

ORIGINAL ARTICLE

Somatotypological prerequisites for physical fitness in primary school students

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ABSTRACT

Aim: To experimentally investigate the relationship between somatotype and physical fitness level in primary school students (aged 7-10) during ball-handling exercises.

Materials and Methods: The research, conducted during the 2024-2025 school year, involved 238 students (boys – $n = 118$, girls – $n = 120$) aged 7-10. To determine the students' body-build type (somatotype) and their somatometric assessment, the weight-height coefficient and somatoscopy were used. Pedagogical testing was employed to evaluate the results of ball-handling exercises. To determine the relationship between somatotype and indicators of students' physical fitness during ball-handling exercises, Pearson's linear correlation analysis was applied.

Results: It was found that in the distance throwing, the best results were achieved by boys with a higher weight-height coefficient aged 9 and 10 ($r = 0.48$ and $r = 0.43$), the best results in the vertical jump were recorded among students with a lower weight-height coefficient aged 8 and 10 ($r = -0.64$ and $r = -0.4$). Dribbling speed is higher among 10-year-old girls with a lower weight-height coefficient ($r = 0.30$), while the best results in the vertical jump are achieved by girls with a lower weight-height coefficient aged 8 and 9 ($r = -0.34$ and $r = -0.3$).

Conclusions: It has been established that the somatotype of students aged 7-10 influences only their performance in ball-handling exercises requiring speed and strength. In contrast, coordination skills are closely linked to other motor abilities and mental functions, which may serve as a basis for predicting their motor aptitude in various types of sports games.

KEY WORDS: primary school students, ball-handling exercises, somatotype, physical fitness, physical education, elements of sports games

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INTRODUCTION

Physical education, as an integral part of school education, is aimed at fostering students' physical, social, and spiritual well-being and preparing them for an active, long-lasting life. The current trend toward a decline in students' physical condition, a decrease in their motivation to engage in physical exercise, and a decline in the status of physical education classes in schools creates an urgent need to optimize the school's physical education system, particularly by seeking new approaches to teaching the subject referred to as "Physical Education [1, 2].

Primary school age (7-10 years) is an active stage of growth and development of the child's body, the most optimal period for the development of motor skills and the initiation of motor skill training. In primary school, the foundation is laid for schoolchildren's further physi-

cal development, based on acquired knowledge, motor experience, and motor readiness [3].

Physical education for primary school students has its own specific characteristics, determined by their age-related anatomical, physiological, and psychological developmental features, as well as their adaptation to new learning conditions, which are characterized by a sharp increase in mental activity against the backdrop of severely limited motor activity. In this regard, properly organized physical education during the primary school years is not only a necessary condition for the comprehensive and harmonious development of students but also the foundation for their continued physical development [4, 5].

Children aged 7-10 have a particular need for movement and play, so active and sports games are a universal tool for the physical education of primary school

students, as they spark interest and have significant educational, health-promoting, and awareness-raising value [6].

It is known that one of the modern trends in improving physical education for schoolchildren is the differentiation of its forms, means, and methods. However, the traditional system of school physical education takes into account only gender- and age-related patterns of development, that is, it is designed for the “average” student, although it has been proven that individual characteristics of their physical development, including somatotype, influence the quality and speed of learning physical exercises and the development of motor skills in students, particularly in primary school [7, 8]. Taking into account the physical characteristics of primary school students when teaching game-oriented physical exercises allows each student to perform at an optimal intensity and increases learning effectiveness.

AIM

The aim is to experimentally investigate the relationship between somatotype and physical fitness level in primary school students (aged 7-10) during ball-handling exercises.

MATERIALS AND METHODS

The research involved 238 students (boys – $n = 118$, girls – $n = 120$) aged 7-10 from Lyceum No. 35, Lyceum No. 17 “Kyrylivskiy,” Lyceum No. 183 “Fortuna,” Lyceum No. 205, and Lyceum “Dominanta” in Kyiv (Ukraine) (7 years old – 54 students: boys – $n = 28$, girls – $n = 26$; 8 years old – 58 students: boys – $n = 23$, girls – $n = 35$; 9 years old – 59 students: boys – $n = 33$, girls – $n = 26$; 10 years old – 67 students: boys – $n = 34$, girls – $n = 33$). The research was conducted during physical education classes taught by a qualified physical education teacher. Classes were held three times a week, lasting 35 minutes for first-grade students (7-year-olds) and 40 minutes for grades 2-4 (8-10-year-olds), which helped maintain their physical performance. Physical education classes for children aged 7-10 were primarily game-oriented; their content included elements of sports games and gymnastics, which helped maintain the children’s interest, reduce psychological and mental strain, and promote the natural development of coordination, speed, and strength. All schoolchildren involved in the research had no health issues. The research was open in nature; the children’s parents were informed and gave consent for their participation. The pedagogical testing was conducted in the gym in November-December 2024 by physical education teachers in the presence of the

school physician. The school physician took anthropometric measurements, and the physical education teacher visually determined the somatotype to confirm the results of the metric assessment.

To determine the students’ somatotype, the weight-height coefficient was used, in which the body weight (kg) is divided by the body height (m) raised to the third power (a coefficient proposed by Professor T. Yu. Krutsevykh [9]). To determine body-build type during the research, somatometric measurements were taken using traditional medical instruments: a height rod and a set of scales. The coefficient obtained from the calculation was compared with tabulated data (Table 1) to determine the somatotype.

In addition, somatoscopy was used to refine the somatometric assessment of body-build type; that is, students’ somatotypes were visually assessed based on somatoscopic indicators of physical development (chest shape, leg shape, etc.).

Since physical education classes were predominantly game-oriented, i.e., included elements of sports games, this research aimed to assess students’ constitutional type based on their level of physical fitness in ball-handling and jumping exercises. Therefore, using pedagogical testing, the results of the following ball-handling exercises were examined: throwing a small ball over the head at a target from a distance of 8 meters (number of successful throws out of 5 attempts); passing a basketball by bouncing it off the floor (number of successful passes out of 10 attempts); stopping a rolling soccer ball with the sole of the foot (number of successful stops out of 5 attempts); kicking a soccer ball for accuracy from a distance of 6 meters (number of successful kicks out of 5 attempts); throwing a small ball over the head for distance (in meters, best of 3 attempts); dribbling a basketball with the right or left hand in a straight line for 20 meters (time in seconds); catching a volleyball flying toward you (in points based on the number of successful attempts); juggling a balloon (number of times in the best of 2 attempts); throwing a basketball over the head from a sitting position (in meters, best of 3 attempts); throwing a volleyball against a wall for 30 seconds from a distance of 1 meter (number of times); standing vertical jump (in centimeters). Students performed the motor tests after a standard warm-up, which included various types of running and walking, as well as general physical exercises in motion and on the spot without equipment.

The research was conducted during November-December of the 2024-2025 academic year, during which data were collected on body-build type and physical fitness levels in ball-handling exercises for the specified group of students; for the convenience and objectivity

Table 1. Weight-height coefficient in schoolchildren aged 7-10 years of different body-build types (somatotypes)

Age, years	Somatotype			
	Digestive	Muscular	Thoracic	Asthenic
Boys				
7	13.8	12.6	11.8	9.6
8	13.7	12.6	11.4	9.4
9	13.5	12.3	11.1	9.1
10	13.2	12.1	11.1	8.7
Girls				
7	13.5	12.7	11.5	9.2
8	13.2	12.4	11.4	8.8
9	13	12.3	11	8.6
10	13	11.9	11.7	8.3

Source: compiled by the authors of this study

of the data, measurements were taken two months after the summer break following a series of physical education classes incorporating elements of sports games. The data were analyzed at the Department of Theory and Methods of Physical Education at Dragomanov Ukrainian State University (Kyiv, Ukraine).

To determine the relationship between somatotype and the level of physical fitness of 7- to 10-year-old students in ball-handling exercises, Pearson’s linear correlation analysis was used. The existence of a relationship and the difference between individual values were considered significant at a 95 % significance level ($p \leq 0.05$).

The participants and their parents were informed about the research objectives and voluntarily agreed to participate. The research results were reviewed and approved by the Academic Integrity Committee of the Dragomanov Ukrainian State University (No. 34 dated May 14, 2025).

AI STATEMENT

The author states that no AI tools were used in writing this article.

FRAMEWORK

This study was carried according to the research plan of the Faculty of Physical Education, Sports and Health of the Dragomanov Ukrainian State University in 2023-2027 in accordance with the theme “Monitoring, control and evaluation of learning results in physical culture, the basics of healthy lifestyle” (state registration number 0113U009185).

RESULTS

To confirm differences in the physical development of schoolchildren of the same age and to justify the impor-

tance of taking somatotype into account in the physical education of primary schoolchildren, anthropometric measurements were taken from primary school students. Thus, during the pedagogical experiment, the percentage of children in the same age and gender group with different somatotypes was determined (Table 2).

Thus, the average height of 7-year-old boys is 127.7 ± 4.6 cm, and that of girls is 125.6 ± 4.3 cm; the average body weight of 7-year-old boys is 27.0 ± 4.2 kg, and that of girls of the same age is 24.5 ± 3.1 kg. The weight-height coefficient indicators, calculated using the formula for the somatotype of 7-year-old boys (28 individuals in total), indicate that more than one-third of 7-year-olds belong to the asthenic somatotype, specifically 28.6 %, the thoracic somatotype accounts for 14.3 %, the muscular type accounts for over 35 %, and the digestive type 21.4 %. A similar examination of 7-year-old girls (26 individuals) revealed that girls of the muscular and thoracic somatotypes were distributed equally – 19.2 % each, nearly half – 46.2 % – had the asthenic somatotype, and 15.4 % had the digestive somatotype. The results of the empirical somatotype determination coincided with the visual assessment of 7-year-old girls.

Measurements of 8-year-old children revealed that the average height of boys (23 individuals) was 131.0 ± 6.4 cm, and of girls (35 individuals) was 131.1 ± 5.4 cm; body weight was 28.3 ± 5.0 kg and 26.7 ± 4.1 kg for boys and girls, respectively. In terms of the weight-height coefficient, 8-year-old boys with asthenic and digestive somatotypes were distributed almost equally – 34.8 % and 30.4 %, respectively – and the same result was observed for representatives of the muscular and thoracic body-build types – 17.4 % each. Among 8-year-old girls, about half – 51.4 % – had the asthenic somatotype, more than a third – 22.9 % – had the

Table 2. Characteristics of the somatotypological status of the research participants aged 7-10 years, %

Somatotype	Age, years							
	7		8		9		10	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Asthenic	28.6	46.2	34.8	51.4	12.2	19.2	17.6	33.3
Thoracic	14.3	19.2	17.4	22.9	15.1	30.8	23.5	24.3
Muscular	35.7	19.2	17.4	14.3	15.1	38.5	26.5	21.2
Digestive	21.4	15.4	30.4	11.4	57.6	11.5	32.4	21.2

Source: compiled by the authors of this study

Table 3. The relationship between the physical fitness levels of students aged 7-10 and their somatotype

Weight-height coefficient	Throwing a small ball for distance, m	Vertical jump from a standing position, s	Dribbling a basketball for speed, m
Boys, aged 8	0.01	-0.64	0.03
Girls, aged 8	0.14	-0.34	0.11
Boys, aged 9	0.48	0.02	0.22
Girls, aged 9	0.21	-0.30	0.14
Boys, aged 10	0.43	-0.40	0.01
Girls, aged 10	0.002	-0.13	0.30

Source: compiled by the authors of this study

thoracic somatotype, 14.3 % had the muscular type, and 11.4 % had the digestive type. The results of the empirical somatotype determination confirmed the accuracy of the visual assessment of girls in this age group.

Diagnostic assessment of 9-year-old students revealed the following: the average height of boys (33 individuals) was 139.3 ± 6.1 cm, and of girls (26 individuals) was 137.1 ± 6.3 cm; body weight was 37.5 ± 5.9 kg and 31.5 ± 4.1 kg, respectively. Based on the weight-height coefficient, it was determined that among boys of this age group (a total of 33 examined), children of the digestive somatotype significantly predominated – 57.6%, with equal numbers of representatives of the muscular and thoracic body-build types at 15.1% and 12.2%, and of the asthenic type at 12.2%. The 9-year-old girls were unevenly distributed across somatic body-build types. We found that 38.5% of the girls had a muscular somatotype, 30.8% had a thoracic somatotype, and 19.2% and 11.5% had asthenic and digestive somatotypes, respectively. The results obtained were consistent with the visual assessment of the girls' body types.

The average height of 10-year-old boys (34 individuals) is 146.1 ± 9.1 cm, and their body weight is 37.9 ± 8.8 kg. The average measurements for girls of this age group (33 individuals) are 140.7 ± 6.1 cm and 33.4 ± 5.6 kg for height and weight, respectively. Regarding the somatometry of 10-year-old boys, the results of the empirical determination of somatotype revealed 32.4% of the digestive type, 26.5% and 23.5% of the muscular and thoracic types, respectively, and only 17.6% of the asthenic type. All types of somatic

body constitution are represented in nearly equal proportions among 10-year-old girls: asthenic – 33.3%, thoracic – 24.3%, and muscular and digestive – 21.2% each. The findings corresponded with the visual assessment of somatotypes in girls of this age group.

The correlation analysis was conducted to examine the influence of somatotype on the level of physical fitness among 7-10-year-old students, revealing correlations that vary by students' age and gender (Table 3).

Table 3 presents statistically significant correlations between the weight-height coefficient and the results of motor tests administered to students aged 7-10. The data show that for 9- and 10-year-old boys, the results of the small-ball throwing for distance, which demonstrates speed and strength capabilities, have a moderate correlation with the weight-height coefficient ($r = 0.48$ and $r = 0.43$, respectively, at $p \leq 0.05$). In boys aged 8 and 10, correlation relationships were found between vertical jump results and the weight-height coefficient ($r = -0.64$ and $r = -0.40$, respectively, at $p \leq 0.05$). In girls aged 8 and 9, a significant relationship was found between vertical jump performance and the weight-height coefficient ($r = -0.34$ and $r = -0.30$ at $p \leq 0.05$). In 10-year-old girls, a significant correlation relationship was found between basketball dribbling speed and the weight-height coefficient ($r = 0.30$ at $p \leq 0.05$). No other significant relationships were found between the results of the remaining motor tests and the constitutional characteristics of the younger schoolchildren's physical development.

The data obtained from the correlation analysis confirm that the performance level of various ball-handling

exercises depends on the weight-height coefficient. The success of performing strength, speed, and speed-strength exercises in boys aged 7-10 years, as well as speed and speed-strength exercises in girls of this age group, depends on the value of the weight-height coefficient. No significant correlation was found between the success of performing exercises of a different nature and the value of the weight-height coefficient, which confirmed the results of pedagogical observations: representatives of different somatotypes perform similar exercises with equal success.

Based on the results obtained, it can be concluded that children's somatotype affects only the performance of speed- and strength-based exercises. In contrast, the performance of coordination exercises is not closely linked to children's constitutional characteristics. These relationships arise because, in motor activity, coordination of movements is a psychomotor process in which its various components – intellectual, psychophysiological, sensorimotor, and motor – are combined.

It has been established that the influence of anthropometric data of primary school-aged children on the level of physical fitness in exercises with elements of sports games is indirect. Thus, their influence has been documented in specific gender-age groups of primary school students, and the significance of children's somatotype has been clarified only in speed- and strength-based exercises (jumping, throwing, and running). The data obtained can serve as a basis for differentiating teaching methods for elements of sports games for students aged 7-10. The research confirms differences in body constitution types among students of the same age and gender, which, in turn, implies varying potential for physical development and success in learning physical exercises. The above justifies taking into account the somatotypological characteristics of schoolchildren in primary school physical education classes, not only in the teaching of physical exercises but also in the objective assessment of their motor performance.

DISCUSSION

The period of a child's life from ages 6-7 to 9-10 is referred to as early school age. When defining its boundaries, consideration is given to the characteristics of children's mental and physical development, as well as their transition to academic activities, which become their primary focus [10]. Throughout early school age, the child's body continues to grow and develop, and body proportions change, particularly the ratio of head size to body length. However, the growth rate of children of both sexes slows down, while weight gain accelerates. On these indicators, boys outpace girls.

However, in terms of chest growth, girls catch up with boys by age 9 and surpass them by age 10 [11, 12].

Physical education for primary school students has specific characteristics determined by their anatomical, physiological, and psychological features. In this regard, rationally organized physical education in early school age, taking into account individual differences in growth and physical development, is a priority area for improving school physical education [13].

Somatotype (body-build type, constitution) largely determines children's genetic predisposition to certain motor activities and their performance in various physical exercises. The existence of a correlation relationship between somatotype indicators and indicators of motor abilities in primary school students is explained by their common basis – the body's natural metabolism, which, on the one hand, influences the characteristics of body structure, and on the other, the body's reactivity and the level of functioning of its systems [14, 15].

It has been established that in early school age, the development of speed qualities varies with somatotype and age. Thus, at 6-7 years of age, speed qualities develop best in individuals of the digestive type; from 7 to 8 years of age, in the muscular type; and from 9 to 10 years of age, in the muscular and asthenic somatotypes. Significant differences were also found in the development of physical qualities such as explosive strength, coordination in distance throws, and in cyclic locomotion. It was also shown that absolute muscle strength was greatest in girls with the thoracic and muscular somatotypes [16].

Among boys aged 7 to 10 years with an asthenic body-build type, the greatest improvement was observed in coordination during distance throws with the non-dominant hand; for the thoracic type – explosive strength of the upper limb muscles (distance throws); for the muscular type – explosive strength of the lower limb muscles (jumping) and mobility in the shoulder joints; and for the digestive type – general endurance and coordination in cyclic locomotion. At the same time, in boys aged 7 to 8 years with an asthenic body-build type, there is a sharp improvement in coordination of throws with the dominant hand, cyclic locomotion, explosive strength of the lower-limb muscles, and absolute muscle strength. During this age range, changes in individuals with a thoracic somatic body type occur only in shoulder joint mobility; in the muscular type – in indicators of absolute strength, speed endurance, and speed of individual movements; and in the digestive type – in explosive strength of the lower limb muscles and coordination. Between the ages of 8 and 10, boys show significant improvement in the development of the following physical qualities: in individuals with an asthenic body-build

type – explosive strength of the upper limb muscles, speed of individual movements; in the thoracic type – coordination in throws with the non-dominant hand, speed endurance; and in the muscular type – explosive strength of the upper limb muscles [17].

It has been confirmed that, in the lower grades, the highest level of motor activity throughout the day is observed among children of the muscular type, and the lowest among girls and boys of the digestive type. Girls of the asthenic type show lower results in exercises related to endurance, strength, balance, flexibility, and speed. Other indicators of motor abilities in individuals of the asthenic-thoracic type are high in speed-strength abilities, endurance, and relative strength; average in the development of balance and flexibility; and low in the strength of the hand's flexor muscles [18]. Thus, one of the indicators of individual development in early school-age children is body-build type (body structure or somatotype), which is associated with the rate of ontogenesis and the level of functional indicators of the cardiovascular, respiratory, and motor systems.

At the present stage, a system of physical education has been established that is based primarily on the principles of age and gender differentiation among students, as well as their health and physical fitness, yet the intensity of biological maturation, characteristics of physical development (body height and weight), the development of psychological traits, and body-build type are scarcely taken into account. Thus, age and gender are generally accepted factors in the development of physical education curricula. However, it has been proven that one of the dominant factors influencing changes in students' physical fitness indicators is body-build type, as well as body length, circumference measurements, and body weight [19].

Therefore, anthropometric indicators and constitutional characteristics of students' body structure should form the basis for differentiated instruction in ball-handling physical exercises in primary school as criteria that determine the selection of means and methods for developing motor skills and shape the content of instructional material during ball-handling exercises in physical education classes for students aged 7-10. During primary school, body length and weight have varying effects on students' motor abilities. The specific relationship between anthropometric indicators in various motor actions was identified: in throws and tosses, body weight has the dominant influence; in

vertical jumps, taller and relatively lighter students have a noticeable advantage. Taking children's somatotypes into account during physical education classes can enhance the effectiveness of motor training and serve as a basis for predicting children's motor aptitude across various physical exercises. At the same time, the issue of differentiating physical exercises across types, particularly ball-handling exercises, in physical education classes for younger students of different somatotypes remains under-researched.

Traditional criteria for assessing schoolchildren's physical fitness are differentiated by gender and age and do not account for the somatotypological characteristics of children's physical development [20]. To provide a more informative assessment of students' motor abilities, it is necessary to develop educational standards and physical fitness norms based on students' body-build type classifications (their somatotypes). Such criteria will not only allow for an objective assessment of children's motor performance. Still, they will also enable the identification of students' motor aptitude in various types of physical exercises, in this case, in sports games.

CONCLUSIONS

It has been established that the influence of the weight-height coefficient on the success of mastering ball-handling exercises increases with age and is observed only in speed- and strength-based exercises (jumping and throwing) ($p \leq 0.05$). Establishing the relationship between the level of mastery of ball-handling exercises and the physical build of primary school students can form the basis for a differentiated teaching methodology for ball-handling exercises, as well as in the development of criteria for assessing the academic achievements of primary school students in ball-handling exercises during physical education classes based on the level of development of specific motor skills for students in each grade, taking into account gender and somatotype. The results obtained can serve as a basis for developing a methodology to predict the motor aptitude of children aged 7-10 across various sports games.

PROSPECTS FOR FURTHER RESEARCH

Prospects for further research will focus on developing a differentiated methodology to predict motor aptitude in children aged 7-10 across various sports.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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