siekanska et al. (2013) suggests that the high-expectation athletes may perceive coaching behavior as something that inhibits (rather than enhances) their athletic progress. It is known that false assumptions regarding the athlete's performance potential may bring about negative

effects when it comes to the actual performance outcomes.

The level of sport achievements was also found to affect the perception of what hindered the athletic development. Athletes occupying the lower sport levels pointed out to the presence of excessive criticism. This was, however, not the case with their renowned counterparts. Such a difference can be related to a different interpretation of the coach's behavior (Siekanska et al., 2013). Following this lead, we have decided to investigate the difference within football players specifically. The aim of this study was, therefore, to explore and reveal the particular differences in the perception of coaching behavior between the professional and the amateur football players at the senior competition rank.

METHODS

Subjects

The sample has consisted of 75 male football players, senior competition rank, divided into two sub-samples: 50 professional competition rank (age 23.58 ± 3.55) and 25 amateur competition rank (age 24.00 ± 3.74) players. The rrespondents have completed the Coach Behavior Questionnaires (Leadership Scale in Sport) (Chelladurai, 1990) as well as provided the general data pertaining to the duration of their football practicing at the time when they first started their official training, to the length of their training with the current coach and to the count of training hours per week. The data have been presented in Table 1.

Procedure

The Leadership Scale for Sport (LSS) is the most commonly used questionnaire for examining the coaching behavior (Chelladurai, 1990). It contains five subscales that outline the dimensions of the coach's behavior: (1) instructiveness (describing the athletic skills and the coach's tactical instructions aimed at improving athletes' performance); (2) democratic behavior; (3) autocratic behavior (related to the coach decision making); (4) social support and (5) positive feedback. The internal consistency estimates have ranged from .45 to .93, whereas the test-retest reliability coefficients ranged from .71 to .82. The relative stability of the factor structure across the different samples confirmed the factorial validity of the scale. In addition, the interpretation of the factors has served to establish the scale content validity (Chelladurai & Saleh, 2016)

Statistical analysis

The statistical analysis has been conducted by means of SPSS 20.0 software. As a part of it, the basic descriptive statistical data were calculated for the analyzed quantitative variables. As a foundation for the comparisons, the T-test for the small independent samples has been used. The results where p was lower than the accepted significance level ($p < .05$) have been considered statistically significant.

RESULTS

Following the order of the data processing methods this chapter presents the results of the research and the interpretation of the obtained data.

Table 1. The basic descriptive statistical parameters of the general data variables

Variables	Competition rang	N	Mean	SD	r
Age	Professional	50	23.58	3.55	.63
	Amateur	25	24.00	3.74	
Sports internship	Professional	50	15.18	3.29	.75
	Amateur	25	14.92	3.74	
Start of the carieer	Professional	50	7.96	1.14	.37
	Amateur	25	8.32	2.36	
Training with the current coach (years)	Professional	50	1.68	.65	.03
	Amateur	25	1.36	.49	
Hours per week with the c(hours)	Professional	50	11.10	2.08	**.00**
	Amateur	25	6.48	1.58	

Professional-ranked football players spend, on average, more time per week with a coach (11.10 ± 2.08) than the amateur-ranked football players (6.48 ± 1.58).

Table 2 presents the descriptive data of the variables covered by the survey. For all the variables, the following basic descriptive parameters were calculated: Mean, Standard deviation (SD), Skew coefficients and Kurt.

Table 2. Descriptive statistical parameters for professional-level respondents

Variables	N	Min.	Max.	Mean	SD	Skew.	Kurt.
Instructiveness	50	2.62	4.92	3.39	.52	.80	-.00
Democratic behavior	50	1.67	4.44	2.59	.61	1.26	1.61
Autocratic behavior	50	2.60	4.20	3.39	.37	.09	-.25
Social support	50	1.50	4.13	2.52	.59	1.10	1.15
Positive feedback	50	2.60	5.00	3.54	.65	.74	-.32
Total score	50	12.61	22.49	15.43	2.15	1.36	1.90

Mean - mean, SD - standard deviation, Skew. - coefficient of asymmetry, Kurt. - coefficient of curvature

The mean score on the respondents subscales in the professional competition rank is the highest on the Instruction, Autocratic Behavior and Positive Feedback subscales, while the lowest average value is on the Social Support scale, which refers to the coaches' concern for the well-being of their athlete.

Table 3 presents the basic descriptive statistical parameters of the variables covered by the survey. For all the variables, the following basic descriptive parameters were calculated: Mean, Standard deviation (SD), Skewness coefficients, and Kurtosis.

Table 3. Descriptive statistical parameters for amateur level respondents

Varijable	N	Min.	Max.	Mean	SD	Skew.	Kurt.
Instructiveness	25	2.92	4.77	3.67	.49	.11	-.42
Democratic behavior	25	2.11	4.67	3.25	.55	.11	.91
Autocratic behavior	25	2.20	3.80	3.00	.40	.14	-.20
Social support	25	2.00	4.00	3.01	.48	.17	-.19
Positive feedback	25	3.00	4.80	3.95	.42	-.01	.16
Total score	25	13.55	21.15	16.88	1.69	.51	.56

Mean - mean, SD - standard deviation, Skew. - coefficient of asymmetry, Kurt. - coefficient of curvature

Respondents coming from the amateur competition rank have ascribed the highest values concerning their coaches on the Positive Feedback scale. Table 3 shows the results of the T-test for the small independent samples, which allows for the determination of the difference(s) between the professional and the amateur competition level. It has been found that along all the dimensions there is a statistically significant difference at the level of $r < .005$, except in the case of the Instruction scale, where the difference was at the level of $r < .05$. The sample of athletes covered by this survey is characterized by different perceptions of the coach's behavior, which indicates that coaches belonging to the professional and the amateur competition rank differ significantly in their behavior towards their athletes. All the obtained results corroborate the initial hypotheses.

Table 4. T - test for small independent samples

Variables	t	df	Sig. (2-tailed)	Mean Difference	Std. Difference	95% Confidence Interval Errorof the Difference Lower	Upper
Instructiveness	-2.29	50.89	.03	-.28	.12	-.53	-.03
Democratic behavior	-4.67	52.62	.00	-.66	.14	-.94	-.37
Autocratic behavior	4.05	45.03	.00	.39	.09	.19	.58
Social support	-3.86	57.76	.00	-.49	.13	-.74	-.23
Positive feedback	-3.30	68.59	.00	-.41	.12	-.66	-.16
Total score	-3.18	59.49	.00	-1.45	.45	-2.36	-.54

The aim of this research was to conceptualize the behavior of coaches in football between professional and amateur competition rank. This topic has so far been studied in a number of research (Bortoli, 2015; Kenow & Williams, 1999; Siekanska et al., 2013). Siekanska et al. (2013) have investigated gender differences in the perception of the coach-athlete interactions. The results have revealed that females were ready to build up a relationship and spend time with other members of their team more often than the males. Therefore, they paid more attention to the coaching behaviors manifested in the form of the maintaining of good spirit and personalized training sessions. On the other hand, males have focused more on such factors as the control and the error correction because in their case they have served as specific clues toward peak performance.

The differences between the professional and the amateur competition coaches were the lowest in the case of the Instruction Scale, which characterizes sport behavior aimed at improving the performance of athletes by emphasizing and facilitating difficult and strenuous exercises,

training skills, techniques and sport tactics as well as cooperation development among the athletes.

Kashnar's (2016) research results indicate that athletes favor a more instructive leadership style, i.e. a coach who provides information, general instruction, training and exercise specific instruction, technique explanations, tactics, aligns the efforts of athletes and has patience, all crucial for the process of effective sport learning and training. Instructive behavior (training and instruction) provides feedback, and is characterized by rewarding compensation and coaching behavior that motivates athletes by recognizing, acknowledging and balancing good performance. A coach praises the athlete for the good performance, explains to the individual when s/he performs a task well, tries to always reward the athlete for the good performance and expresses satisfaction when the athlete performs the planned activities well.

An earlier study (Aleksic Veljkovic et al. 2016) of the perception of coaches' behavior in sports showed that there is a significant difference between the styles of behavior in individual and team sports. The results have shown that athletes in individual sports prefer the democratic

behavior of coaches, meaning that the coach includes the athletes into the decision-making process concerning the goals, tactics, and the competion/game strategy, as opposed to the autocratic behavior of coaches who make decisions without previously consulting athletes. Also, the research has shown differences in the leadership behaviors in male and female coaches. For example, Jambor & Zhang (1997) found female coaches to play a greater role in the socially supportive behaviors

compared to the male coaches, while Mondello & Janelle (2001) found that male team coaches gave more positive feedback to their athletes compared to the female coaches (Gesualdo, 2011).

The evaluation of the athletes can be influenced by three groups of variables: situational such as the nature of the sport, the level and the nature of the competition and the atmosphere in the team. The second group is comprised of the variables that mainly relate to the individual differences between the coaches and the athletes such as the gender, age, attitudes, motives, goals. The third group of variables concerns the dimensions of the coach's perception of the athlete's behavior.

All the players should be treated equally by their fellow players and their coaches, otherwise, the crucial harmony within the team is easily disturbed. The players are those who, by far, feel and experience the impact of the coach's work. The interesting thing is that they attach less importance to the knowledge of the game, and more to the character traits of the coaches. This is the essential reason why their opinion in the debate on what makes a coach great (or not) is invaluable. In this research, the goal was to identify differences with respect to the level of competition and it was shown that differences exist.

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SELF-EFFICACY AND INTERPERSONAL ORIENTATION IN THE PREFERENCE FOR THE TYPE OF SPORT AMONG STUDENTS OF FACULTY OF SPORT AND PHYSICAL EDUCATION

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ABSTRACT

The main aim of this research was to determine whether self-efficacy and interpersonal orientation influence on the subject's preference for the type of sport- collective or individual. The survey was conducted on the sample of 149 people, 109 of which being male and 40 participants were female. The results in this study showed that there is no statistically significant difference between the subscales of the Interpersonal orientation (Need for people, Friendship, Distrust, Social isolation) and General self-efficacy with the preference for the type of sport among the students of the Faculty of Sport and Physical Education in Niš.

Keywords: self-efficacy, interpersonal orientation, sport, students

INTRODUCTION

Self-efficacy

How we perform a task, activity, or obligation depends on our beliefs about our own effectiveness, as well as those specific to a particular situation. Beliefs about self-efficacy determine how people feel, think, motivate themselves, and therefore how they behave. Bandura (1997) believes that efficacy beliefs are a key factor in the composition of human capabilities. It has been shown that different people with similar skills, or the same person in different backgrounds, can perform an action poorly, adequately or even excellently, depending on the change in belief in personal effectiveness. Effective functioning requires both the skills and the belief that we can use those skills effectively. This theory predicts that when the perception of self-efficacy is high, a person will engage in tasks that enhance the development of his or her skills and abilities, and when self-efficacy is low, people will not engage in new tasks that could be used by them to acquire new skills. In addition, by avoiding such tasks, the person will not receive any feedback that can counteract the negative perception of self-efficacy. People who underestimate their efficiency will limit their potential for advancement and development, and accordingly, if they do not take on greater challenges, are likely to suffer from unnecessary anxiety and self-doubt that may increase the likelihood of failure (Pintrich and Schunk, 1996).

Self-efficacy beliefs are formed based on several sources of information. The most important source is personal experience in similar situations. Successful past experiences build a strong sense of self-efficacy, while failures weaken it. Observing others' success is another source of belief in self-efficacy. This source has less power of personal experience and depends on the observer's assessment of the similarity between himself and the model and the importance of the model to the observer. Research has shown how vicarious experiences in terms of modeling can enhance the self-efficacy of individuals and lead to enhanced performance (Feltz, Landers & Raeder, 1979; McAuley, 1985).

When it comes to the sports domain, athletes can have performance evaluations of their abilities, skills and strength to overcome the challenges they need, but they can also have an expectation of an outcome, in terms of how they will fare in a competitive context, whether they will master an opponent. In theory of self-efficacy, these are two basic types of expectation in the process of

realizing goal-directed behavior: expectation of efficiency and expectation of an outcome. Self-efficacy expectations should not be confused with outcome expectations. Outcome expectancies are defined as the belief that certain behaviors will lead to certain outcomes. Self-efficacy, on the other hand, is the belief in one's ability to successfully perform the behavior in question. (Bandura, 1977).

Self-efficacy is a recognizable and valuable trait within the sport. Players, coaches and sports psychologists all know how strong this psychological construct is on the thoughts, feelings, behaviors, and especially the player's performance. Athletes equate self-efficacy with self-confidence, and often attribute successes on the field to being confident, and failures to not have enough confidence in their game or to completely lose confidence in it. In team sports, athletes recognize the need to have confidence not only in themselves but also in their teammates - in the whole team. Coaches are very interested in learning about methods that can help athletes build, maintain and regain confidence. They also understand that their confidence in their own ability to train athletes is important and, when present, creates a powerful effect on athletes. Sports psychologists are often called upon to design training sessions with psychological skills that incorporate strategies for improving efficiency (Feltz, D. L., Short, S. E., & Sullivan, P. J., 2008).

Interpersonal theory

“A personality can never be isolated from the complex of interpersonal relations in which the person lives and has his being” (Sullivan, 1953a, p. 10).

According to Sullivan, interpersonal learning of social behaviors and self-concept is based on an anxiety gradient associated with interpersonal situations (1953b). He said that every interpersonal situation can be ranged from rewarding (where people feel highly secure) through various levels of anxiety, and ending in series of situations associated with such intense anxiety that they are dissociated from experience.

Karen Horney (1945) proposed a tripartite interpersonal model that fits the established goals. Horney provided a rationale for thinking in terms of three basic interpersonal configurations. These configurations help to explain a person's perception of his social environment and his actions toward the objects in his life space. According to Horney, people can be placed into three groups, which reflect their predominant mode of response to others: (1) those who move toward people (complaint), (2) those who move against people (aggressive), and (3) those who move away from people (detached). Each mode of response involves a different strategic method of coping with other people.

Compliant-oriented people want to be part of the activities of others. They wish to be loved, wanted, appreciated, and needed. They see in other people a solution for many problems of life and wish to be protected, helped, and guided.

Aggressive-oriented people want to excel, to achieve success, prestige, and admiration. Other people are seen as competitors. Aggressive people strive to be superior strategists, to control their emotions, and to bring their fears under control. Strength, power, and unemotional realism are seen as necessary qualities to them.

Detached-oriented people want to put emotional "distance" between themselves and others. Freedom from obligations, independence, and self-sufficiency are highly valued. Such people do not want to be influenced or to share experiences. Detached people consider themselves more or less unique, possessing certain gifts and abilities that should be recognized without having any need to go out of their way to show them to others. The detached type is distrustful of others, but does not wish to "stay and fight." Homey suggested that people frustrated in their compliant or aggressive tendencies, or both, may well adopt this response trait.

The construct of interpersonal orientation (IO) is proposed as useful for understanding behavior in certain social situations. The ones who have high IOs are interested in other people and they tend to make more contacts; the ones with low IOs are less interested and responsive to others.

METHODS

The main purpose of this study was to determine whether self-efficacy and interpersonal orientation influence on the subject’s preference for the type of sport they choose- collective or individual.

Subjects

This research is aimed at the student population of Faculty of Sport and Physical Education in Niš. The sample consisted of 149 students, 109 male and 40 female. All of them have a preference in the particular sport and in this research it is registered 19 different collective or individual sports (football, basketball, handball, volleyball, water polo, American football, swimming, synchronized swimming, dancing, cycling, fencing, aikido, judo, karate, kick-box, MMA, gymnastics, athletics, fitness).

Procedure

For this research it has been used the scale of General self-efficacy and the scale of Interpersonal orientation. The original version of the General self-efficacy scale was constructed by Schwarzer and el. in 1997 (Schwarzer, Basler, Kwiatek, Schroder, Zhang, 1997). At first it consisted out of 20 items, but then was reduced to 10 items. In the research of Croatian subjects, it has shown internal consistency reliability Cronbach alpha from .853 to .874 (Ivanov, Penezić, Gregov, 1998; Penezić et al., 1998, 1999). Cronbach alpha for the scale in this research is .709.

The scale of Interpersonal orientation was constructed by Bezinović in 1987 (Bezinović, 1987). In the research of Lacković-Grgin et al. (1988) reliability of all four subscales was checked (The need for people, Friendship, Distrust and Social isolation) and the Cronbach alpha was .85, .82, .81 and .79. In this research, the Cronbach alpha for every subscale is .78, .77, .69 and .75.

Statistical analysis

The obtained data were processed by the following procedures:

- Descriptive statistics
- T-test

RESULTS

Table 1 and table 2 present frequencies and percentages of 19 different sports that were registered in this study.

Table 1. Descriptive statistics- sport

Type of sport	Football	Basketball	Handball	Volleyball	Water polo	American football	Swimming	Synchronized swimming	Dancing
Frequency	30	20	15	16	6	2	9	3	7
Percent	20.1	13.4	10.7	10.1	4.0	1.3	6.0	2.0	4.7

Table 2. Descriptive statistics- sport

Type of sport	Forcing	Cycling	Judo	Karate	Aikido	Kick-box	MMA	Athletics	Gymnastics	Fitness	Total
Frequency	1	3	7	5	4	5	1	7	3	5	149
Percent	.7	2.0	4.7	3.4	2.7	3.4	.7	4.7	2.0	3.4	100.0

Table 3. Descriptive statistics- subscales of the Interpersonal orientation

Subscales	N	Min	Max	AS	SD
Need for people	149	2	30	16.4	5.8
Friendship	149	3	32	18.8	5.8
Distrust	149	4	26	13.9	4.8
Social isolation	149	.0	23	9.7	4.9

Table 3 presents descriptive statistics of all four subscales of the Interpersonal orientation scale- empirical minimum and maximum, means and standard deviation.

The results presented in the table number 4 and 5 show that there is no statistical significance between tested variables (Need for people, Friendship, Distrust, Social isolation, General self-efficacy) and the type of sport (collective or individual), nor between tested variables and the gender.

Table 4. The difference in expression of subscales of the Interpersonal orientation and General self-efficacy regarding to the type of sport (T-test)

Subscales	Sport	N	Mean	t	p
Need for people	collective	89	17	1.614	.119
	individual	60	15.5		
Friendship	collective	89	19.2	.981	.384
	individual	60	18.3		
Distrust	collective	89	13.8	-.338	.108
	individual	60	14.1		
Social isolation	collective	89	10.1	.961	.928
	individual	60	9.3		
General self-efficacy	collective	89	39.1	-.410	.925
	individual	60	39.7		

Table 5. The difference in expression of subscales of the Interpersonal orientation and General self-efficacy regarding to the gender (T-test)

Subscales	Gender	N	Mean	t	p
Need for people	male	109	16.3	-.339	.112
	female	40	16.7		
Friendship	male	109	18.9	.175	.963
	female	40	18.7		
Distrust	male	109	13.9	-.224	.784
	female	40	14.1		
Social isolation	male	109	9.9	.696	.929
	female	40	9.3		
General self-efficacy	male	109	39	-.729	.290
	female	40	40.2		

DISCUSSION

According to the results of this study, there is no statistically significant difference between subscales of the Interpersonal orientation, that are Need for people, Friendship, Distrust and Social isolation, and General self-efficacy regarding to the type of sport- collective or individual, that respondents in this research prefer. Knowing the theory, it was to be expected that respondents who prefer collective sport over individual would have higher scores on the subscale of Need for people and Friendship, and lower scores on the subscales of Distrust, Social isolation and General self-efficacy. For the ones who prefer individual over collective sport, the opposite is expected. The results in this study can be explained by the sample, which is composed of the students that are not professionals in the sports they participate in. Being a professional implies to have at least two training sessions per day, to have 10+ trainings per week and to always be prepared for the upcoming competitions. Students who study and train can be considered as amateurs in sport, who maybe once were professionals, but with new obligations which faculty requires, everyday lectures, practices and studying for the exams, it is very hard to keep up with described training rhythm. Having knew that fact, we can conclude that they are not as engaged in the training process and competitive routine as professionals and they do not take their engagement in sport that seriously. Continuing trainings have influence not only on physical aspects of the athlete, but on psychological as well. Doing sports from the young age at that high level of engagement forms certain habits and constructs in behaviour.

The results of the study on the difference in expression of subscales of the Interpersonal orientation and General self-efficacy regarding to the gender also show that there is no statistical significance between them. Taking this in notice, we can conclude that being more or less self-efficient and more or less interpersonal oriented is not gender related.

CONCLUSION

Summarizing the results presented above, it can be concluded that there is no statistically significant difference between variables of this research and the preference of the type of sport that students of the Faculty of Sport and Physical Education choose. We can also conclude that there is no difference between these variables and the student's gender.

The basic limitations of this study are the sample and the absence of knowing for how long

and how much is every of respondents engaged in the sport they have chosen as their preference. Also, one of the weaknesses of this study, which is typical for this type of research, refers to the adequacy and motivation of respondents to provide introspective psychological data on the given questions.

At the end, recommendation for the following researchers is to examine this topic more minutely. Also, by conducting this study on the sample of the professional athletes, surely different and more scientifically worth results will be obtained.

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RELATION BETWEEN HAND GRIP CONTRACTILE CHARACTERISTICS AND SIMPLE FAST ARM MOVEMENT MEASURED BY IMU SENSORS

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ABSTRACT

Fast and simple movements are the main form of movements in all sports. The aim of this paper is to determine the relations between contractile and kinematic characteristics of simple, rapid movements of the dominant arm. The research involved 38 subjects, students of the University of Belgrade and Ljubljana (19 males and 19 females). Measurements of the contractile characteristics of the hand were performed using a standardized Hand Grip test by application of tensiometric dynamometry. Measurement of the kinematic characteristics of the maximally fast arm motion was performed using the adapted "Hand tapping test" and an IMU sensor. In the tested group of men, a statistically significant correlation was found between three pairs of variables, and in the group of tested women group between five pairs of variables. The results have shown that the maximally fast hand movements are statistically significantly influenced by the contractile ability of the absolute maximum force generation and that in the tested men's and women's group the correlation structure of the pairs of variables differed in the two examined spaces.

Keywords: muscle force, muscle explosiveness, rapid movement, acceleration

INTRODUCTION

Fast simple movements are the main form of movements in all sports (Verkohshansky, 1996). In monitoring system of applied training methods, systematic testing is an important process for periodically determining the actual physical condition of the athlete. From the aspect of the movement, sport is a complex system. The motor complexity in terms of sports specific movement pattern requires a specially developed control system. One of the basic procedures for controlling the athlete's training is the testing system. Sport results in top achievements have a more or less constant trend of progress. Improvements of the testing system provide the conditions for increasing the training efficiency and consequently, the continuity of progress of the sports results (Gembris et al., 2002).

Laboratory testing and field testing are dominant methods of information gathering for athletes. The given information indicates the level of athletes physical fitness, and it is also used for calculating the potential of physical abilities and the efficiency of athletes performance (Tanner & Gore, 2013; Dopsaj, 2015).

The phenomenology of quantitative relationships between physical fitness data obtained by measuring some basic physical property under non-specific stress conditions, and data obtained by measuring characteristic movements under specific stress conditions, has not yet been sufficiently explored in the sports sciences.

The development of sports science in testing athletes increasingly requires a multi-structured approach to data sampling, that is, the application of multiple measurement methods. In this sense, more and more researchers are concerned with the measurement of basic physical properties, expressed in non-specific and specific conditions of competitive stress (Zarić et al., 2018). The main goal of such research is to define new informative measures of different basic and sports specific

tests conditions for determining the level of specific or competitive physical fitness (Markovic et al., 2017; Kos et al., 2019).

However, when performing a single movement the maximum speed represents one of the most important physical abilities for athletes, whether or not they are tested in basic, i.e., non-specific or sports specific conditions.

The relationship between the fundamental, i.e. isometric contractile potential of the muscle, which can be measured by the maximal level of achievable voluntary force, by various characteristics of the explosive force and the characteristics of the single movement realized with maximal speed, have not been sufficiently explored in the system of sports science. For this reason, it is not yet known to what extent and how the contractile ability is associated with the manifestation of maximum movement speed. Therefore, this paper aims to determine the relationship between contractile characteristics and kinematic characteristics realized in a simple, maximally rapid, movement of the dominant arm.

METHODS

Subjects

The research involved 38 subjects, students of the University of Belgrade and Ljubljana (19 males, Age=25.2±6.2 yrs., BH=186.6±6.0 cm, 86.3±12.6 kg, BMI=24.87±3.01 kg•m^{-2}, and 19 females, Age=23.9±5.1 yrs., BH=167.1±5.5 cm, 59.2±8.5 kg, BMI=21.12±1.93 kg•m^{-2}).

Procedure

Measurements of the contractile characteristics of the hand were performed by a standardized Hand Grip test on the dominant arm using the method of tensiometric dynamometry (Marković et al., 2018; Zarić et al., 2018; Dopsaj et al., 2019) with five variables:

- F_{max} - maximal force, expressed in N,
- RFD_{max} - maximal level of explosive force, i.e., maximal explosiveness, expressed in N/s,
- $RFDF_{max}$ – the general level of explosive force, i.e., basic explosiveness, expressed in N/s,
- tF_{max} - time to reach F_{max}, expressed in s,
- $tRFD_{max}$ - time to reach RFD_{max}, expressed in s,

Measurements of the kinematic characteristics of the maximally fast arm motion were performed using an adapted "Hand tapping test" (Figure 1) and an IMU (Inertial Measurement Unit) sensor (STMicroelectronics LSM6DS33, 2017). The acquired hand acceleration signal is processed and characterized by seven variables:

1. t_1 - the time from the start of the movement to the first tap with hand, expressed in s,
2. t_2 - the time from the first tap to the second tap with hand, expressed in s,
3. t_{sum} - the total tapping time, expressed in s,
4. $Amax_1$ - maximum acceleration, expressed in m/s^2,
5. $Amax_2$ - maximum deceleration expressed in m/s^2,
6. dA/dt_1 - maximum acceleration gradient, expressed in m/s^3, and,
7. dA/dt_2 - maximum deceleration gradient, expressed in m/s^3.

It should be noted that all acceleration-related variables were measured in the first part of taping, until the first tap with hand.

Statistical analysis

The basic descriptive statistics measures of central tendency (MEAN) and data dispersion (standard deviation - SD and coefficient of variation - cV%) were calculated. The relations between the observed variables were determined by applying a parametric correlation analysis - Pearson correlations. All statistical analyses were conducted using SPSS Statistics v19.0 software package, while the level of statistical significance was defined for the 95.0% probability criterion, i.e. $p < 0.05$.

RESULTS

Table 1 shows all calculated descriptive statistics with the examined variables separately by gender.

Table 1. Results of descriptive statistical analyses in handgrip test and hand tapping test.

	MALE			FEMALE		
	Mean	SD	cV%	Mean	SD	cV%
Fmax (N)	529.87	95.11	17.95	323.72	62.88	19.42
RFDmax (N/s)	3528.87	703.92	19.95	2116.55	494.79	23.38
tFmax (s)	0.683	0.280	40.97	0.638	0.282	44.18
RFDFmax (N/s)	901.21	358.60	39.79	623.95	321.40	51.51
tRFDmax (s)	0.119	0.012	9.85	0.122	0.010	8.15
t_1 (s)	0.187	0.029	15.22	0.215	0.032	14.76
t_2 (s)	0.195	0.030	15.29	0.202	0.029	14.37
t_SUM (s)	0.382	0.053	13.77	0.416	0.054	12.88
Amax_1 (m/s²)	5.697	1.716	30.12	4.253	1.336	31.42
Amax_2 (m/s²)	11.128	3.490	31.36	9.494	2.919	30.75
dA_dT_1 (m/s³)	74.110	29.023	39.16	53.585	20.528	38.31
dA_dT_2 (m/s³)	205.644	66.593	32.38	167.311	94.305	56.37

Table 2. Correlation between contractile characteristics of the dominant hand and kinematic characteristics of the maximally fast arm motion for the male sample.

	Male sample	**t_1**	**t_2**	**t_SUM**	**Amax_1**	**Amax_2**	**dA_dT_1**	**dA_dT_2**
Fmax	Pearson Correlation	-.376	-.383	*-.418*	.291	.214	.127	-.052
	Sig. (2-tailed)	.113	.105	*.075*	.227	.380	.604	.833
RFDmax	Pearson Correlation	*-.445*	*-.401*	**-.465***	.312	.316	.156	-.097
	Sig. (2-tailed)	*.056*	*.089*	**.045**	.193	.187	.524	.691
tFmax	Pearson Correlation	-.047	.164	.064	-.066	-.169	-.316	-.203
	Sig. (2-tailed)	.847	.503	.795	.789	.489	.188	.405
RFDFmax	Pearson Correlation	-.178	-.341	-.287	.295	.332	**.498***	.241
	Sig. (2-tailed)	.467	.153	.234	.220	.165	**.030**	.321
tRFDmax	Pearson Correlation	**.517***	.085	.330	*-.438*	-.338	-.361	.132
	Sig. (2-tailed)	**.023**	.729	.168	*.061*	.157	.128	.589

Table 3. Correlation between contractile characteristics of the dominant hand and the kinematic characteristics of the maximally fast arm motion for the female sample.

	Female sample	**t_1**	**t_2**	**t_SUM**	**A_{max}_1**	**A_{max}_2**	**dA_dT_1**	**dA_dT_2**
Fmax	Pearson Correlation	**-.485***	-.166	-.377	*.398*	.084	.304	.382
	Sig. (2-tailed)	**.035**	.496	.112	*.092*	.734	.206	.106
RFDmax	Pearson Correlation	**-.557***	-.381	**-.537***	**.478***	.272	.366	*.437*
	Sig. (2-tailed)	**.013**	.107	**.018**	**.038**	.260	.123	*.062*
tFmax	Pearson Correlation	.166	-.096	.048	.041	.085	-.146	-.176
	Sig. (2-tailed)	.497	.695	.846	.867	.730	.551	.472
RFDFmax	Pearson Correlation	*-.424*	.047	-.226	.121	-.015	.140	.192
	Sig. (2-tailed)	*.071*	.848	.352	.623	.952	.567	.432
tRFDmax	Pearson Correlation	.255	**.524***	*.433*	-.356	-.330	-.264	-.276
	Sig. (2-tailed)	.293	**.021**	*.064*	.135	.168	.274	.252

Table 2 and Table 3 show the results of correlations between contractile characteristics of the dominant arm and kinematic characteristics of the maximally fast arm movement in relation to gender.

Figure 1. The initial position of the subject's hand with the IMU sensor attached to the glove on Taping test.

Figure 2 shows kinematic records of the taping motion obtained using the IMU sensor, i.e. the acceleration signal for two repeated tests with two subjects. All quantitative parameters are derived from acceleration signals: time to impact, maximal acceleration, maximal deceleration, and maximal acceleration gradient. A great similarity can be observed in terms of the repeatability of the record as the individual specificity of movement of each subject.

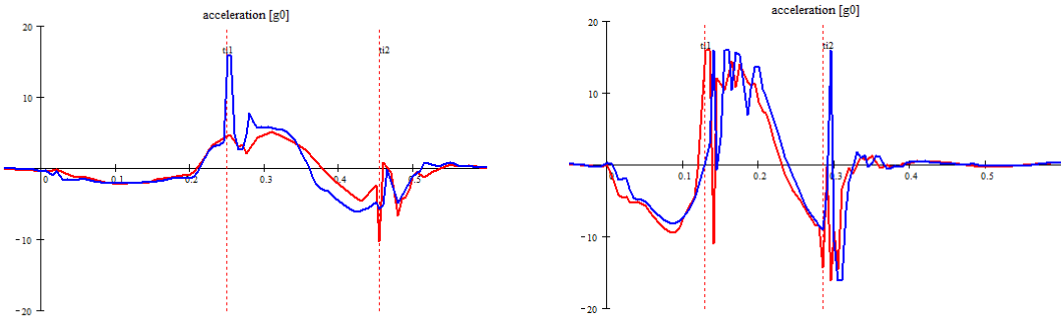

Figure 1 shows the position of the subject's hand with the IMU sensor attached to glove while testing the maximum speed of a single movement using the Taping test

Figure 2. Kinematic motion records in taping test: hand acceleration signal for two repeated tests with two subjects, one slower on the left and one faster on the right. Time mark dotted vertical lines are the moments of the first and the second impact.

DISCUSSION

Based on the results of the maximum isometric muscle force and maximum explosiveness of the tested subjects, it can be concluded that average handgrip force (F_{max}) was 529.87 ± 95.11 N for men and 323.72 ± 62.88 N for women, while RFD_{max} was 3528.87 ± 703.92 N / s and 2116.55 ± 494.79 N / s for men and women, respectively (Table 1). The average values obtained for both men and women are consistent with previously published work, which only confirms the high validity of the measured results (Ivanovic & Dopsaj, 2012; Markovic et al., 2018; Dopsaj et al., 2019).

When considering the kinematic variables of maximally fast horizontal arm movement, it was determined that duration of the extension and flexion movements in the elbow joint was 0.187 ± 0.029 and 0.195 ± 0.030 s, respectively. The total time of maximally fast taping was at the level of 0.382 ± 0.053 s. In the sample of women, the determined values were 0.215 ± 0.032, 0.202 ± 0.029 s and 0.416 ± 0.054, respectively (Table 1). Regarding the variables that define the kinematics of maximally fast horizontal arm movement, it was determined that the time of extension and flexion movements in the elbow joint were 0.187 ± 0.029 and 0.195 ± 0.030 s, respectively, i.e. the total time of maximal rapid arm taping was at the level of 0.382 ± 0.053 s. In women, the values were 0.215 ± 0.032, 0.202 ± 0.029 s and 0.416 ± 0.054, respectively (Table 1).

The average value of the maximum hand movement acceleration was at the level of 5.697 ± 1.716 m/s^2, while the average value of the maximal deceleration in the same movement was at the level of 11.128 ± 3.490 m/s^2. For women, the given values were 4.253 ± 1.336 m/s^2 and 9.494 ± 2.919 m/s^2, respectively. The acceleration and deceleration gradients were at 74.110 ± 29.023 m/s^3 and 205.644 ± 66.593 m/s^3 for men, respectively, 53.585 ± 20.528 m/s^3 and 167.311 ± 94.305 m/s^3, respectively (Table 1). All values of the coefficient of variation of the kinematic variables in men are in the range of 13.77% for the variable t_SUM to 39.16% for the variable dA_dT_1. In women, a slightly larger range of variation of the measured kinematic variables was found, from 12.88% to 56.37% for t_SUM and dA_dT_2. Generally speaking, these variables can be accepted as highly or moderately homogeneous.

The results of statistical analysis in relation to the tested group of men, show a significant correlation between the three pairs of variables: RFD_{max} & t_{sum} (r=-0.465, p=0.045), $RFDF_{max}$ & dA/dT_1 (r=0.498, p=0.030), and $tRFD_{max}$ & t1 (r=0.517, p=0.023). In general, for men, the results have shown that higher maximal explosive muscle force (RFD_{max}) shortens the time of a single tap movement. Subjects with a higher level of basic explosiveness ($RFDF_{max}$) have the potential to produce a higher acceleration in taping movements. A proportional relationship between the time required to generate maximal explosiveness, as a neural analogy to the time required for maximum intense muscle excitation ($tRFD_{max}$), and time from the start of the movement to the first tap with hand (t1), was determined. In

other words, the longer it takes to maximize the intense excitation of the hand muscles, the longer it takes to execute the taping movement and vice versa (Table 2).

In the tested group of women (Table 3), a statistically significant correlation was found between five pairs of variables, where the highest correlations were between: RFD_{max} vs t_1, t_SUM and A_{max}_1 (r=-0.557, p=0.013, r=-0.537, p=0.018 and r=0.478, p=0.038, respectively), between F_{max} vs t_1 (r=-0.485, p=0.035), as well as between $tRFD_{max}$ vs t_2 (r=0.524, p=0.021). Very similar to men, the results have shown that the higher is the maximum explosive force (RFD_{max}), the shorter is the time of a single tap movement (t_1 and t_SUM). Also, if the maximum isometric muscle force level (F_{max}) is higher, then the potential for realizing a shorter time for individual taping movement is greater. Furthermore, in women, a positive statistically significant relationship was found between the time required to generate maximal explosiveness, as a neural analogy to the time required for maximal intense muscle excitation ($tRFD_{max}$), with time from the first tap to second tap with hand (t_2). In other words, the longer it takes to maximize the intense excitation of the arm muscles, the more time it takes to realize the second phase of the taping movement and vice versa (Table 3).

CONCLUSION

The results have shown that the maximally fast hand movement in tested men is statistically significantly influenced by the contractile ability of maximal and basic explosiveness (RFD_{max} and $RFDF_{max}$, respectively). On the contrary, the maximum rapid hand movement in women is influenced by maximal explosiveness (RFD_{max}) and maximal force production of the muscle (F_{max}). In both men and women, there was a statistically significant positive correlation between the time required to reach maximal muscle excitation ($tRFD_{max}$) and the time of the movement. Generally, the correlations obtained between contractile variables (latent biologic potential) and kinematic variables (manifest ability), prove a positive cause-effect relationship between muscle characteristics by type of strength and motor ability by type of maximum movement speed.

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STUDENTS ON THE MARKETING OF PERSONAL QUALITIES OF SPORTING CELEBRITIES WITH PUBLIC PRESTIGE

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ABSTRACT

The definitive role of personal qualities and professional skills of sporting celebrities with public prestige determine the public attitude to a certain service or product in the area of sports and physical education. Once established the good image and popularity have a great potential to give impetus to the development of any sport organization (club) or any specific mark. They can become the main driving force for people engaged with sporting activities, either in school or in a sporting center or club. Such environment gives the feeling of stability, quality and success. The purpose of this study is to answer some questions about the model of distinguished performer of certain public role or function, by making reference to the hypothesis that consumers of sporting activities are in demand for marketing messages which are given special attention. The aim of study is the opinion of people engaged in sports on the factors that influence the quality of their performance and drive higher their prestige in society. Subjects consists of 126 successful teachers of physical education and sports, coaches and sport participants. The study was conducted by using the classical research methods: questioning and marketing-oriented inquiry - focus group discussion – by means of a structured questionnaire including 4 main segments - image (the qualities of successful sporting celebrities), social status, personal dynamic characteristics and terminal values, each containing at least six open-end and closed-end questions. The study cites mathematical statistical data and makes use of the comparative analysis to process the results. In general, the inquiry showed that the inquired participants in the study regarded the mentioned factors very important and determinative for their public prestige. It may be summarized that people engaged with physical education and sports give consideration to the selected factors and believe that such particulars influence the establishment of overall public prestige and attitude. It is recommended to conduct such inquiries among sporting participants on regular intervals and to use the results of such inquiries as a reference point to measure the feelings and problems in that sector.

Key words: Sport, physical education, marketing, image, student.

INTRODUCTION

The definitive role of personal qualities and professional skills of sporting celebrities with public prestige determine the public attitude to a certain service or product in the area of sports and physical education (Kostov, & Kostova, 2005). Once established the good image and popularity have a great potential to give impetus to the development of any sport organization (club) or any specific mark (Smith P. 1993). They can become the main driving force for people engaged with sporting activities, either in school or in a sporting center or club. Such environment gives the feeling of stability, quality and success (Afanasiev, 1998**,** Makarov, AM., 2000., Tsolov, 2007). The purpose of this study is to answer some questions about the model of distinguished performer of certain public role or function (Adler, & Taune, 1987), by making reference to the hypothesis that consumers of sporting activities are in demand for marketing messages which are given special attention (Davies, 1997). Objectives of the study were: 1. research and descriptive classification of the definitions for image of celebrities with public prestige; 2. analysis of the dynamic characteristics of successful sport players to attract the public attention and to expand the markets and increase the number of potential buyers and defining the terminal values of the different groups of renowned sport players.

The aim of study is the opinion of people engaged in sports on the factors that influence the quality of their performance and drive higher their prestige in society.

METHODS

Subjects

Subjects consists of 126 successful teachers of physical education and sports, coaches and sport participants.

Procedure

The study was conducted by using the classical research methods: questioning and marketing-oriented inquiry - focus group discussion – by means of a structured questionnaire including 4 main segments - image (the qualities of successful sporting celebrities), social status, personal dynamic characteristics and terminal values, each containing at least six open-end and closed-end questions.

Statistical analysis

The study cites mathematical statistical data and makes use of the comparative analysis to process the results. The original syntax was preserved as much as possible. The factors selected for assessment include: profession, social class, origin, sex, family, age, education, income, professional ranking (title), duration of title held, professional reputation, prospects for career development, proofs for public recognition of activity, assessment of the inquired participant's personality, personal self-assessments, temporal characteristics of self-assessments, intellectual, volitional and psychological traits and personal attractions. The inquired participants were asked to mark the extent to which they agreed with the opinions expressed in the questionnaire by either underlining or numbering the right answer.

RESULT ANALYSIS

I SEGMENT

Definitions for image (the qualities of successful sporting participants)

Image is a complex, collective concept, combining a wide scope of quantitative and qualitative characteristics of a person or organization (company) (Sandanski, 2009, https://bg.wikipedia.org/wiki/Имидж.). To maintain a consumer-acceptable image requires analysis of the criteria that make up an image – to subside the negative traits, to improve and set new trends, requirements, etc., to educate society in a way to establish the positive image on a new higher level (Baun, & Brady, 1993, Margaret. B., 1997, Bankov, P., Nikolova El., 2002).

This segment required them to give definitions using not more than 10 words, and then again but this time by using not more than 5 words. The idea was to emphasize the descriptor's importance in the definition by reducing the number of descriptors (Vatev, 1993, Ivanova, L., 2000).

Definitions including not more than 10 words.

4 categories were formed, which were arranged by range of frequency (the most commonly used were placed first):

1. image, advertising, popularity, traditions, value, rules, mark, phenomenon, stereotype;
2. impresses, means, separates, differentiates, motivates, conforms, builds, trusts, communicates;
3. sporting spirit, attention, respect, honesty, sustainability, science strength, will, energy, art;
4. intelligence, memory, attention, respect, emotional stability, taking the risk, making decisions, team work, conflicting and leadership skills.

Definitions including not more than 5 words.

1. image, advertising, popularity, rules, model.
2. differentiates, motivates, builds, communicates, impresses;
3. sporting spirit, phenomenon, respect, will, art;
4. emotional stability, taking the risk, making decisions, team work, leadership.

By analyzing the results we find that image exists in the public conscience in the form of flow of data that provokes imaging and emotional reaction. It is formed spontaneously, without knowing, in the public (society) and purposefully through the channels of perception – by visual impact, by verbal impact (speaking in the widest sense), by events and by context. It is not still but it is subject to changes – prompted by urge to make spontaneous comparison – a characteristic feature of society – to observe, to compare, and to assess.

II SEGMENT

Personal social status

The second segment included characteristics such as parents' education, nature and prestige of the profession, income rate, description of neighboring environment, degree of financial comfort, etc. Every socially-based characteristic reflected the hierarchy of social status positions.

The first question in this segment asked information about the profession of inquired participants. 50% of them were teachers of physical education and sports. The others were – sport players (32.5%), administrative employees and sporting participants on public basis (17.5%). 83% had acquired social class and only 17% had inherited social class. This is only natural because the social stratification is a typical feature of all societies.

100% of the inquired successful sporting participants had degree of higher education – 84 were in mature age, 22 were elderly and 20 were youths (fig. 1).

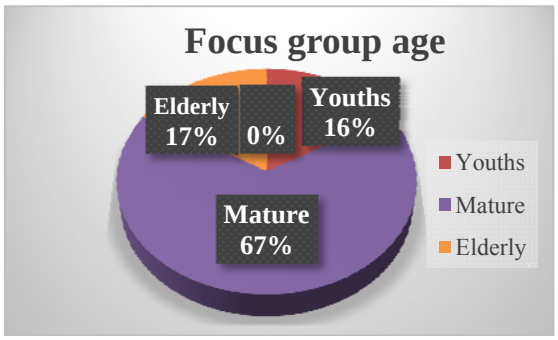

Fig. 1 Focus group age

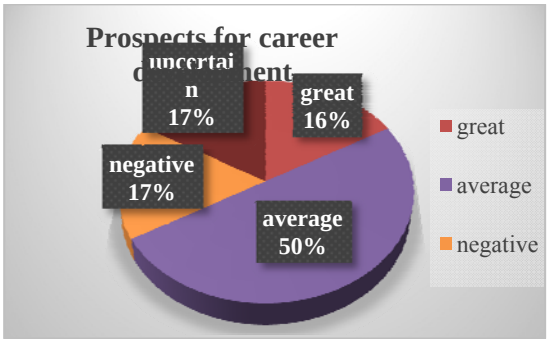

Fig. 2 Prospects for career development

With regard to income – 100% answered to have average income rate, 83% of it was earned but still they defined their financial condition (income) as low. The reason for this is mainly due to the low payment in the area of sporting activities in Bulgaria. The future sport specialists think this factor is producing negative influence on the prestige of sport and physical education and determines the low social positions of sport celebrities from the past.

Fig. 2 shows the prospects for career development - 16% defined them as "great", 50% as "average" and the remaining 34% defined them as either "negative" or "uncertain".

Conclusion is that our social environment is changing day after day and renowned sportsmen are forced to learn in the process of developing to be able to meet expectations. That is the reason why so many inquired participants expressed negative or uncertain vision on their career development. They did not think they would find enough satisfaction and valuation in this sphere of activity. We believe that the building of a good reputation and the availability of serious prospects for sporting participants are extraordinary important for people who have strategy and are exacting but at the same time wants to be respected, valued and needed. If our society could ensure this, then all parties will be satisfied: they from their efforts; the parents from their children's achievements; students and sportsmen from their teacher, coach, instructor and the results they have achieved.

Despite the differences existing in social status, the study of personal dynamic characteristics and terminal values allows for them to be combined into a certain group of qualities that model an important social role and function to build a positive social status.

III SEGMENT

Personal dynamic characteristics

The inquired participants were asked to answer six questions by checking them with 1, 0, -1 standing for positive, neutral and negative. While answering the third segment of the questionnaire and the focus group discussion which followed it was noticed that both men and women very quickly gave an answer to the question "Proofs for the social recognition of one's activity" (fig. 3). 55% of inquired participants checked by neutral or negative mark the over emphasis given by media and the society. The author of this study thinks that the answer lies with the years of transition.

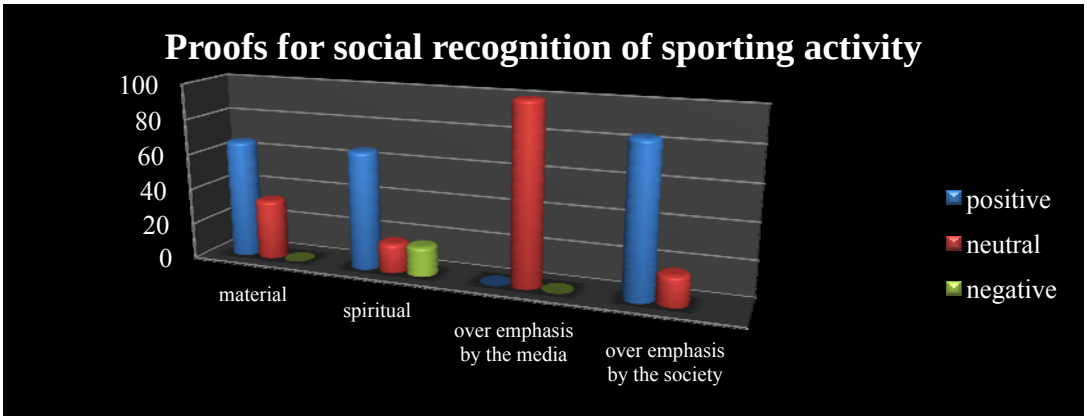

Fig. 3 Personality assessment

They saw that the good, honest and capable people were not given opportunities to prove themselves in society and were replaced by the corrupted, the arrogant and the unreachable, by those who acquired their wealth with crimes. All that reflected on the consumers' way of thinking and behavior.

Self-assessment directly affects one's skills and knowledge. Most of the self-assessments were realistic. This is indicative of people who are striving to keep and enhance their prestige and reputation. They are highly intelligent and capable of adapting effectively to changing situations. They described themselves as good professionals who were not sparing on themselves and loved sports and children. Only 19% had lower self-esteem. They also shared that they were failure-avoidance oriented. The objective self-assessment plays a crucial role for one's self-respect, which is a pre-requisite for one's achievements. Positive self-assessment is the key for development.

With regard to the question about personal qualities and attractions, 100% of inquired participants positively stated that they were ambitious and loved to be respected. Most of them described themselves as experienced and qualified, diligent, logical, purposeful, sociable, joke and fun-loving, sincere and possessing good manners. Success lies on the way one presents oneself. That is why it is important to create such a personal image that would help one become a good professional and successful sport player.

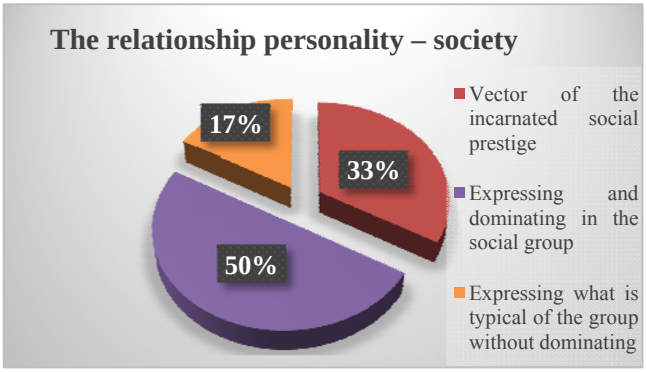

Fig. 4 Public attitude

The sixth question treating the personality – community relations was answered by 17% expressing what was typical of the group, without dominating. That means that they disliked conflicts and would agree with the prevailing opinion of majority. 50% would express their opinion and dominated in the social community. 33% were vectors of the incarnated public prestige and the new way of thinking (Fig. 4). They would oppose or support the group opinion, backing their position with arguments.

The authors of this study (the students) gave positive assessment on the personality of inquired participants. The latter were described as "responsible, persevering and exacting". Positive assessment of personality was also given by the superiors, the assistants, the experts, the collaborators, friends, family, and analysists (Fig. 5). No inquiry data was collected from journalists and people who could define themselves as adversaries.

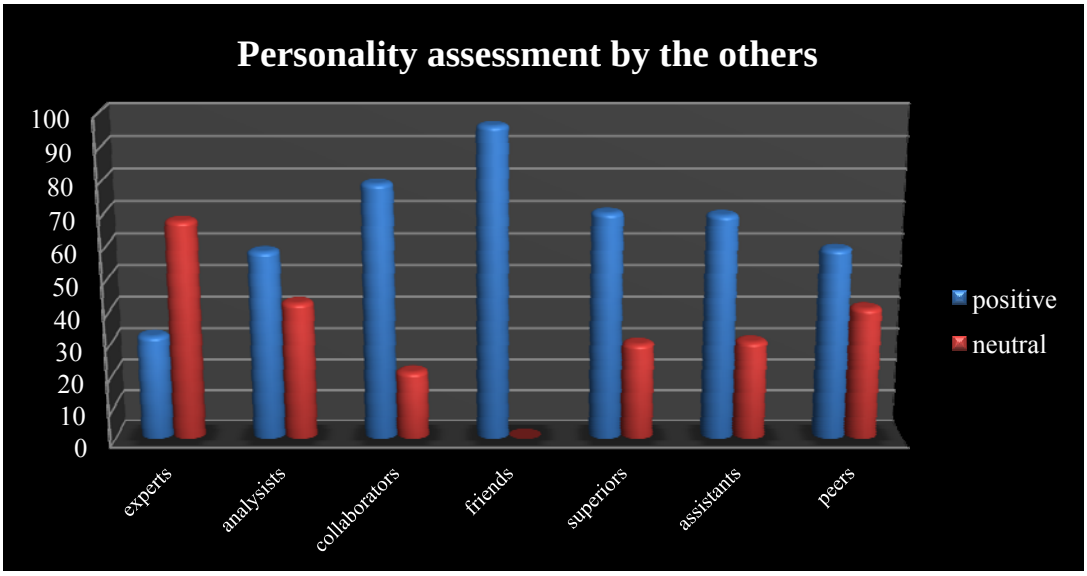

Fig. 5 Personality assessment by the others

IV SEGMENT

Terminal values

The final segment of our questionnaire dealt with terminal values (fig. 6). They treated the meaning of one's existence or the life aims that a person would like to attain.

All inquired participants in the study shared the positive feeling of happiness, unfortunately that feeling was not due to any government performance and social recognition but rather to the presence of family values, good friends, knowledge, culture and tolerance. 105 of them gave neutral or negative answer to the indicators of money, financial security and peace of mind, which showed that the social status failed to give them a feeling of security. Still they shared "the harder the victory is won, the greater the happiness from that victory is". 66% of inquired participants answered to have a positive feeling of inner harmony, which is a good indicator in itself taken alone. It is important for coaches to be well-balanced persons in order to produce optimal good influence on students and sport trainees. Sporting skills are quite often linked and compared to artistic skills – that is the skill to teach anybody anything.

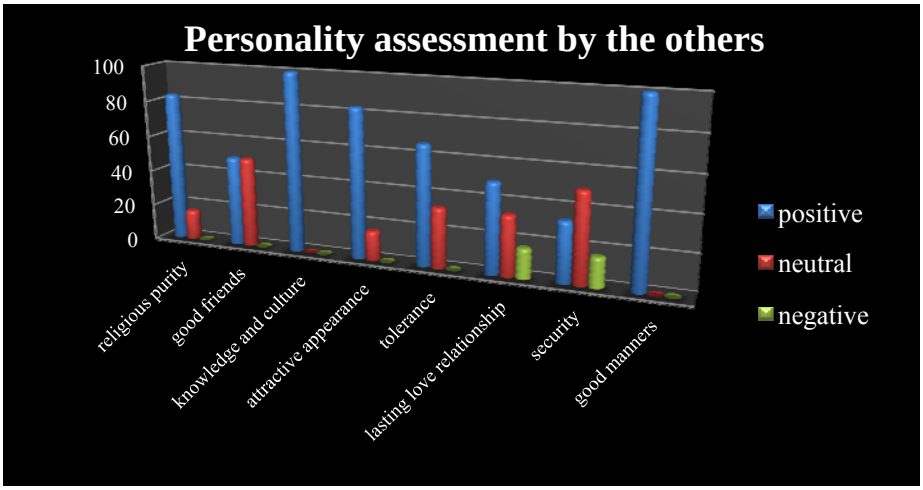

Fig. 6 Personality assessment by the others

CONCLUSION

In general, the inquiry showed that the inquired participants in the study regarded the mentioned factors very important and determinative for their public prestige. It may be summarized that people engaged with physical education and sports give consideration to the selected factors and believe that such particulars influence the establishment of overall public prestige and attitude. It is recommended to conduct such inquiries among sporting participants on regular intervals and to

use the results of such inquiries as a reference point to measure the feelings and problems in that sector. Therefore, in the area of sports and physical education there must be a strategy to ensure the development of and the attitude to sporting participants and for improving the possibilities for communication and dialogue. In the modern world economy and highly competitive environment, the sustainable good image and the creation of a positive long-lasting public reputation evolved to become one of the main competitive advantages.

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GENDER DIFFERENCES IN SPORTS MEDIA REPORTING ON BASKETBALL AT THE OLYMPIC GAMES 2016.

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ABSTRACT

This paper aimed to gain new insights into how and to what extent the domestic media reported on basketball players at the 2016 Rio de Janeiro Olympic Games and to identify differences between the reporting sources. The sample of the research material is based on the Serbian media in the electronic edition Politika, Kurir, Večernje Novosti, as well as the portal of RTS media public service, from 05.08.2016 to 21.08.2016. The data included information on the number of articles dedicated to male and female basketball players, the number of words in the text, the number of photos and gender of the actors in the photos, active or passive representation of male and female basketball players on and off the field, camera angle, emotions in photographs and exposure level of the athletes bodies in the photographs. If one considers the distribution by sources of text, it can be seen that the largest number of articles in the period under review was published by KURIR and the least by RTS and that in all sources there was a significantly higher number of articles on athletes. Percentage of the total number of articles, sources allocated space to the athletes, and concerning female athletes, this difference is greatest with RTS. In terms of the number of photographs, POLITIKA and KURIR had in their articles an approximate number of photographs devoted to male and female athletes. The most unfavorable ratio (28-1 for the benefit of male athletes) was recorded by the public media service RTS, while in VEČERNJE NOVOSTI, the ratio was 2-1, also for the benefit of men. Overall, the findings of this research show that there is still an imbalance in the way male and female athletes are portrayed by media and that there is a need for some changes in this area.

Keywords: basketball, Olympic Games, Serbia, media, content analysis.

INTRODUCTION

The image of female athletes in the public depends heavily on the media, which, unfortunately, does not sufficiently address them. There is an impression that the results achieved by women in sports are not equally significant, but their physical appearance and attractiveness are rather put first. All of the above contradicts the principles advocated by the Olympic Committee, sports organizations, and relevant institutions in our country. A closer look at how women and male athletes are represented in the media is necessary, because the media plays a very important role in forming the ideological meanings of femininity and masculinity in sports and society, as well. Media coverage of the Serbian women's and men's basketball teams at the 2016 Olympic Games in Rio de Janeiro is an extremely appropriate research case. In Serbia basketball can be seen as a gender-neutral sport because it is equally played by women and men. Both basketball teams achieved great success in the 2016 Olympics by winning medals. The men's team won the silver and the women's bronze medals, which is why this case offers great opportunities to look at the influence of the media on the social construction of gender. Research on the proportions of athletes in electronic media, which has included sports competitions, has noted a greater representation of the male athlete population. All broadcast media outlets have generally paid more attention to the male population in sports. Feminist-oriented media researchers claim that sports media is a bastion of male domination, with male hegemony represented through the marginalization and trivialization of female athletes and the portrayal of female athletes in the form of sexual objects (Sabo & Curry Jansen, 1992; Boyle & Haynes, 2009). Previous research on this field can be systematically divided into two groups: papers that emphasize the quantitative predominance of

men in the media in terms of the number of articles, words per article, number of photos or videos, and papers that highlight qualitative differences in media sports reporting. Research conducted in the United States (The Global Media Monitoring Project 2010 - North America Regional Report) states that men represent 67% of the total number of appearances in sports television news. Sport covers about 7% of articles, and it should be noted that women in sports are written only in the context of their success in sports such as tennis, volleyball, basketball (86%). Very little is written about female athletes in other sports (football, kickboxing, judo, karate, chess, swimming, etc.), although female athletes from these disciplines have made equally significant awards and recognitions. The success of a women's team is spoken almost exclusively by their male coaches as experts (92%), followed by photographies. Over the past year, more and more articles have been published on the pages of sports about women of famous athletes, their families and their beauty (Jones, 2006). A study on "Equality between men and women in audiovisual media sports programs" conducted by the Electronic Media Agency (AEM), in collaboration with the Balkan Research Regular Network (BIRN), has shown devastating results. The program of three national televisions - RTS 1, RTL and Nova TV - was analyzed during one week in February, March and April during one year. Sports news were analyzed as part of news programs on the three most watched channels with national frequency. In all, 63 sports news programs, including 370 broadcasts. Out of these 370 broadcasts, only 14 were dedicated to women's sports, representing less than 4% of the total, while 86% refered to men, and slightly less than 10% to both sexes. Koivula emphasized that mass media play a significant role when it comes to sport, since most sporting events are viewed precisely through the media. Research has also shown that the way of writing used in the media plays a significant role in portraying and describing gender differences in the media, especially when it comes to portraying male and female athletes (Koivula, 1999).

The aim of this paper was to determine analytically whether the media in different ways cover and represent male and female athletes and thus play a role in the ideological construction of gender in sport, that is, how different media in Serbia presented male and female basketball players at the 2016 Olympic Games.

METHODS

The method used in the research was content analysis. Content analysis is a research technique for the objective, systematic and quantitative descriptions of the manifestation of the content of communication (Berelson, 1952). As a quantitative method, content analysis numbers and measures categories such as words, phrases or images (Hesmondhalgh, 2006). Content analysis is a popular method for the study of gender differences in media representations, since it can determine recurring patterns which can shape our attitudes, values and convictions (van Zoonen, 2004).

Subjects

The sample of the research material is based on the Serbian media in an electronic edition. Three daily newspapers were selected (Politika, Kurir, Večernje novosti), as well as the RTS media public service portal. This focus is determined, first of all, because newspapers continue to play an important role in presenting the Olympics (Markula, 2009). Newspapers are one of the most advanced media forms and the sports section is one of the most important and widely read (Coakly, 2003). In order to carry out the research and perform a representative analysis, the aim was to select representative Serbian media that have a large national circulation and differentiate in their format and manner of presenting media information, in order to better explore the range of press discourses. According to the site traffic monitoring system, these portals have a high traffic rating and page views. That is why the sample is made of three dailies and one media portal, which differ in the way information is presented, and are at the top of the most visited media in Serbia. All articles were published in the period from 05.08.2016 to 21.08.2016. These dates coincide with the dates of the opening and closing ceremonies of the 2016 Olympic Games.

Procedure

Material coding methods were used to determine whether the photographs of male and female athletes are related exclusively to some sporting event or were made on occasions which do not belong to any type of sport or sporting event, and whether they indicate an attempt at degrading their participation in sport.

Code Instrument

The gender of the athlete, the gender of the author of the text, the level of activity and the content of the photographs are the variables coded for this research.

The gender of the athlete is coded: (a) male, and (b) female;

Place where the athlete is shown: (a) on the field, (b) off the field

Activity level: (a) active (that is, the athlete is on the move and doing something concrete), (b) passive (e.g. the athlete loves a medal and poses);

Camera shooting angle: (a) below eye level, (b) eye level, (c) above eye level;

Emotions in photographs: (a) sadness, (b) crying, (c) joy, (d) anger, (e) disappointment, (f) hug;

Body exposure level: (a) first level, (b) second level, (c) third level, (d) fourth level.

Statistical analysis

The following methods were applied in the research: descriptive method, systematization, and quantitative-qualitative content analysis.

RESULTS

The obtained results were examined through hypotheses. The largest number of articles in the surveyed period was published by KURIR (43%), slightly less VEČERNJE NOVOSTI (35%), while POLITIKA (13%) and RTS (9%) had a significantly smaller share among text sources.

H1 – More articles are about male athletes;

Table 1. Number of articles by source

	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(57%) 23 (13%)	(57%) 68 (38%)	(97%) 28 (16%)	(55%) 59 (16%)	178
female athletes	(30%) 12 (14%)	(30%) 41 (46%)	(3%) 1 (1%)	(33%) 35 (36%)	89
both	(13%) 5 (13%)	(18%) 24 (65%)	(0%) 0 (0%)	(7%) 8 (22%)	37
neither	(0%) 0 (0%)	(13%) 1 (17%)	(0%) 0 (0%)	(5%) 5 (22%)	6
	40	134	29	107	310

If one considers the distribution by sources of text, it can be seen that the largest number of articles in the period under review was published by KURIR and the least by RTS and that in all sources there was a significantly higher number of articles on male athletes (Table 1).

H2 – More words are in articles that refer to male athletes;

Table 2. Number of words in articles by source

	POLITIKA – average number of words	KURIR - average number of words	RTS - average number of words	VEČERNJE NOVOSTI - average number of words
male athletes	662	243	199	415
female athletes	640	292	78	356
both	470	1079	0	2245
neither	0	151	0	2290

H3 – There are more photos of male athletes;

Table 3. Number of photos in articles by source

	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(48%) 24 (7%)	(43%) 137 (42%)	(97%)28 (9%)	(62%) 139 (42%)	328
female athletes	(40%) 20 (9%)	(43%) 140 (61%)	(3%) 1 (0%)	(31%) 70 (30%)	231
both	(4%) 2 (7%)	(4%) 12 (44%)	(0%)0 (0%)	(6%) 13 (48%)	27
neither	(8%) 4 (10%)	(10%) 33 (80%)	(0%)0 (0%)	(2%) 4 (10%)	41
	50	322	29	226	

H4 – Women are more often depicted in photographs outside of a sports field;

Considering the manner of representing athletes on and off the field by sources (Table 4), it can be concluded that the male athletes were more

represented on field within the texts in all sources, except in POLITKA, where they had equal participation (50% each).

Table 4. The representation of athletes on and off the field in articles by source

ON FIELD	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(50%) 18 (10%)	(57%) 94 (47%)	(100%) 25 (14%)	(27%) 44 (24%)	181
female athletes	(50%) 18 (17%)	(38%) 63 (40%)	(0%) 0 (0%)	(15%) 25 (14%)	106
both	(0%) 0 (0%)	(0%) 7 (20%)	(0%) 0 (0%)	(58%) 97 (54%)	104
	36	164	25	166	
OFF FIELD	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(36%) 5 (8%)	(63%) 40 (63%)	(75%) 3 (5%)	(34%) 16 (25%)	64
female athletes	(21%) 3 (10%)	(27%) 17 (57%)	(25%) 1 (2%)	(19%) 9 (14%)	30
both	(21%) 3 (10%)	(8%) 5 (17%)	(0%) 0 (0%)	(47%) 22 (34%)	30
	11	62	4	47	

H5 - Women are more often shown in photographs in the "inactive pose".

In the inactive view, the biggest difference in favor of athletes was recorded with VEČERNJE NOVOSTI (66% - 34%) and the smallest with KURIR (53% - 47%).

Table 5. Active and inactive portrayal of athletes in articles by sources

active portrayal	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(74%) 14 (6%)	(48%) 70 (32%)	(100%) 27 (12%)	(67%) 108 (49%)	219
female athletes	(26%) 5 (4%)	(52%) 77 (57%)	(0%) 0 (0%)	(33%) 53 (39%)	135
	19	147	27	161	
inactive portrayal	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(37%) 10 (11%)	(53%) 46 (52%)	(0%) 0 (0%)	(66%) 33 (37%)	89
female athletes	(63%) 17 (22%)	(47%) 40 (45%)	(100%) 2 (2%)	(34%) 17 (19%)	76
	27	86	2	50	

H6 – Women appear more photographed than men in camera shots below the eye level:

Table 6 shows that all sources depicted athletes below eye level more than female athletes with the exception of POLITIKA that presented female athletes more this way.

Table 6. The representation of athletes below, above and at eye level in articles by source

below eye level	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(43%) 6 (7%)	(67%) 42 (46%)	(100%) 8 (9%)	(67%) 35 (38%)	91
female athletes	(57%) 8 (17%)	(33%) 21 (23%)	(0%) 0 (0%)	(33%) 17 (19%)	46
	14	63	52	52	
at eye level	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(54%) 20 (11%)	(52%) 70 (40%)	(92%) 11 (6%)	(64%) 74 (42%)	175
female athletes	(46%) 17 (14%)	(48%) 65 (37%)	(8%) 2 (1%)	(36%) 41 (23%)	124
	37	135	12	115	
above eye level	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(67%) 10 (12%)	(74%) 34 (40%)	(89%) 8 (9%)	(72%) 33 (39%)	85
female athletes	(33%) 5 (16%)	(26%) 12 (39%)	(11%) 1 (3%)	(28%) 13 (42%)	31
	15	46	9	46	

Also, all sources more closely depicted athletes at eye level and this difference was most pronounced with RTS (92% - 8%). The biggest share in portraying athletes in this way had VEČERNJE NOVOSTI (42%), while that of athletes was KURIR (37%).

H7 - Women are more often depicted in photographs in "more emotional states";

Table 7. Emotional states of athletes in articles according to sources

sadness	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(0%) 0 (0%)	(33%) 1 (25%)	(100%) 1 (25%)	(67%) 2 (50%)	4
female athletes	(0%) 0 (0%)	(67%) 2 (30%)	(0%) 0 (0%)	(33%) 1 (25%)	3
	0	3	1	3	
cry	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(0%)0 (0%)	(33%)1 (50%)	(0%)0 (0%)	(50%)1 (50%)	2
female athletes	(0%)0 (0%)	(67%)2 (67%)	(0%)0 (0%)	(50%)1 (33%)	3
	0	3	0	2	
happiness	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(48%)10 (14%)	(56%)31 (44%)	(75%)3 (4%)	(59%)27 (38%)	71
female athletes	(52%)11 (20%)	(44%)24 (44%)	(25%)1 (2%)	(41%)19 (35%)	55
	21	55	4	46	

H8- Women are more often depicted in nude poses in photographs.

Table 8. The level of exposure in photos of athletes in articles according to sources

Level 1	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(94%) 16 (43%)	(38%) 9 (24%)	(0%) 0 (0%)	(43%) 12 (32%)	37
female athletes	(6%) 1 (3%)	(62%) 15 (45%)	(100%) 1 (3%)	(57%) 16 (48%)	33
	17	24	1	28	
Level 2	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(55%) 18 (9%)	(63%) 69 (35%)	(100%) 28 (14%)	(71%) 82 (42%)	197
female athletes	(45%) 15 (17%)	(37%) 40 (45%)	(0%) 0 (0%)	(29%) 34 (38%)	89
	33	265	28	116	
Level 3	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(52%) 12 (11%)	(59%) 61 (54%)	(0%) 0 (0%)	(65%) 41 (36%)	114
female athletes	(48%) 11 (14%)	(41%) 43 (57%)	(0%) 0 (0%)	(35%) 22 (29%)	76
	23	104	0	63	
Level 4	POLITIKA	KURIR	RTS	VEČERNJE NOVOSTI	
male athletes	(0%) 0 (0%)	(0%) 0 (0%)	(0%)0 (0%)	(100%) 5 (100%)	5
female athletes	(100%) 1 (100%)	(0%) 0 (0%)	(0%) 0 (0%)	(0%) 0 (0%)	1
	1	0	0	5	

DISCUSSION

The subject of this research were newspaper articles (texts and accompanying photographs) on sports in the electronic newspapers of the three daily newspapers (Politika, Kurir, Večernje novosti), as well as the content of internet portal of RTS media public service. The most widely read news items were selected, which by their writing can influence the formation of a media image of women athletes and which can contribute to their affirmation or marginalization, depending on the manner in which information about sports events is presented. The aim of this paper was to gain new insights into how and to what extent the domestic

media reported on basketball players at the 2016 Rio de Janeiro Olympic Games, and to identify differences with the source of reporting. The KURIR wrote most of all sources about both (65%), while VEČERNJE NOVOSTI devoted more space to texts of a general character (22%), and RTS did not have texts in these two categories. In terms of space allocated to female athletes (given the categories of texts within the same source), these sources differ and were the most represented in VEČERNJE NOVOSTI (33%). In texts about athletes, RTS devoted almost all texts to athletes (97%), while the remaining three sources equally considered athletes within their texts. From all three sources, the KURIR had the largest share in texts about male athletes (38%), female athletes (46%) and both (65%), while VEČERNJE NOVOSTI had the largest share in general texts (more than other sources, 22%). If one considers the distribution by sources of text, it can be seen that the largest number of articles in the period under review was published by KURIR and the least by RTS and that in all sources there was a significantly higher number of articles on athletes. All three sources allocated significantly more space (as a percentage of the total number of articles) to male athletes, and in relation to female athletes this difference is the largest with RTS. This was expected and confirmed the hypothesis H1, with this research confirming the results of previous research from different areas where male athletes are more dominant in the media than female athletes (Billings & Angelini, 2007).

POLITIKA had on average the highest number of words per article on female athletes compared to other sources, though it still had a slightly higher number of words per article on male athletes. The KURIR alone had longer texts on female athletes (292 words) than on female athletes (243 words).

In terms of the number of photographs, POLITIKA and KURIR had in their articles an approximate number of photographs devoted to both genders. The most unfavorable ratio (28-1 for the benefit of male athletes) is recorded by the public media service RTS, while in VEČERNJE NOVOSTI, the ratio is 2-1, also for the benefit of men. Overall, the largest number of photographs were published by the KURIR, giving a roughly balanced relationship in gender reporting. RTS's media service, in its gender-unbalanced reporting, creates an unfavorable image of female athletes.

According to some researches, during media coverage of sports events, women athletes are more often represented in photographs outside the sports field. Considering the manner of representing athletes on and off the field (Table 4), it can be concluded that male athletes were more represented within the field in all sources, except in POLITIKA where they had equal participation (50% male and female), and RTS did not have any photos of the female athletes on the field.

All sources, except the KURIR, depicted athletes more in the active pose and the KURIR favored women because they were displayed more than the men in the active pose, while the biggest difference in favor of the athletes was at RTS that did not display any female athlete photo in active pose. VEČERNJE NOVOSTI had the most photos but twice as many photos of male than female athletes, and POLITIKA had the fewest photos. In the inactive view, the biggest difference in favor of male athletes was recorded with VEČERNJE NOVOSTI (66% - 34%) and the smallest with KURIR (53% - 47%). POLITIKA portrayed almost twice the athlete in inactive display relative to the athlete. RTS did not have a large number of photographs in this category (2) and they presented the athletes in inactive mode. In the category of male athletes, the highest share in the inactive display had the KURIR (52%) the smallest RTS (0%), and in the category of female athletes the highest share also had the KURIR (45%) and the smallest RTS (2%). The highest number of active-view photographs had VEČERNJE NOVOSTI (161) and the least POLITIKA (19), while the highest number of inactive-view photographs had the KURIR (86) and the smallest RTS (2). Duncan (1990) states that men are prominent as active subjects, while women are framed and more often presented as inactive or passive objects. Such findings exist in other studies (George, Hartley & Paris 2001). However, there are studies in which different results have been obtained. Studies of Canadian, South African, British and American newspapers report that men and women are most often portrayed in action or sport, and that percentages vary very little by gender (Lee, 1992). Hardin et al. (2002) found that 78% of women and 81% of male athletes were represented in "active photography" in US newspapers. Comparing media coverage of the UK, US and Canada, Vincent et al. (2002) state that both women and men are most often represented in active (competitive) situations (women, 51%; men, 52%). Male athletes in POLITIKA and VEČERNJE NOVOSTI were more featured in this level of body exposure, and in the KURIR and RTS athletes. The biggest difference within the body exposure in the photographs was with RTS (100% - 0%) and the smallest with POLITIKA (55% - 45%). Table 7 shows that happiness (joy) as the emotional state was the most represented (most photos in all sources), and that male athletes are more predominantly portrayed in this emotional state in all sources except POLITIKA where female athletes are more portrayed in this emotional state. The greatest share in displaying this emotional state had the

KURIR (because it had the most photos) and the smallest RTS. Embrace as an emotional state was more prevalent than negative emotional states, but less than a joy, and male athletes were more dominant in this emotional state at RTS and VEČERNJE NOVOSTI, and that KURIR and POLITIKA depicted more female athletes this way. VEČERNJE NOVOSTI had the biggest share in portraying this emotional state in male athletes, and it was POLITIKA in female athletes.

CONCLUSION

If one considers the distribution by sources of text, it can be seen that the largest number of articles in the period under review was published by KURIR and the least by RTS and that in all sources there was a significantly higher number of articles on athletes. Percentage of the total number of articles, sources allocated space to the athletes, and concerning female athletes, this difference is greatest with RTS. In terms of the number of photographs, POLITIKA and KURIR had in their articles an approximate number of photographs devoted to athletes. The most unfavorable ratio (28-1 for the benefit of male athletes) was recorded by the public media service RTS, while in VEČERNJE NOVOSTI, the ratio was 2-1, also for the benefit of men. Overall, the findings of this research in the Serbian media show that there is still an imbalance in the way men and women are portrayed by media and that there is a need for some changes in this area.

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Истраживање о "Равноправности између мушкараца и жена у спортским програмима аудиовизуалних медија", које је спровела Агенција за електронске медије (АЕМ) у сарадњи са Балканском истраживачком регуларном мрежом (БИРН).

DIMINISHED WALKING PERFORMANCE AFTER PROLONGED BED REST

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ABSTRACT

Introduction: Prolonged physical inactivity or immobilization after sports injuries and/or surgery could lead to serious cognitive and motor dysfunction that prevent rapid recovery and lead to future falls. Previous research has shown that gait control provides the demand for cognitive centres of the brain and that dual-task assessments may indicate an increased risk of falling or a protection strategy to prevent falls. The aim of the present study was to evaluate the locomotory performance after 10 days of complete physical inactivity/bed rest.

Methods: Ten healthy young volunteers (average age = 23 years) successfully completed 10 days of horizontal bed rest. Gait speed parameter was obtained with the 2D OptoGait system (Microgate, Italy) under self-selected and fast paced walking condition.

Results: Ten days of horizontal bed rest had no significant impact on the self-selected gait speed ($p=0.190$). In contrast, bed rest significantly decreased gait speed in fast paced walking condition ($p=0.009$).

Discussion & Conclusion: Our results showed that 10 days of bed rest are long enough to affect the locomotory function in healthy adults. Moreover, the effects are larger in tasks that require more attentional resources (higher complexity tasks). The results can be used for the future development of effective countermeasures for rehabilitation and/or space flight purposes.

Keywords: bed rest immobilization, falls, microgravity analog, dual-tasking

INTRODUCTION

Walking is a rhythmic motor task involving complex motor, sensory and cognitive processes (Marusic et al., 2015; Holtzer, Verghese, Xue, & Lipton, 2006; Scherder et al., 2007). When a person walks, continuous integration of visual, proprioceptive and vestibular sensory information is required, as well as positioning of joints to prevent falls, inclusion of feedback from the terrain to allow routine changes in positioning and stride length, and constant observation of the environment to avoid fall risk situations (Giordani & Persad, 2005; Hausdorff, Yogev, Springer, Simon, & Giladi, 2005). In older people, however, even more attention is needed for motor control while walking, indicating increased involvement of attentional resources during walking (Beauchet & Berrut, 2006; Gschwind, Bridenbaugh, & Kressig, 2010; Kressig, 2010). Age-related neuromotor changes such as reduced motor strength or reduced sensory input (vision, hearing and proprioception) increase the attentional demands of walking. This increased demand is met at the expense of a reduction in central processing capacity for attention reserves (Gschwind et al., 2010; Kressig, 2010). The effects of shared attention on motor performance and gait control could be assessed using a dual-task methodology (Marusic et al., 2015; Marušič, 2015).

The bed rest model was first used in the 19th century for medical treatments with the aim of reducing the metabolic burden on the human body, accelerating the healing process and thus promoting the recovery process. Later in the 1960s, bed rest was used to simulate acute adaptations to the microgravity environment during space flights (Parry & Puthucheary, 2015; Adams et al., 2003;). In fact, bed rest could be modeled according to the so-called bed rest protocol, especially during longer hospital stays, where healthy participants spend several days in a horizontal or more extreme head-down tilt bed rest condition. The negative adaptations of the cardiovascular system were observed to be similar in spaceflight and bed rest confined persons (Goswami, 2017).

With regard to a simulation of the aging process, the negative effects of bed rest occur ten times faster than those caused by the normal aging process (Vernikos and Schneider, 2009). The aim of this study was therefore to assess the extent to which young and healthy adults lose the ability to perform locomotory tasks successfully after being exposed to 10-day bed rest.

METHODS

All procedures were carried out in accordance with the Declaration of Helsinki and were approved by the National Medical Ethics Committee. Written informed consent was obtained from all participants prior to the study.

Subjects

Ten healthy young volunteers (All males; Age 22.9 ± 4.7 years; BMI 23.6 ± 2.5 kg/m^2) successfully completed 10 days of horizontal bed rest. Nine participants were right-handed and one left-handed. All participants had normal or corrected-to-normal vision and reported no history of cardiovascular, neurological, or psychiatric conditions. Exclusion criteria were smoking, regular alcohol consumption, ferromagnetic implants, history of deep vein thrombosis, acute or chronic skeletal, neuromuscular, metabolic and cardiovascular disease condition.

Procedure

The spatio-temporal gait parameters were measured with the 2D OptoGait system (Microgate, Bolzano, Italy), which provides valid and reliable data (Lienhard, Schneider, & Maffiuletti, 2013). Five transmission and five reception bars were placed parallel to each other in a 5 m x 2 m hall and the first bar was located about 50 cm from the starting point. Two additional bars were placed perpendicular to the other bars to obtain additional parameter gait width. The data were sampled at 1000 Hz and analyzed with the software OptoGait, version 1.12.15.0. The first step was systematically excluded for each individual base due to accelerations at the beginning of each five-meter measuring section.

Figure 1: Optogait setup. 1: five 1m transmitting and receiving bars; 2: 2D system for additional gait parameters e.g. gait width; 3: real-time feedback of gait performance representing step lengths.

The participants were asked to walk in 1 minute of self-selected and fast-paced walking speed. The instructions were given as to how one would normally walk on a longer route or if one is in a hurry and takes a bus.

The initial step was defined with a high-speed camera and the gait was checked again at the end of the measuring period. All gait data was reprocessed offline to correctly define the left and right step.

Statistical analysis

The data were analyzed with IBM SPSS Statistics 25.0 software (SPSS, Inc., Chicago, IL). Normality of the distribution of the parameters

was tested graphically (histogram) and with the Shapiro-Wilk's test. Pre-post bed rest differences were tested with a paired sample t test. Statistical significance was set at the level of $p < 0.05$.

RESULTS

The data was normally distributed ($p>0.05$). For self-selected gait speed, paired sample t test showed no significant decline ($p=0.190$). To the opposite, gait speed under fast pace walking condition was significantly reduced ($p=0.009$). Figure 2 represents gait speed pre-post bed rest in self-selected and fast pace walking condition.

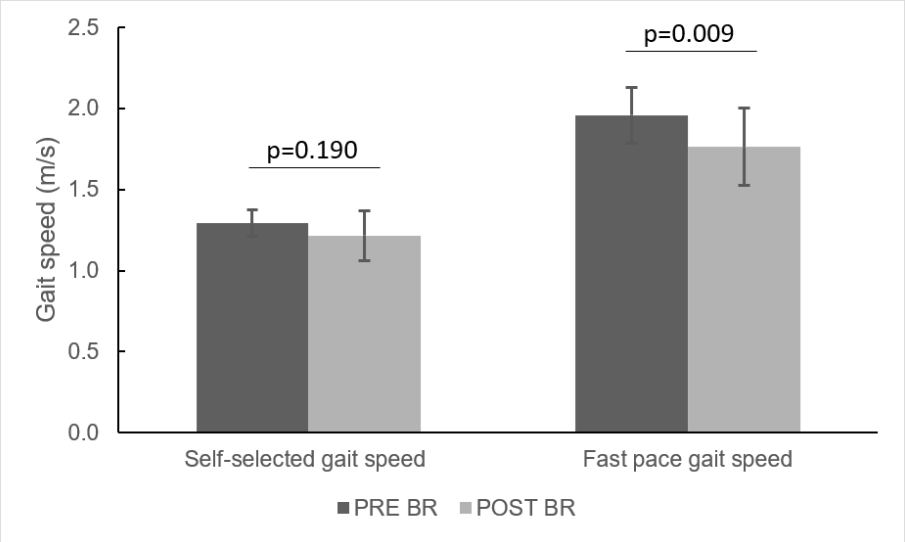

Figure 2: Gait speed in self-selected and fast pace walking condition PRE and POST bed rest

DISCUSSION

The 10-day bed rest ended without any medical complications and drop outs. The results of our study show that 10 days of bed rest are long enough to affect the locomotory function in healthy adults. Our results also show that an average decrease of 5.7% in the self-selected gait speed did not meet the significance level, while an average decrease of 9.9% for fast pace gait speed was significant. Similar to our self-selected gait speed results, Mulder et al. (2014) also found no changes in gait, but in a much shorter, 5-day bed rest campaign. It appears that longer bed rest periods are required to detect a significant decrease in gait speed or a higher complexity of tasks, as was previously the case with older volunteers who underwent 14-day bed rest (Marusic et al., 2015; Marusic et al., 2019).

Future studies must address the locomotory function after bed rest while monitoring brain activity simultaneously. One of the possibilities would be the mobile brain/body imaging (MoBI) (e.g. Malcolm et al., 2015; Gwin et al., 2010; Jungnickel et al., 2019). So far, longer bed rest campaign (60 days of head-down tilt) showed that post-bed rest more neural control is needed for foot movement (Yuan et al., 2018). This would be one of the possible mechanisms of gait decline even after shorter periods of bed rest confinement.

When planning future studies, the following strengths and limitations must be taken into account. A small sample size would require a comparable control group which would have a rigorous control of dietary, exercise and lifestyle changes within 10 days of monitoring or the third measurement after 10 days of the rehabilitation process. Future research should also consider women and evaluate other spatio-temporal gait parameters such as stride length, stride width, double support and swing time. Another focus should be on measuring gait variability.

CONCLUSION

The results of the current study show that after 10 days of complete bed rest there is a significant decrease in locomotor performance. Statistical significance has only been achieved for fast walking, which requires more attentional resources. Future analyses should show the deterioration of dual-task walking conditions (tasks with higher complexity). The results can be used for the future development of effective countermeasures for rehabilitation and/or space flight purposes.

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SPORTS BASED METAPHORS AS ALL-AROUND INFUSION

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ABSTRACT

The use of sports metaphors to convey business lessons both within and outside the classroom is a common phenomenon. The sports metaphor, however, is prone to misuse and can often inadvertently exclude large segments of the student population. To address these issues, we put forth an innovative and novel pedagogical approach that attempts to capitalize better on the shared meanings between athletics and certain business practices. Using the sports of tennis, football and basketball, we demonstrate how sports metaphors can be responsibly used to aid in the understanding of business lessons, such as managerial decision making. The research methods used were standards models of extracting metaphorical and literal meanings. Thus metaphor identification system relies on distributional clustering. The data to test the identification module were extracted from the metaphor corpus created by Shutova and Teufel (2010). Their corpus is a subset of the BNC (Burnard 2007). The context-based probabilistic model is used for paraphrase generation of metaphorical expressions and the selectional preference model for theur literalness detection. The key difference between the two models is that the former favors the paraphrases co-occuring with the words in the context more frequently than other paraphrases occurances, and the latter favors the paraphrases co-occuring with the words from the context more frequently than with any other lexical items in the corpus. The system thus incorporates the following components: 1. a context-based probabilistic model that acquires paraphrases for metaphorical expressions from a large corpus; 2. a WordNet similarity component that filters out the irrelevant paraphrases based on their similarity to the metaphorical term (similarity is defined as sharing a common hypernym within three levels in the WordNet hierarchy); 3. a selectional preference model that discriminates literal paraphrases from the metaphorical ones.

Keywords: sports metaphors, distributional clustering, use and misuse of metaphors, communication, memory triggering

INTRODUCTION

Instructors often use metaphors to enhance the learning experience. Lakoff and Johnson (1980) suggest that metaphors are important because they can deeply influence a person's attitudes, perceptions, and world view. Because of the increasing popularity of athletics within US culture, sports' metaphors are becoming more common (Palmatier & Ray, 1989). Unfortunately, these metaphors are often used without thought or consideration to possible student reactions.

This paper introduces a class module aimed at teaching important business lessons through the responsible use of sports metaphors. First, we briefly discuss the needs and benefits of using sports metaphors within the classroom. Second, we draw attention to some potential pitfalls of misusing these unique metaphors. Finally, we demonstrate how the sports of tennis, football, rugby, basketball and many other ball related sports can aid students in understanding aspects of leadership and managers' position in decision making which pretty much corresponds with sports life.

Why to Use Sports Metaphors

As many researchers have noted, metaphors are linguistic devices that can improve communication and enhance learning (Lakoff & Johnson, 1980; Morgan, 1986). To begin, metaphors can simplify difficult concepts. For instance, researchers have found that using sports can assist children to learn difficult math problems (Freedman, Hanvey, Lindsey, Ryan, & Bell, 1995). Also, metaphors can often communicate more efficiently than other forms of expression. For example, Archer and Cohen (1998) argue that court judges often use sports metaphors in their judicial opinions to capture a point quickly. Finally, listeners usually respond to metaphors. This is particularly important when the subject matter is viewed as dry or overly technical.

Metaphors, then, are unique because they trigger an individual's memory and sensory capacities and thus increase the motivation to learn regardless of the subject area (Hill & Levenhagen, 1995). Because many people participate or have participated in athletics, sports metaphors are often likely to generate listener interest. So sports metaphors are of educational value because they can simplify difficult concepts, shorten communication cycles, and generate listener interest in many subject areas. The world is run in large part by the government and private business, but the nation's No. 1 hobby appears to be sports. So, it is no small wonder that the language of business and government is steeped in sports metaphors. How many will one hear over the next week or so? One simply has to keep count and in the end one would be surprised by the results.

The first one usually to hear is that a player would sign a contract with a certain team because that team had the "inside track." This is a horse or dog racing term and refers to the advantage that the top position often has. It also refers to NASCAR and the pole position. It did not work this time – the player signed elsewhere. Football references are everywhere. People in both business and government are looking for a "quarterback" for leadership, and they do not want to "fumble the ball" while moving said ball "down the field." Bill Shacklett often says they have a "game plan" for success, reaching their goal and, naturally, scoring a touchdown.

If something happens during this game plan that either insures success or destroys the plan then that something is called a "game changer." For instance, if the quarterback breaks his ankle – that's a definite game changer. Naturally, if you see success slipping away then you could attempt a desperate "Hail Mary." If you've been cheated or tricked in your efforts for success, this is a "low blow." Your early efforts toward your goal can be named for rounds – Round 1 or 2 for instance. Your final action that gained success is the "knockout punch." These are all boxing terms, of course. Easy questions are "softballs," and when you absolutely know the answer or action to be taken it's a "slam dunk." If you have no idea what to answer or do, then you are "behind the eight ball." If you do everything correctly and in order with no mishaps, then you have "run the table." This is a billiard term. A remark that a person is "out of bounds" generally means they made a remark or did something totally unacceptable or at least questionable. This is a golf term or perhaps football, basketball or soccer.

Baseball has been with us since the Civil War, so it is full of terms we use daily. Strangely it has no "out of bounds." It has something even better. If a person does the wrong thing virtually every day they could be described as a "foul ball." I'll bet there's a "foul ball" in your family, work place or daily life. If a person is a foul ball they will often be described as "out in left field." There is at least one foul ball or someone in left field in every workplace, classroom, family or office and on every team. This is not necessarily a bad thing. If there's a big challenge, I hope someone "steps up to the plate" and "knocks it out of the park." Terrific success is a "home run." If you do hit a home run, be sure and "touch all the bases" on your way home.

METHODS

Several research methods to extract different metaphorical meanings were used: parsing and lexical acquisition technologies (distributional clustering and selectional preference induction) which operate with a high accuracy. More specifically the following were used in our British National Corpus (BNC) (Burnard 2007): 1. a context-based probabilistic model that acquires paraphrases for metaphorical expressions from a large corpus; 2. a WordNet similarity component that filters out the irrelevant paraphrases based on their similarity to the metaphorical term (similarity is defined as sharing a common hypernym within three levels in the WordNet hierarchy); 3. a selectional preference model that discriminates literal paraphrases from the metaphorical ones. To give just an example of metaphor meaning derivation: a. Government loosened its strangle-hold on business. (Narayanan 1999), b. Government deregulated business. (Narayanan 1999). Shutova (2010) study containing single-word verb metaphors found that 44% of the investigated sentences were translated incorrectly due to metaphoricity. Due to the high frequency of metaphor in text according to corpus studies, such a high level of error becomes important for machine translation (MT). It re-ranks the paraphrases, de-emphasizing the metaphorical ones and emphasizing the literal ones. The system, consisting of independent metaphor identification and paraphrasing modules, operates with a high precision (0.79 for identification, 0.81 for paraphrasing, and 0.67 as an integrated system).

Procedure

Interestingly enough English business language is wrought with sports metaphors but real life business deal negotiators must have prior both declarative and procedural knowledge in order to successfully close the deal. Let us analyze the

following hopefully win-win negotiation deal discussion:

Bob: Well, is Trevisos going to play ball (baseball - play a game, *idiom - do business with*), or are we going to strike out (baseball -go out, *idiom -fail*) on this deal (*idiom - contract*)?

Pete: The latest locker talk (general sports -talk among the players, *idiom - gossip, rumours*) is that our game plan (American football -plan which plays to make, *idiom - plan of action*) is a real contender (boxing - very possible winner, *idiom -person with a good chance of success*) for the contract.

Bob: Yeah, the other team has two strikes against it (baseball -one step from going out or loosing, *idiom - close to not succeeding*) after they fumbled (American football - lose possession of the ball, *idiom - make a serious mistake*) last week.

Pete: They had a great chance of scoring (any sport - to make a point, *idiom - to succeed*) but I think Trevisos thought they weren't up to scratch (horseracing - not capable of winning, *idiom - not having the right qualities*) on some of the details.

Bob: They pretty much put themselves into a no-win situation (baseball - impossible to win, *idiom - impossible to succeed*) by stalling for time (American football - to delay the game, *idiom - to delay information or a decision*) on the figures from Smith's and Co. If we can get to home (baseball - score a run, *idiom - complete the desired action*) at the next meeting I think that we should be able to take the ball and run (American football - continue to go forward, usually a long distance, *idiom - continue in the right direction*).

Pete: If our numbers are right, we should be able to call the shots (basketball - to decide who shoots, *idiom - to make the decisions*) from here.

Bob: We just need to jockey ourselves into position (horseracing - put yourself into a good position to win the race, *idiom - to move into position to succeed*) to close the deal.

Pete: Make sure that you take along your team players (general sports - players who work together with other players, *idiom - people who work together with other staff*) next week. I want to be sure that everyone is playing with a full deck (cards - having all the necessary cards, *idiom - having the correct mental abilities*) and that everyone can field (baseball - to stop a hit ball, *idiom - to handle or deal with*) any question asked. No down for the count! (*idiom - lacking any prospects of recovering from the setback*).

Bob: I'll take Shirley and Harry along. They are no second stringers (team sports -second class members of the team, *idiom - less important workers*), they can present the ballpark figures (baseball - the place where the game is played, idiom - *general financial numbers*) and then I will bring it on home (baseball - to score a run, *idiom - to finish with success*). Otherwise, a full-court press (*idiom - giving an all-out effort to accomplish a task*).

Pete: Great, good luck with the pitch (baseball - to throw the ball to the batter, *idiom - to present the subject*)!

Conceptual metaphor manifests itself in natural language in the form of linguistic metaphor (or metaphorical expressions) in a variety of ways. The most common types of linguistic metaphor are lexical metaphor (i.e., metaphor at the level of a single word sense, multi-word metaphorical expressions, or extended metaphor, which spans over longer discourse fragments as in our above mentioned example of a business deal negotiation composed solely of different sports related metaphors. Lakoff and Johnson (1980) state following examples:

1. I've never won an argument with him. 2. You disagree? Okay, shoot!

RESULTS AND DISCUSSION

After statistical analyses of the business related modules containing sports metaphors following conclusions could be drawn: not all are in favor of extensive sports metaphors use in the language of business besause of several analogies of the two "disciplines". In sport, time is always of the essence and speed matters. No one values the runner who stops to think or the player who takes time out for reflection. Many business leaders get to the top spot because they've worked fast and furiously for years — only to be baffled and confused that what's needed now is just the opposite. On the field, action is everything but business leadership demands critical thinking, debate and exploration, habits few CEOs have been encouraged to develop. As Margaret Hefferman (2014) claims "The problem is that successful businesses are infinitely more complex, subtle and contingent than any race or game. Companies aren't saved by a single kick or shaving seconds off completion times." She argues against the absolute focus on self which athletic prowess demands as standing completely at odds with the collective nature of business achievement. Nevertheless, magazine covers and hagiographies sporting the rugged profiles of business leaders perpetuate the same trope: the heroic soloist can and will win the day, singlehandedly returning triumphant, medal in hand. Such triumphant language turns the domain of business into the domain of sports and even most ordinary words are used to spice up the world of negotiation and financial priming. For example, the word *pour* is used very frequently in a corpus.

POUR

nonliteral cluster wsj04:7878 N **As manufacturers get bigger, they are likely to pour more money into the battle for shelf space, raising the ante for new players.**

wsj25:3283 N **Salsa and rap music pour out of the windows**.

wsj06:300 U **Investors hungering for safety and high yields are pouring record sums into single premium, interest-earning annuities.**

literal cluster

wsj59:3286 L **Custom demands that cognac be poured from a freshly opened bottle**.

An example of the data of Birke and Sarkar for non-literal and literal cluster (2006).

Most prominent sports related metaphors in our analyzed corpus were the following:

- We're in the 9th inning and we can't strike out now.
- Keep your eye on the ball.
- Time out…we need a new game plan.
- That's par for the course.
- We can't afford to fumble the ball now.
- Let's touch base on this report.
- We need someone to quarterback this project.
- Don't bring in a rookie for the job.
- We've got two strikes against us.
- Sprint to the finish.
- This sale is a hole-in-one.
- Let's swing for the fences.
- We need to recruit quality players.
- Your department needs to go the distance.
- We struck out with the prospect.
- You need to take one for the team.
- We need a pinch hitter on this project.
- If we can just get to the line…
- Let's go the whole nine yards.
- Are they willing to play ball?
- We need to level the playing field.
- You miss 100 percent of the shots you don't take.
- Take the ball and run with it.
- They beat us at our own game.
- We must focus on the blocking and tackling necessary to meet our profit goals.
- Let's come out swinging.
- If we have to play hardball, we will.
- Go knock it out of the park.
- Can you run interference?
- You're way out in left field.
- The ball is in their court now.
- It's time to send in the heavy hitters.

CONCLUSION

This is just to barely scratch the surface. There are dozens and dozens examples more. It also seems that irrelevant of the type of specific domain language sports metaphors are permeating all spheres of life and language is most prone to this blending of ordinary and specific register languages. Although not many people are taking up sport on a regular basis sports language is used most regularly not just to denote sports events and sports disciplines reality. The source contains a series of cognitive entailments that are potentially mapped on to the target. This multi-faceted image can directly determine the listener's impression of the news event. Or, it can indirectly influence this impression by guiding processing of other literal information pertaining to the news event. Under appropriate circumstances, metaphorical language may also influence the message recipient's motivation or ability to systematically process a political, business or any other type of communication. Otherwise, we might end up behind the eight-ball, or, if ordinary language translated "in a very bad position".

Pedagogical implications

There are several implications emerging from the research in terms of future policy and practice in continuing professional development of ESP science teachers. As with experienced teachers, developing cognitive, metacognitive and affective strategies involves more than simple practical experience. We can rely on statistical data but they are only the signposts to what will make language more interesting to our sports students. Novice teachers need not only procedural knowledge about scientific literacy teaching but also conditional knowledge. The development of this knowledge demands the opportunity to compare and contrast their experiences with those of others and thus further their proficiency in specific domain knowledge including indispensable language of sports (Meier, 2017). Thus sports language with all its specificities is prevailing in other professional languages of medicine, law, business and knowing about the roots of sports metaphors requires more than ever the knowledge of cultural patterns of a given society as well.

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DIFFERENCES IN COGNITIVE ABILITIES AND PERSONALITY TRAITS BETWEEN HANDBALL PLAYERS AND GENERAL POPULATION

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ABSTRACT

The main goal of this paper was to identify differences between handball players and the general male population in cognitive characteristics and six personality traits. The study sample consisted of 14 handball players who play for HC „Železničar" Niš in the 2019/20 season. All subjects completed a battery of cognitive tests KOG-3 (Wolf, Momirović & Dzamonja, 1992) and HEXACO-60 personality test (Ashton & Lee, 2009) with six domains: Honesty-Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness and Openness to Experience. The results showed that handball players are better at cognitive functioning and have a less pronounced Openness to Experience trait.

Keywords: handball, cognition, personality traits

INTRODUCTION

Handball is a very dynamic team sport and requires different motor and psychological skills. When it comes to psychological characteristics in sports, the most commonly discussed are cognitive (intellectual) abilities and personality traits. Many authors claim that perceptive abilities are important in many sports, especially in team sports (Zwierko, 2007). Moreover, there is a correlation between perceptual abilities and the coordination of movement in musicians (Hughes & Franz, 2007). Cognitive abilities play a significant role in motor learning (Fitts & Posner, 1967; Gruić, 2014). Elite athletes respond to and process visual information faster than recreational athletes or non-athletes (Barcelos, Morales, Maciel, Azevedo i Silva, 2009). In judo, the connection between cognitive ability and performance has been established (Mitić, Mučibabić & Stanković, 2012), and the results of the study confirm the existence of a positive influence of cognitive factors on the efficiency of the deflection of the ball with forearms in volleyball (Stojanović, Milenkoski, & Nešić, 2006). Cognitive abilities are very important for achieving success in handball because of their connection with motor abilities (Stankovic, Ilić & Bojić, 2014). Some authors (Malacko & Stanković, 2011) find that cognitive tests IT-1 (efficiency of perceptive processor), S-1 (efficiency of parallel processor) and AL-4 (efficiency of serial processor) are in interaction with several latent motor variables in handball players.

When discussing personality traits and their impact on sport performance it is important to emphasize that, in handball, there are no statistically significant differences between players in different positions, except in introversion-extraversion (with a lower score in goalkeepers than in other positions) (Čavala, Trninić, Jašić, & Tomljanović, 2013), and that there is no difference in psychological traits between younger and older handball players (Sindik, Missoni, & Horvat, 2015). Authors (Kajtna, Vuleta, Pori, Justin, & Pori, 2012) tried to compare successful and less successful goalkeepers in handball and find no difference in aggression and anxiety (both state and trait). The others (Trninić, Trninić, & Penezić, 2016) compared personality traits among different athletes and claim that football, handball and water polo players differ considerably in their conscientiousness and openness. Also, they found that, in comparison to young players, senior players show more prominent agreeableness and

conscientiousness (ability to control impulses). Comparing the psychological characteristics of men and women in handball, it was found that extraversion, confidence and concentration are more pronounced in men (Paušek, Paušek, Sertić, Missoni, & Sindik, 2017). When it comes to successful and less successful juniors, it has been found that they are not different in psychological terms, except that successful players are less honest (Rogulj, Nazor, Srhoj & Božin, 2006). Summarizing the research of the connection between personality traits and sports success, it can be concluded that long-term success in sport is partly a function of personality whereas short-term success is unrelated to personality (Allen, Greenlees, & Jones, 2013).

During the preparation for the competition season 2019/20 HC, ''Železničar " decided to test the psychological functioning of the club's players and the functioning of the team as a group. The psychological report on each individual player and their functioning is delivered to the staff. However, the main goal of this study was to check whether the psychological characteristics of handball players differ in relation to the average population. This finding has no practical value for the coaches and players, but can present psychological characteristics that are more pronounced in athletes, specifically handball players, compared to the general population.

METHODS

The study sample consisted of 14 handball players who play national super league (Handball Club,''Železničar", Niš) in the 2019/20 season. All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. All subjects completed a battery of tests of cognitive function KOG-3 (Wolf, Momirović & Dzamonja, 1992), which consists of three tests: IT-1, AL-4 and S-1. The IT-1 test (the efficiency of perceptive processor) measures perceptual ability (perceptual analysis, structuring and identification). The AL-4 test (the efficiency of serial processor) measures verbal comprehension ability. Test S-1 (the efficiency of parallel processor) measures visual specialization. The raw scores on all three tests were converted to the z-scale, and the individual's IQ was calculated based on the sum of the Z-values.

Subjects also completed the HEXACO-60 personality test (Ashton & Lee, 2009), which estimates six personality domains (each with four subscales)*: Honesty-Humility Domain* (*Sincerity*, *Fairness*, *Greed Avoidance*, *Modesty), Emotionality Domain* (*Fearfulness*, *Anxiety*, *Dependence*, *Sentimentality), Extraversion Domain* (*Social Self-Esteem*, *Social Boldness*, *Sociability*, *Liveliness*), *Agreeableness Domain* (*Forgivingness*, *Gentleness, Flexibility, Patience*), *Conscientiousness Domain* (*Organization*, *Diligence*, *Perfectionism*, *Prudence*), *Openness to Experience Domain* (*Aesthetic Appreciation*, *Inquisitiveness*, *Creativity*, *Unconventionality*).

Data analysis was performed using the Statistical Package for the Social Sciences (v20.0, SPSS Inc., Chicago, IL, USA). One sample t-tests were used to compare the differences between the obtained values and the average values which were determined during the standardization of the test. For HEXACO domains (Honesty-Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness and Openness to Experience) these values are 3.09, 2.87, 3.54, 3.16, 3.34 and 3.44 respectively. Statistical significance was p .05.

RESULTS AND DISCUSSION

In Table 1 the basic parameters of descriptive statistics for the variables included in this research are presented.

Table 1: Results of descriptive statistics for all variables

	N	Mean	Std. Deviation	Std. Error Mean
Honesty-Humility	14	3.271	.6832	.1826
Emotionality	14	2.707	.6754	.1805
Extraversion	14	3.60	.455	.122
Agreeableness	14	3.278	.680	.182
Conscientiousness	14	3.485	.617	.165
Openness to Experience	14	2.60	.767	.205
IQ	14	106.429	8.4258	2.2519

Table 2 presents the results of the one sample t-test. The differences between the obtained values of the investigated variables were determined in relation to the average values obtained when these tests were standardizing. For HEXACO domains (*Honesty-Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness and Openness to Experience*) these values are 3.09, 2.87, 3.54, 3.16,

3.34 and 3.44 respectively. For the overall score the battery KOG-3, the reference value is the average IQ score (100). The results show that handball players are statistically significantly different from the average male population only in the lower expression of the Openness to Experience variable, whereas they have higher IQ.

Table 2: Results of t-test between the obtained and the average values

	t	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
Honesty-Humility	.994	13	.339	.181	-.213	.576
Emotionality	-.902	13	.383	-.162	-.553	.227
Extraversion	.493	13	.631	.060	-.203	.323
Agreeableness	.652	13	.526	.118	-.274	.511
Conscientiousness	.883	13	.393	.145	-.210	.502
Openness to Experience	-4.094	13	.001	-.840	-1.283	-.396
IQ	2.855	13	.014	6.428	1.564	11.293

The highest average z-value was obtained by handball players on the IT-1 tests. High score on the test could mean that the respondent can quickly and accurately notice the information while performing various motor tasks, so he can quickly adapt his performance according to changes in the environment. Also, high average z-values were obtained on test S-1. The high score on this test indicates that the respondent has good spatial orientation. In a handball context, this factor can be linked to good line play, good line-up position, timely and adequate passes. The results are in accordance with the results of previous studies (Barcelos, Morales, Maciel, Azevedo & Silva, 2009; Stankovic, Ilić & Bojić, 2014; Malacko & Stanković, 2011).

The absence of major psychological differences between handball players and the general population is in agreement with previous studies that state that these differences do not exist even between different athletes (Čavala, Trninić, Jašić, & Tomljanović, 2013; Sindik, Missoni, & Horvat, 2015; Kajtna, Vuleta, Pori, Justin, & Pori, 2012; Trninić, Trninić, & Penezić, 2016). In our study, handball players were found to be statistically significantly different from the general population only in the less pronounced Openness to Experience trait. *The participants* with very low scores on this scale are rather unimpressed by most works of art, feel little intellectual curiosity, avoid creative pursuits, and feel little attraction to ideas that may seem radical or unconventional (Lee & Ashton, 2008). This result suggests that it is necessary to create an adequate system for the intellectual and spiritual development of athletes. This can only be achieved if we seriously pay attention to the problem of dual career in sport.

CONCLUSION

The aim of this paper was to identify differences between handball players and the general male population. Differences in cognitive functioning and in the expression of six personality domains were examined. The results showed that handball players are better at cognitive functioning thanks to, above all, better perceptual and spatial abilities. Handball players have been found to have a less pronounced Openness to Experience trait, which can be developed, and therefore, the attention should be focused on the problem of dual careers in sport. The main limitation of this study is the small sample size.

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