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Research article

ASSOCIATION BETWEEN BODY COMPOSITION AND CARDIORESPIRATORY FITNESS OF ADOLESCENTS

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Abstract. *With the aim to investigate the association between body composition of adolescents and cardiorespiratory fitness, this research was carried out on a sample of seventh grade primary school students (38 female and 44 male students). The sample of measuring instruments for body composition assessment were: body mass index, triceps, subscapularis and suprailiac subcutaneous adipose tissue, body fat percentage, muscle mass percentage and fat-free mass. The "Beep" test was used for the assessment of cardiorespiratory fitness. At the multivariate level the results have shown that body composition, as a system predictor, explained 51% (p= .000) of variance of cardiorespiratory fitness of the total sample of students, 29% (p= .021) of the girls and 51% (p= .000) of the boys. At the univariate level of the total sample it was noticed that the sum of three skinfolds (t= -4.91; p= .000) and fat-free mass (t= 4.54; p= .000) had a high influence on system prediction. The sum of three skinfolds in the total sample, sample of girls and sample of boys had a negative impact on cardiorespiratory fitness. For the girls, body fat percentage had a positive impact on cardiorespiratory fitness, while in the total sample and sample of boys, fat-free mass had a positive impact on cardiorespiratory fitness. It could be concluded that the association between body composition components and* VO_{2max} *was clearly demonstrated in adolescents.*

Key words: *association, body composition, cardiorespiratory fitness, adolescents*.

INTORDUCTION

Both body composition (BC) and cardiorespiratory fitness (CRF) have been shown to be risk factors for future health outcome (Goran, Fields, D.A., Hunter, G.R., Herd, S.L., & Weinsier, 2000). A low CRF level is considered as independent risk factor for the development of diseases such as cardiovascular disease and the risk of premature mortality

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from all causes (Farrel, Finley, Haskell, & Grundy, 2015). In the recent decade, decline in physical activity as well as a downward trend in CRF levels among young adults has been observed. Considering the negative health impacts of obesity, the trend toward excess adiposity among school-age children is a public health concern (Arango et al., 2013). One of the factors contributing to the increasing adiposity among children and adolescents may be a reduction in total energy expenditure, caused by a decrease in physical activity (Ekelung et al., 2001). Regular physical activity is an important part of a healthy lifestyle and it is associated with decreased risk of heart disease, obesity and lower levels of stress (Brown, 1991); also the CRF of athletes is an important element of success in sports achievements (Shete, Bute, & Deshmukh, 2014).

CRF denotes the general extent of metabolic processes occurring in the human body, and stands for a larger portion of the total energetic capacity (Ranković et al., 2010). CRF is indicated by maximal oxygen uptake per minute (VO_{2max}) as the international standard and primarily determined by the efficiency of mechanisms supplying active muscles with oxygen from the air (Basset & Howley, 2000). The basic unit of measuring maximal oxygen uptake is its absolute value expressed in liters or milliliters per minutes. However, the absolute value is highly affected by body mass (BM), so it is often expressed as relative value in milliliter/kg/minutes (Ranković et al., 2010; Shete et al., 2014). Other factors affecting CRF include BM and BC (Maciejczyk et al., 2014). BC and VO2max are essential indicators of good physical fitness (Gligoroska, Manchevska, Efremova, Todorovska, & Nikolić, 2015).

Early studies have shown that another factor such as BC is closely related with VO_{2max}, especially BC components such as muscle mass (MM), the physiological basis for this association is assumed to be the direct relation between skeletal MM and its capacity to consume oxygen for energy metabolism (Hunt et al., 1998), and body fat percentage (BF%) (Amani et al., 2010, Goran et al., 2000). The relationship between MM and VO2max is directly proportional and inversely proportional to BF% (León-Ariza, Botero-Rosas, & Zea-Robles, 2017). Improvement in some BC components such as the body mass index (BMI), body MM and BF% as result by the exercise can improve VO_{2max} (Tomassoni, Blanchard, & Goldfarb, 1985).

Most of the studies report that well developed MM and low percentage of subcutaneous adipose tissue are predictors of good sport performance (Ostojić & Živanić, 2001; Popović, Akpinar, S., Jakšić, Matić, & Bjelica, 2013; Gligorska et al., 2015).

Obese and overweight persons, whose high BM is caused by high body adiposity, display a considerably lower VO_{2max} relative to their BM (Maciejczyk et al., 2014). Studies have found a reduced VO2max as BMI increased (Ortega, Ruiz, Castillo, & Sjöström, 2008). However, a high BM, as well as a high BMI can also be caused by a high amount of fat free mass (FFM) in persons with normal (or even low) body fat (BF) (Maciejczyk et al., 2014). Goran et al., (2000) reported that it would not be excess weight or the amount of BF that interfered with VO_{2max}, but rather the amount of FFM. VO_{2max} is also related to lower visceral and abdominal subcutaneous adipose tissue, but independent of BMI (Wong et al., 2004; Janssen et al., 2004). Nassis, Psarra, and Sidossis (2005) reported that total and central adiposity was lower in children with high VO_{2max} compared with children with low VO_{2max} in European boys and girls. In that study (Nassis et al., 2005), total and abdominal fat was estimated by sum of skinfolds and VO_{2max} was indirectly assessed by the 20m shuttle run test (Lee & Arslanian, 2007).

Anthropometry is considered a simple, inexpensive and easy-to-use method in epidemiological studies. BMI and skinfolds measurements provide excess weight information, but BMI indicates total BF and the sum of skinfolds indicates BF distribution (de Andrade Goncalves, Nunes, & Silva, 2017). Reliable and valid approach for estimation of human body composition is a technique known as bioelectrical impedance (BIA). This method is safe, noninvasive, provides rapid measurements, requires little operator skill and subject cooperation, and is portable (Lukaski, Johnson, Bolonchuk, & Lykken, 1985). Also in epidemiological studies involving young people, the most common test for assessing cardiorespiratory fitness was the 20-m shuttle run test (Beep Test), or modifications of this test (Ortega et al., 2008). The 20-m shuttle run can provide accurate predictions of VO_{2max} with very strong correlations with actual VO_{2max} (McNaughton, Hall, & Cooley, 1998). The VO_{2max} can then be estimated from the score obtained in this test from the published tables in Ramsbottom, Brewer, & Williams (1988). The aim of this study was to investigate associations between body composition and cardiorespiratory fitness of adolescents and ability to predict VO_{2max} from BC variables.

METHODS

Participants

A sample of 82 healthy seventh grade primary school students aged 13.73 ± 0.29 (BH: 163.62±8.98 cm; BM: 55.35±10.75 kg), were selected to participate in this study. The sample were classified into 2 subsamples, 44 boys (BH: 165.79±10.76 cm; BM: 57.83±12.81 kg) and 38 girls (BH: 161.11±5.46 cm; BM: 52.47±6.80 kg).

Procedures

All experimental procedures and possible risks and benefits were explained to each student. Further, each student participated voluntarily. Signed consent was obtained from their parents prior to the onset of participation and approval to conduct the study was granted by school principals. The study protects the children's privacy by allowing for anonymity and was designed in compliance with the recommendations for clinical research of the Declaration of Helsinki (2013) of the World Medical Association. This study was also reviewed and approved by the Ethics Committee of the Faculty of Sport and Physical Education, University of Niš.

Anthropometric measurements and body composition

Body height (BH) was measured using the Martin anthropometer GPM 101 *(GPM GmbH Switzerland)*, following standard procedures (Norton et al., 2001). Values of BH were measured and recorded in millimeters (mm). Body mass (BM) was measured with accuracy of 0.1 kg with an electronic body weight scale Omron BF511 *(Omron Healthcare Co, Kyoto, Japan)*. BMI (kg/m^2) was calculated from the standard equation BM/BH^2. Skinfold thickness was measured using GPM 6100 *(GPM GmbH Switzerland)*, with an accuracy of 0,2 mm at the triceps, subscapular and suprailiac sites, according to the methodology recommended by the International Biological Program (Weiner & Lourie, 1969). A GPM caliper provides a constant pressure of $10g/mm^2$. The measurement results were evaluated 2 seconds after the grip is caught on the skin. All three sites of skinfold thicknesses were summed up to provide the sum of skinfolds (SUM3). Body composition components BF% and MM% were assessed using the BIA electronic scale Omron BF511. FFM was derived by subtracting BF from BM (Ellis, 2000). The participants were asked to avoid the following procedures before body composition measurement as described by Rech, Cordeiro, Petroski, & Vasconcelos (2008), not to perform any physical exercises during 12 hours before testing, not to eat or drink anything during the four hours before the evaluation, to urinate at least 30 minutes before the evaluation, not to take any diuretics during the seven days prior to the test, and not to consume alcohol during 48 hours preceding the test.

Cardiorespiratory fitness assessment

CRF was assessed with the endurance on the 20-m shuttle-run test, also known as the "Beep test" from the Eurofit test battery (Adams, Klissouras, Ravazzolo, Renson, & Tuxworth, 1988). In this test, children run back and forth between two lines, 20 m apart. The running pace was given by an auditape. Running speed was 8.0 km/h at the start of the test and increased by 0.5 km/h every minute. The test was stopped when the child was unable to reach the 3 m zone situated ahead of each 20 m line two times consecutively at the moment of the audio signal (Ahmaidi, Collomp, Caillaud, & Prefaut, 1992). VO2max values were calculated from the published tables in Ramsbottom et al. (1988).

Statistical analysis

Descriptive statistics, Kolmogorov–Smirnov (normality of the distribution) and Levene's (homogeneity of variance) tests were calculated for all experimental data before inferential testing. Pearson simple and partial correlation coefficients were used to determine the correlation between the predictor variables (BMI, SUM3, BF%, MM%, FFM) and criterion variable (CRF). For further investigation of the association and explanatory power of the predictor variables on criterion variable, a multiple linear regression analysis was used. Statistical procedures were performed using STATISTICA 10 (StatSoft Inc, Tulsa OK, USA) and the level of significance was set at $p \leq 0.05$.

RESULTS

The Kolmogorov-Smirnov tests have shown that the data were normally distributed and no violation of homogeneity of variance was found using Levene's test. With the normal distribution of the results of BC and CRF assessment, it is possible to apply parametric statistical procedures. For determining the explanatory power of the predictor variables on the criterion variable, multiple linear regression analyses were applied. Selected BC predictor variables (BMI, SUM3, BF%, MM%, FFM) were included for building the initial regression model for prediction of VO_{2max} as the criterion variable. The initial model was tested for assumptions for multicollinearity among predictor variables. The first step was observation of the correlation matrix between the predictor variables. The correlation matrix showed that the variable BMI was in high significant correlation with all other variables in girls (SUM3, r= 0.75; BF%, r= 0.78; MM%, r= -0.40; FFM, r= 0.60), and also in boys (SUM3, r= 0.87; BF%, r= 0.83; MM%, r= -0.52;

FFM, r= 0.54) and the total sample (SUM3, r= 0.76; BF%, r= 0.53; MM%, r= -0.35; FFM, r= 0.51). The next step in the confirmation of the presence of multicollinearity was observation of the variance inflation factor (VIF). After observation, VIF values were high for BMI (VIF=5.36) for girls, (VIF=9.63) for boys and (VIF=4.61) for the total sample; therefore, the presence of multicollinearity was confirmed for BMI. In the final step, BMI was excluded from the initial regression model due to multicollinearity with other variables from the predictor system. The remaining variables were included in the final regression model for further analysis. The results of this analysis are given in Table 1 - 3 and graphically shown in Figure 1-3.

Statistically significant simple correlations were not found between variables from the predictor system and VO_{2max}, but further analysis of partial correlation coefficients showed statistically significant correlations. A negative partial correlation was found between SUM3 and VO_{2max}, and positive correlations were found between BF% and VO_{2max} in girls. The multiple linear regression identified that BC components presented an explanatory power for VO_{2max} 29% (p=.021). The BC components with the highest explanatory power in the regression model for VO_{2max} were SUM3 (p=0.002) and BF% (p=0.006) in girls (Table 1).

Table 1 Descriptive statistics, correlation coefficients and multiple regression model results for the girls.

	Mean	SD	Min.	Max.	Beta	Part r	r	t(33)	p-level
SUM3 (mm)	45.71	9.59	25.20	67.60	**-0.88**	-0.51	-0.29	-3.41	**0.002***
BF % (%)	26.80	4.85	14.90	37.00	**0.73**	0.45	0.01	2.93	**0.006***
MM % (%)	39.49	4.32	29.90	45.10	0.29	0.29	0.15	1.77	0.087
FFM (kg)	38.18	3.63	32.08	45.87	0.10	0.10	-0.15	0.58	0.566
VO_{2max} [ml/(kg*min)]	27.14	4.48	20.90	40.20					
	R= .54	R^2= .29	F(4;33)= 3.32	SEE= 4.00	p= **.021***				

Legend: Mean - arithmetic mean; SD - standard deviation; Beta – standardized regression coefficient; Part r - partial correlation coefficient; r – simple correlation coefficient; R - coefficient of multiple correlation; R^2 - coefficient of multiple determination; F – F-test of the relationship between the dependent variable and the set of independent variables; SEE - standard error of estimate; p – coefficient of statistically significance of multiple regression.

An analysis of the correlation coefficients between BC components and VO_{2max} in boys showed statistically significant negative correlations between SUM3, BF% and VO_{2max} (p<0.01). Also a further analysis of the partial correlation coefficients showed a statistically significant negative correlation between SUM3 and VO_{2max} and a positive correlation between FFM and VO_{2max}. The multiple linear regression identified that BC components presented explanatory power for VO_{2max} 51% (p=.000) in boys. The BC components with the highest explanatory power in the regression model for VO_{2max} were SUM3 (p=0.000) and FFM (p=0.006) in boys (Table 2).

Table 2 Descriptive statistics, correlation coefficients and multiple regression model results for the boys.

	Mean	SD	Min.	Max.	Beta	Part r	r	t(39)	p-level
SUM3 $_{(mm)}$	37.53	17.02	16.00	69.60	**-0.89**	-0.52	-0.63	-3.80	**0.000***
BF % $_{(\%)}$	15.65	7.43	5.20	36.80	0.10	0.05	-0.53	0.33	0.740
MM % $_{(\%)}$	47.53	7.93	31.70	61.50	-0.05	-0.04	0.28	-0.25	0.804
FFM $_{(kg)}$	48.26	8.82	33.32	68.02	**0.39**	0.42	0.04	2.91	**0.006***
$VO_{2max\ [ml/(kg*min)]}$	33.15	5.16	22.60	44.60					
	R= .71	R^2= .51	F(4;39)= 10.19		SEE= 3.79		p= **.000***		

The analysis of the correlation coefficients between BC components and VO_{2max} in the total sample showed several statistically significant correlations. A negative correlation was found between SUM3, BF% and VO_{2max} and a positive correlation was found between MM%, FFM and VO_{2max}. Also further analysis of the partial correlation coefficients showed a statistically significant negative correlation between SUM3 and VO_{2max} and a positive correlation between FFM and VO_{2max}. The multiple linear regression identified that BC components presented an explanatory power for VO_{2max} 51% (p=.000) in the total sample. The BC components with the highest explanatory power in the regression model for VO_{2max} were SUM3 (p=0.000) and FFM (p=0.000) in the total sample (Table 3).

Table 3 Descriptive statistics, correlation coefficients and multiple regression model results for the total sample.

	Mean	SD	Min.	Max.	Beta	Part r	r	t(77)	p-level
SUM3 $_{(mm)}$	41.32	14.58	16.00	69.60	**-0.79**	-0.49	-0.57	-4.91	**0.000***
BF % $_{(\%)}$	20.81	8.45	5.20	37.00	0.33	0.18	-0.57	1.59	0.115
MM % $_{(\%)}$	43.80	7.63	29.90	61.50	0.23	0.20	0.45	1.78	0.078
FFM $_{(kg)}$	43.59	8.54	32.08	68.02	**0.48**	0.46	0.31	4.54	**0.000***
$VO_{2max\ [ml/(kg*min)]}$	30.37	5.69	20.90	44.60					
	R= .71	R^2= .51	F(4;77)= 19.81		SEE= 4.10		p= **.000***		

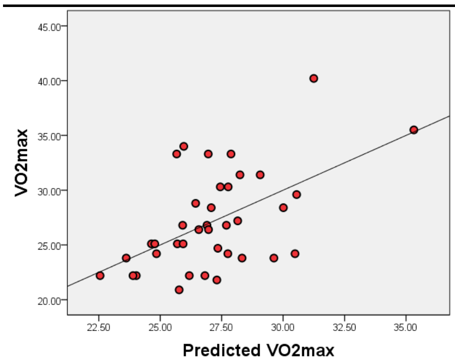

Fig. 1 Association between predicted values of VO_{2max} from the regression model equation and actual VO_{2max} values for the girls.

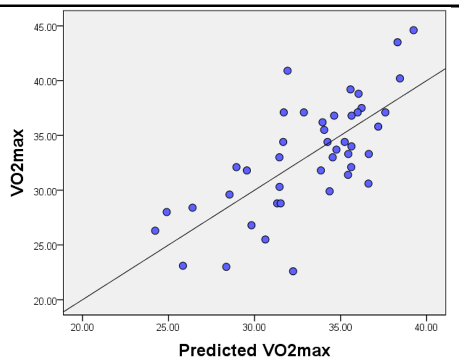

Fig. 2 Association between predicted values of VO_{2max} from the regression model equation and actual VO_{2max} values for the boys.

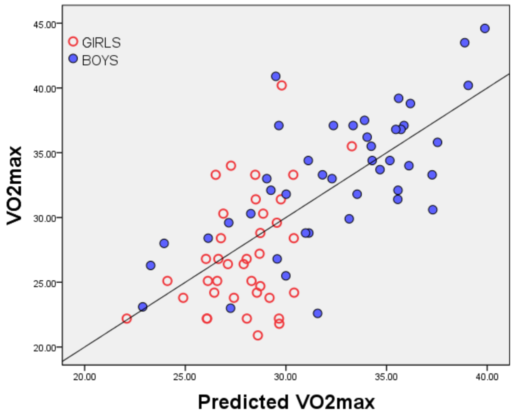

Fig. 3 Association between predicted values of VO_{2max} from the regression model equation and actual VO_{2max} values in the total sample.

DISCUSSION

The results of anthropometric measures of our sample showed that the average age, BH, BM were similar to the values given by Watanabe, Nakadomo, & Maeda (1994); Ekelund et al., (2001); Winsley, Armstrong, Middlebrooke, Ramos-Ibanez, & Williams (2006); Aires et al., (2010); Sharma, Subramanian, & Arunachalam (2013).

The current study examined the association between body composition and VO_{2max} of 13-year-old boys and girls. The VO_{2max} has been widely accepted as a criterion for the assessment of CRF. Depending on different methods used in studies, VO_{2max} has been expressed either as l/min (Watanabe et al., 1994; Bandyopadhyay & Chatterjee, 2003; Winsley et al., 2006; Sharma et al., 2013) or as ml/kg/min (Watanabe et al., 1994; Ekelung et al., 2001; Winsley et al., 2006; Aires et al., 2010; Sharma et al., 2013) or as adjusted for the FFM value ml/FFMkg/min (Watanabe, 1994; Bandyopadhyay & Chatterjee, 2003). In this study VO_{2max} has been expressed as ml/kg/min, thus the results of the association between BC and VO_{2max} were compared only with studies that used same VO_{2max} value. The results obtained from simple correlation coefficients indicate a significant negative correlation between SUM3 and VO_{2max} for the girls (r=-0.29), for the boys (r=-0.63) and the total sample (r=-0.57). This result supports the findings of the study by de Andrade Goncalves et al. (2017) who found correlation coefficients almost similar to the ones in this study (r=-0.45) for the girls and (r=-045) boys. Similar results were also found in previous studies, which demonstrated that the sum of trunk skinfolds were also in a negative correlation with VO_{2max}, in a study by Ekelund et al. (2001) (r=-0.43) for the girls and (r=-0.48) for the boys, as well as in a study by Winsley et al. (2006) (r=-0.43) for the girls and (r=-0.26) boys, Galaviz et al. (2012) reported stronger negative correlation coefficients (r=-0.58) for the girls and (r=-64) boys, similar values were found by Lee & Arslanian (2007) (r=-63). A positive correlation between the sum of three trunk skinfolds and VO2max were only found in the study by Ara, Moreno, Leiva, Gutin, & Casajús (2007) (r=0.48). The present study results showed the presence of a statistically significant negative correlation between BF% and VO_{2max} (r=-53) for the boys and (r=-

0.57) the total sample, but a significant correlation was not found for the girls (r=0.01). These results are in accordance with the results found in previous studies, Maciejczyk et al. (2014) reported (r=-0.40) for male students, the same results were found in study by Amani et al. (2010). In studies by Ekelund et al. (2001) and by Mota et al. (2002) very similar correlations (r=-0.48) and (r=-0.49) in boys were found. A strong negative correlation was found in the study by Ostojić & Živanić (2011) (r=-0.76) and a very similar result was reported by Mondal & Mishra (2017) (r=-0.75) in the total sample. Other studies shown no significant correlation between body fat percent and VO_{2max}, (r=0.16; r=-0.10) (León-Ariza et al., 2017; Shete et al., 2014). The results of the present study are in accordance with the findings from other studies which confirmed that the sum of trunk skinfolds as an indicator of fat distribution and total body fatness and cardiorespiratory fitness are frequently used in association with each other and it is often implied that these parameters have a strongly inversely proportional relationship. The current results showed a statistically positive correlation between MM% and VO_{2max} only in the total sample (r=0.45). Similar results were found in a previous study of León-Ariza et al. (2017), which demonstrated that muscle mass exhibited a stronger positive correlation with VO_{2max} (r=0.61) in the total sample. In this study a significant correlation between FFM and VO_{2max} was found only in the total sample (r=0.31), similar coefficient (r=0.37) was reported in a study by Mondal & Mishra (2017).

After the exclusion of BMI due to multicollinearity, all other body composition components were analyzed in order to explain the VO_{2max} variation of adolescents in this study. The results showed that the sum of the three skinfolds (triceps, subscapular and suprailiac) and body fat percent were the body composition markers that had the highest predicting power for VO_{2max} in girls (Table 1), SUM3 with a significant negative partial correlation (Part. r=-0.51) and strong beta coefficient (Beta=-0.88) in accordance with the results found in study de Andrade Goncalves et al. (2017) and BF% with a significant positive partial correlation (Part. r=0.45) and (Beta=0.73). For the boys (Table 2.) it was determined that SUM3 and FFM were most responsible for predicting the power of the regression model. SUM3 with a significant negative partial correlation (Part. r=-0.52) and strong beta coefficient (Beta=-0.89) is very similar to the results for the girls, and FFM with a significant positive partial correlation (Part. r=0.42) and (Beta=0.39). Also similar results were found in the total sample (Table 3.), SUM3 and FFM were strongest BC markers for predicting VO_{2max}, SUM3 with a significant negative partial correlation (Part. r=-0.49) and strong beta coefficient (Beta=-0.79), and FFM a with significant positive partial correlation (Part. r=0.46) and (Beta=0.48).

The best explanatory power of SUM3 for predicting VO_{2max} may indicate that using the sum of three sites of the skinfolds is more accurate to estimate the influence of total body fat on cardiorespiratory fitness as fat distribution does not occur in a similar way for individuals; when using the sum of these skinfolds, it is possible to clearly see the trend of global accumulation of body fat (de Andrade Goncalves et al., 2017). It was found that BF% has a strong positive influence on VO_{2max} for the girls, but the mechanism by which the BF% content increases the VO_{2max} is not yet clear. It was assumed that body fat helped to increase O_2 uptake capacity for its own aerobic metabolism (Bandyopadhyay & Chatterjee, 2003). Fat has no augmenting action towards cardiorespiratory responses or towards muscle oxygen extraction capacity. However, adipose tissue starts to breakdown during exhaustive work to yield energy by oxidative metabolism and this demand of O_2 is fulfilled by a higher uptake of O2 that is solely because of the fat and not for FFM. Therefore, fat might not be dead weight, rather it might have enough mobility to influence VO_{2max} (Bandyopadhyay & Chatterjee, 2003). Furthermore, it was found for the boys and the total sample that large amounts of FFM were related to suitable cardiorespiratory fitness values due to the oxidative potential of muscle fibers (Yanek el al., 2015)

After regression models were analysed, it was possible to put together regression model equations for calculating the predicted values of VO_{2max}. A standard equation format for multiple regression analysis was used: $Y= \beta_0 + \beta_1X_1 + \beta_2X_2 +... \beta_nX_n$, (Y-dependent variable, β_0 - intercept, $\beta_1, \beta_2,... \beta_n$ - regression coefficients, $X_1,X_2,...X_n$ - independent "predictor" variables) (Alexopoulos, 2010).

The equation for the calculation of predicted values of the regression model for the girls:

$$VO_{2max} = 11.33752 -0.41231*SUM3 +0.67407*BF\% +0.30134*MM\% +0.12272*FFM$$

The equation for the calculation of predicted values of the regression model for the boys:

$$VO_{2max} = 32.77095 -0.27087*SUM3 +0.06698*BF\% -0.03027*MM\% +0.22662*FFM$$

The equation for the calculation of predicted values of the regression model in the total sample:

$$VO_{2max} = 17.13831 -0.30691*SUM3 +0.22344*BF\% +0.16843*MM\% +0.31845*FFM$$

Associations between the predicted and actual values of VO_{2max} are shown in Tables 1-3 and Figures 1-3.

CONCLUSION

From the obtained results it could be concluded that the association between body composition components with VO_{2max} was clearly demonstrated in adolescents. With the exception of MM% and FFM in girls and BF% and MM% in boys and the total sample, the remaining predictors were able to explain the VO_{2max} variation in the adolescents of this study. The sum of triceps, subscapularis and suprailiac skinfolds showed the best power to explain cardiorespiratory fitness with the negative impact on VO_{2max} values of adolescents. One interesting finding was that the second most powerful body composition marker for predicting cardiorespiratory fitness was body fat percentage with a positive impact on VO_{2max} values for the girls. The second most powerful BC marker for the boys and the total sample was fat-free mass also with a positive impact on VO_{2max} values. In summary, the most accurate regression model was found for the boys, similar as for the total sample, but a less accurate regression model was found for girls. However, this study has some limitations which have to be pointed out. The sample included in this study were only seventh grade students and only field tests were used for estimating body composition and cardiorespiratory fitness. Future studies should be conducted including the same and other samples by using direct measures of body composition, such as computed tomography and magnetic resonance imaging and direct measures of VO_{2max} such as an ergospirometric system in order to develop more accurate regression models.

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RELACIJE IZMEĐU TELESNE KOMPOZICIJE I KARDIORESPIRATORNE IZDRŽLJIVOSTI ADOLESCENATA

Sa ciljem da se utvrde relacije između telesne kompozicije i kardiorespiratorne izdržljivosti adolescenata, sprovedeno je istraživanje na uzorku učenika sedmog razreda (38 devojčica i 44 dečaka). Uzorak mernih instrumenata za procenu telesne kompozicije je bio sačinjen od: indeksa telesne mase, kožnih nabora tricepsa, leđa i trbuha, procenta telesne masti, procenta mišićne mase i bezmasne mase tela kao sistem prediktorskih varijabli. "Bip" test je korišćen za procenu kardiorespiratorne izdržljivosti. Na multivarijantnom nivou rezultati su pokazali da komponente telesne kompozicije kao prediktorski sistem objašnjavaju 51% (p=.000) varijanse kardiorespiratorne izdržljivosti kod ukupnog uzorka, 29% (p=.021) kod devojčica i 51% (p=.000) kod dečaka. Na univarijantnom nivou kod ukupnog uzorka je uočeno da suma kožnih nabora (t= -4.91; p=.000) i bezmasna masa tela (t= 4.54; p=.000) imaju najveći uticaj u prediktorskom sistemu. Suma kožnih nabora u ukupnom uzorku, u uzorku devojčica kao i u uzorku dečaka ima negativan uticaj na kardiorespiratornu izdržljivost. Procenat masti ima pozitivan uticaj na kardiorespiratornu izdržljivost samo kod devojčica, dok je u ukupnom uzorku i uzorku dečaka pozitivan uticaj na kardiorespiratornu izdžrljivost uočen kod bezmasne mase tela. Može se zaključiti da postoje značajne relacije između komponenti telesne kompozicije kao prediktora i kardiorespiratorne izdržljivosti kao kriterijuma kod adolescenata.

Ključne reči: *relacije, telesna kompozicija, kardiorespiratorna izdržljivost, adolescenti.*