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Research article

FITNESS PARAMETERS AND MORPHOLOGICAL CHARACTERISTICS OF OVERWEIGHT AND OBESE CHILDREN AGED SEVEN

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Abstract. *The aim of the research was to determine the correlation of morphological characteristics and fitness parameters of overweight and obese boys aged seven. The sample of participants consisted of 198 pupils (boys) aged seven years, from elementary schools from the territory of the city of Niš, Paraćin, Bela Palanka, Leskovac and others, classified as a category with increased body mass or obesity. Morphological characteristics were determined by measuring parameters of longitudinal (3), transversal, (3) circular dimensions (3) and body mass and measurement of subcutaneous fat tissue (3). For the assessment of muscular fitness, body composition and cardiorespiratory fitness, the following tests were used: the plyometric leap, precancer-turn-off, percentage of body fat and Body Mass Index (BMI); a shuttle run test based on the calculated VO2max (L) and VO2max (ml/kg/min) values. A canonical correlation analysis was used to determine the correlation between morphological characteristics and fitness parameters. The level of statistical significance was set at .05. The results of the study showed that there is a statistically significant association (p<.01) between morphological characteristics and fitness parameters in overweight and obese boys aged seven. Participants who have higher values of voluminosity and body width have higher values of fat percentage in the body as well as BMI. Smaller explosive power was found in participants with higher values of skin folds. It has been determined that body mass and voluminosity positively affects the strength of the arm and shoulders, that is, they adversely affect the VO2max values.*

Key words: *Fitness, Morphological Characteristics, Overweight, Obesity, Prepubescent Age*

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INTRODUCTION

Childhood and adolescence obesity increased during the latest decades and became extremely prevalent in the developed countries leading to a modern "obesity epidemic" (Psaltopoulou et al., 2019). According to the World Health Organization-WHO, overweight and obesity are defined as abnormal and excessive fat accumulation that may impair health (WHO, 2019). They arise as a result of the imbalance between energy consumption and energy input (Bukara-Radujković & Zdravković, 2009).

A large number of studies in the last two decades have shown a marked trend in the increase in being overweight, especially in children (Wang & Lobstein, 2006), with the highest increase registered in the United States. Between 2011 and 2014, 17% of US children ages 2 to 19 met the criteria for obesity and 5.8% for extreme obesity (Ogden et al., 2016). One-third of the children in the world (31%) have excessive body mass (Spiotta & Luma, 2008). In the WHO European Region one child out of 3 is overweight or obese (Nittari et al., 2019). The obesity of children and adolescents in Serbia has taken on epidemic proportions in recent years. According to the International Obesity Task Force in 2005, Serbia is at the very top of countries with a sudden increase in obesity in children and adolescents. (Wang & Lobstein, 2006). The official document of the Ministry of Health of the Republic of Serbia confirms that one-fifth of children and youth aged 7 to 19 (18%) are overweight and obese (Ministry of Health of the Republic of Serbia, 2007).

The research suggests that overweight and obese children have poorer motor development (Graf, et al., 2004), and that fitness parameters in the last decade have recorded a constant decline. When it comes to morphological characteristics and obesity in the research by Manić (2007), the results showed that body height and body mass are very favorable to the obese, as well as the thickness of the skin folds, that is, the subcutaneous fat tissue, while it is very important that the volume of the abdomen which is larger in over-nutrition and obesity be reduced because abdominal adiposity, i.e. the amount of visceral fat is one of the predictors of metabolic syndrome (Sisson et al., 2009). Krneta, Kerić, & Pelemiš (2011) indicate that the high level of fitness parameters of younger school age children is of great importance for their regular life and work activities, therefore systematic dealing with sports activities is an important factor in raising the level and maintaining the state of their motor efficiency. The authors also showed the negative impact of the increased body mass index on the motor status of children of all ages, especially in children with significantly increased Body Mass Index (BMI), and that the motor status of male participants is significantly affected by BMI.

The aim of the research was to determine the relationship between the morphological characteristics and the fitness parameters of overweight and obese boys aged seven.

METHODS

Sample of participants

The sample of participants consisted of 198 boys aged seven years (7.11±.38, Mean±SD) from elementary schools from the territory of the city of Niš, Paraćin, BelaPalanka, Leskovac and others, who are classified as children with increased body mass or obesity. The entire sample was derived from the boys' population that were tested within the project

"Anthropological Characteristics of Children of Southeast Serbia - Condition, Changes and Trends", realized by the Faculty of Sport and Physical Education of the University of Niš. The boys who participated in the study had an average body height of 135.37±7.65 cm, a body mass of 40.79±7.85 kg and BMI values of 22.42±3.14 kg/m^2 and were selected based on the specific values that were made by Cole, Bellizzi, Flegal, & Dietz (2000) for age and sex for children and adolescents aged 2 to 18.

The Ethical Committee of the Faculty of Sport and Physical Education, University of Niš, certified that this investigation conformed to all ethical standards regarding scientific investigations involving human participants in accordance to the Helsinki Declaration. Prior to the testing, written consent was obtained from parents to allow the children to be tested. The participants whose parents did not sign the agreement were not tested, nor were those who had health problems.

Measuring instruments

Morphological characteristics were determined by measuring longitudinal parameters (body height, arm length and leg length), transversal (shoulder width, pelvic width and hip width), circular dimensions and body mass (body mass, middle volume of the breast, volume of the upper arm when the arm is stretched and volume of the thigh), and the subcutaneous fat tissue by measuring the thickness of the skin folds (skin folds of the upper arm, back and abdomen). All measurements that were carried out in the research were carried out using the technique proposed by the International Biological Program (Weiner & Lourie, 1969).

To evaluate the fitness parameters, the procedures recommended for the given age were used. For the assessment of muscular fitness, a plyometric jump was used (Nazarenko, 2000) and a forward bend-twist-throw out (Kostić et al., 2009). For the evaluation of body composition, a percentage of body fat was used which was determined by the values of skin folds of triceps and skin folds of the back, using the equation proposed by Slaughter et al. (1988) and BMI (Cole et al., 2000). Cardiorespiratory fitness was determined using the Shuttle Run Test 20m (Leger & Lambert, 1982) by calculating the VO2max values (absolute value VO2max - L; relative value VO2max - ml/kg/min).

Data processing

The statistical package Statistics 6.0 was used for data processing. The basic descriptive parameters were calculated: the mean value (Mean), the minimum value (Min), the maximal value (Max), the standard deviation (SD), range (Range). A canonical correlation analysis was used to determine the relationship between morphological characteristics and fitness parameters. The level of statistical significance was set at level $p \leq .05$.

RESULTS

Table 1 Descriptive statistics

Morphological characteristics					
	Mean	SD	Min	Max	Range
Body height [cm]	135.37	7.65	103.40	152.00	48.60
Leg length [cm]	74.56	4.81	61.00	85.80	24.80
Arm length [cm]	56.90	3.84	46.80	75.50	28.70
Shoulder width [cm]	31.77	2.07	27.20	36.50	9.30
Pelvis width [cm]	22.19	2.01	15.80	27.30	11.50
Hip width [cm]	25.14	1.96	17.50	30.00	12.50
Body mass [kg]	40.79	7.85	25.90	59.10	33.20
Volume of the chest [cm]	67.07	7.06	48.50	85.00	36.50
Volume of the upper arm [cm]	20.20	3.01	12.30	35.80	23.50
Volume of the hip [cm]	41.88	5.00	21.40	57.60	36.20
Skin fold of the upper arm [mm]	15.90	6.63	1.10	36.90	35.80
Skin fold of the back [mm]	14.01	6.95	2.20	33.80	31.60
Skin fold of the abdomen [mm]	19.22	7.69	2.50	36.70	34.20
Fitness parameters					
Plyometric jump	16.76	4.57	4.00	30.00	26.00
Forward bend-twist-throw out Right side[dm]	21.78	12.50	6.00	82.00	76.00
Forward bend-twist-throw out Left side [dm]	20.57	10.91	4.00	72.00	68.00
Forward bend-twist-throw out∑ [dm]	42.34	22.88	10.00	154.00	144.00
Body fat [%]	33.03	7.54	9.78	47.35	37.57
BMI [kg/m^2]	22.42	3.14	14.47	31.49	17.02
VO2max[L]	1.78	0.04	1.74	1.97	0.24
VO2max [ml/kg/min]	44.68	8.74	29.19	66.99	37.80

Legend: Mean - mean value; SD - standard deviation; Min - minimum value; Max-maximum value; Range - range; BMI - Body Mass Index; VO2max - Oxygen consumption

Table 1 presents the values of descriptive parameters of the morphological characteristics and fitness parameters of the participants involved in the research.

Table 2 Cross-correlations of the morphological characteristics and fitness parameters

	Plyometric jump	Forward bend twist-throw out∑	Body fat	BMI	VO2max L	VO2max ml
Body height	-.08	.33	.42	.39	.64	**-.80**
Leg length	**-.02**	.29	.38	.42	.61	**-.76**
Arm length	-.07	.22	.30	.31	.51	-.63
Shoulder width	-.12	.25	.54	.63	.66	**-.80**
Pelvis width	-.22	.25	.73	.73	.63	**-.83**
Hip width	-.13	.25	.71	.73	.65	**-.86**
Body mass	-.17	.30	.71	**.86**	.76	**-.98**
Volume of the chest	-.28	.29	.72	**.77**	.63	**-.84**
Volume of the upper arm	-.23	.21	.73	.67	.50	-.73
Volume of the thigh	-.12	.26	.65	.65	.54	-.71
Skin fold of the upper arm	-.22	.19	**.88**	.62	.51	-.62
Skin fold of the back	-.32	.20	**.91**	.74	.49	-.67
Skin fold of the abdomen	-.37	.19	**.83**	.65	.45	-.65

Legend: BF% - Fat percentage; BMI - body mass index; VO2max L - maximum oxygen consumption in liters per minute; VO2max ml - maximum oxygen consumption in milliliters per kilogram per minute

Table 2 shows the cross-correlation matrix between fitness parameters and morphological characteristics. The correlations from -.02 to .98 were determined. The results showed that some parameters had moderate, while some parameters had high correlations. The lowest correlation values were determined between the leg length and the plyometric jump (-.02). Moderate correlations were found between the skin fold of the upper arm (-.22), the skin fold of the back (-.32) and the skin fold of the trunk (-.37) and the plyometric leap.

The correlations of morphological characteristics with the test forward bend-twist-throw out range in the values from .19 to .33. The highest negative correlation value was determined between body mass and VO2max ml (-.98.) and between the skin fold of the back and body fat (.91).

Table 3 Isolated canonical function

	R	R2	X^2	df	P
0	.99	.98	1662	78	**.000**
1	.98	.95	915	60	**.000**
2	.90	.81	350	44	**.000**
3	.37	.14	38	30	.161
4	.19	.03	10	18	.933
5	.13	.02	3	8	.908

Legend: R-canonical correlation; R2 - coefficient of determination;
X^2- Bartlett's Chi-square test; Df- degree of freedom; P-probability

By means of a canonical correlation analysis using Bartlett's Chi-square test ($\chi 2$), it was found that there are statistically significant correlations of the three pairs of canonical factors in the test sample (p=.000). The first pair of canonical correlation factors is .99 (R=.99), for the second pair .98 (R=.98), and for the third pair the correlation is .90 (R=.90).

The square of the canonical correlation (R2) which explains the common variation of variables from the total variability of the analyzed variables system for the first pair is R2=.98, which means that the isolated function is explained with 98% of the total variability, for the second pair is R2=.95 which means that the isolated function is explained with 95% of the total variability, and for the third pair it is R2=.81 which means that the isolated function is explained with 81% of the total variability.

Table 4 Factor structure

	Root 1	Root 2	Root 3		Root 1	Root 2	Root 3
Body height	.64	.73	-.22	Plyometric jump	-.24	.16	.17
Leg length	.61	.65	-.10	Forward bend-twist-throw out∑	.28	.19	-.08
Arm length	.49	.61	-.14	Body fat	.88	-.30	-.37
Shoulder width	.75	.35	.02	BMI	.92	-.17	.35
Pelvis width	.86	.13	-.09	VO2max L	.72	.27	.07
Hip width	.86	.20	-.05	VO2max ml	-.94	-.31	-.08
Body mass	.95	.28	.10				
Volume of the chest	.86	.10	-.01				
Volume of upper arm	.79	-.00	-.14				
Volume of the thigh	.74	.07	-.06				
Skin fold of the upper arm	.78	-.22	-.41				
Skin fold of the back	.84	-.33	-.25				
Skin fold of the abdomen	.78	-.20	-.29				

Legend: BMI - Body Mass Index; VO2max L - maximum oxygen consumption in liters per minute;
VO2max ml-maximum oxygen consumption in milliliters per kilogram per minute

Table 4 shows the structure of the isolated factors. As the first canonical factor in the area of morphological parameters, the largest projections were determined for the variables: body mass (.95), hip width (.86), volume of the chest (.86) and skin fold of the back (.84). The first canonical factor can be defined as the factor of voluminosity and body width.

In the area of fitness parameters, it can be seen that the largest projections on the first isolated canonical factor were determined for the variable VO2max (-.94) and they are negative values, while positive projections were determined for the variables BMI (.92) and BF% (.88). This canonical factor can be defined as a factor of aerobic ability and nutrition. The greatest projection was achieved on the other isolated canonical factor in the area of morphological characteristics, and the variables were positive: body height (.73), length of the leg (.65) and arm length (.61). The second factor of canonical correlation is the factor of the longitudinal dimension of the skeleton. In the area of fitness parameters, it can be seen that the largest projections on the second isolated canonical factor were determined for the variables: VO2max ml (-.31) and Body fat (-.30). This factor is the factor of aerobic ability and fat tissue. On the third isolated canonical factor in the area of the morphological characteristics of the largest projection, the negative variables were estimated for the assessment of skin folds (upper arm=- .41; abdomen=- .29; back=- .25). The third isolated canonical factor is defined as the factor of subcutaneous fat tissue.

In the fitness parameters area, it can be concluded that the largest negative projection on the third isolated canonical factor was determined for the BF% (-.37) variable, and the largest positive projection for the BMI variable (.35). This factor can be called fatty tissue and nutrition factor.

Discussion

The analysis of the cross-correlation matrix between fitness parameters and morphological characteristics (Table 2) determined a number of statistically significant correlations. A positive correlation was determined for the body mass and volume of the chest and the BMI values, as well as for the skin fold of the back, abdomen and upper and with BF%. The obtained results confirm that participants who have a higher body mass also have higher BMI values, and the case is much the same with skin folds. Boys with higher abdominal, upper arm and back folds also have a higher percentage of body fat. The results obtained are expected, because in practice the percentage of fat is most often measured directly by indirect methods, based on the thickness of the skin folds, but also through the height-mass relationship, specifically by calculating the BMI (Đorđević, 2005). Moderate correlations were found between the plyometric leap and the skin folds, that is, subcutaneous fat tissue had a negative impact on explosive leg force and was an obstructive factor in motor tasks requiring lifting and transmitting body mass in the area (Bala, Jakšić, & Katić, 2007; Milanese, Bortolami, Bertucco, Verlato, & Zancanaro, 2010; Đorđević, Pantelić, Kostić, & Uzunović, 2015). For performing tasks requiring the manifestation of explosive arm strength, higher values of subcutaneous fat tissue, voluminosity and body mass do not make it difficult to achieve them, because such tasks do not require the movement of the body in the area, and the results obtained are consistent with other studies (Bala et al., 2009; Manić, 2007; Đorđević et al., 2015), respectively, positive correlations have been established between excess mass and strength of the arm.

A negative correlation was found between all morphological characteristics and VO2max ml. The greatest negative correlation was determined between body mass, transverse dimensionality and volume of the chest and VO2max [ml/kg/min], which is consistent with the results of some studies (Esmaeilzadeh & Ebadollahzadeh, 2012; Ara, Moreno, Leiva, Gutin, & Casajús, 2007; Bunc, 2006). The results showed that participants with higher body mass, as well as wider hips, pelvis and volume of the chest have poorer cardiorespiratory fitness results. A group of authors (Ortega et al., 2011) in a prospective six-year study, on a sample of 598 children aged 9.5 years, determined factors that affect the onset of obesity in puberty. The results of the study have shown that the level of cardiorespiratory endurance (VO2max) is the largest negative obesity predisposition. Even surprisingly, the risk of obesity is reduced by as much as 10% with an increase in VO2max of only 1 ml/kg/min.

Based on the values of the canonical correlation coefficients (Table 3), a significant correlation of morphological characteristics and fitness parameters at the significance level of .01 (p=.000) was established. By analyzing the relations of the first pair of canonical factors, i.e. the factor of voluminosity and body width in the area of morphological characteristics and the factor of aerobic abilities and nourishment in the fitness ability area, whose relation is explained by 98% of the common variability, it is concluded that participants with higher values of voluminosity and body width also have higher values of fat percentage in the body as well as BMI, and negative results of cardiorespiratory endurance or VO2max [ml/kg/min]. The results obtained confirm the fact that overweight and obese children achieve lower results when the cardiorespiratory fitness is concerned and that increased body mass results in a reduction in VO2max [ml/kg/min] (Esmaeilzadeh & Ebadollahzadeh, 2012). Some authors (Macfarlane & Tomkinson, 2007) found that there is a significant trend in declining cardiorespiratory fitness parameters in children, which are closely related to body status. High body mass values with a low level of cardiorespiratory fitness show insufficient physical activity of the participants (Macura, Pešić, Đorđević-Nikić, Stojiljković, & Dabović, 2007).

The second canonical pair in the space of morphological characteristics, i.e., the Longitudinal Dimensional Factor and the Factor of Aerobic Abilities and Fat Tissue in the fitness parameters area (Table 4), whose relation explains 95% of the common variability, indicates that participants with higher longitudinal dimensionality measures have a lower percentage of body fat but also a lower relative consumption of oxygen VO2max [ml / kg / min]. Unlike the obtained results, Manić (2007) found in her study that children with more fat tissue have a higher body height. However, in the aforementioned study, older elementary school children, aged 11 to 14 participated. In this period, the preadolescence period, growth and development have a relatively small increase, and changes that occur are influenced by environmental factors (Gligorijević, 2008). The results obtained in our study show that participants with higher body height have less subcutaneous fatty tissue. The data obtained in this way are expected because in this period of growth and development the height of the body increases significantly, that is, the intensive bone growth in length is increased, while the body mass at this age does not increase significantly. Growth and development in bone and muscle tissue takes place continuously, relatively and linearly, but not in subcutaneous fat tissue (Bala et al., 2009).

The relation of the third canonical pair or factor of the subcutaneous fat tissue in the predictor set and the factor of fat tissue and nutrition in the criterion set explains 90% of the common variability. The relation of the third pair of canonical factors suggests that participants who have lower values of subcutaneous fat tissue have a lower percentage of fat as expected because the percentage of body fat was determined by the values of skin folds (Slaughter et al., 1988).

CONCLUSION

The results of the study indicate that there is a significant correlation between morphological characteristics and fitness parameters in overweight and obese boys aged seven. Participants who have higher values of voluminosity and transverse dimensionality of the skeleton also have higher values of body fat as well as BMI. Participants who have higher values of skin folds have less explosive power. It has been determined that body mass and voluminosity positively affect the strength of the arm and shoulder. Overweight and obese boys have lower values when cardiorespiratory fitness is concerned. Increased body mass and obesity lead to a reduction in VO2max [ml/kg/min].

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FITNES PARAMETRI I MORFOLOŠKE KARAKTERISTIKE PREKOMERNO UHRANJENIH I GOJAZNIH DEČAKA UZRASTA SEDAM GODINA

Cilj istraživanja jeste da se utvrde relacije morfoloških karakteristika i fitnes parametara prekomerno uhranjenih i gojaznih dečaka uzrasta sedam godina. Uzorak ispitanika činilo je 198 učenika (dečaka) uzrasta sedam godina (prvi razred) osnovnih škola sa teritorija grada Niša, Paraćina, Bele Palanke, Leskovca i dr. Antropometrjiske karakteristike utvrđene su merenjem parametara longitudinalnih, transverzalnih, cirkularnih dimenzija i mase tela i merenjem *potkožnog masnog tkiva. Za procenu fitnes prametara koristili su se testovi preporučeni za uzrast ispitanika, a mereni su mišićni fitnes, telesna kompozicija i kardiorespiratorni fitness. Za utvrđivanje povezanosti između antropometrijskih karateristika i fitnes parametara koristila se kanonička korelaciona analiza. Rezultati ove studije ukazuju da postoji statistički značajna povezanost antropometrijskih karakteristika i fitnes parametara kod prekomerno uhranjenih i gojaznih dečaka uzrasta sedam godina.*

Ključne reči: *Fitnes parametri, antropometrijske karakteristike, preuhranjenost, gojaznost predpubertetsko doba*