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INFLUENCE OF BODY COMPOSITION AND PHYSICAL FITNESS ON JUMPING SUCCESS OF 14 YEARS OLD STUDENTS

Original scientific paper

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Abstract

In this paper, the influence of body composition and physical fitness in the success of some jumping have been investigated. The purpose of this paper is to establish the impact between body composition and physical fitness as a predictive system and jumping as a criterion system. The survey was conducted in a sample of 170 male entities aged 14 years ± 6 months, primary school students at "BajramShabani" and "NaimFrashëri" - Kumanovo. Nine variables were applied - 5 dimensions for evaluation of body composition and four for evaluation of physical fitness. Data were analyzed using regression analyses and multivariate analysis of the group. Variables body composition which have express the impact with tests of physical fitness have an impact level (P <0.000). As we look separately, we can see that the impact of the high jump test has reached a significance value of 20.9%, in variables arm subcutaneous fat tissue with a Beta coefficient (-.621) value of 0.000 and abdominal subcutaneous fat tissue have a Beta coefficient (.347) value of 0.004. The quintuple jump reached a 21.5% significance level, in subcutaneous fat tissue arm variable had a Beta coefficient value (-.334) and impact value of 0.024. The long jump test has a 27.7% significance level, but in subcutaneous fat tissue arm variables with Beta coefficients of -0492 are worth 0.000. From this research, we can conclude that the physical fitness in this case of jumps that express the explosive strength of the lower limbs have low BMI level and skin folds, while statistical influence in the motor variables has only the variables arm skin folds and in one case a variable abdominal skin folds, from which we can conclude that to have good results in jumps we should have as little as possible adipose (fat) tissue in the abdomen and arms and the same adipose (fat) tissue should be replaced with pure muscle mass.

Keywords: *Body composition, physical fitness, correlation, regression*

INTRODUCTION

Body composition has been described as a confounding factor in vertical jump performance, and several studies have attempted to categorize those body composition variables which better explain jump ability during childhood and adolescence (Pérez-López, Sinovas, Alvarez – Valverde & Valades, 2015) and tried to determine the nature of the relationship between anthropometric factors and vertical jump performance (Davis, Brisscoe, Markowski, Saville & Taylor, 2003; Abidin & Adam, 2013; Nikolaidis, 2013; Sharma, Gandhi, Meitei, Dvivedi & Dvivedi, 2017). The vertical jump is a relevant skill for assessing motor development during preadolescence and adolescence (Keiner, Sander, Wirth & Schmidtbleicher, 2013). Body size has been proposed as a confounding factor in vertical jump performance during childhood and adolescence (Markovic, Mirkov, Nedeljkovic & Jaric, 2014; Menzel et al. 2013) and several variables related to body composition have been found to be predictors of vertical jump performance (Aouichaoui et al. 2012; Markovic & Jaric, 2005; 2007) including: age, height, weight, and fat free mass. It is well known that the average height and weight of youth have significantly changed from generation to generation. Such body weight differences are mostly influenced by changes in muscle mass and fat accumulation. There has been an observable bodyfat mass increase over time in both genders, but the accumulation of body fat is higher and the level of fitness is lower in the female population (Ailhaud & Hauner 1998; Bodzsár, 1998). However, body fat content becomes stable in the post-pubescent years, where the acceptable range of the body fat percentage is between21-25% in girls of this age period (Lohman, 1992; Pucsok, 2000). The majority of research studies have examined the relationships between leg power and anthropometric parameters (Davison & Birch 2001). To the best of our knowledge, there is no study on the effect of socioeconomic factors on vertical jumping performance as well as on anthropometric parameters in athletic children in our countries. Starting from this, the main objective of the research is to determine whether body composition and physical fitness influence on success jumping in 14 years old students.

METHODS

Participants

The study samples were derived from male students aged 14 years ± 6 months. The research was conducted in 170 entities, of "Bajram Shabani" and "Naim Frasheri" elementary schools in Kumanovo. The sample in this research is unselective regarding the anthropometrics and the motor skills – tests for estimating the explosive force. The results obtained from this research are taken only by the tested samples who regularly attended the classes of physical and health education and participated in all the tests.

Variables

The sample of variables was represented with set of nine variables in total, including five measures for body composition and four physical fitness measures.

The body composition measures included five variables in total. They were following: 1) BMI - body mass index, 2) AASFT - arm subcutaneous fat tissue, 3) APSFT - pulp subcutaneous fat tissue, 4) ATHSFT - thigh subcutaneous fat tissue, 5) AABSFT - abdominal subcutaneous fat tissue. Physical fitness was estimated using 4 variables for evaluation of explosive strength. Following tests were applied: 6) MHJ - high jump, 7) MQJ - quintuple jump, 8) MLJ - long jump, and 9) MTJ - triple jump.

Statistical analyses

Basic descriptive statistics parameters were calculated to all data from the study. To validate the impact of BMI and subcutaneous fat tissue as a predictive system and motor skills as a criterion system, regression analysis or impact analysis that enters the multivariate analysis group is used. The SPSS 22.0 statistical program was used for processing the results.

RESULTS

Basic descriptive parameters presented in Table 1, shows the main values and indicators for males aged 14 and over: minimum score, maximum score, arithmetic mean, as a central indicator, standard deviation as the main dispersive score, and the main indicator of the form of the distribution curve, curve asymmetry (Skewness), as well as curve roundness (Kurtosis). From these data, it is noted that the BMI - body mass index average is 20.96, which means that in this age group there is not overweight, but we have to do with a normal feeding unit, eventually, any student has overweight or a rare case of emphasized overweight obesity. The main indicator of the dispersion of results is the standard deviation. Standard deviation values are low in the anthropometric variables such as: BMI- body mass index, AASFT – arm subcutaneous fat tissue, APSFT- pulp subcutaneous fat tissue, ATHSFT- thigh subcutaneous fat tissue, AABSFT- abdominal subcutaneous fat tissue, which means that it is about homogeneous results, while motor variables such as: MHJ-high jump, MQJ- quintuple jump, MLJ -long jump, and MTJ-triple jump, which results are of a higher level, which means heterogeneous results, respectively results that have higher variability. The asymmetry of the curve (Skewness) is small in almost all variables, and in some with negative values. The values of the roundness of the curve (Kurtosis) in the most variables are below 2.75 so that all of these values are platicurtic, which means that the results are distributed from the arithmetic mean.

The correlations between the variables were tested for two levels of reliability: p=0.01 and p=0.05. Also, the coefficients of correlation values are scaled so that the level up to ± 0.2, is a trivial correlation, the coefficient value (± 0.2 - ± 0.4) is considered as a low correlation, the coefficient value (± 0.4 - ± 0.7) is considered as an important correlation, the value of the coefficient (± 0.7 - ±0.9) is considered as a high correlation and the coefficient value (± 0.9 - ±1.0) is considered as much a very high correlation. Table 2 shows the intercorrelation coefficients for all variables in the results of 14-year-old males. High-value correlations appear between variables: arm subcutaneous fat tissue (AASFT) correlates with thigh subcutaneous fat tissue (ATHSFT), with a value of .833** (**- this sign represent the reliability level p=0.01, while the sign * reliability level p=0.05), quintuple jump (MQJ) correlate with a triple jump (MTJ), with a value of .819**, arm subcutaneous fat tissue (AASFT) correlate with the abdominal subcutaneous fat tissue (AASFT), with a value of .774**, long jump (MLJ) correlate with a triple jump (MTJ), with a value of 773**, the body mass index (BMI) correlates with arm subcuteanous fat tissue (AASFT), with a value of 731**, BMI correlates with the thigh subcuteanous fat tissue (ATHSFT), with a value of .709** and quintuple jump (MQJ) correlate with long jump (MLJ), with a value of .701. This suggest that when the values of subcuteanous fat tissue increase, that the value of body mass index increases as well, with which we can conclude that the higher the values of subcutaneous fat tissue are, the samples research in this paper will also be at the level of overweight. Also correlations where their coefficients have statistically significant values, among these variables there are: (BMI) and (AASFT), with a value of .696**, (MHJ) and (MLJ), with a value of .665**, (AAPSFT) and (AASFT), with a value of .615**, (MLJ) and (MTJ) with a value of 596**, (BMI) (APSFT) (.547**), (MHJ) (MQJ) (.545**), (AASFT) (MLJ) (-.539**), (ATHSFT) (MLJ) (-498), (AASFT) (MTJ) (-487**), (ATHSFT) (MTJ) (-471**), (AASFT) (MTJ) (-428**), (AASFT) (MQJ) (-422**), (ATHSFT) (MLJ`) (.404**). Also, in this table are presented correlations of variables, where their coefficients have also low value and some correlations with significant statistical value, therefore we will not comment them at all. Below are shown the linear regression charts of high jump motor abilities (MHJ) of boys of this age group.

Results from regressive correlation between body composition variables and a high jump criterion variable are presented in Table 3. According the results, it can be seen that the multiple correlations between the dependent variable, in this case, the height jump (MHJ), as well as all other independent variables (predictive) is of statistical significance (0.458), respectively explains the common variability of 20.9% (R=0.209), while the other 79.1% of the explanation of the common variability of the criterion variables (MHJ) belongs to the other anthropological characteristics (motor, anthropometric, conative, cognitive etc.) The reliability level p=0.000 indicates that the value of variability between and within the multiplication regression variation group differs from statistical significance, so it is important to comment on the impact of predictable variables on this capability one by one.

In Table 4 are presented the standardized beta coefficients with the values of impact on the criterion variable (MHJ). This shows that the highest impact on this skill has the variable of arm subcutaneous fat tissue (AASFT), with a value of -0.621 and a level of reliability (significance) of 0.000. But since this value is negative, this means that the influence of this variable is negative. The highest positive influence has the variables of abdominal subcutaneous fat tissue (AABSFT), with its beta coefficient of 0.347, with a reliability level of 0.004, whereas other predictive variables do not have any statistically significant impact on this ability as assessed by the high jump test (MHJ).

The value of the multiple correlation coefficient between the prediction variables and the quintuple jump criterion variable (MQJ) is presented in Table 5. This value (0.464) explains the common variability of about 21.5% (R2=0.215), while the other percentage of 78.5 % of the explanation of the common variable of criterion variable (MQJ) belongs to other anthropological characteristics (motor, anthropometric, functional, conative, etc.).

The results from regression analysis of MQJ variables are presented in Table 6. As shown, the standardized beta coefficients with the values of impact on the criterion variable (MQJ). From this table it is seen that the higher impact on this skill has the arm subcutaneous fat tissue (AASFT), with a value of -0.334 and the reliability level of 0.000, which means that this variable negatively affects the outcome in question.

From Table 7 can be seen that the multiple correlations between the predictive variables and the long-jump criterion variable (MLJ) is 0.556, which is characterized as the value of the significant statistical level, respectively explains the common variability of about 31%, while the other 69% of the explanation of the common variable of criterion variable (MLJ) belongs to the other anthropological characteristics (motor, anthropometric, cognitive, social etc.). Based on the level of reliability, we can proceed with the analysis of the degree of the influence of predictive variables on the criterion variable.

Results from regression analysis of MLJ variables are presented in Table 8. As shown that the high impact on this skill has arm subcutaneous fat tissue (AASFT), with beta coefficients value -0.492 and a reliability level of 0.000.

From Table 9 can be seen that the multiple correlations between

Table 1. Basic statistical parameters of body composition and physical fitness

	N	Min.	Max.	Mean	Std. Dev.	Skewness	Kurtosis
BMI	170	13.90	31.80	20.9606	3.56238	1.027	.623
AASFT	170	3.70	19.90	10.0912	4.64135	.840	-.393
APSFT	170	3.90	19.80	13.3776	4.40967	-.063	-1.045
ATHSFT	170	4.90	19.80	11.3465	4.35010	.687	-.774
AABSFT	170	4.20	19.80	10.7635	4.30245	.801	-.477
MHJ	170	10.00	57.00	32.9765	8.05304	.000	-.295
MQJ	170	410.00	1167.00	866.4882	133.33347	-.185	.026
MLJ	170	115.00	238.00	171.0118	24.51228	-.074	-.103
MTJ	170	340.00	663.00	498.1294	66.85829	-.034	-.436

Table 2. Inter-correlation between body composition and physical fitness

	BMI	AASFT	APSFT	ATHSFT	AABSFT	MHJ	MQJ	MLJ	MTJ
BMI	1								
AASFT	.731**	1							
APSFT	.547**	.653**	1						
ATHSFT	.709**	.833**	.690**	1					
AABSFT	.696**	.774**	.615**	.694**	1				
MHJ	-.187*	-.382**	-.247**	-.329**	-.150	1			
MQJ	-.278**	-.425**	-.367**	-.421**	-.291**	.545**	1		
MLJ	-.361**	-.539**	-.404**	-.498**	-.382**	.665**	.701**	1	
MTJ	-.319**	-.487**	-.428**	-.471**	-.389**	.596**	.819**	.773**	1

Table 3. Regressive correlation between body composition variables and a high jump criterion variable (MHJ)
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.458a	.209	.185	7.26874	.209	8.688	5	164	.000

Table 4. Regressive analysis of MHJ variables (the coefficients)
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	
		B	Std. Error	Beta		
1	(Constant)	34.184	3.885		8.798	.000
	BMI	.297	.248	.132	1.199	.232
	AASFT	-1.078	.256	-.621	-4.211	.000
	APSFT	-.092	.182	-.051	-.508	.612
	ATFSFT	-.205	.255	-.111	-.804	.422
	AABSFT	.650	.220	.347	2.961	.004

a. dependent variable: MHJ

Table 5. Regressive connectivity between body composition with quintuple jump criterion variable (MQJ)
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.464a	.215	.191	119.89663	.215	9.000	5	164	.000

a. Predictors: (Constant), AAST, APSFT, BMI, ATHSFT, AABSFT

Table 6. Regression analysis of MQJ variables (the coefficients)
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	
		B	Std. Error	Beta		
1	(Constant)	970.081	64.086		15.137	.000
	BMI	3.783	4.093	.101	.924	.357
	AASFT	-9.592	4.223	-.334	-2.271	.024
	APSFT	-4.213	3.002	-.139	-1.404	.162
	ATFSFT	-6.316	4.202	-.206	-1.503	.135
	AABSFT	3.896	3.624	.126	1.075	.284

a. dependent variable: MQJ

Table 7. Regressive connectivity between body composition with long jump criterion variable (MQJ)
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.556a	.310	.289	20.676	.310	14.708	5	164	.000

a. Predictors: (Constant), AAST, APSFT, BMI, ATHSFT, AABSFT

Table 8. Regression analysis of MLJ variables (the coefficients)
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	
		B	Std. Error	Beta		
1	(Constant)	194.497	11.051		17.599	.000
	BMI	.628	.706	.091	.889	.375
	AASFT	-2.601	.728	-.492	-3.572	.000
	APSFT	-.433	.518	-.078	-.836	.405
	ATFSFT	-.950	.725	-.169	-1.311	.192
	AABSFT	.574	.625	.101	.918	.360

a. dependent variable: MLJ

Table 9. Regressive connectivity between body composition with a triple jump criterion variable (MTJ)
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.522a	.272	.250	57.90073	.272	12.267	5	164	.000

a. Predictors: (Constant), AAST, APSFT, BMI, ATHSFT, AABSFT

Table 10. Regression analysis of MTJ variables (the coefficients)
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	
		B	Std. Error	Beta		
1	(Constant)	554.979	30.949		17.932	.000
	BMI	2.718	1.977	.145	1.375	.171
	AASFT	-4.704	2.039	-.327	-2.307	.022
	APSFT	-2.423	1.450	-.160	-1.672	.096
	ATFSFT	-2.839	2.029	-.185	-1.399	.164
	AABSFT	-.160	1.750	-.010	-.092	.927

a. dependent variable: MTJ

the dependent variable, in this case, a triple jump (MTJ), and all other independent variables (predictive) has a statistic significance (0.522), respectively explains the common variability of about 27.2% (R2=0.272), while the other 72.8 % of the common variability of the criterion variable (MTJ) is related to other anthropological characteristics (motor, anthropometric, conative etc.). The level of the reliability is 0.000, which means that we can proceed with the analysis of the degree of impact of predictive variables on the criterion variable.

Results from regression analysis of MTJ variables are presented in Table 10. According the presented results, it can be seen that the highest impact on the skill has the arm subcutaneous fat tissue (AASFT), with a beta coefficient value of -0.327 and the confidence level of 0.022, which based on negative predictions of the beta coefficient, it means that the impact of this variable is negative.

DISCUSSION AND CONCLUSION

Positive correlation between body weight and standing long jump determined in our study, was also confirmed in the study of Aslan, Büyükdere, Köklü, Özkan, & Özdemir, (2011). Aouichaoui et al. (2014), in their study on puberty period athletes, determined a negative correlation between vertical jump performance and body weight, height and body mass index. The authors Silvestre, West, Maresh & Kraemer (2006) determined a strong correlation between body composition and vertical jump and Ostojic Majic &Dikic (2006) determined a strong correlation between body composition and anaerobic strength. In the study conducted on athletes, Copić, Dopsaj, Ivanović, Nešić & Jarić (2014), determined that the higher the body fat percentage, the lower the vertical jump height. Studies also reported for correlations between body mass, vertical jump and peak power measured during force-velocity test. The authors suggested that athletes with high jump performances or peak power have high percentage of type II muscle fibers. Jump weight measurements is a simple practical tool helping to identify talented children in explosive sports that require movement of body mass or the manipulation of an external mass (Taylor, Cohen, Voss, & Sandercock, 2010). According to Piucco & Santos (2009), excess body fat induces an increase in body mass which results in a loss of athletic performance in movements that involve speed and explosive power, such as jumps, since acceleration is equal to force divided by mass (Lorenzo & Chamorro, 2004). It can be stated that lower subcutaneous adipose tissue, especially in the trunk region, is a desirable body composition component, since it means less ballast mass (fat) which generates no power. Thus, it provides a lighter body mass to be carried and allows a higher vertical velocity to be achieved during jump performance (Roschel et al. 2009). Based on the conclusions of Maćkala, Michalski, Čoh & Rausavljević (2015), that the highest correlation exists between body height and trunk length (r=0.93), our assumption leads us again to the propulsive phase of the CMJ test where trunk angular displacement is crucial for jump height. In their study, Stojanović, et al. (2020) evidence that the sum of five skinfolds had a negative impact on tests for vertical jump performance assessment. Bases on this, it could be concluded that the relationship between body composition components and vertical jump performance was demonstrated in adolescents. In the study of Aouichaoui et al. (2012), three multiple regression equations were calculated for children, adolescents, and the whole cohort. Previous data from a population of active children between the ages of 7 and 13 years revealed that age, height, weight, and fat-free mass were the body composition variables that most accurately predicted vertical jump performance.

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