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CONNECTION OF ANTHROPOMETRIC INDICATORS AND MOTOR ABILITIES OF PRIMARY SCHOOL STUDENTS

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Veljko Vukićević[1]
Faculty of Sport and Physical Education, Novi Sad, Serbia

Nikola Lukić
Faculty of Sport and Physical Education, Novi Sad, Serbia

Stanko Zečević
Elementary School ”Svetozar Miletić” Vrbas, Serbia

Abstract: The aim of the study was to determine the association between manifest variables of motor skills and body mass index in elementary school students aged 9 to 12. The study was of a transversal nature, that is, only one measurement was conducted on this population of students. The sample consisted of third, fourth, fifth and sixth grade male students from the elementary school "Svetozar Miletic" in Vrbas, a total of 95 respondents. In order to determine the coreelation between predictor variables system and the criterion variable, as well as the individual contribution of the predictor to the definition of the criterion variables, linear regression analysis was applied. The obtained results show that there is a statistically significant correlation in the 3rd grade students in the variables of deep trunk inclination and high hinge with the body mass index, there is no statistically significant correlation of manifested motor skills variables with the body mass index in the 4th and 5th grade students. The 6th grade students show statistically significant correlation between the trunk flexion variables for 30 s and block start 30m sprint with body mass index. Attitudes towards the teacher provide valuable information about what students think and feel about them, thus creating adequate conditions for effecting change and improving both teaching and relationships with students.

Key words: *elementary school, students, physical education, body mass index*

[1] ✉ vukicevicveljko9@gmail.com

INTRODUCTION

BMI is a simple index that represents the relationship between body weight and height, and is commonly used to classify overweight and obesity. It is defined as the ratio of body weight to height in meters squared (kg / m2). Children with BMI between the 85th and 95th percentiles are overweight, and if the BMI is greater than the 95th percentile, children are considered obese (Cattaneo et al., 2010). In children and adolescents, BMI is calculated in the same way as in adults, but the interpretation of the values obtained is different for two reasons:

a) the amount of fat in the body changes with age and b) the amount of fat in girls and boys varies. Survey results (Bolton-Smith et al., 2000) on a sample of an adult population in Scotland reveal that, in self-assessments, both sexes tend to underestimate both body weight and height, leading to a slight error in the BMI calculation. With aging, the underestimation of body height decreases and the underestimation of body weight increases. Obese people, people with diabetes, and patients with myocardial infarction tend to underestimate their body weight (Bolton-Smith et al. 2000; Sherry et al. 2007). Therefore, estimates of actual body weight and height based on self-reported values have been developed for use in some populations. In clinical practice, self-report data are not appropriate for the assessment of obesity (Bolton-Smith et al., 2000). Body mass index (BMI) has been used extensively in anthropological research in recent years as an indicator of the body constitution of respondents. In the field of kinesiological research, BMI has often been used as a control indicator of body constitution in relation to various indicators of kinesiological activity. More recent studies (Graf et al., 2004; Santos et al., 2009; D'Hondt et al., 2009) have shown an association of increased BMI with decreased levels of motor skills in children of different ages. These and many other studies have clearly indicated the link between BMI and motor performance. However, some research, such as that of Kapetanakis et al. (2010), has shown that BMI values are not related to all motor abilities. The authors did not find a correlative relationship between the variables for the estimation of explosive leg strength and BMI in young athletes. Also, research (Chiodera et al., 2008) has shown that a specific program of kinesiological activities in school can improve the motor status of children without changing the BMI. In a study of young school-age children (Drid et al., 2013), it was observed that increased body mass index had a significant negative effect on motor skills: whole-body coordination, arm strength and shoulder girdle. Examining the influence of body mass on coordination skills in young students, (Kostic et al., 2009) found that this influence is more pronounced in girls than boys. The generally negative impact of increased body mass index is noticeable in all motor abilities except flexibility, which was confirmed in a sample of elementary school students from Greece (Tokmakidis et al., 2006). In a review study (Cattuzzo, et al., 2016), which included 44 studies on the association between weight and motor skills, 33 studies indicated the inverse metric of these two groups of variables. This implies that lower body mass values, i.e. lower body weight means better motor skills. Thus, this proves that the impact of obesity and overweight is kinanthropologically significant and that it carries certain consequences.

According to Nitsin (2000), motor abilities are very complex, genetically conditioned, with high rates of genetic predisposition and must be identified in order to be able to work on increasing them. It is necessary to know which motor skills can be most effectively and rationally increased and at what time of a child's development.

The motor space is difficult to classify, and it is even more difficult to determine certain regularities within it. For this reason, research is being done to reduce motor manifestations to a smaller set of motor factors, the so-called. latent dimensions (Dimitros, 2003).

(Krsmanovic & Berkovic, 1999) define motor skills as one side of a person's movement capabilities or personality dimensions, which participate in solving motor tasks. The aim of the study is to determine the effect of manifested motor skills variables on Body Mass Index in students aged 9 to 12.

METHOD

Sample of respondents

The sample consisted of third, fourth, fifth and sixth grade male students from Vrbas, aged 9 to 12, with a total of 95 (third grade 25 students, fourth grade 24 students, fifth grade 24 students, sixth grade 22 students) respondents. They are of different social status, healthy persons without mental impairments.

Measuring instruments

For the purpose of this research, a battery of tests has been put together to assess motor skills, that is, a sample of variables that includes motor variables. Also, two anthropometric measurements (body height and body weight) were performed, which subsequently indirectly calculated the BMI value.

The trunk flexion test was used to assess the flexion of the lower back, gluteus, and muscles of the back lobe, the high jump and long jump tests were used to assess the high jump and long jump skills, the block start 30m sprint test was used to estimate speed, the 30s trunk flexion test was used to assess repetitive abdominal muscle strength, the pull-up endurance test was used to assess static shoulder muscle strength, and the 300m running test was used to assess endurance.

Description of the measurement procedure

Measurement and testing was carried out in Vrbas in the physical education hall of the "Svetozar Miletic" elementary school and on the open grounds of the Center for Physical Culture "Drago Jovovic" during the second semester of the 2016/2017 academic year with the active participation of the authors of the paper and with the supervision of professors of physical education. Anthropometric measurements and motor skills testing were performed on four sub-samples: third, fourth, fifth and sixth grade students. For anthropometric measurements, the following instruments were used: an anthropometer according to Martin, and a scale that allows a measurement accuracy of 0.5 kg and which can be adjusted to the zero position. The tests were arranged so as to avoid the impact of one test on another. The testing protocol was explained in detail to the subjects prior to the start of the test. Each subject had one trial, followed by two measured attempts. Only a better result was taken for the analysis. There was a two-minute break between trials and a 5-minute break between tests. Prior to the measurement, 10-15 minute warm-up and moderate-intensity exercises were conducted to prepare for further work.

Data processing methods

The obtained results of all tests were processed by descriptive statistical analysis procedures. For the four pre-formed sub-samples for all analyzed variables, descriptive statistics were calculated: arithmetic mean (AS), standard deviation (S), minimum (MIN) and maximum (MAX) values, CV (coefficient of variation), Sk - skewness (slope of distribution)) and Kurt - kurtosis (distribution elongation). The Kolmogorov-Smirnov test was used to test the normality of distribution. The results of all measurements were processed using the statistical program IBM SPSS 20.0. In order to determine the influence of the system of predictor variables on the criterion variable, as well as the individual contribution of the predictor to the definition of the criterion variables, linear regression analysis was applied. The criterion variable was the Body Mass Index. A statistically significant effect was considered for the significance level $p = 0.5$.

RESULTS

Table 1 shows the results of the descriptive statistical parameters of anthropometric and motor variables of the 3rd grade students. Based on the results we can conclude that the average height of the group is 140cm and the average body weight is 34kg, while the average body mass index is 17.28kg /m^2

Table 1. *Descriptive statistics of anthropometric variables, in 3rd grade students*

Variables	AS	S	MIN	MAX	CV(%)	Sk	Kurt	KS
Body height	140,20	6,07	124,00	149,00	4,33	-,978	,905	,634
Body weight	34,04	4,29	26,00	42,00	12,60	,316	-,638	,657
Body mass index	17,28	1,59	14,85	20,49	9,24	,435	-,588	,494

Legend: AS- arithmetic mean; S-standard deviation; MIN - minimum values; MAX - maximum values; CV - coefficient of variation; Sk- skewness; Kurt-kurtosis; KS - values of ks coefficient

Based on the coefficient of variation (CV), and knowing that there is a rule according to which if the relative value of the coefficient is less than 30%, (sample, basic set) it can be considered homogeneous and the arithmetic mean as a representative central value. In this case, the coefficient of variation is well below 30%, so the sample can be considered homogeneous. Two variables (body weight and body mass index) have positive asymmetry in that the curve is shifted to the left, while the results are grouped in the lower values zone. Kurtosis represents the curvature of the distribution, that is, shows that the observed distribution of results is elongated or flattened. In terms of body weight and body mass index, it is a negative platykurtic distribution, which tells us that the results are distant from (scattered around) the arithmetic mean. If the value of kurtosis is positive then it is a leptokurtic distribution as is the case with body height which means that the results are closely grouped around the arithmetic mean.

Table 2. *Impact of manifested motor skills variables on body mass index in 3rd grade students.*

Variables	AS	S	KS	R	rpart.	Beta	t	p
Deep leaning of the trunk on the floor	18,76	6,69	,808	,308	,460	,441	2,139	,047
Pull-up	16,47	10,26	,659	-,180	-,469	-,567	-2,191	,043
Trunk flexion for 30s	12,36	2,65	,463	,046	-,008	-,008	-,032	,975
Long jump	192,24	19,19	,611	-,073	,030	,045	,124	,903

High jump scissor	71,60	5,90	1,234	-,217	-,215	-,297	-,909	,376
Block start 30m sprint	6,07	,492	,689	-,001	-,431	-,651	-1,968	,066
300m running	81,15	10,89	1,091	,173	,362	,479	1,599	,128

R=,619 R2=,383 F=1,505 P=,231

Legend: AS- arithmetic mean; S-standard deviation; KS - values of ks coefficient; R - multiple correlation value; R2 is the square value of the multiple correlation coefficient; F - value of F relation; P- significance of coefficient R (Sig); r- linear correlation of predictors and criteria (zero order r); rpart- partial correlation of each predictor; Beta-standardized partial regression coefficients; t- value of the t-test; p- statistical significance

The results presented in Table 2 indicate that the value of the coefficient of multiple correlation P=0.231 shows that the applied system of predictors has no statistically significant correlation with the criterion variable in 3rd grade students. Based on the analysis of the influence of individual predictor variables on the criterion variable, we can conclude that there is a statistically significant influence of the trunk flexion on the floor variable p = 0.047 and the pull-up variable p = 0.043 on the body mass index criterion variable in 3rd grade students. The beta value indicates that the positive direction of influence of the trunk flexion on the floor varable beta = 0.441, and the negative direction of the influence of the pull-up variable beta = -0.567.

Table 3 shows the descriptive statistics of anthropometric variables in 4th grade students. Based on the results, we can conclude that the average group height is 145 cm, the average body weight is 38 kg and the average body mass index is 17.89 kg/m². Based on the coefficient of variation, we can conclude that the group is homogeneous.

Table 3 *Descriptive statistics of athropometric variables in 4th grade students*

Variables	AS	S	MIN	MAX	CV(%)	Sk	Kurt	KS
Body height	145,56	7,16	136,00	161,00	4,91	,567	-,593	,627
Body weight	38,08	6,06	28,30	52,00	15,93	,638	,049	,755
Body mass index	17,89	1,88	14,89	22,21	10,50	,324	-,441	,514

Legend: AS- arithmetic mean; S-standard deviation; MAX – maximum values; CV- coefficient of variation, Sk – skewness; Kurt – kurtosis; KS - values of ks coefficient;

All three variables have a positive asymmetry so that the curve is always shifted to the left, while the results are grouped into a zone of lower values. In body height and body mass index, we have a negative platykurtic distribution, which means that the results are scattered around the arithmetic mean. The distribution is leptokurtic for the body weight variable, which means that the results are closely grouped around the arithmetic mean.

Table 4 *Impact of manifest variables of motor abilities on body mass index in 4th grade students.*

Variables	AS	S	KS	r	rpart.	Beta	t	p
Trunk flexion on the floor	19,37	5,13	,617	-,029	,023	,027	,094	,927
Pull-up	22,35	15,20	,756	-,250	-,142	-,158	-,572	,575
Trunk flexion for 30s	14,20	2,10	,870	-,320	-,322	-,330	-1,361	,192
Long jump	238,62	49,89	,816	,001	-,067	-,117	-,268	,792
High jump scissor	74,79	6,33	,956	-,094	,032	,051	,128	,899
Block start 30m sprint	6,64	,557	,665	,205	-,029	-,040	-,115	,910
300m running	75,93	3,27	,939	,289	,235	,290	,968	,347
R=,464	2=,215	F=,626	P=,728					

Legend: AS- arithmetic mean; S-standard deviation; KS - values of ks coefficient; R - multiple correlation value; R2 is the square value of the multiple correlation coefficient; F - value of F relation; P- significance of coefficient R (Sig); r- linear correlation of predictors and criteria (zero order r); rpart- partial correlation of each predictor; Beta-standardized partial regression coefficients; t- value of the t-test; p- statistical significance

Based on the significance of the coefficient P = 0.728 in Table 4, we can conclude that the applied predictor system is not statistically significantly related to the criterion variable in the 4th grade students. We can also conclude from the analysis of the predictive values of individual variables (p) that there is no statistically significant influence of individual variables on body mass index in the 4th grade students. Table 5 presents basic descriptive statistics of anthropometric variables of the 5th grade students. Based on the results we can conclude that the average height of the group is 147cm, the average body weight is 40kg, and the average body mass index is 18.59kg / m2. The coefficient of variation indicates that the group is homogeneous.

Table 5. *Descriptive statistics of anthropometric variables, in 5th grade students*

Variable s	AS	S	MIN	MAX	CV(%)	Sk	Kurt	KS
Body height	147,57	6,68	131,00	160,00	4,52	-,259	,382	,659
Body weight	40,73	9,30	30,00	64,50	22,85	,820	,347	,768
Body mass index	18,59	3,50	14,07	27,20	18,85	1,038	,506	1,015

Legend: AS- arithmetic mean; S-standard deviation; MIN - minimum values; MAX - maximum values; CV - coefficient of variation; Sk- Skewness; Kurt-kurtosis; KS - values of ks coefficient

By analyzing the asymmetry of the distribution, we can conclude that only in the body height parameter the curve is shifted to the right, while in the body weight and body mass index it curves to the left. Also, in the body mass index the skewness measure is slightly above normal values Sk = 1,038. If we look at the curvature of the distribution, we can conclude that it is a leptokurtic curve, because the values of all three variables are positive, and this means that all results are grouped around the arithmetic mean.

Table 6. *Impact of manifested motor skills variables on body mass index in the 5th grade students.*

Variables	AS	S	KS	r	rpart.	Beta	T	p
Deep leaning of the trunk on the floor	23,70	6,27	,543	,003	,259	,266	1,072	,300
Pull-up	19,69	10,25	,932	-,191	-,042	-,041	-,168	,869
Trunk flexion for 30s	12,70	1,96	,894	-,259	-,299	-,380	-1,256	,227
Long jump	225,87	27,33	,471	-,008	-,212	-,220	-,867	,399
High jump scissor	85,20	12,46	,852	,338	,235	,260	,969	,347
Block start 30m sprint	5,59	,276	,787	,290	,204	,197	,833	,417
300m running	74,87	2,11	,532	-,194	-,327	-,465	-1,383	,186

R=,587 R2=,344 F=1,199 P=,358

Legend: AS- arithmetic mean; S-standard deviation; KS - values of ks coefficient; R - multiple correlation value; R2 is the square value of the multiple correlation coefficient; F - value of F relation; P- significance of coefficient R (Sig); r- linear correlation of predictors and criteria (zero order r); rpart- partial correlation of each predictor; Beta-standardized partial regression coefficients; t- value of the t-test; p- statistical significance

By analyzing Table 6, we can conclude that there is no statistically significant correlation of the predictor system with the criterion variable P = 0.358 in 5th grade students. There is also no statistically significant influence of individual predictor variables on the criterion variable, since no p value is below 0.05.

Table 7 presents basic descriptive statistics of anthropometric variables of the 6th grade students. Based on the results we can conclude that the average height of the group is 157cm, the average body weight is 46kg, and the average body mass index is 18.63kg / m2. Based on the coefficient of variation, we can conclude that the group is homogeneous.

Table 7. *Descriptive statistics of anthropometric variables, in 6th grade students*

Variables	AS	S	MIN	MAX	CV(%)	Sk	Kurt	KS
Body height	157,07	8,52	138,20	170,00	5,42	-,706	,017	,710
Body weight	46,09	9,15	33,00	65,00	19,85	,379	-,810	,600
Body mass index	18,63	3,15	12,96	26,78	16,93	,831	1,068	,675

Legend: AS- arithmetic mean; S-standard deviation; MIN - minimum values; MAX - maximum values; CV - coefficient of variation; Sk- Skewness; Kurt-kurtosis; KS - values of ks coefficient

Based on the results, we can conclude that the body weight and body mass index variables have a positive asymmetry, and their curve is shifted to the left. On the other hand, the body height variable has a negative asymmetry and the curve is shifted to the right. Kurtosis tells us about the elongation and the flatness of distribution; with the body height and body mass index variables the distribution is positive, which tells us that the distribution is leptokurtic and the results are closely distributed around the arithmetic mean. For the body weight variable, the distribution is negative or platikurtic, and the results are distant from the arithmetic mean.

Table 8. *Impact of manifested motor skills variables on body mass index in 6th grade students.*

Variables	AS	S	KS	R	rpart.	Beta	t	p
Deep leaning of the trunk on the floor	21,40	7,19	,659	,007	,054	,027	,203	,842
Pull-up	38,07	21,97	,732	-,491	,265	,238	1,027	,322

Trunk flexion for 30s	15,31	2,33	1,025	,371	,553	,317	2,483	,026
Long jump	244,68	49,02	,658	-,391	-,230	-,179	-,883	,392
High jump scissors	86,36	8,61	,721	-,542	,213	,159	,815	,429
Block start 30m sprint	5,62	,410	1,067	,782	,605	,585	2,841	,013
300m running	70,91	3,51	,969	,766	,457	,461	1,924	,075

R=,892 R2=,795 F=7,763 P=,001

Legend: AS- arithmetic mean; S-standard deviation; KS - values of ks coefficient; R - multiple correlation value; R2 is the square value of the multiple correlation coefficient; F - value of F relation; P- significance of coefficient R (Sig); r- linear correlation of predictors and criteria (zero order r); rpart- partial correlation of each predictor; Beta-standardized partial regression coefficients; t- value of the t-test; p- statistical significance

Based on the analysis of Table 8, we can conclude that there is a statistically significant correlation of the applied predictor system with the criterion variable P = 0.001. The system of predictor variables explains 79% of criterion variability (R2 * = 0.795), while for the rest of the variability criteria variables responsible for some other characteristics and abilities that were not covered by the predictor system used. Also, based on the reł}sults of the analysis of the predictive value of individual predictor variables, we can conclude that there is a statistically significant influence of the 30-second trunk flexion variable p = 0.026 and the block start 30m sprint variable p = 0.013. Looking at the value of standardized regression coefficients (beta) we can conclude that both variables have a positive influence on the criterion variable.

DISCUSSION

The results show that there is no statistically significant correlation of the manifested variables of motor ability at different ages with the students' body mass index. The P value in all sub-samples examined is of no statistical significance in the 3rd grade students, it was found that there was a statistically significant correlation of the deep leaning of the trunk on the floor and high pull-up variables with body mass index. The deep leaning of the trunk on the floor variable was found to be related, and the high pull-up variable was found to be unrelated, which is logical, since at that age the musculature of the upper extremities is not sufficiently developed and the higher the body mass index in the student the worse the result. These data are consistent with the research results (Fogelholm et al., 2008). No statistically significant correlation of any manifested motor skill variable with body mass index was found in the 4th and 5th grade students. As for the 6th grade students, it was found that there was a statistically significant correlation between the trunk flexion for 30s and block start 30m sprint variables with body mass index. Both variables have a positive correlation. In case of block start 30m sprint, this is logical because the higher the score, the worse the result, and therefore the higher the body mass index. The trunk flexion for 30s variable can be explained by the sensitive phase of development in which children are in the 6th grade, and by a generally poor test result. As body volume increases with the rise of BMI, and thus generally interferes with movement, then the results of the trunk lifting test appear as a logical consequence of these circumstances. When analyzing motor variables that constitute statistically significant differences, it can be seen that differences were found in those variables that used to evaluate the flexibility, explosive and repetitive power, which is consistent with the findings (Baine et al., 2009) obtained on a similar sample of subjects.

CONCLUSION

Based on the results of the research, we can conclude that in the 3rd grade students it was found that there was a statistically significant correlation of the variables deep leaning of the trunk on the floor and height in the hinge with the body mass index. In the 4th and 5th grade students, no correlation of the tested motor variables was found with the body mass index, while in the 6th grade students the trunk flexion for 30 seconds and block start 30 m sprint was in negative correlation with the body mass index. Motor efficiency in young people is extremely important for their daily life and work activities, so systematic exercise in sports activities is an important factor in raising the level and maintaining the state of their motor efficiency. However, this is not enough, it is necessary to act preventatively in terms of weight regulation and its alignment with body height. The negative association of increased body mass index with motor status of children of all ages is evident, especially in children with significantly increased BMI.

Suggestions for future research should be to test students using more motor tests. This study mainly covered athletics-related tests because at that point in time, that was the teaching unit that was being covered. Also, measurements should be carried out on a larger sample. Similar research should be done with female students, as the sensitive phase of development occurs earlier and is accompanied by much more turbulent changes in motor and body structure.

Parents, educators, teachers and physical education teachers play a big role in creating the conditions for healthy growth of children; with school, physical education classes for many children are the only option for systematic and professionally guided physical exercise. That is why teachers and physical education teachers assume considerable responsibility for the further development and encouragement of motor abilities and skills, which enable children to competently engage in physical activity and sports. In order for physical education teachers and other teachers to meet these professional challenges, it is necessary to ensure that their initial education is of high quality and that they continue professional development, based on modern scientific knowledge and experiences of good practice.

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