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Gender Differences in Children Related to the Body Composition and Movement Coordination

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Abstract

The present research was conducted on a sample of 95 younger school children (age range 7-8 years) divided into two groups: 40 boys and 55 girls, in order to define the relation of basic anthropometric values, physical composition and BMI values to movement coordination by performing three motor tests. The ex post facto research design was used. Our results indicate that there are statistically significant gender differences related to the movement coordination in favor of the boys. Regression analyses results pointed out that the system of predictor variables in boys had statistically significant influence only on the manifestation of hypothetic motor factor of coordination for the variable Obstacle course backwards. All estimated predictor variables: body height, body weight, BMI, overall muscle tissue, overall fat tissue and overall water quantity positively correlate to this criterion. The predictor system did not have significant influence on other variables regarding the coordination assessment. Children still generally respond to the tasks; that is, the general motor factor is emphasized. A greater distinction should be expected once the children enter the prepubertal phase.

Key words: *bioelectrical impedance; BMI; impact on classroom teaching; morphological characteristics; motor ability.*

Introduction

Body height and body weight are commonly described as the best indicators of of the physical state of population, and to some extent, of children's growth and development. They are influenced by the interaction between genetic and environmental factors, but they also depend on the ethical and socio-cultural characteristics of a population. Their relationship can be used to establish physical proportions and nutrition level (Krneta, Kerić, & Pelemiš, 2011; Pelemiš, Branković, & Banović, 2016) by calculating the BMI (body weight (kg)/body height (m^2)) (Mei, Grummer-Strawn, Pietrobelli, Goulding, Goran, & Dietz, 2002). This type of index is most commonly used in a wide range of epidemiological studies related to the nutrition of a population (Heyward & Wagner, 2004). If the BMI values are above or below the expected standard values for weight, serious health problems can emerge. The data found in literature emphasize that the ideal body weight and motor abilities are influenced by different factors, such as age, gender, physical constitution, lifestyle, physical activity, social status and ethnicity (Danubio, Amicone, & Vargiu, 2005; Ishizaki et al., 2004). At the base of every precisely planned and programmed physical activity, a number of physiological and metabolic processes are at work. A body engaged in that way reacts to changes in almost all physiological systems; primarily skeletal-muscle, cardio-vascular, respiratory, endocrine and immune systems (Mišigoj-Duraković, 2006).

At birth, the quantity of water in muscles is about 80%, but in a grown-up person, it is reduced to 70%–75%. The weight of the muscle tissue in a newborn is about 23% of the total weight. That percentage increases during growth and development, and at the age of eight, it is about 27%, at the end of puberty about 32% and in a mature person it is over 40%. Recent papers suggest that this percentage in a mature person goes up to 45% and in athletes, it is even above 50%. In relation to body weight, which increases about 21 times throughout the life span, muscle tissue weight increases 37 times (Sente et al., 2012). It is a well-known fact that physical activity contributes to tissue building, although it is not entirely clear in which way. Every living cell contains free-flowing and bound water. In order to live, it is important to maintain water quantities within certain limits. Water makes up between 55% and 60% of overall body mass of adults and even more than that in case of children.

The skeletal mass acquired during childhood is a key determinant for healthy bones later in life. Physical activity, especially if well-directed and monitored, represents an important anabolic stimulus (Eliakim & Yoram, 2003). The principal strain on skeleton is exercised by muscle contractions. The bone adjusts to the strain to be able to maintain its structure and functional role (Frost, 2000). Anabolic influence of physical activity is mostly limited to persons who go through intensive training programs.

Individual distribution of fat tissue depends on hormones and is related to gender. In females, there is a relatively higher amount of fat tissue than in males. The ratio between fat and muscle tissue in a female is usually 28%: 39%, and in a male 18%: 42% (Roshe, Heymsfield, & Lohman, 1996). The chemical composition of fat tissue changes during the life cycle. The fat tissue cell is filled with a drop of neutral fat which pushes the nucleus and cytoplasm to one side of the cell wall. Fat tissue is capable of retaining a great quantity of water (up to 70% of its own mass) and releasing it. Its purpose in the body is either to store reserves of nutriments, or it is a structural element for building of fat tissue that fills the extracellular space in the body and is rarely used even in times of extreme hunger.

Both genders experience an increase in the adipose and fat-free tissue with age. After the age of 11, the fat mass levels are significantly higher in girls, while fat-free component levels are higher in boys. Children and adults who have high body mass values are facing serious health risks, which can be detrimental to their lives (Daniels, 2006). These risks are primarily related to cardiovascular disease, diabetes, asthma (Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007). In the period between 10 and 14 years of age, the difference between the genders regarding the active cell mass is not detected, but after the age of 14, those characteristics can be detected in boys. At the age between 12 and 13, there are significant gender differences regarding active resistance and phase angle (Andreenko & Nikolova, 2011a). The differences in coordination and physical composition of younger school age children were established in favor of the boys (Lepeš, Halaši, Mandarić, & Tanović, 2014a). The differences between morphological characteristics in children of the opposite gender were established as well (Bala & Katić, 2009; Horvat, Mišigoj-Duraković, & Prskalo, 2009; Pelemiš, V., Pelemiš, M., Mitrović, & Džinović, 2014). Also, it was pointed out that boys had developed better coordination, agility, precision, balance and strength, compared to girls, who exhibit domination in flexibility (Horvat, Babić, & Jenko Miholić, 2013; Mandić, Martinović, & Stamatović, 2010). After the analyses of the findings of previous studies, it is clear that dimorphic differences in coordination and morphological characteristics can be established in children at this age. However, a lack of research would be reflected on the relations between anthropometric measures, body composition and coordination in children. This study should provide answers to the question which segments of body composition and basic morphological characteristics contribute most to the performance of one of three hypothetical factors of coordination, and examine the possibility of planning new educational content in Physical Education instruction.

The aim of the present study is to define the influence of physical composition, morphological characteristics and BMI on movement coordination in children aged 7 to 8 years.

Methods

All measurements and tests were performed on a sample of 95 subjects divided into two groups - 40 boys and 55 girls. All subjects were attending the second term of first grade of Branko Ćopić primary school in Belgrade, in 2016. Before the research was conducted, the children's parents had been informed about the course of the study and they had provided their written consent (The Declaration of Helsinki, 2013).

The basic anthropometric measures were selected as a sample of measuring instruments: 1) *Body height* (cm) – measured by anthropometry (Martin) and 2) *Body weight* (0.1 kg) measured by InBody 230 (Biospace Co., Ltd., Seoul, Korea).

Body composition was assessed by: 1) *Overall muscle quantity* (0.1 kg) – measured by InBody 230 (Biospace Co., Ltd., Seoul, Korea); 2) *Overall fat tissue quantity* (0.1 kg) – measured by InBody 230 (Biospace Co., Ltd., Seoul, Korea) and 3) *Overall water quantity* (0.1 kg) – measured by InBody 230 (Biospace Co., Ltd., Seoul, Korea).

Based on the body height and body weight values, the BMI index (Body mass index) was calculated:

$$BMI = BW/(BH)^2$$

Legend: BMI – Body Mass Index; BW – Body Weight; BH – Body Height.

The InBody 230 apparatus based on the bioelectrical impedance (BIA) was used to determine the physical composition. The BIA analysis is a fast, inoffensive method for evaluating physical composition on the field or in clinical surroundings. It was used in previous studies involving similar samples of subjects (Lepeš et al., 2014b; Reguli, Bernaciková, & Kumstát, 2016) and it proved to be a useful method. It has become a referral method for scientific studies concerned with physical composition analyses (Sudarov & Fratrić, 2010). In comparison with DEXA InBody (Biospace Co., Ltd., Seul, Korea), it proved to be producing precise (r=0.974) results.

For the evaluation of body coordination, the standardized tests by Gredelj, Metikoš, Hošek, & Momirović (1975) were selected. They were described and taken from the applied research (Bala, 1981; Aleksić, Stanković, Milenković, Karalejić, Lilić, & Mekić, 2013), which included: reorganization of the movement stereotype - 1) *Obstacle course backwards* (0.1 s); body coordination - 2) *Coordination by baton* (0.1 s) and the execution speed of complex motor tasks - 3) *Slalom with three balls* (0.1 s).

The *Obstacle course backwards* test required 1-1.5 minutes per subject. The used instruments included a vaulting box and a stopwatch. The place where the test was performed was a room with the flat and smooth floor and minimum dimensions 12 x 3 m. A one-meter line was drawn with a visible tape that marked the start, and parallel to it, another line was drawn 10 meters farther. Three meters away, across from the starting line, the bottom part of the vaulting box was placed, and six meters away from the starting line, the frame of the vaulting box was placed, with its wider side touching the ground. The placement spots of the vaulting box were marked with visible lines. The starting position of the subjects was "quadrupedal" (leaning only on their feet and palms), with their backs turned to the obstacles. Their feet were placed along the starting line. The subjects' task was – after the "Start" signal – to cover the space between the two lines (10 meters) while walking backwards on all fours. The first obstacle had to be overcome by climbing and the other one by going under it. The subjects were not allowed to turn their heads, and they had to look between their legs the whole time. The task was performed once, after the trial run. There was a brief pause between the trial run and the task performance. The task was accomplished when the subject had managed to cross the finishing line with both hands. The performance time was recorded in tenths of seconds, beginning with the "Start" signal, and ending with the crossing of the finishing line with both hands. If the subjects moved any from the obstacles, they had to put them back themselves and repeat that part of the task. In that case, the stopwatch would not pause.

The time required for the execution of the *Coordination by baton* test was around 2 minutes per subject. The instruments used were a stopwatch and a stick. The task was performed within a 2 x 2 m space. The subject stood in the center of the field and held the stick with both hands, behind his knees. After the "Start" signal, the subject had to step over the stick without dropping it, with both feet on the ground, until lifting his hands above their head. Then he had to repeat the same process, and get back to the starting position. The task was accomplished when the subject had returned to the starting position in the accurate way. The time was measured beginning with the "Start" signal and ending with the fulfillment of the task. The task was performed three times, with a pause long enough for recuperation, and only the subject's best performance was taken as the score.

The Slalom with three balls test took 2.5-3 minutes per subject. The instruments used were three medicine balls weighing 1 kg each, five slalom poles, a colored tape and a stopwatch. The test was performed within a 12 x 5 m space. The poles were placed on a 10-meter track, with a 2-meter distance between each. The first pole was 2 meters away from the starting line. Next to the one-meter starting line the pole positions were marked. The starting position of the subject was to stand behind the medicine balls, which were placed right behind the starting line. After the "Start" signal, the subjects started to roll all three medicine balls together on the ground between the poles, as fast as they could. After reaching the last pole, they would turn around and roll the medicine balls between the poles back to the starting line. The subjects were allowed to use their legs for help. The task was accomplished when the subjects crossed the starting line with all three medicine balls. The score was the time measured in hundredths of seconds beginning with the "Start" signal and ending when the last medicine ball and subject crossed the finishing line. If the subject "lost" the medicine balls during the rolling and slalom, he would have to gather them and continue his task from the spot where he had lost them. If the subject knocked down a pole, the examiner would put it back in its place, and the subject would proceed with the task without stopping. If the subject made mistakes (e.g. missed a pole), he would continue with the task from the spot where he had made the mistake, and during that time the stopwatch would not pause. The examiner checked if the poles were in their marked places before every new subject started performing the task.

The data processing methods included the calculation of the basic descriptive statistical data: the arithmetic mean (M), standard deviation (SD), minimum (MIN) and maximum (MAX) result, skewness – measure of distribution symmetry (Skew) and kurtosis – measure of distribution homogeneity (Kurt). The next step was the analysis of statistically significant differences between the sample groups using the multivariate (MANOVA) and the univariate (ANOVA) variance analysis. Using the multiple regression analysis, the influence of morphological characteristics on motor variables for coordination assessment was determined and they represented the criterion variable.

Results

On average, male subjects were shorter than female subjects (127.95 cm to 128.25 cm), but they were heavier (26.46 kg to 25.77 kg). Boys had more muscle tissue, less overall fat tissue and a higher percentage of overall water quantity compared to girls (Table 1).

Subsamples of boys and girls had the normal nutritional status. Skewness values point to the pronounced positive asymmetric distribution of the variables: body weight, overall fat tissue quantity, and BMI in boys and overall muscle quantity, overall fat tissue and overall water quantity, which points to the fact that most boys and girls have lower values of the aforementioned characteristics.

Based on the descriptive statistics presented in Table 1 and observed from the point of gender-related dimorphic differences, it can be concluded that both male and female subjects were at a similar growth and skeletal development level. However, a greater variability of results can be detected in variables for the assessment of the nutritional status and physical composition, which is caused by huge differences in body composition and weight.

Table 1

Descriptive statistical data of anthropometric variables, physical composition variables and BMI

Variable	Group	Mean	SD	Minimum	Maximum	Sk	Kurt
Body height (0.1 cm)	Boys	127.95	45.82	1175	1355	-0.27	-0.81
	Girls	128.25	58.76	1150	1445	0.41	0.62
Body weight (0.1 kg)	Boys	26.46	4.82	18.00	42.70	1.28	2.19
	Girls	25.77	5.52	18.60	41.30	0.93	0.45
Overall muscle quantity (0.1 kg)	Boys	11.64	1.47	8.40	15.50	0.19	0.34
	Girls	10.91	2.00	8.10	17.60	1.18	1.63
Overall fat tissue quantity (0.1 kg)	Boys	4.83	3.67	1.70	20.50	2.54	8.36
	Girls	5.18	3.14	1.70	14.30	1.18	1.04
Overall water quantity (0.1 kg)	Boys	16.93	1.78	13.00	21.00	0.06	0.01
	Girls	16.17	2.46	12.60	24.70	1.24	1.99
BMI (kg/m^2)	Boys	16.08	2.29	13.04	25.07	1.94	5.21
	Girls	15.57	2.56	11.40	22.66	0.82	0.46

Legend: Mean - arithmetic mean: SD – standard deviation; Sk – skewness (skewing of result distribution); Kurt – kurtosis (elongation of results distribution).

Considering the average values of the motor variables for the assessment of hypothetical motor factor of coordination, it can be concluded that the average values in male subjects were lower on average, which is better, regarding all three variables, than in girls: obstacle course backwards, coordination by baton and slalom with three balls (Table 2).

Table 2

Descriptive statistics of motor variables

Variable	Group	Mean	SD	Minimum	Maximum	Sk	Kurt
Obstacle course backwards (0.1 sec)	Boys	25.18	9.35	13.70	54.12	1.16	0.96
	Girls	28.68	7.37	12.80	46.60	0.55	0.01
Coordination by baton (0.1 sec)	Boys	6.31	1.24	5.03	10.12	1.30	1.29
	Girls	6.57	1.29	5.02	9.15	0.51	-1.10
Slalom with three balls (0.1 sec)	Boys	36.27	7.10	24.90	60.00	1.41	2.21
	Girls	43.55	10.57	24.20	64.70	0.34	-0.86

Legend: Mean - arithmetic mean: SD – standard deviation; Sk – skewness (skewing of results distribution); Kurt – kurtosis (elongation of results distribution).

Table 3 shows the results of the diagonal Pearson correlation coefficient variables tested for boys below the diagonal, while the results for girls are presented above the diagonal, in order to show that they meet the criteria for regression analysis. The last two variables, *Coordination by baton* and *Slalom with three balls,* did not meet the preconditions of linearity of the relationship of variables, since the coefficients exceed the permitted values. Therefore, the regression analysis of these two variables will be presented without the Beta regression coefficients.

Table 3

Linear relationship variables tested for both sexes

Variable	1	2	3	4	5	6	7	8	9
Body height	**1,000**	.668**	.283*	.780**	.369**	.705**	-.142	-.297*	.097
Body weight	.666**	**1,000**	.900**	.882**	.881**	.799**	.082	-.099	.156
Overall muscle quantity	.365*	.937**	**1,000**	.676**	.928**	.617**	.193	.051	.159
Overall fat tissue quantity	.747**	.669**	.496**	**1,000**	.589**	.884**	-.033	-.188	.123
Overall water quantity	.384*	.892**	.931**	.322*	**1,000**	.545**	.218	.019	.206
BMI	.791**	.705**	.519**	.993**	.355**	**1,000**	.000	-.163	.070
Obstacle course backwards	.434**	.606**	.543**	.306	.586**	.331*	**1,000**	.746**	.100
Coordination by baton	.284	.156	.060	.140	.090	.141	.470**	**1,000**	-.144
Slalom with three balls	-.112	-.113	.084	-.024	-.192	.031	.011	-.207	**1,000**

Legend: There is no statistically significant correlation; * - Statistically significant correlation in the scope p<0.05; ** - Statistically significant correlation in the scope p <0.01.

Based on the values of the Wilk's F test presented in Table 4, it can be concluded that there are no statistically significant differences between the subjects pertaining to gender with regard to their morphological characteristics and nutritional status.

Table 4

Differences between the subjects with regard to gender in anthropometric variables and BMI

Gender	Variable	F	p	F	P
Boys Girls	Body height	0.05	0.82	0.59	0.63
	Body weight	0.40	0.53		
	BMI	0.98	0.34		

Legend: f – unvaried F test; p – level of statistical significance of F test; F – multivariate Wilk's F test; P – statistical significance of multivariate F test.

After analyzing the values of Wilk's F test presented in Table 5, it can also be concluded that there are no statistically significant differences between boys and girls with regard to physical composition.

Table 5

Differences between the subjects estimated by gender in variables for the assessment of physical composition

Gender	Variable	f	p	F	P
Boys Girls	Overall muscle quantity	3.77	0.06	2.09	0.11
	Overall fat tissue quantity	0.25	0.62		
	Overall water quantity	2.76	0.10		

Legend: f – unvaried F test; p – level of statistical significance of F test; F – multivariate Wilk's F test; P – statistical significance of multivariate F test.

By observing the values of the Wilk's test presented in Table 6, it can be assumed that there is a statistically significant difference between the subjects of different gender with regard to coordination. By individual analysis of each variable for the assessment of hypothetical coordination factor it is concluded that there is a difference in the variables *Obstacle course backwards* and *Slalom with three balls* in favor of the boys.

Table 6

Differences between the subjects with regard to gender in motor variables

Gender	Variable	f	p	F	P
Boys Girls	Obstacle course backwards	4.16	**0.04**	3.00	**0.00**
	Coordination by baton	0.77	0.38		
	Slalom with three balls	14.36	**0.00**		

Legend: f – unvaried F test; p – level of statistical significance of F test; F – multivariate Wilk's F test; P – statistical significance of multivariate F test.

Further on in the text, the results of each criterion variable for coordination assessment within the predictor system are presented in the form of numerical data divided according to gender (Tables 7, 8 and 9). Results of the regression analysis of the criterion variable Obstacle course backwards (Table 7) indicated that there is a statistically significant influence of predictor variables on the analyzed criterion.

Table 7

Results of the regression analysis of Obstacle course backwards

Variable	Boys				Girls			
	r	p	Beta	pbeta	r	p	Beta	pbeta
Body height	0.43	**0.00**	-1.09	0.39	-0.14	0.15	-0.10	0.92
Body weight	0.61	**0.00**	4.45	0.16	0.08	0.28	-0.87	0.69
BMI	0.54	**0.00**	-3.04	0.24	0.19	0.08	0.14	0.93
Overall muscle quantity	0.31	**0.03**	1.13	0.44	-0.03	0.41	0.19	0.74
Overall fat tissue quantity	0.59	**0.00**	0.03	0.96	0.22	0.06	0.71	0.23
Overall water quantity	0.33	**0.02**	-1.51	0.38	0.01	0.50	0.12	0.69
R				0.67				0.34
R^2				0.45				0.12
P				**0.00**				0.39

Legend: r – Pearson correlation coefficient; p – level of statistical significance for r; Beta – regression coefficient; pbeta – level of significance of regression coefficient; R - multiple correlation coefficient; R^2 – determination coefficient; P – significance of multiple coefficient correlation.

Upon examination of the results of regression analysis of the *Coordination by baton* variable (Table 8), it appears that there is no statistically significant influence of predictor variables on the criterion variable in neither gender.

Table 8

Results of the regression analysis of Coordination by baton

Variable	Boys		Girls	
	r	p	r	p
Body height	0.28	0.04	-0.30	0.01
Body weight	0.16	0.17	-0.10	0.24
BMI	0.06	0.36	0.05	0.36
Overall muscle quantity	0.14	0.19	-0.19	0.09
Overall fat tissue quantity	0.09	0.29	0.02	0.45
Overall water quantity	0.14	0.19	-0.16	0.12
R		0.40		0.34
R^2		0.15		0.11
P		0.43		0.42

Legend: r – Pearson correlation coefficient; p – level of statistical significance for r; Beta – regression coefficient; pbeta – level of significance of regression coefficient; R - multiple correlation coefficient; R^2 – determination coefficient; P – significance of multiple coefficient correlation.

After the examination of the results of regression analysis of the *Slalom with three balls* (Table 9) variable, it appears that there is no statistically significant influence of predictor variables on the criterion variable in neither gender.

Table 9

Results of the regression analysis of the Slalom with three balls

Variable	Boys		Girls	
	r	p	r	p
Body height	-0.12	0.25	0.10	0.24
Body weight	-0.11	0.24	0.16	0.13
BMI	-0.08	0.30	0.16	0.12
Overall muscle quantity	0.02	0.44	0.12	0.19
Overall fat tissue quantity	-0.19	0.12	0.21	0.07
Overall water quantity	0.03	0.42	0.07	0.31
R		0.40		0.32
R^2		0.16		0.10
P		0.41		0.48

Legend: r – Pearson correlation coefficient; p – level of statistical significance for r; Beta – regression coefficient; pbeta – level of significance of regression coefficient; R - multiple correlation coefficient; R^2 – determination coefficient; P – significance of multiple coefficient correlation.

Discussion

The main results of this study carried out on a sample of boys and girls aged 7-8 years from Belgrade indicates that they have a normal nutritional status, they are of similar longitudinal skeleton dimensions and body weight, and that they have similar average values of overall quantities of muscle, fat tissue and water. The results are consistent with the findings obtained by quantitative research conducted by Bala (2004) on a sample that included children who were one year younger. Recent study by Stamm, Gebert, Guqqenbuhl, and Lamprecht (2014) even suggests the presence of gender differences in the height/weight ratio. That trend is a growing one, and is more prevalent in older school-age children. The age of seven is a period related to intensive growth of long bones, therefore similar longitudinal development level is a consequence of heterogeneity of growth and body development and biological maturity of children, while different lifestyles in urban environment affect the levels of muscle tissue, fat and water in physical composition of subjects. As far as results relating to the physical composition of children of younger school age are concerned, they are similar to the results obtained by Andreenko and Nikolova (2011b) and Martinović, Pelemiš, V., Branković, Živanović, and Pelemiš, M. (2013), who have established that boys have a higher percentage of muscle tissue and a lower percentage of overall fat tissue compared to girls. The balance of body weight used to calculate BMI when compared with the percentile curves for this age group shows that the average values for both genders fall under the 57th percentile for boys and girls aged 7, and 67th percentile for children at the age of 8. This may indicate that the nutrition of children is of good quality, and that the two subsamples can be classified as having normal weight. Still, in this part of Europe we cannot talk about the prevalence of obesity in the same terms as in Western Europe and the United States, as evidenced by Yajnik's research (2000). The prevalence of obesity in the US has increased dramatically in the past three decades. There is a different range of obesity in children and adolescents. Research conducted by Lo, Maring, Chandra, Daniels, Sinaiko, Daley, Sherwood, Kharbanda, Parker, Adams, Prineas, Magid, O'Connor, and Greenspan (2014) suggests that the prevalence of obesity and severe obesity was higher in boys than in girls, and highest among children of Hispanic ethnicity. BMI was related to a higher percentage of physical height, which is interesting. In obese children at the age of five, obesity or elevated BMI was high - about 80%. The authors have shown that obesity in early childhood can have significant health consequences later in life. Research conducted in Turkey by Inal, Canbulat, and Bozkurt (2015) reveals the fact that the overall prevalence of obesity was detected in 25.6% of children, while it was classified as excessive in 14.5% of children in the total sample of the children tested. The authors note that the mothers' way of life, particularly in terms of BMI and physical activity, can influence obesity among children, and that it is necessary to create a strategy for improving physical activity and eating habits of mothers. On the other hand, a certain percentage of underweight children was recorded in the eastern part of Europe in Georgia (Kherkheulidze, Nemsadze, Kavlashvili, Kandelaki, & Adamia, 2010). Adequate nutrition is essential for the full development of a child's potential and, to a large extent, for the developmental status of children, as noted by Kitsao-Wekulo, Holding, Taylor, Abubakar, Kvalsvig, and Connolly (2013), and it is particularly noticeable in obese children. Similar findings were obtained in China, where the prevalence of malnutrition is associated with stunted growth in children under the age of five. However, this situation has steadily normalized (Chen, He, Wang, Deng, &

Jia, 2011). Research by Freedman, Mei, Srinivasan, Berenson, and Dietz (2004) carried out in the United States suggests that a higher prevalence of obese children is related to a higher level of nutrition. The research that focuses on this aspect indicates that overweight has negative emotional and social effects on individuals. Just one kilogram of body fat requires about 6 kilometers of new blood vessels, which puts additional pressure on the cardiovascular system, which explains the correlation between the overweight and the cardiovascular disease (Grubic, 2008). It should be emphasized that, based on the above-mentioned findings, significant differences in body composition should be expected when children enter prepubertal phase.

Quantitative differences in the demonstration of coordination were determined in favor of the boys. An extreme variability of results is visible in both subsamples in all three coordination assessment variables. The result differences within the subgroups are remarkable. Based on skewness of distribution, it can be concluded that boys' average results fall into a field of lower values in all three variables. Lower values were recorded for most subjects, which points to a better state of coordination in this group (inversion metric-time, expressed in seconds). The results of research relating to body coordination have confirmed the findings obtained by Halaši and Lepeš (2012), who had detected a higher coordination level in boys than in girls of the same age. The results can also be linked to the findings of Fratrić, Orlić, Badža, Nešić, Goranović, and Bojić (2012), where gender-related differences in motor skills of children between 7 and 10 years of age were identified at all levels. It seems that coordination in boys was at a higher level of development than in girls, which could be a consequence of overall motor performance generally more evident in boys. Different ways of performing physical activity created better coordination of movements, which improved motor experience in boys compared to girls of the same age. The research established that boys, probably due to enhanced motor performance in the preschool period, and due to greater motivation for accomplishment in that period of development, achieve better results on coordination tests than do girls of the same age. Girls at that age have different interests. The difference between coordination exercised by boys and girls occurs due to "motor capacity potential", but also due to other factors which help develop and put into effect such capacity. Firstly, it is the physical activity carried out during the day. The coordination in children of younger school age is to a great extent determined by lifestyle, level of physical activity, morphological characteristics, but, above all, it is determined by cognitive abilities and learning characteristics (Dolenc, Pistotnik, & Pinter, 2002). Malina, Koziel, and Bielicki (1999) suggest that the age of seven is the period when physical activity with the aim of developing motor skills has the best effects, and developmental status, or biological maturity, significantly affects motor tasks performance, suggesting that close attention should be paid to coordination skills of the girls.

Such link is explained by 45% of joint variability of predictor system and criterion in boys. The remaining percentage can be explained by some other characteristics and abilities that were not included in the predictor system (motivation concentration, conative characteristics, but most of all, other anthropometric characteristics: transversal dimensionality of skeleton and volume of upper limbs), but which can play a decisive role in performing tasks that require coordination. However, a positive correlation of all predictor variables with the criterion was found. The boys with pronounced body height, weight and higher BMI, larger overall muscle mass, water and overall fat tissue mass accomplished poorer results on a test. Their overall body coordination was poorer. A higher percentage of fat tissue and mass disabled their performance on the test. The positive correlation of muscle tissue was surprising, but it can be justified by lower cognitive abilities and weaker movement coordination in those boys. No statistically significant influence of predictor variables on the criterion was established in girls. The shared variability was found to be only 12%. Some other characteristics and abilities had a greater influence on girls' demonstration of body coordination. Future research should take into consideration the cognitive abilities, learning characteristics and socio-economic factors, which play a significant role in demonstrating motor performance in childhood. No statistically significant correlation between boys and girls was found in body composition and coordination by baton test. There was also found no correlation between the predictor system and Slalom with three balls coordination test. The surveys carried out by Zenić, Foretić, and Blažević (2013) have indicated that the greatest relation established between anthropometric variables and physical fitness has been achieved in the BMI variable. The most important thing is to point out that the authors recommended a nonlinear regression model to determine the relation because it identifies breakpoints in line regression and indicates the true nature of the relationship between variables.

Conclusion

The findings of this study can be perceived as encouraging, especially taking into account the fact that the developed Western countries have recorded a constant growth of body mass index in children, while children of both genders from Belgrade exhibit the normal nutritional status. In general, it should be stressed that during the growth and development the relation between motor abilities and morphological characteristics changes, as well as the relation between the components of physical composition. The limitations of this study are reflected in the fact that the sample included children who are from Belgrade and who were not randomly selected, and thus the external validity of the research is slightly compromised, as well as the generalization of the results. It is necessary to monitor children constantly during different developmental stages. Later on in life, especially in puberty, greater gender-related differences in physical composition and motor abilities can be expected. For now, most children react to the tasks at hand; that is, the overall motor factor is evident.

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Spolne razlike u tjelesnoj kompoziciji i njihova relacija s koordinacijom kod djece

Sažetak

Istraživanje je provedeno na uzorku od 95 djece mlađeg školskog uzrasta (7 – 8 godina) podijeljenih u dvije skupine: 40 dječaka i 55 djevojčica s ciljem definiranja osnovnih antropometrijskih mjera, tjelesne kompozicije, te izračunavanja vrijednosti indeksa tjelesne mase (BMI) i procijenjene koordinacije putem tri motorička testa. Koristio se ex post facto nacrt istraživanja. Istraživanjem je utvrđeno postojanje statistički značajnih razlika u pogledu koordinacije u korist dječaka. Rezultati regresijske analize ukazali su na to da je sustav prediktorskih varijabli kod dječaka imao statistički značajan utjecaj na manifestaciju hipotetskog motoričkog faktora koordinacije samo u varijabli Poligon natraške. Sve prediktorske varijable: Tjelesna visina, Tjelesna masa, BMI, Ukupna količina mišića, Ukupna količina tjelesne masti i Ukupna količina vode u pozitivnim su korelativnim odnosima s tim kriterijem. Prediktorski sustav nije ostvario značajan utjecaj s ostalim varijablama za procjenu koordinacije. Djeca još uvijek generalno reagiraju na postavljene zadatke, odnosno ističe se genaralni motorički faktor, a veće razlike treba očekivati s ulaskom djece u pretpubertetsku fazu.

Ključne riječi: *bioelektrična impedansa; ITM; morfološke karakteristike; motoričke sposobnosti; utjecaj na razrednu nastavu.*

Uvod

Tjelesna visina i tjelesna masa najčešće su okarakterizirane kao najbolji pokazatelji fizičkog stanja stanovništva, te donekle rasta i razvoja djeteta. Pod utjecajem su interakcije genetskih i ekoloških čimbenika, ali ovise i o etničkim i socio-kulturnim karakteristikama stanovništva. Njihov odnos može se koristiti za određivanje tjelesne proporcije i stanja uhranjenosti (Krneta, Kerić, i Pelemiš 2011; Pelemiš, Branković, i Banović, 2016) i to izračunavanjem ITM (tjelesna masa (kg)/tjelesna visina (m2)) (Mei, Grummer-Strawn, Pietrobelli, Goulding, Goran, i Dietz, 2002). Taj indeks najviše je rasprostranjen kada se vrše velika epidemiološka istraživanja za procjenu uhranjenosti stanovništva (Heyward i Wagner, 2004). U slučajevima kada vrijednosti ITM premašuju standardne vrijednosti za normalnu masu, mogu nastati ozbiljni zdravstveni problemi.

U podatcima iz literature ističe se da su idelana tjelesna masa i motoričke sposobnosti pod utjecajem različitih faktora, kao što su dob, spol, tjelesne konstitucije, način života, tjelovježba, socijalni status i pripadnost etničkoj skupini (Danubio, Amicone, i Vargiu, 2005; Ishizaki i sur., 2004). U osnovi svake točno planirane i programirane fizičke aktivnosti odvija se velik broj fizioloških i metaboličkih procesa. Tijelo angažirano na taj način reagira promjenama u gotovo svim fiziološkim sustavima, u prvom redu mišićno-koštanom, srčanožilnom, respiratornom, endokrinom i imunološkom sustavu (Mišigoj-Duraković, 2006).

Po rođenju postotak vode u mišiću iznosi 80%, da bi se kod odraslog čovjeka zaustavio na 70-75%. Težina mišićne mase kod novorođenčeta iznosi oko 23% ukupne tjelesne mase. Rastom i razvojem taj postotak se povećava, pa se oko osme godine kreće oko 27%, na kraju puberteta oko 32%, a kod zrelog muškarca više od 40%. Noviji radovi iznose podatke da se taj postotak kod zrelih muškaraca kreće do 45%, a da kod sportaša prelazi 50%. U odnosu na tjelesnu masu koja se tijekom cijelog života uveća za 21 put, masa mišićnog tkiva uveća se za čitavih 37 puta (Sente i sur., 2012). Činjenica je da fizička aktivnost doprinosi izgradnji tkiva. Ali još uvijek nije sasvim jasno na koji način. Svaka živa stanica sadrži slobodnu ili vezanu vodu. Za održavanje života bitno je da se količina vode održava u određenim granicama. To čini 55-60% ukupne mase odraslih osoba i nešto više kod djece.

Koštana masa stečena tijekom djetinjstva ključna je determinanta zdrave kosti tijekom kasnijeg života. Fizička aktivnost, osobito ona koja je usmjerena i kvalitetno praćena, predstavlja značajan anabolički stimulans (Eliakim i Yoram, 2003). Najveće opterećenje u odnosu na kostur stvaraju kontrakcije mišića. Kost se prilagođava spomenutim opterećenjima radi očuvanja svoje strukturne i funkcionalne uloge (Frost, 2000). Anabolički utjecaji fizičke aktivnosti u većini su slučajeva ograničeni na osobe koje se bave intenzivnim programiranim treningom.

Raspored masnog tkiva kod čovjeka ovisi o hormonima i pokazuje ulogu spolne pripadnosti. Kod osoba ženskog spola postoji relativno više masnog tkiva nego kod osoba muškog spola. Odnos masti i mišića je kod osoba ženskog spola 28% : 39%, a kod osoba muškog spola 18% : 42% (Roshe, Heymsfield, i Lohman, 1996). Kemijski se sastav masti tijekom života mijenja. Ćeliju masnog tkiva ispunjava kapljica neutralne masti, koja jedro i citoplazmu potiskuje uz jedan kraj stanične opne. Masno je tkivo sposobno primiti veliku količinu vode (do 70% svoje mase) i ponovno je otpustiti. U čovjekovu tijelu ono služi kao spremište rezervne hrane ili kao element građe pri stvaranju masnih tijela (corpus adiposum) koja ispunjavaju mrtve prostore u organizmu i vrlo se slabo troše, čak i kod dugotrajnih gladovanja.

Starenjem dolazi do povećanja adipoznog i bezmasnog tkiva kod oba spola. Nakon 11. godine masna je masa značajno više zastupljena u tjelesnoj kompoziciji kod djevojčica, a bezmasna je komponenta više zastupljena kod dječaka. Djeca i odrasli koji posjeduju visoku tjelesnu masu suočavaju se s ozbiljnim rizicima opasnima po zdravlje i po život (Daniels, 2006). Ti se rizici ponajprije odnose na poremećaje kardivaskularnih bolesti, diabetes, astmu (Freedman, Mei, Srinivasan, Berenson, i Dietz, 2007). U razdoblju između 10. i 14. godine razlike među spolovima u odnosu na masu aktivnih ćelija nisu uočene, ali poslije 14. godine te karakteristike počinju se pojavljivati u korist dječaka. U dobi od 12. do 13. godine postoje značajne spolne razlike u pogledu aktivnog otpora i faznog kuta (Andreenko i Nikolova, 2011). U tom uzrastu pokazuju se i razlike u koordinaciji i tjelesnom statusu u korist dječaka (Lepeš, Halaši, Mandarić, i Tanović, 2014a). Također su kod djece različitog spola uočene i razlike u morfološkim karakteristikama (Bala i Katić 2009; Horvat, Mišigoj-Duraković i Prskalo, 2009; Pelemiš, V., Pelemiš, M., Mitrović, i Džinović, 2014). Ističe se da dječaci razvijaju bolju koordinaciju, agilnost, preciznost, ravnotežu i snagu u odnosu na djevojčice, koje pokazuju dominaciju u fleksibilnosti (Horvat, Babić, i Jenko Miholić, 2013; Mandić, Martinović, i Stamatović, 2010). Nakon spoznaja o nalazima dosadašnjih istraživanja, jasno je da su utvrđene dimorfizne razlike u koordinaciji i morfološkim karakteristikama u navedenom uzrastu, ali nedostatak istraživanja ogledao bi se u relacijama između antropometrijskih mjera, tjelesnog sastava i koordinacije u djece. Ova bi studija trebala dati odgovore na pitanja o tome koji segmenti tjelesne kompozicije i temeljnih morfoloških karakteristika najviše pridonose izvođenju jednog od tri hipotetska faktora koordinacije, kao i mogućnost planiranja novih nastavnih sadržaja u razrednoj nastavi iz oblasti tjelesne i zdravstvene kulture.

Cilj je ove studije da ukaže na utjecaje određenih komponenata tjelesne kompozicije, morfoloških karakteristika i ITM na manifestaciju koordinacije djece starosti 7 i 8 godina.

Metode

Sva mjerenja i testiranja provedena su na uzorku od 95 ispitanika, podijeljenih na dva subuzorka 40 dječaka i 55 djevojčica. Svi ispitanici su u trenutku mjerenja pohađali prvi razred osnovne škole „Branko Ćopić" u Beogradu, R. Srbija. Roditeljima djece je prije istraživanja podijeljen anketni upitnik u kojem je bio naveden plan i tijek studije, a potpisima su odobrili istraživanja na svojoj djeci (Declaration of Helsinki, 2013).

Kao uzorak mjernih instrumenata izabrane su osnovne antropometrijske mjere: 1) *Tjelesna visina* (cm) – bila je izmjerena uz pomoć antropometra po Martinu i 2) *Tjelesna masa* (0,1 kg) – bila je izmjerena s pomoću InBody 230 (Biospace Co., Ltd, Seul, Korea).

Tjelesna kompozicija bila je procijenjena s pomoću: 1) *Ukupna količina mišića* (0,1 kg) – bila je izmjerena s pomoću InBody 230 (Biospace Co., Ltd, Seul, Korea); 2) *Ukupna količina tjelesne masti* (0,1 kg) – bila je izmjerena s pomoću InBody 230 (Biospace Co., Ltd, Seul, Korea) i 3) *Ukupna količine vode* (0,1 kg) – bila je izmjerena s pomoću InBody 230 (Biospace Co., Ltd, Seul, Korea).

Na temelju tjelesne visine i tjelesne mase izračunat je indeks ITM (Body mass index):

$$ITM = TM/(TV)^2$$

Legenda: ITM – Indeks tjelesne mase; TM – Tjelesna masa; TV – Tjelesna visina.

Određivanje tjelesne kompozicije bilo je utvrđeno uređajem Inbody 230, koji djeluje na temelju bioelektrične impedance (BIA). Analiza BIA je brza, neinvazivna metoda za evaluiranje tjelesne kompozicije, u terenskim i kliničkim uvjetima. Koristila se u prijašnjim istraživanjima na sličnom uzorku ispitanika (Lepeš i sur., 2014b; Reguli, Bernaciková, i Kumstát, 2016) i dobro se pokazala. Postala je referentna metoda u istraživačkim studijama analize tjelesne kompozicije (Sudarov i Fratrić, 2010). Usporedba s DEXA-om pokazala je da In Body (Biospace Co., Ltd, Seoul, Korea) daje jako precizne (r=0,974) rezultate.

Za procjenu koordinacije tijela izabrani su standardizirani testovi Gredelj, Metikoš, Hošek, i Momirović, (1975) koji su opisani i preuzeti iz primijenjenog istraživanja (Bala, 1981; Aleksić, Stanković, Milenković, Karalejić, Lilić, i Mekić, 2013) reorganizacija stereotipa gibanja 1) *Poligon natraške* (0,1 s); koordinacija tijela 2) *Okretnost palicom* (0,1 s) i brzina izvođenja kompleksnih motoričkih zadataka 3) *Slalom s tri lopte* (0,1 s).

Test *Poligon natraške* zahtijevao je vrijeme od 1 do 1,5 minuta za jednog ispitanika. Koristili su se švedski sanduk i štoperica. Mjesto izvođenja podrazumijevalo je prostoriju s ravnim i glatkim podom, čije su minimalne dimenzije bile 12 x 3 metra. Povlačila se linija od jednog metra vidljivom trakom koja je označavala start, a paralelno s njom na udaljenosti od 10 metara još jedna linija. Tri metra od startne linije poprijeko se postavljao donji dio švedskog sanduka, a zatim na 6 metara od startne linije postavljao se okvir švedskog sanduka, i to tako da tlo dodiruje svojom duljom stranom. Mjesta postavljanja švedskog sanduka također su bila obilježena vidljivim linijama. Početni položaj ispitanika bio je „četveronožni" (ispitanik oslonjen samo na stopala i dlanove) leđima okrenut preprekama. Stopala su mu bila uz startnu liniju. Ispitanikov zadatak bio je da nakon znaka „Sad" hodanjem unatrag četveronoške prijeđe prostor između dviju linija (10 metara). Prvu prepreku trebao je savladati penjanjem, a drugu provlačenjem. Tijekom zadatka ispitanik ni u jednom trenutku nije smio okrenuti glavu, već stalno gledati između nogu. Zadatak je izvodio jedanput, poslije probnog pokušaja. Između probnog pokušaja i izvođenja ispitanik bila je kratka pauza. Zadatak se završavao kada bi ispitanik s obje ruke prelazio liniju cilja. Vrijeme se registriralo u desetinkama sekunde od znaka „Sad" do prijelaza objema rukama preko linije cilja. Ako bi ispitanik pomicao jednu ili drugu prepreku, morao bi sam namjestiti i ponoviti taj dio zadatka. Štoperica se u tom slučaju ne bi zaustavljala.

Za izvođenje testa *Okretnost palicom* bilo je potrebno vrijeme od oko dvije minute po jednom ispitaniku. Koristila se 1 štoperica i 1 palica. Zadatak se izvodio na mjestu od 2 x 2 metra. Ispitanik se nalazio na sredini terena, a palicu je držao s obje ruke iza koljena. Na znak „Sad" ispitanik je morao prekoračiti palicu bez puštanja, s jednom i drugom nogom na zemlji sve do uzručenja i također natrag isto do početnog položaja. Zadatak je završavao kada se ispitanik vraćao u početni položaj na ispravan način. Mjerilo se vrijeme u sekundama od znaka „Sad" pa do završetka zadatka. Zadatak se izvodio 3 puta s pauzom dovoljnom za oporavak, a kao rezultat se uzimalo samo najbolje izvođenje ispitanika.

Za test *Slalom s tri lopte* bilo je potrebno oko 2,5 do 3 minute za jednog ispitanika. Koristile su se tri medicinke težine 1 kg, pet stalaka za slalom, traka u boji i štoperica.

Zadatak se izvodio na prostoru dimenzija 12 x 5 metara. Na stazi dužine 10 metara stalci su bili raspoređeni na udaljenosti od 2 metra. Prvi stalak bio je udaljen 2 metra od startne linije. Uz startnu liniju dužine 1 m bila su obilježena mjesta za stalke. Početni stav ispitanika bio je stojeći iza medicinki koje su postavljene neposredno iza startne linije. Na znak „Sad" ispitanici su počinjali kotrljati sve tri medicinke zajedno, što su brže mogli, po tlu između stalaka. Oko posljednjeg stalka su se okretali, a zatim su medicinke kotrljali u pravcu starta između stalaka. Pri izvođenju zadatka ispitanici su se mogli služiti i nogama. Zadatak je završavao kada bi ispitanik zajedno sa sve tri medicinke prelazio startnu liniju. Rezultat je predstavljalo vrijeme u stotinkama sekunde od znaka „Sad" do prijelaza posljednje medicinke i ispitanika preko ciljne linije. Ako bi ispitanik prilikom kotrljanja i slaloma medicinki lopte „gubio", morao bi ih skupiti i nastaviti zadatak na mjesta na kojem ih je izgubio. Ako bi ispitanik rušio stalak, mjeritelj bi ga vraćao na mjesto, a ispitanik bi nastavljao s izvođenjem zadatka bez zaustavljanja. Ako bi ispitanik griješio (promašivao stalak i slično), nastavljao bi s izvođenjem zadatka na mjestu gdje bi pogriješio, a za to se vrijeme štoperica ne bi zaustavljala. Mjeritelj je prije svakog novog ispitanika provjeravao jesu li stalci na označenim mjestima.

Metoda obrade podataka sadržavala je izračun: osnovnih deskriptivnih statistika: aritmetičku sredinu (AS), standardnu devijaciju (S), minimalni (MIN) i maksimalni rezultat mjerenja (MAX), *skewness* – mjeru simetričnosti distribucije (Skew) i *kurtosis* – mjeru homogenosti distribucije (Kurt). Potom se testiralo postojanje statistički značajnih razlika između skupina ispitanika za sve analizirane varijable s pomoću multivarijatne (Manova) i univarijatne (Anova) analize varijance. Multiplom regresijskom analizom bio je utvrđen utjecaj skupa morfoloških karakteristika na motoričke varijable za procjenu koordinacije, koje su predstavljale kriterijske varijable u radu.

Rezultati

Subuzorak ispitanika muškog spola prosječno je bio niži od ispitanog subuzorka ženskog spola (127,95 cm prema 128,25 cm), ali su zato bili prosječno teži (26,46 kg prema 25,77 kg). Dječaci su imali prosječno višu zastupljenost ukupne mišićne mase, manji postotak ukupne tjelesne masti i veći postotak ukupne količine vode u organizmu u odnosu na djevojčice (tablica 1). Subuzorci dječaka i djevojčica normalnog su stanja uhranjenosti. Vrijednosti skjunisa ukazuju na izrazito pozitivnu asimetričnu distribuciju varijabli: *Tjelesna masa, Ukupna količina tjelesne masti* i *ITM* kod dječaka i *Ukupna količina mišića, Ukupna količina tjelesne masti* i *Ukupna količina voda*, što ukazuje na činjenicu da je većina dječaka i djevojčica s manjim vrijednostima navedenih karakteristika.

Na temelju rezultata deskriptivnih statistika iz tablice 1 može se zaključiti da je subuzorak dječaka i djevojčica na sličnoj razini rasta i razvoja longitudinalnosti skeleta koji su promatrani u skupinama spolno dimorfiznih razlika, a da se u varijablama za procjenu stanja uhranjenosti i tjelesne kompozicije uočava veća varijabilnost rezultata prouzrokovana velikim razlikama u tjelesnom sastavu i većim razlikama tjelesne mase.

Tablica 1

Uzevši u obzir prosječne vrijednosti motoričkih varijabli za procjenu hipotetskog motoričkog faktora koordinacije, može se utvrditi da su prosječne vrijednosti kod subuzorka dječaka bile prosječno niže – bolje u sve tri varijable u odnosu na subuzorak djevojčica: *Poligon natraške*, *Okretnost palicom* i *Slalom s tri lopte* (tablica 2).

Tablica 2

U tablici 3 ispod dijagonale prikazani su rezultati Pearsonova koeficijenta korelacije testiranih varijabli za dječake, a iznad za djevojčice, radi ispunjavanja petpostavki za regresijsku analizu. U dvije posljednje varijable *Okretnost palicom* i *Slalom s tri lopte* nisu ispunjeni preduvjeti linearnosti odnosa varijabli s obzirom na to da koeficijenti prelaze dopuštene vrijednosti. Zbog toga će se regresijska analiza za te dvije varijable prikazati bez regresijskih Beta koeficijenata.

Tablica 3

Na temelju vrijednosti multivarijatnog Wilksova F testa, iz tablice 4, može se zaključiti da nema statistički značajne razlike između ispitanika različitog spola u pogledu njihovih morfoloških karakteristika i stanja uhranjenosti na danom uzorku ispitanika.

Tablica 4

Analizirajući vrijednosti Wilksova F testa iz tablice 5, također se konstatira da ne postoji statistički značajna razlika ni u pogledu tjelesne kompozicije između dječaka i djevojčica.

Tablica 5

Promatrajući vrijednosti multivarijatnog Wilksova F testa, iz tablice 6, može se zaključiti da postoji statistički značajna razlika između ispitanika različitog spola u pogledu koordinacije. Pojedinačnom analizom svake ispitane varijable za procjenu hipotetskog faktora koordinacije, konstatira se da ta razlika postoji u varijablama: *Poligon natraške* i *Slalom s tri lopte* u korist dječaka.

Tablica 6

U daljnjem dijelu rada prikazani su rezultati svake kriterijske varijable za procjenu koordinacije u sustavu prediktorskih varijabli, u vidu brojčanih informacija za ispitanike različitog spola (tablice 7, 8 i 9). Regresijskom analizom kriterijske varijable *Poligon natraške* (tablica 7) kod subuzorka dječaka, utvrđeno je postojanje statistički značajnog utjecaja sustava prediktorskih varijabli na ispitivani kriterij.

Tablica 7

Pregledom rezultata regresijske analize varijable *Okretnost palicom* (tablica 8), uočava se nepostojanje statistički značajnog utjecaja sustava prediktorskih varijabli na kriterij kod oba spola.

Tablica 8

Pregledom rezultata regresijske analize varijable *Slalom s tri lopte* (tablica 9), uočava se da nema statistički značajnog utjecaja sustava prediktorskih varijabli na kriterijsku varijablu kod oba spola.

Tablica 9

Rasprava

Glavni rezultati ovog istraživanja dječaka i djevojčica u dobi od 7 do 8 godina iz Beograda, R. Srbija, ukazuju na činjenicu da su normalnog stanja uhranjenosti, slične longitudinalne dimenzionalnosti skeleta i tjelesne mase, te da posjeduju slične prosječne vrijednosti ukupnih količina, mišića, masti i vode. Rezultati su u skladu s dobivenim nalazima kvantitativnih istraživanja Bale (2004) na godinu dana mlađem uzorku. Novija istraživanja Stamm, Gebert, Guqqenbuhl, i Lamprecht (2014) čak ukazuju na to da su prisutne spolne razlike u odnosu tjelesne visine i tjelesne mase i da postoji trend rasta u razlikama, te da je prisutniji kod starijeg školskog uzrasta. Razdoblje 7. godine povezuje se s intenzivnim rastom dugih cjevastih kostiju, pa je sličana razina longitudinalnosti posljedica heterokronosti rasta i razvoja organizma i biološke dobi djece, a različit način života u urbanoj sredini utjecao je na različitu razinu zastupljenosti mišića, masti i vode u tjelesnoj kompoziciji ispitanika. Što se tiče dobivenih rezultata koji se odnose na tjelesni status djece mlađega školskog uzrasta, on se podudara s dobivenim nalazima (Andreenko i Nikolova, 2011b; Martinović, Pelemiš, V., Branković, Živanović, i Pelemiš, M., 2013) koji su utvrdili da dječaci imaju veći postotak mišićnog tkiva, a niži postotak ukupnog masnog tkiva u odnosu na djevojčice. Stanje stupnja uhranjenosti izračunato preko ITM kada se usporedi s percentilnim krivuljama za taj uzrast ukazuje na to da prosječne vrijednosti oba spola potpadaju pod 57. percentil za dječake i djevojčice od 7 godina, i 67. prercentil za uzrast djece od 8 godina. To može ukazati na to da je prehrana djece dobre kvalitete, te da oba subuzorka klasificira kao normalno uhranjene. Ipak, u ovom dijelu Europe ne možemo govoriti o prevalenciji pretilosti kod djece u istim uvjetima kao u zapadnoj Europi i SAD-u, o čemu svjedoče istraživanja Yajnik's (2000). Rasprostranjenost pretilosti u SAD-u je dramatično porasla u protekla tri desetljeća. Postoji različit spektar pretilosti u djece i adolescenata. Istraživanja koja su proveli Lo, Maring, Chandra, Daniels, Sinaiko, Daley, Sherwood, Kharbanda, Parker, Adams, Prineas, Magid, O'Connor, i Greenspan, (2014) ukazuju na to da je prevalencija pretilosti i teške pretilosti bila veća kod dječaka nego kod djevojčica, a najviša među djecom hispanske nacionalnosti. ITM je bio povezan s većim postotkom visine, što je zanimljivo. Kod pretile djece u dobi od 5. godine pretilost ili povišen ITM bio je visok, približno 80%. Autori su ukazali na to da pretilost u ranom djetinjstvu poslije može imati značajne posljedice na zdravlje. Istraživanje provedeno u Turskoj od Inal, Canbulat, i Bozkurt (2015) govori o činjenici da je ukupna prevalencija pretilosti primijećena kod 25,6%, a prekomjerna kod djece 14,5% od ukupnog uzorka testirane djece. Autori navode da način života majki, posebno u pogledu ITM i fizičke aktivnosti, može utjecati na pretilost među djecom, te da je potrebno oblikovati strategiju za poboljšanje fizičke aktivnosti i prehrambenih navika majki. S druge strane određeni stupanj pothranjenosti djece zabilježen je u Gruziji (istočna Europa) (Kherkheulidze, Nemsadze, Kavlashvili, Kandelaki, i Adamia, 2010). Ofgovarajuća prehrana bitna je za potpun razvoj djeteta i uvelike određuje razvojni potencijal i status djece, što se navodi u nalazima Kitsao-Wekulo, Holding, Taylor, Abubakar, Kvalsvig, i Connolly, (2013), a posebno je primjetno kod pretile djece. Slični nalazi istraživanja zabilježeni su i u Kini gdje se prevalencija pothranjenosti dovodi u vezu sa zaostajanjem u rastu kod djece mlađe od 5 godina, a danas je u znatnoj mjeri normalizirana (Chen, He, Wang, Deng, i Jia, 2011). Istraživanja Freedman, Mei, Srinivasan, Berenson i Dietz, (2004) u SAD-u ukazuju na to da s porastom prevalencije pretila djeca imaju sve teži stupanj uhranjenosti. Istraživanja koja idu u tom pravcu ukazuju na činjenicu da višak kilograma ima negativne socijalne i emocionalne posljedice na samog pojedinca. Samo jedan kilogram tjelesnih masti osigurava novih šest kilometara krvnih žila, što stvara pritisak na kardiovaskularni sustav, te se odatle objašnjava povezanost kardiovaskularnih bolesti i stupnja pretilosti kod djece (Grubić, 2008). Treba istaknuti da značajne razlike po spolu u tjelesnoj kompoziciji treba očekivati u pretpubertetskoj fazi.

Utvrđene su kvantitativne razlike u manifestaciji koordinacije u korist subuzorka dječaka. Uočava se izniman varijabilitet rezultata kod oba subuzorka u sve tri varijable za procjenu koordinacije. Iznimno su velike razlike u ostvarenim rezultatima unutar svakog subuzorka. Na temelju nagnutosti distribucije može se utvrditi povećana koncentracija rezultata u zoni manjih vrijednosti u sve tri varijable kod dječaka. Većina ispitanika zabilježila je manje vrijednosti, što ukazuje na bolje stanje koordinacije te grupe ispitanika (inverzni metrika-vrijeme u sekundama). Rezultati istraživanja vezani uz koordinaciju tijela potvrđuju nalaze Halaši i Lešpeš (2012) u kojima je potvrđena viša razina koordinacije dječaka u odnosu na djevojčice istog uzrasta. Rezultati su također povezani s nalazima Fratrić, Orlić, Badža, Nešić, Goranović, i Bojić (2012), gdje su razlike po spolu u motoričkim sposobnostima identificirane na svim razinama u dobi od 7 do 10 godina. Može se utvrditi da su dječaci trenutno na višoj razini razvoja koordinacije u odnosu na djevojčice, što može biti posljedica cjelokupnog motoričkog ponašanja koje je kod dječaka istaknutije nego kod djevojčica. Drugačije fizičke aktivnosti dovele su do stvaranja bolje koordiniranih pokreta, bogatijeg motoričkog iskustva dječaka u odnosu na djevojčice istog uzrasta. Istraživanjem je utvrđeno da dječaci, vjerojatno zaslugom bogatijeg motoričkog života ostvarenog tijekom predškolskog uzrsta, kao i većom motivacijom za postignućem u tom razdoblju razvoja postižu bolje rezultate u testovima koordinacije u odnosu na djevojčice istog uzrasta. Djevojčice u istraživanom razdoblju imaju drugačije interese. Nastala razlika u koordinaciji dječaka i djevojčica događa se zbog „motoričkog potencijalnog kapaciteta", ali i drugih čimbenika koji pomažu da se takav kapacitet razvija i manifestira, a prije svega se misli na razinu fizičke aktivnosti tijekom dana. Koordinaciju djece mlađeg školskog uzrasta u velikom mjeri predodređuju životne navike, razina fizičke aktivnosti, morfološke karakteristike i prije svih njih vjerojatno kognitivne sposobnosti i konativne karakteristike (Dolenc, Pistotnik, i Pinter, 2002). Autori Malina, Koziel, i Bielicki (1999) sugeriraju da je razdoblje od 7. godine ono u kojem je razvoj motoričkih sposobnosti najviše izražen i ima najbolje efekte, a biološka zrelost značajno utječe na motoričke zadatke, te da je posebnu pozornost potrebno usmjeriti na koordinaciju djevojčica.

Utvrđena je povezanost tjelesne kompozicije i testa *Poligon natraške* koja je objašnjavala 45% zajedničkog varijabiliteta prediktorskog sustava kod dječaka. Preostali postotak može se pripisati nekim drugim karakteristikama i sposobnostima koje nisu bile obuhvaćene primijenjenim sustavom prediktora (motivacija, koncentracija, konativne karakteristike i prije svega druge antropometrijske karakteristike: transferzalna dimenzionalnost skeleta i obimi gornjih ekstremiteta) koji mogu imati odlučujuću ulogu prilikom izvođenja koordinacijskih zadataka. Međutim utvrđena je pozitivna korelacija svih prediktorskih varijabli s kriterijem, odnosno dječaci s izraženijom tjelesnom visinom, masom i većim BMI, većom ukupnom masom mišića, vode i ukupnom masom masti ostvarivali su lošije reultate na testu. Opisani ispitanici posjedovali su slabiju koordinaciju cijelog tijela. Veći postotak masti i veća masa tijela onemogućavala je izvođenje testa. Iznenađujući su rezulati pozitivne korelacije mišićne mase, ali se mogu opravdati slabijim kognitivnim sposobnostima i slabijom koordinacijom pokreta takvih dječaka. Kod subuzorka djevojčica nije utvrđen statistički značajan utjecaj sustava prediktorskih varijabli na kriterij. Zajednički je opisani varijabilitet iznosio svega 12%. Na koordinaciju cijelog tijela veći su utjecaj kod djevojčica istog uzrsta imale neke druge karakteristike i sposobnosti. Vjerojatno se u sljedećim istraživanjima moraju uzeti u obzir kognitivne sposobnosti i konativne karakteristike, te socio-ekonomski faktori koji u dječjem uzrastu imaju veliku ulogu na kompletno motoričko ponašanje djeteta. Nije utvrđena statistički značajna povezanost tjelesne kompozicije i koordinacijskog testa *Okretnost palicom* kod oba spola. Također nema povezanosti sustava prediktora s koordinacijskim testom *Slalom s tri lopte*. Istraživanja koje su proveli Zenić, Foretić, i Blažević (2013) ukazuju na to da je najveći odnos između antropometrijskih varijabli i motoričkih sposobnosti izražen putem BMI, a bitno je istaknuti da autori preporučuju nelinearni regresijski model koji identificira točke prekida u liniji regresije i ukazuje na pravu prirodu odnosa između varijabli.

Zaključci

Može se zaključiti da nalazi dobiveni istraživanjem ohrabruju, posebno ako se uzme u obzir da razvijene zapadne zemlje bilježe konstantan rast indeksa uhranjenosti kod djece. Kod djece oba spola iz Beograda, R. Srbija, stanje uhranjenosti je normalno. Treba naglasiti da je tijekom rasta i razvoja odnos između motoričkih sposobnosti i morfoloških karakteristika promjenjiv, kao i odnos između sustava tjelesne kompozicije. Ograničenja ove studije ogledaju se u nerandomiziranom uzorku djece iz Beograda, R. Srbija, čime je bitno ugrožena eksterna validnost istraživanja, a time i generalizacija dobivenih rezultata. Djecu je u svakom slučaju neophodno trajno pratiti u razvojnim fazama. U kasnijim razdobljima, posebno u pubertetu, mogu se očekivati značajnije razlike po spolu u sastavu tjelesne kompozicije i motorike. Za sada djeca na postavljene motoričke zadatke reagiraju još uvijek cijelim bićem i oslikavaju prisustvo generalnog motoričkog faktora.