

THE RELATIONS BETWEEN PHYSICAL ACTIVITY AND BODY COMPOSITION OF SCHOOL-AGE CHILDREN

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Abstract. *The aim of this research was to determine the connection between the level of physical activity and body composition among school-age children. The sample of participants included 479 students, 250 boys and 229 girls, school-age children, with an average age of $12,5 \pm 1,08$. Their level of physical activity was evaluated using the FELS PAQ questionnaire, while their body composition was evaluated using the BIA method. To determine a connection between the group of predictor variables and the criterion variables, a canonical correlation analysis was used. The obtained results indicated that there is a positive correlation between the level of physical activity and the parameters of body composition, both for the sample of school-age boys ($p = .002$), and the sample of girls ($p = .048$). It could be concluded that the participants who were physically more active scored lower values for Body Fat and BMI, that is, higher values for Muscle Mass and Lean Body Mass.*

Key words: *physical activity, body composition, elementary school, children*

1. INTRODUCTION

During the entire evolutionary process, muscle activity was a deciding factor for the survival of the human race. At the level of development that society has reached at this point, and the increasingly greater influence of robotization and industrialization, the need for muscle activity is decreasing. At the beginning of the 21st century, the level of physical activity is sufficient to meet the basic human needs. Approximately 35,5% of the adult population is minimally physically active, while 15,3% only take part in borderline effective motor/sports activities (Pišot & Fras, 2005). The development of civilization has led to a decrease in the level of physical activity, which complicates and increases the importance of muscle activity in the body (Dodig, 1998). Researchers have confirmed the

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importance of physical activity for good health (Warburton, Nicol & Bredin, 2006); however, a general decrease in physical activity in the overall population can be noted. Apart from the decrease in the level of physical activity among adults, this trend can also be noted among children (Livingstone, Robson, Wallace, & McKinley, 2003). Bukara-Radujković & Zdravković (2010) point out that the level of physical activity of children has significantly fallen over the past few years, while the intake of food energy has increased, which leads to the emergence of obesity. Even though children are by their nature active, the older they get, the more prone to inactivity they become (Aarnio, 2003), while during adolescence, their daily calorie intake (depending on body weight in kilograms) corresponds to approximately one half of the intake at the age of 6 (Rowland, 1999). Similar findings were published by Kimm et al. (2002), who concluded that the trend of participating in physical activity during adolescence among boys, and especially among girls, has decreased by as much as 50% compared to the amount of physical activity they participated in up to the age of ten.

A low level of physical activity is characteristic of industrialized countries, and has a special influence on the somatic and psychological development of children (Harsha, 1995). Regular physical activity prevents a sudden increase in body mass and illnesses which are related to obesity. In combination with a diet regime, physical activity can significantly influence the reduction of body mass and changes in the metabolism, that is, the mechanisms of depositing fatty tissue in the human body (Mitić, 2001). There are numerous factors which directly or indirectly influence the daily level of physical activity of children and adolescents, and Bauman et al. (2012) point out the significance of identifying and understanding the relations and determinants which influence the level of physical activity.

Gordon-Larsen et al. (1999) studied the influence of physical activity and inactivity on the emergence of obesity among adolescents. The level of physical activity was expressed in the number of hours of physical activity on a weekly basis. The level of physical activity, that is intense, was represented as the metabolic equivalent through which physical activity is defined as moderate or high. Statistically significant differences in the body composition of ethnic groups were noted among inactive adolescents, while these differences were much smaller among the physically active. The authors concluded that physical inactivity among adolescents correlates with the emergence of overweight, irrespective of socio-demographic factors. A similar study was carried out by Ischander et al. (2007), who studied body composition, physical activity as well as inflammatory mediators among normally nourished female participants. All of the female participants had the same BMI within the normal nutritional level range, but the experimental group was physically more active, while the control group included a sedentary population. It was confirmed that the female participants in the experimental group had better scores for body composition, especially lean body mass, stronger bones and a lower level of inflammatory factors compared to the more sedentary female participants.

Children who spend a lot of time in front of the TV have a greater BMI and a greater percentage of body fat, and are physically less active. A study carried out by the American Public Health Association - Health Communities (1991) confirmed the mutual relationship between watching television and obesity. Watching television reduces the time which, could be spent taking part in a particular physical activity. On the other hand, watching television is closely bound to intake of food and beverages, and all this leads to an increase in obesity.

However, certain studies which have focused on the connection between physical activity and BMI among children aged 7 to 14 did not indicate any statistically significant correlations. In a study by Raustorp et al. (2004) the connection between physical activity and BMI was studied in a sample of 871 children aged 7 to 14. Their level of physical activity was measured using a pedometer, i.e. the number of taken steps. The analysis of the number of steps and BMI of the boys and girls did not show any statistically significant correlations in any of the age groups.

The aim of the research was to determine whether there is a connection between the level of physical activity and body composition of school-aged boys and girls.

2. METHOD

2.1. Sample of participants

The sample of participants consisted of 479 school-aged boys and girls (with an average age of $12,5 \pm 1,08$). There were a total of 250 boys and 229 girls. The average body height of the boys was $164,8 \pm 12,2$ cm, and body mass was $57,5 \pm 14,7$ kg, while the average body height of the girls was $159,8 \pm 7,8$ cm, and body mass was $52,2 \pm 10,1$ kg. All of the participants were healthy while taking part in the study. The research was approved by the Ethics Committee of the Faculty of Sport and Physical Education, University of Niš, in accordance with the Helsinki Declaration. Prior to the realization of the study, parental consent and consent from the schools were obtained for participation.

2.2. Procedure

To evaluate body composition, the Bioelectrical Impedance Analysis – BIA was used (Cunningham, 1987; Jackson, Pollock, Graves & Mahar, 1988). A digital scale of the brand Omron was used (model BF511). The following parameters were used in the study: Body Fat [%], Body Fat [kg], Muscle Mass [%], Muscle Mass [kg], Lean Body Mass [%], Lean Body Mass [kg] и BMI [kg/m²]. The values of Lean Body Mass [%] and Lean Body Mass [kg] were calculated using the Ellis equation (2001).

The level of physical activity was also determined using the FELS PAQ. The FELS PAQ is a standardized questionnaire which is used to evaluate the intensity of the physical activity of children and adolescents aged 7 to 19, whose validity has been confirmed (Reith, Hou, Young, & Maynard, 2005). The questions were designed so as to provide insight into the level of physical activity in three categories: a) physical activity as a part of the sport; b) physical activity during leisure time; and c) physical activity as part of working around the house. Calculating the total result included a summation of the results in each individual field (sport + leisure time + work around the house)...

2.3. Statistical analysis

For all the applied variables in the research, basic descriptive statistical parameters were used. The connection between the predictor and the criterion was determined by a canonical correlation analysis, using the statistical 7.0 program (StatSoft. Inc., Tulsa, OK, USA). The level of significance was set at .05

3. RESULTS

Table 1. Shows the basic descriptive statistical parameters of body composition and the level of physical activity of the boys and girls. Based on the relationship between the standard deviation and range, it could be concluded that the discrimination was satisfactory, that is, that the values of the Std.Dev... are found within the 1/6 Range.

The average values of the parameters of the muscle mass of the boys are 21,90kg, that is 38, 14%, while the average values for fat tissue are 11,01kg, that is 18, 28%. The average values of the sport index are 4.09, the leisure index 3.81 and work index 3.00, which led to the average total results of physical activity being 10,91.

When it comes to the body composition of the girls, the average values of the parameters of muscle mass are 17,42kg that is 33, 58%, while the average values of fat tissue are 13, 12 kg, that is 24, 04%. The values of the sport index are 3.52, the leisure index 3.53 and the work index 3.37, which led to the average total result of physical activity being 10,42.

Table 1 Descriptive statistics for the boys (n=250) and girls (n=229)

	B o y s				
	Mean	Std.Dev.	Min	Max	Range
Body Fat [%]	18,28	8,68	5,30	43,90	38,60
Body Fat [kg]	11,01	7,33	1,42	48,07	46,66
Muscle Mass [%]	38,14	3,70	28,10	44,80	16,70
Muscle Mass [kg]	21,90	5,67	8,61	33,94	25,33
Lean Body Mass [%]	81,72	8,68	56,10	94,70	38,60
Lean Body Mass [kg]	3,11	1,63	0,68	9,44	8,76
BMI [kg/m ²]	20,92	3,86	10,87	38,34	27,47
Sports index	4,09	0,64	1,67	5,00	3,33
Leisure index	3,81	0,58	1,00	5,00	4,00
Work index	3,00	0,83	1,00	5,00	4,00
Total score	10,91	1,24	5,50	14,33	8,83
	G i r l s				
	Mean	Std.Dev.	Min	Max	Range
Body Fat [%]	24,04	7,16	5,70	42,30	36,60
Body Fat [kg]	13,12	5,97	1,73	33,31	31,57
Muscle Mass [%]	33,58	2,31	26,20	38,60	12,40
Muscle Mass [kg]	17,42	3,25	8,57	28,21	19,63
Lean Body Mass [%]	75,96	7,16	57,70	94,30	36,60
Lean Body Mass [kg]	3,71	1,29	0,76	7,12	6,36
BMI [kg/m ²]	20,30	3,32	11,37	30,35	18,98
Sports index	3,52	0,73	1,67	5,00	3,33
Leisure index	3,53	0,63	1,33	5,00	3,66
Work index	3,37	0,78	1,00	5,00	4,00
Total score	10,42	1,36	6,33	14,00	7,66

Legend: (Mean) – means, (Std.Dev.) – Standard deviation, (Min) – minimal result, (Max) – maximal result, (Range) – range.

Table 2 shows the correlations between the predictor set and the criterion set of the applied variables for the sample of boys.

Table 2 The cross-correlation between the body composition and physical activities of the boys

	Sports index	Leisure index	Work index	Total score
Body Fat [%]	-.07	-.15	-.08	-.18
Body Fat [kg]	-.03	-.07	-.02	-.06
Muscle Mass [%]	.09	.21	.12	.26
Muscle Mass [kg]	.13	.21	.15	.31
Lean Body Mass [%]	.07	.15	.08	.18
Lean Body Mass [kg]	-.05	-.11	-.06	-.13
BMI [kg/m ²]	.02	-.02	.00	.01

There is a moderate correlation between the Total score and Muscle Mass [kg] (.31). Low positive correlations were determined between the Total score and Muscle Mass [%] (.26) and Lean Body Mass [%] (.18). Low negative correlations were determined for the Total score and the parameters for the evaluation of Body Fat [%] (.18) and Lean Body Mass [kg] (-.13). Furthermore, low positive correlations were determined between the Leisure index and Muscle Mass [kg] (.21) and Muscle Mass [%] (.21). Negative correlations were determined between the Leisure index and Body Fat [%] (.15). Positive low correlations were determined between Muscle Mass [kg] and the Sports index (.13) and Work index (.15).

The connection between the set of predictor variables and the set of criterion variables among the girls is shown in Table 3. The only low correlation that exists is the one between the variable Total score and the variable Muscle Mass [kg] (.13). All the other correlations are negligible.

Table 3 The cross-correlations between the body composition and physical activity of the girls

	Sports index	Leisure index	Work index	Total score
Body Fat [%]	.03	-.03	-.01	.01
Body Fat [kg]	.05	-.01	-.01	.05
Muscle Mass [%]	-.01	.05	-.01	.03
Muscle Mass [kg]	.07	.06	.02	.13
Lean Body Mass [%]	-.03	.03	.01	-.01
Lean Body Mass [kg]	.01	-.03	-.02	-.01
BMI [kg/m ²]	-.02	-.03	-.04	-.03

To determine the relations between the body composition and level of physical activity of the boys and girls, a canonical correlation analysis was used (Table 4).

Table 4 The canonical correlations between the predictor and criterion for the boys and girls

	Canonical R	Canonical R ²	Chi-sqr.	p
Boys	.41	.17	54,48	.002**
Girls	.36	.13	41,49	.048*

Legend: Canonical R - canonical correlation coefficient; Canonical R² - the coefficient of determination for a pair of canonical factors; Chi-Sqr. - Bartlett's H2 test; p - statistical significance; Level of significance: ** p < .01, * p < .05.

Based on the obtained results, it was determined that among the boys there are statistically significant correlations between the system of variables of body composition and the variables for the evaluation of physical activity. The canonical correlation analysis determined that there is a statistically significant connection between the first pair of canonical factors, and that it has a value of, 41 ($R=, 41$). The level of significance is .01 ($p= .002$). The squared canonical correlation coefficient (R^2) which explains the shared variance of the variables from the two sub-groups in relation to the overall variety of the analyzed systems of variables are $R^2= ,17$, which means that the isolated canonical function is explained with 17% of the overall variance.

When determining the relations between the parameters of body composition and physical activity among the girls, it was determined that there is a statistically significant correlation between the first pair of canonical factors, with a value of, 36 ($R=, 36$). , at the level of significance of .05 ($p= .048$). The squared canonical correlation coefficient (R^2) which explains the shared variance of the variables from the two sub-groups of the overall variance of the analyzed systems of variables has a value of $R^2= ,13$, which means that the isolated function is explained by 13% of the overall variance.

Table 5 shows the structure of the canonically isolated factors for the boys. The greatest projections on the isolated canonical factor in the space of the body composition of the boys was determined for Muscle Mass [kg] (.76) and Muscle Mass [%] (.60), as well as Lean Body Mass [%] (.39) and Body Fat [%] (- .39).

In the space of the parameters for the evaluation of the level of physical activity, the isolated factor is mostly defined by the total physical activity (Total score .97), followed by the Leisure index (.64), Work index (.45), and Sports index (.35).

Table 5 The structure of the isolated canonical factors for the boys

	Root 1		Root 1
Body Fat [%]	- .39	Sports index	.35
Body Fat [kg]	- .08	Leisure index	.64
Muscle Mass [%]	.60	Work index	.45
Muscle Mass [kg]	.76	Total score	.97
Lean Body Mass [%]	.39		
Lean Body Mass [kg]	- .27		
BMI [kg/m ²]	.06		

The structure of the isolated canonical factors for the girls is shown in Table 6. In the space of body composition, we can note that the greatest projections on the isolated canonical factor for the girls were determined for Muscle Mass [kg] (.42), followed by Body Fat [kg] (.22), Body Fat [%](.10) and Lean Body Mass [%] (-.10).

In the second group of data, the function is defined by four parameters for the evaluation of the level of physical activity. The greatest projections on the isolated canonical factor were determined for the Total score (.95), Sports index (.67), and Work index (.33).

Table 6 The structure of the isolated canonical factors for the girls

	Root 1		Root 1
Body Fat [%]	.10	Sports index	.67
Body Fat [kg]	.22	Leisure index	.33
Muscle Mass [%]	.02	Work index	.63
Muscle Mass [kg]	.42	Total score	.95
Lean Body Mass [%]	-.10		
Lean Body Mass [kg]	.06		
BMI [kg/m ²]	-.01		

4. DISCUSSION

The obtained values for the BMI of the boys (20,92kg/m²) and girls (20,30kg/m²) indicate that there is no numerically great difference between the genders, and that according to the World Health Organization, based on the cited values, the tested boys and girls belong to a normally nourished population (Maksimović et al., 2009). Similar results were obtained in the studies carried out by Macura et al. (2010) and Kaj, Németh, Tékus & Wilhelm (2013). When it comes to the percentage of subcutaneous fatty tissue, the results indicate that the boys have somewhat lower values compared to the girls, and that expectedly the percentage of muscle is somewhat lower among the girls. The average values for Body Fat [%] obtained in our study were 18, 28% and 24, 04%, for the boys and girls, respectively. By analyzing the results provided in other studies (Rakić et al., 2003; Stokić et al., 2002), we can conclude that the cited values of Body Fat [%] indicate a normal percentage of subcutaneous fat tissue. The results of the study carried out by Kaj, Németh, Tékus & Wilhelm (2013) indicate the existence of certain differences in the values of subcutaneous fat tissue, but the differences are not numerically significant.

Average values that have to do with participation in physical activities indicate that school-aged boys take more part in sports activities during physical education classes and during leisure time, while the girls are more active when working around the house. Furthermore, the Total score indicates greater physical activity on the part of the boys compared to the girls of the aforementioned age. In numerous studies it has been indicated that boys are physically more active than girls. In a review paper of the current patterns of physical activity of children (Corbin, Pangrazi & Le Masurier, 2004) it was cited that boys of all ages and grades during their education are more active than girls, irrespective of how their physical activity was evaluated and which type of activity was studied. In a study carried out by Đokić (2014) which had the aim to evaluate the physical activities of boys and girls from the elementary schools of Novi Sad, physical activities related to school were evaluated – physical education classes, sports activities and leisure time activities. In all three studied fields of physical activity, a difference was determined between the boys and girls. It was determined that boys are more active than girls. Other studies have also confirmed the obtained results (Ekelund, Neovius, Linné, Brage, Wareham & Rössner, 2005; Chung, Skinner, Steiner & Perrin, 2012). What is disconcerting is the fact that the use of a computer and playing video games is a sedentary activity which is the most widespread one among the younger population (Koezuka et al., 2006).

When determining the connection between the parameters of body composition and the level of physical activity, the obtained results indicate that in the case of the boys there is a sequence of moderate and low correlations, while for the girls a correlation was only determined between the Total score and the parameter Muscle Mass [kg]. All the other correlations in the case of the girls are negligible. The obtained results agree with those of other studies (Maksimović et al., 2009). The results of this study indicate that adolescents who take part in certain physical activities (sport) scored significantly lower values for Body Fat, and higher values for Muscle Mass. Ekelund et al. (2005) determined a statistically significant negative correlation between the levels of physical activity and the values of Body Fat among boys, but not among girls. Kimm et al. (2005) point out the fact that the decrease in the level of physical activity stems from the increase in the level of obesity. In a study carried out by Ekelund et al. (2002) body composition and the level of physical activity were studied among obese adolescents and normally nourished adolescents, as was their calorie intake. The results have confirmed that obese adolescents are far less physically active than normally nourished adolescents. There is a positive correlation between sedentary activities, and Body Fat, but not BMI (Wanner et al., 2016). Furthermore, weight status is inversely proportional to physical activity (Chung, Skinner, Steiner & Perrin, 2012). Decreased physical activity could be the cause for the occurrence of obesity and also a potential trigger for numerous illnesses, which could also lead to a decrease in aerobic and anaerobic capacity (Maffeis, 1997; Janssen, Katzmarzyk, Boyce, King & Pickett, 2004). Insufficient physical activity and increased sedentary behavior during childhood and adolescence are directly related to the later onset of obesity (Fleming-Moran, & Thiagarajah, 2005; Patrick, Norman, & Calfas, 2004). In the study carried out by Cooper, Wedderkopp, Wang, Andersen, Froberg & Page (2006) it was proven that participants who were physically more active had a better performance for cardio-respiratory fitness and scored higher values for BMI. Correa-Rodríguez, Rueda-Medina, González-Jiménez & Schmidt-RioValle (2016) pointed out that the parameters for the evaluation of the level of physical activity are consistently related to body composition, especially to Lean Body Mass. Even in the reviews of other authors, the hypothesis that a higher level of physical activity influences decreased adiposity among children and adolescents has been proven (Jiménez-Pavón, Kelly & Reilly, 2010). There is a negative correlation between total physical activity and moderate physical activity and the Fat Mass Index, while there is a positive correlation between time spent in sedentary activity and the Fat Mass Index. Higher values of the Fat Mass Index are connected to the decrease in the total physical activities and moderate physical activities, that is, an increase in the sedentary lifestyle (Hjorth et al., 2014). The obtained results have shown that there is a positive correlation between the level of physical activity among school-age children and the measured parameters of body composition, both among boys and girls. The results of the realized study are in agreement with the existing research.

5. CONCLUSION

This research focused on the connection between the physical activity and body composition of school-age boys and girls. The results have indicated that there is a statistically significant connection between the set of predictor variables and the set of

criterion variables, that is, that there is a connection between the levels of physical activity and body composition. It was determined that boys and girls who are more physically active scored lower values for Body Fat, and higher values for Muscle Mass and Lean Body Mass. The influence of physical activity on the parameters of body composition is more pronounced among boys than it is among girls

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POVEZANOST FIZIČKE AKTIVNOSTI I TELESNE KOMPOZICIJE DECE ŠKOLSKOG UZRATA

Cilj istraživanja bio je da se utvrdi povezanosti nivoa fizičkih aktivnostima i telesne kompozicije dece školskog uzrasta. Uzorak ispitanika obuhvatio je 479 ispitanika, 250 dečaka i 229 devojčica školskog uzrasta, prosečne starosti $12,5 \pm 1,08$ godina. Nivo fizičke aktivnosti procenjen je pomoću FELS PAQ upitnik, a telesna kompozicija metodom BIA. Za utvrđivanje povezanosti između skupa prediktorskih varijabli i kriterijumskih varijabli primenjena je kanonička korelaciona analiza. Dobijeni rezultati pokazali su da postoje pozitivne korelacije između nivoa fizičkih aktivnosti i parametara telesne kompozicije bilo da se radi o uzorku dečaka školskog uzrasta ($p = .002$), ili o uzorku devojčica ($p = .048$). Može se zaključiti da ispitanici koji su fizički aktivniji imaju niže vrednosti telesnih masti i BMI, odnosno više vrednosti mišićne mase i bezmasne telesne mase.

Ključne reči: fizička aktivnost, telesna kompozicija, osnovna škola, deca