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IMPACT OF BODY MASS ON THE MOTOR ABILITIES MANIFESTATION IN STUDENTS OF DIFFERENT AGES

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ABSTRACT
Studying the students' body weight is a problem of the present day primarily associated with assessing their health status. However, few scientific studies reveal its impact on students' abilities to acquire physical education content. That is why we set ourselves the aim to establish the influence of students' body mass on their motor abilities manifestation. Methods: Using the standard for our education system test battery, we measured the height, weight, and physical ability of 218 boys and girls in the 4th, 7th, and 12th grades from 3 schools in Sofia. We processed the results using correlation analysis (Pearson's r). Results: We found that being overweight in 4th-grade boys and girls had a negative impact on the manifestation of all the motor skills studied. During puberty (in the 7th grade), the higher body mass index makes it difficult for students to manifest their speed and strength. In the 12th grade, it favours the manifestation of lower limb strength and endurance in girls and dramatically harms the boys' manifestation of speed and agility. Conclusion**:** As a result of the correlation between body mass and motor skills we derived, teachers can plan more accurately the means and methods of physical training in the lesson for students of different ages.

Key words: correlations, physical ability, body mass index, ages.

INTRODUCTION

The only subject in our education system directly related to improving students' health and working capacity is 'Physical Education and Sport'. This is because physical exercise performance stimulates proper physical development, and intense physical exertion leads to better development of motor skills. Numerous studies to assess the impact of physical activity on students' health and working capacity have been carried out over the years. They show the changes in height and body mass (1, 2), the state of motor skills (3, 4), and the relations between indicators of physical development and physical ability (5, 6). Very few scientific studies reveal the impact of physical and biological development indicators on manifesting motor skills. D. Dimitrova (2001) studied the influence of age and body mass on students' physical performance but did not show how different weight values affect the manifestation of the studied skills (7). Therefore, such a study can provide many solutions to expand the possibilities for more effective physical education and sport content learning in different school periods.

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METHODS

The research aimed to determine the impact of the student's body mass on the manifestation of their motor abilities. To achieve it, the following tasks were set and solved:

1. To develop a theoretical rationale for the problem under consideration.
2. To examine the indicators of physical development and physical ability of students in their 4th, 7th, and 12th grades.

3. To find the interdependence between the studied students' body mass and motor skills and derive practice recommendations.

The subject of the study is the impact of body mass on the students' motor abilities manifestation.

At the beginning of the school year 2022/23, 218 students (111 boys and 107 girls) from the 4th, 7th, and 12th grades were studied. These grades are final for primary, junior, and secondary school stages. The 4th-grade students were 46 boys and 37 girls, the 7th-grade students were 38 boys and 35 girls, and the 12th-grade students were 27 boys and 35 girls. The students mentioned above are from the following schools: 81 Secondary School 'Victor Yugo', National Trade and Bank Secondary School, and Professional High School of Telecommunications.

A comprehensive research methodology of literary sources, observation, and discussion was applied. Height (cm), weight (kg), and body mass index (8) were examined. The state of motor skills was established through the following tests: 1) '30-meter Running' (s) - for speed; 2) 'Standing Long Jump' (cm) - for lower limb's explosive power; 3) 'Throwing a Solid Ball' (cm) - for upper limbs' explosive power; 4) '200-meter Running' (s) - for endurance; 5) "T-test" (s) - for agility; (9). The results of the study were processed by correlation analysis using Pearson simple linear correlation coefficient (r) and Coefficient of Determination (r^2) (10).

To reveal the impact of body weight on the students' motor abilities, in addition to gender and age, the studied were divided by their BMI into three groups: underweight students (BMI < 18.5), normal weight students (BMI of 18, 5 to 24.99) and overweight students (BMI > 25).

RESULTS

After the mathematical-statistical processing of the research results, we established how strong the correlation between the studied indicators was. Given the purpose, in the correlation matrices, we present only the results revealing the correlations between the student's body weight and individual motor skills. **Table 1** shows the results of the correlation analysis for boys in the 4th, 7th, and 12th grades.

Table 1. *Correlation matrix of the dependencies between body weight and motor skills of boys in the 4th, 7th, and 12th grades (Pearson's coefficient)*

Indicators / Grade / Weight		speed	Explosive strength of the lower limbs	Explosive strength of the upper limbs	Durability	Agility
4th grade	underweight	,323	-,373	-,513	,225	-,251
	normal weight	,055	,019	-,150	,036	-,010
	overweigh	,683*	-,609*	-,425	,337	,370
7th grade	underweight	-,726*	,553*	,223	-,313	-,144
	normal weight	,005	,496	,072	-,438	-,622*
	overweigh	,367	-,355	,208	-,052	-,017
12th grade	normal weight	-,011	,085	,263	-,465*	,249
	overweigh	,644*	-,222	,632*	,162	,609*

Legend: (*) – for statistical significance $\alpha = 0,05$

The results of the 4th-grade boys clearly show that excessive body mass negatively affects the manifestation of their motor skills. High weight values hinder, to a significant extent, the manifestation of speed ($r = 0.683$, $\alpha = 0.05$) and the strength of the lower limbs ($r = -0.609$, $\alpha = 0.05$). These two motor skills and weight have a proportional inverse correlation, which means that as the weight increases, the speed and explosive power of the lower limbs decrease. Similarly, but with a weaker dependence, excessive body mass moderately hinders the upper limbs' explosive power ($r = -0.425$),

endurance (r = 0.337), and agility (r = 0.370). The overweight 4th-grade boys' results were of no surprise and entirely logical. Given their age before puberty, they typically have a higher percentage of body fat at the expense of fat-free mass. Low levels of body weight, including fat-free mass, again hinder the manifestation of some motor skills. This mainly affects the upper limbs' explosive power, where the correlation between body weight and 'Throwing a Solid Ball' test results was strong (r = -0.513) and inverse. Negatively, but to a lesser–moderate degree, body weight affects the manifestation of speed (r = 0.323) and explosive power of the lower limbs (r = -0.373).

The 4th-grade boys who have a normal body mass (BMI from 18.5 to 24.49) showed weak correlations between weight and manifestation of their motor skills (r < 0.3). Again, a lower percentage of fat-free mass as a proportion of body weight affects their ability to provide stronger and faster movements.

Some changes occur in the studied dependencies due to puberty and more focused work in physical education classes. The low levels of body weight begin to benefit the speed and strength of the lower limbs of the 7th-grade boys. At this age, body weight and speed show a strong correlation (r = -0.726, α = 0.05) or determination of 52.7%, and body weight and the explosive power of the lower limbs have a considerable correlation (r = 0.553, α = 0.05) or determination of 30.6%. Physical changes in students' bodies during puberty lead to an increase in fat-free mass at the expense of a decrease in body fat percentage. This helps perform fast and powerful movements with the lower limbs.

Things are a little different with boys with normal weight. Their weight does not affect the manifestation of speed and strength of the upper limbs. In this case, it reveals a significant correlation with agility (r = -0.622, α = 0.05) or determination of 38.7% and a moderate correlation with lower limbs' explosive power (r = 0.496) and endurance (r = -0.438).

Excessive body mass in puberty hinders the manifestation of speed (r = 0.367) and the lower limbs' strength (r = -0.355) moderately.

Boys' excessive body mass at the end of high school hinders speed and agility, favouring the manifestation of the explosive power of the upper limbs. Here, the correlation between body weight and speed (r = 0,644, α = 0,05) and, respectively, agility (r = 0,609, α = 0,05) is significant. Being overweight in these students hinders the speed of the lower limbs' movements. This is also proven by the weak inverse correlation between their weight and the lower limbs' explosive power (r = -0.222). The excessive body mass favours only the manifestation of the upper limbs' explosive power - the correlation is (r = 0.632, α= 0.05). We assume that the established determination between the two indicators of 39.9% is due to the strength of the movements, which is positively influenced by the boys' excessive body mass.

Table 2 shows the results of the correlation analysis in the girls from the 4th, 7th, and 12th grades. The 4th-grade girls with excessive body mass have identical results to their classmates – boys with excessive body mass.

Being overweight in girls has a negative effect on the manifestation of all the studied motor skills. All correlations are inverse - the significant correlations between weight and the lower limbs' explosive power (r = -0.500), weight and endurance (r = 0.538), and weight and agility (r = 0.599), as well as the moderate correlations between weight and speed (r = 0.455) and, respectively upper limbs' explosive power (r = -0.418). At this age, just before puberty, we find that low body weight positively affects girls' speed and strength. In this case, lower weight and the explosive power of the lower limbs show a strong correlation (r = 0.870, α = 0.05). The coefficient of determination between the two indicators is 75.7%. The correlation between weight and upper limbs' explosive power is significant (r = 0.596). The dependence between weight and speed is moderate (r = -0.403).

The correlation between the normal body weight in girls and the upper limbs' explosive power (r = 0.393) is moderate. Weight has a weak correlation with other motor skills (r < 0.3).

Table 2. *Correlation matrix of the dependencies between body weight and motor skills of girls in the 4th, 7th, and 12th grades (Pearson's coefficient)*

Grade / Weight \ Indicators		speed	Explosive strength of the lower limbs	Explosive strength of the upper limbs	Durability	Agility
4th grade	underweight	-,403	,870*	,596	,073	-,100
	normal weight	,049	-,085	,393	-,102	,286
	overweigh	,455	-,500	-,418	,538	,599
7th grade	underweight	,031	,817*	,294	-,221	-,232
	normal weight	,212	,476	,474	-0,45	,198
	overweigh	,407	-,510	,008	,325	-,027
12th grade	normal weight	,016	,318	-,029	,016	-,361
	overweigh	,219	,065	,650*	-,301	,005

Legend: (*) – for statistical significance $\alpha = 0,05$

The dependence between girls' body weight and motor skills changes in puberty. The negative impact of the overweight on speed and endurance is preserved - the correlation with both indicators is moderate, respectively, r = 0.407 and r = 0.325. The correlation between weight and the lower limbs' explosive power is significant (r = -0.510) and negative. In these girls, the increase in body mass is mainly at the expense of body fat. Fat-free mass is not affected. This was proved by the weak correlation between the girls' weight and their upper limbs' explosive power (r = 0.008). This age is a sensitive period for gaining muscle strength, so purposefully working on this motor quality is necessary. This will increase the fat-free mass, which favours the manifestation of students' all motor skills.

In the 7th grade, the strong correlation between body weight and the manifestation of the lower limbs' explosive power (r = 0.817, $\alpha = 0.05$) was preserved in girls with a BMI below the norm. What is interesting in this case is that being underweight has little impact on the manifestation of other motor skills (r < 0.3).

Normal levels of body mass have a positive effect on the students' strength only. Weight showed moderate correlations with the explosive power of lower (r = 0.476) and upper limbs (r = 0.474). Apparently, in these girls, the free-fat mass gaining is more pronounced than the weight gaining at the expense of an increase in the body fat percentage. Normal body weight has little effect on the other motor skills (r < 0.3).

Girls' normal weight at the end of high school has little effect on their motor skills. Three weak correlations were revealed: weight and speed, weight and the upper limbs' explosive power, and weight and endurance (r < 0.3). Moderate weight favours the manifestation of the lower limbs' explosive power (r = 0.318) and agility (r = -0.361). We do not consider the dependencies revealed in the end to be a good indicator of the work done over the years, especially considering the focus of the physical education content in this school stage and the expected results.

We got a strong and moderate correlation in overweight girls. The strong one is between the body weight and the upper limbs' explosive power (r = 0,650, $\alpha = 0,05$). The coefficient of determination is 42.3%. Body mass gain favours the strength abilities for performing the movements in both genders in the 12th grade. Surprisingly, most of the kilograms gained in girls at this age positively influence endurance. The correlation between weight and endurance is moderate (r = -0.361,) whereas the correlation of weight with the rest of the motor skills is weak (r < 0.3).

CONCLUSION

We found that being overweight had a negative impact on the manifestation of all the motor skills studied in the 4th-grade boys and girls. In puberty

(in the 7th grade), the higher body mass made it difficult to manifest speed and strength. In the 12th grade, it favoured the lower limbs' strength and endurance in girls and dramatically hindered the manifestation of speed and agility in boys. At the same time, lower than normal weight favoured the speed and strength of most studied students, especially those in the 7th grade, who were in the period of the most intensive anabolic processes.

Therefore, it is necessary for further research to study the ratio of fat-free mass as a percentage of the student's body weight and to look for a more direct relationship between it and the manifestation of their motor abilities.

The correlations between body mass and motor skills revealed in this study make it possible for teachers to plan more precisely the means and methods of physical training in the lesson so they can be appropriate for students of different age periods.

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