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## FITNESS ABILITIES AND BODY COMPOSITION OF STUDENTS: A SYSTEMATIC REVIEW

Vladimir Veletic<sup>1</sup>, Rosario D'Onofrio<sup>2</sup>

<sup>1</sup>*Faculty of Physical Education and Sport, University of East Sarajevo*

<sup>2</sup>*Faculty of Medicine and Surgery, Sapienza University of Rome*



**Abstract:** *The aim of this paper is to determine the extent to which body composition affects the fitness abilities of pupils and students. Searched databases are: Google Scholar, PubMeb, DOAJ, Kobson, in the time limit for the period from 2011 to 2021. The initial search identified 240 studies, and the final analysis included 11 studies that met the set criteria. The analysis of the results showed that the prevalence of obesity in early childhood can affect later age and that M has better values for body composition and are superior in fitness abilities, as well as that F has a higher% F. It was concluded that the subjects who were more physically active had lower BMI values, ie higher for SM and FFM, and that they had better fitness and were more capable in performing all motor skills tests. Based on the results of all analyzed works, the general conclusion is defined that physical activity can improve certain parameters of body composition.*

**Key words:** *morphological characteristics, motor abilities, influence, physical activity, physical fitness*



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## Introduction

Determining the composition of body composition is a common method, not only in the medical disciplines but also in sports, then in anthropology and pedagogy. There is great interest in new methods and modern procedures in determining the composition of body composition. The focus is, most often, on determining the amount of fat component, due to the analysis of health status and assessment of the existence of possible health risk.<sup>1</sup>

The modern way of life adversely affects human health. Nowadays, the average level of physical activity in the population is getting lower. People who are not involved in some type of physical exercise and activity cause serious consequences for their health and quality of life in general. The results of studies worldwide show that about 80% of the population is insufficiently physically active, and that over 50% of adults are overweight in most developed countries.<sup>2</sup> Obesity, insufficient exercise and poor nutrition are one of the biggest problems of modern society.<sup>3</sup> Research has found that physical inactivity and poor nutrition are associated with about 400,000 deaths per year,<sup>4</sup> where this number is probably higher in relation to the year of research and the present time.

Lifestyle changes, both in industrialized and developing countries, have led to altered lifestyles and diets. Lack of physical activity and caloric diet are some of the dominant factors in the development of obesity in the last twenty years.<sup>5-8</sup> The combined effects of these changes have a negative effect on the overall health status of children and adults, which is why the World Health Organization (WHO) identifies obesity as one of the most important public health problems.<sup>9</sup>

Body composition and physical appearance change under the influence of exercise. Physical fitness at an optimal level, which refers to health status, is associated with a lower risk of disease and improved quality of life.<sup>10-12</sup> Strength development is mainly accompanied by an increase in muscle mass, and an increase in aerobic endurance is often accompanied by a decrease in subcutaneous adipose tissue, and changes in body composition can be even more significant, when a specially programmed exercise is applied and appropriate diet.<sup>13</sup> Physical activity, even without reduced calorie intake, is a very effective method for reducing the risk of chronic diseases, regardless of the degree of obesity.<sup>14</sup>

The motor abilities of children, youth and people are influenced by various structural features that define him as a bio-psycho-socially integrated being. In order for motor abilities to develop continuously and correctly, it is necessary to know the elements that we can act on, and which are crucial for the realization of kinesiological activities. Every physical activity implies a change in a large number of physiological and metabolic processes. The body responds to physical activity with changes in almost all physiological systems, primarily the musculoskeletal, cardiovascular, respiratory, endocrine and immune systems.<sup>15,16</sup>

The aim of this paper is to determine the extent to which body composition affects the fitness abilities of pupils and students.

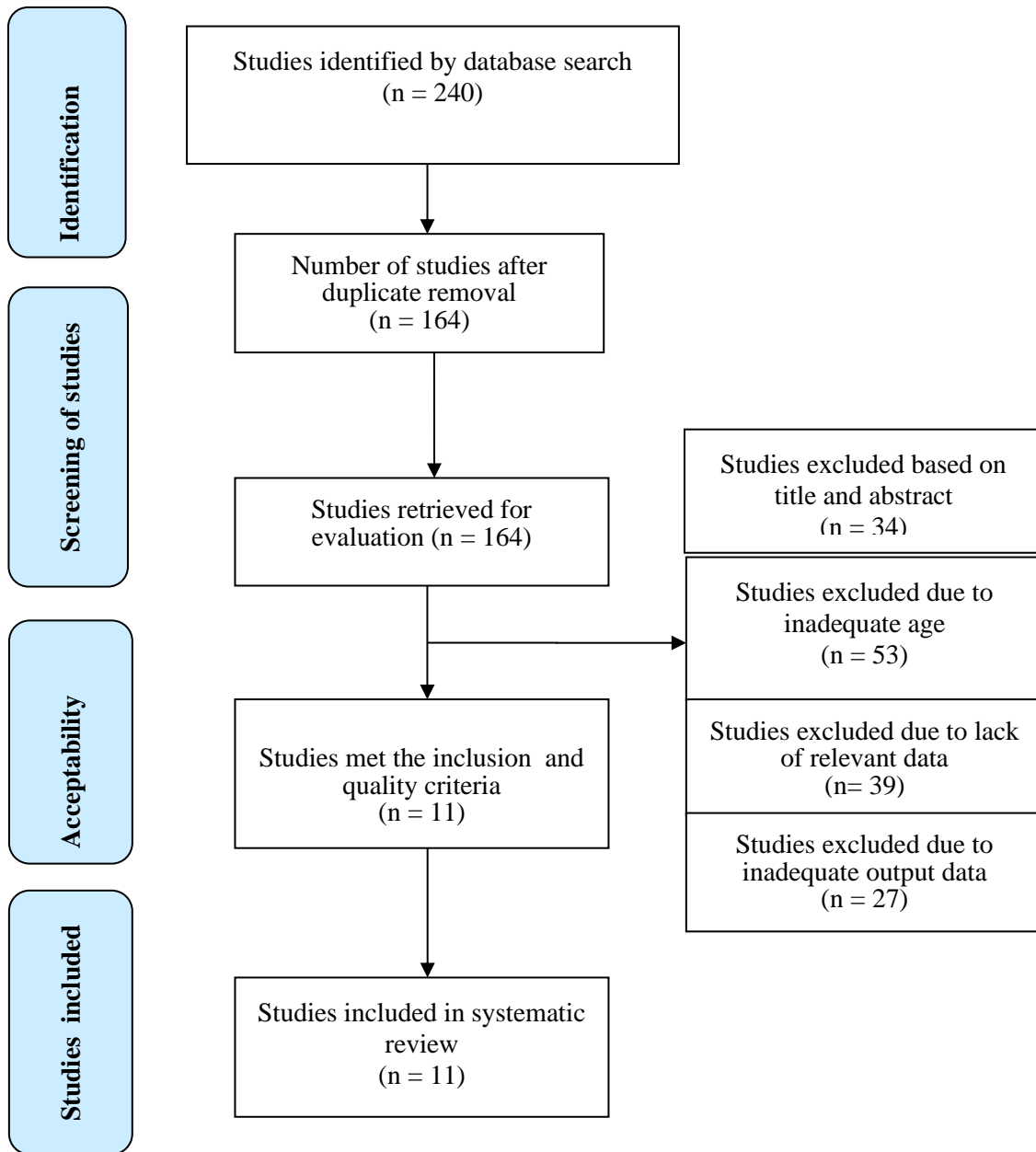


## Methods

A descriptive method and theoretical analysis were used to collect, classify, and analyze targeted research. The following databases were searched: Google Scholar, PubMed, DOAJ, Kobson. The search was limited to works of a more recent date, more precisely in the period from 2011 to 2021. Keywords are searchable in English: morphological characteristics, motor skills, impact, physical activity, physical fitness.

In the first phase of the screening, the relevance of the titles and abstracts of the identified works was checked. In the second phase of the search, complete papers were taken over and considered for inclusion. References from all collected papers were reviewed in order to obtain more research that studied this issue.

The analysis included and analyzed 11 papers that met all the selection criteria. The initial search identified 240 papers, the vast majority of which did not correspond to the research problem. Papers were eliminated based on the following reasons (Figure 1): duplicates ( $n = 164$ ), inadequate methodological form of work ( $n = 34$ ), inadequate age of students ( $n = 53$ ), lack of relevant data ( $n = 39$ ) and inadequate output data ( $n = 27$ ). For the analysis of the collected papers, the descriptive method and the method of theoretical analysis were applied. The analyzed works are presented in the activity diagram (Diagram 1). Each research is presented using the following parameters: author and year of publication of the paper, sample of respondents (number of participants - N, sex - M and F, age), monitored variables, research aim and results.



**Figure 1.** Selection of studies for systematic review.

## Results and Discussion

The aim of this review study is to determine the extent to which body composition affects the fitness abilities of pupils and students. Table 1 shows the results of the collected studies.

AUTHOR AND YEAR	SAMPLE OF PARTICIPANTS		FOLLOWED VARIABLES	OBJECTIVE OF THE RESEARCH	THE RESULTS
	N	Gender and age			
Ostojic et al., 2011 <sup>17</sup>	1121	M (n = 754) 10.4 ± 3.1 F (n = 367) 10.8 ± 2.8	BMI, WC, % F, VO <sub>2max</sub>	Investigate the prevalence of overweight and obesity and the relationship between PA and % F.	The results showed significant differences between M and F in terms of obesity (6.8% -8.2%). M had significantly lower BMI, WC, and %F values. Negative relationship between %F and VO <sub>2max</sub> he was moderately tall.
Gaohua, 2013 <sup>18</sup>	1364	M (n = 1364) 19-22 years	BMI, HG, WC, SLJ, 1000m	Assess BMI and its impact on fitness and functional abilities.	The results show that being overweight has a negative impact on physical abilities. Subjects of normal weight showed better results in all tests except the HG test.
Kaj et al., 2013 <sup>19</sup>	123	Finland (= 27) M (n = 12) F (n = 15) Hungary (= 44) M (n = 23) F (n = 21) USA (= 52) M (n = 33) F (n = 19) 12.31 ± 1.23	BMI, % F, EUROFIT, VO <sub>2max</sub>	Compare the body structure and physical fitness of Finnish, Hungarian and American adolescents.	There were no statistically significant differences in all three groups in BMI in M, and in F there are significantly larger Finnish and American than Hungarian. Finnish adolescents have the highest VO <sub>2max</sub> . Although they have the highest %F.
Razak et al., 2013 <sup>20</sup>	242	Libya (n = 122) Malaysia (n = 120) 18-25	BMI, % F, VO <sub>2max</sub>	Compare PA, exercise time, and body composition between students from Libya and Malaysia.	The results of the study showed a difference in PA with moderate and high intensity, as well as in BMI, %F and there was no difference in VO <sub>2max</sub> .
Zaccagni et al., 2014 <sup>21</sup>	734	M (n = 380) 22.1 ± 3.6 F (n = 354) 21.5 ± 2.9	BMI, BSK, TSK, WC, CFA, CRA, WSR, HG (RHG, LHG), BD, %F, FM, FFM	Assess the main health-related anthropometric characteristics in relation to gender, the amount of PA and sports discipline, and determine the accuracy of BMI, waist circumference and height ratio, as well as the % F indicator.	Statistically significant differences in all anthropometric measures between groups. ANOVA showed statistical significance in BSK, WC, WSR, BD, %F, FM in M in relation to PA, and in F in BMI, CFA, CRA, FFM. In relation to sports activities, statistical significance in CFA, CRA, RHG, LHG, FFM code M, and BMI, WC, CRA, RHG, LHG, FM, FFM of F.
Raistenskis et al., 2015 <sup>22</sup>	532	M (n = 288) F (n = 244) 12.99 ± 0.96	BMI, WHR, % F, 6MWT, VO <sub>2max</sub> , PA	Assess the differences between PA and physical fitness in obese, overweight and normal weight.	The study found that 20.1% of respondents were overweight or obese. They had a moderate to strong PA of 22.4 minutes per day and on average, for 6MWT, exceeded 50.9m less. The duration of moderate and strong physical activity has a very weak relationship with the monitored variables.
Mohammadi, & Saberi, 2016 <sup>23</sup>	156	F (n = 156) 21.7 ± 1.66	BMI, % F, BMR, FFM, WHR, 540m, SJ, SR, 4x9m, PU, SU	Examining relationships between body composition, anthropometry and fitness abilities of female students in Iran.	The results showed a significant correlation between fitness ability, body composition and anthropometry of F (p>0.05). Regular PA and fitness level affect and improve mental health
Hart, 2017 <sup>24</sup>	60	M (n = 30) 21.8 ± 0.44	BMI, % F, WC, VO <sub>2max</sub>	To examine the multivariate association	Mean values of BMI, WC and VO <sub>2max</sub> significantly higher in M.

		F (n = 30) 21.3 ± 0.84		between PA parameters and body composition.	%F was significantly and negatively correlated with muscle strengthening activities, VO <sub>2max</sub> and moderate PA. VO <sub>2max</sub> has a strong positive correlation with BMI (r = .323) and WC (r = .475).
<b>Mondal, &amp; Mishra, 2017<sup>25</sup></b>	54	M (n = 30) F (n = 24) 18-25	BMI, % F, FFM, VO <sub>2max</sub>	Determine VO <sub>2max</sub> and association with BMI, % F, and FFM	The results showed that VO <sub>2max</sub> was significantly higher in M. Increased %F is associated with lower VO <sub>2max</sub> levels, and with increased FFM increases VO <sub>2max</sub> . BMI showed a weak negative correlation with VO <sub>2max</sub> .
<b>Zhang et al., 2018<sup>26</sup></b>	383	M (n = 205) F (n = 178) 18-24 years	BMI, % F, SM, VF, SM, WC, CMJ, 5x5 shuttle run, AT	Examine the association of obese with normal weight with fitness abilities. Assess the physical fitness of obese people with normal weight and with normal weight through SM.	Obese students with normal weight showed poorer results in physical fitness, which is partly explained by lower SM in both M and F.
<b>Bi et al., 2019<sup>27</sup></b>	1761 8	M (n = 8800) F (n = 8818) 7-18 years	BMI, HG, SLJ, SR, 50m, 800m, 1000m	Assess the association between BMI and fitness ability in students.	BMI was significantly associated with fitness abilities during adolescence (13-18 years) in M, and in F before adolescence (7-12 years). In the period from 13 to 18 years, the increase in BMI had a greater impact on fitness ability in M compared to F. Fitness abilities have shown a parabolic relationship with BMI.

**Legend:** *N*- number of participants, *n*- subsample, *M*- male, *F*- female, *WELL*-physical activity, *BMI*- body mass index, *BMR*- basal metabolism, *BD*- body density, % *F*- percentage of fat, *FM*- fat mass, *FFM*- lean mass, *SM*- skeletal muscle mass, *VF*- visceral fat, *BSK*- skin fold biceps, *TSK*- skin fold of triceps, *WHR*- waist-to-hip ratio, *WSR*- waist-to-height ratio, *WC*- waist circumference, *CFA*- flexed upper arm circumference, *CRA*- relaxed upper arm circumference, *HG*- hand grip, *RHG*- right hand grip hands, *LFG*- left hand grip, *VC*- vital capacity, *VO<sub>2max</sub>*- maximum aerobic capacity, *SLJ*- long jump from place, *SR*- seat and reach, *CMJ*- semi-squat jump with preparation, *AT*- Anderson test, *SJ*- Sargent jump, *PU*- push-ups, *SU*- sit-ups, *AH*- joint endurance, *6MWT*- six-minute walking test.

Authors Ostojic et al.<sup>17</sup> investigated the prevalence of overweight and obesity in Serbian school-age children and the relationship between indicators of physical activity and body fat, on a sample of 1121 respondents, 754 males and 367 females, aged 6 to 14 years. The results showed that % F and WC correlated negatively with VO<sub>2max</sub>, indicating that children who have increased physical activity during childhood have lower total and lower abdominal adiposity. Also, the prevalence of overweight (M = 31.5%, F = 32.2%) and obesity (M = 6.8%, F = 8.2%) was high.

Study Gaohua,<sup>18</sup> on a sample of 1364 respondents, determined BMI and its impact on fitness and functional abilities. The results show that overweight and obese subjects (12%) have poorer results, negative impact, in tests of physical ability, only in the HG test was a positive correlation of subjects with a higher percentage BMI.

Kaj et al.<sup>19</sup> aimed to compare the body structure and physical fitness of Finnish, Hungarian, and American adolescents. In a sample of 123 respondents, they found that the prevalence of overweight was 9.3% in Hungarian, 23.07% in Finnish, and 38.2% in American adolescents. There were no statistically significant differences in BMI. The

highest value of the variable  $VO_{2max}$  was in Finnish subjects, although they had the highest percentage of %F. Comparisons between different ethnic groups suggest that adolescents need a greater number and intensity of training to achieve an appropriate level of PA. A EUROFIT battery of tests (European Tests of Physical Fitness, 1993) was used to monitor PA.

Examination of the author Razak et al.<sup>20</sup> showed a significant difference in the time spent exercising with moderate intensity (8.59-7.48 hours per week), mean BMI (22.2-24.2) and % F (13.6-13.3) in favor of Libyan students, and with a strong intensity (4.3-6.3 hours per week) in favor of Malaysian students. The analysis showed that there was no significant difference in  $VO_{2max}$ . The lifestyle of both groups of students did not differ in terms of aerobic fitness, but showed a lower level in BMI and % F in favor of Libyan students, which is explained by the more time spent with moderate activities.

Zaccagni et al.<sup>21</sup> aimed to assess the main anthropometric characteristics related to health in relation to gender, PA and sports discipline, and to determine the accuracy of BMI, WSR, as well as the %F indicator, on a sample of 734 participants. Statistically significant differences in all anthropometric measures between groups were obtained. ANOVA showed statistical significance in the variables BSK, WC, WSR, BD, %F, FM in M in relation to PA, and in F in BMI, CFA, CRA, FFM. In relation to sports activities, statistical significance was obtained in CFA, CRA, RHG, LHG, FFM in M, and BMI, WC, CRA, RHG, LHG, FM, FFM in F.

Evaluation of the difference between physical activity and physical fitness in subjects with normal and overweight and obese, was dealt with by Raistenskis et al.<sup>22</sup> The sample consisted of 532 subjects with a mean age of  $12.99 \pm 0.96$  years. By self-evaluating and completing a physical activity questionnaire, which assesses the mode, frequency, duration, and sedentary activities, two monitoring variables were obtained, moderate to strong intensity of physical activity and time spent in front of the TV. Subjects who were overweight and obese were engaged for 22.4 minutes and had lower  $VO_{2max}$  values. Surprisingly, subjects with normal weight spent on average more time in front of the TV (114.4 minutes) compared to the other group (105.3 minutes), but there were no statistical differences. 6MWT has a very strong statistically positive significance with calculated  $VO_{2max}$  ( $p < 0.001$ ). The BMI-WHR ratio showed very weak, negative significance. The duration of the variable, moderate to strong exercise intensity, had a statistically very weak relationship with 6MWT, WHR, and  $VO_{2max}$  (coefficient  $r = -0.106-0.187$ ).

In their research, Mohammadi, & Saberi,<sup>23</sup> found a significant association between fitness ability, body composition and anthropometry in female students ( $p > 0.05$ ). Statistical analysis was confirmed for the mean value of physical abilities, which is  $16.85 \pm 1.9$  (sum of all motor skills tests). Also, the study showed that regular exercise improves physical health.

Mondal & Mishra<sup>25</sup> are in their research determined  $VO_{2max}$  and association with BMI, % F, and FFM. The results showed that  $VO_{2max}$  in M was significantly higher than F ( $p < 0.001$ ). BMI showed a weak negative correlation ( $r = .0171$ ), % F a strong negative



correlation ( $p < 0.001$ ), and FFM was positively correlated ( $p = .0055$ ) with  $VO_{2max}$ . The study was conducted on a sample of 54 subjects (M  $n = 30$ ; F  $n = 24$ ) aged 18-25. We conclude that an increased %F is associated with a lower level of  $VO_{2max}$ , and with an increase in FFM  $VO_{2max}$  also increases.

The author Hart<sup>24</sup> isexamined the multivariate association between PA parameters and body composition, on a sample of 60 subjects of the student population. Three variables were used for PA,  $VO_{2max}$ , moderate PA, and muscle strengthening activity. The mean values of the variables BMI, WC and  $VO_{2max}$  are significantly higher in M compared to F. %F was significantly and negatively correlated with the muscle strengthening PA variable,  $VO_{2max}$  and moderate PA.  $VO_{2max}$  has a strong positive correlation with BMI ( $r = .323$ ) and WC ( $r = .475$ ). These results may suggest two different relationships between PA and body composition, the general influence of PA on the relationship with body composition, and exercise and body composition.

In a study by Zhang et al.<sup>26</sup> subjects were divided into two groups based on calculated BMI and %F ratio, those with normal weight (BMI 18.5-23.9  $kg/m^2$ , M = < 20% F, F = 30%F) and with normal weight-obese 18.5-23.9  $kg/m^2$ , M = > 20%F, F = 30 >%F). The aim was to examine the association of subjects with normal weight-obesity with fitness abilities and the two groups with each other via SM, to 383 subjects of both sexes. The normal weight group was superior in all fitness tests, which is explained by the higher percentage of SM in both sexes.

Authors Bi et al.<sup>27</sup> aimed to assess the association between BMI and fitness ability in 17,618 student participants, who were classified into four groups according to age (7-9; 10-12; 13-15; 16-18). BMI was significantly associated with fitness abilities during adolescence (13-18 years) in M, and in F before adolescence (7-12 years). In the period from 13 to 18 years, the increase in BMI had a greater impact on fitness ability in M compared to F, where M increased muscle mass and F increased %F. Fitness abilities had a parabolic trend, at first they increased, but with the growth of BMI they decreased.

## Conclusion

The analysis of studies has shown that the prevalence of obesity in early childhood can affect later age. It was easier to motivate subjects with moderate and normal weight to participate in examinations and measurements. Gender differences showed that M, on average, had better values of monitored variables for body composition and were superior in physical activity tests. For the variable %F, in all papers in which it was monitored, higher values were found in F. The authors believe that physical activity should be started in early childhood, through various types of games, in order to later create a habit for it and influence better health. Children need to understand physical activities such as walking, cycling and daily physical exercise and that school workload needs to be increased,

It can be concluded that the subjects who are more physically active have lower BMI values, ie higher values of SM and FFM, that they had better fitness and were more able to perform all tests of motor skills. An active lifestyle, which includes regular weekly



physical activities, is significantly correlated with body composition. Physical activity as a strategy is an affordable, convenient and inexpensive factor, and crucial for improving the quality of physical health.

The research, therefore, confirmed the hypothesis about the positive influence of body composition on the fitness abilities of pupils and students and pointed out the importance of physical activity, both on health and on the physical appearance that we all strive for.

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