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Original Article

Girls with "different volumes and intensity of physical activity constitution types": a comparative analysis

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Abstract:
Research aim is to conduct a comparative analysis of girls' having different volume and intensity of physical activity body types. *Research materials and methods.* The research was conducted in 2018-2019 academic year at the Technical University of Irkutsk (Russia). 707 girls aged 18-21 were under observation during it. Of those, 499 students, who did not have diseases and restrictions for physical education, were assigned to the Ist functional group and 208 students, who had restrictions on the volume and intensity of physical activity - to the IIIrd functional group. The types of the girls' body constitution were evaluated according to the overall, component, and proportional levels of variation in anthropometric indicators and body development variants.
Research results. Differences in somatotypes distribution among girls of different functional and age groups were found. In girls of the Ist functional health group, where students of all ages did not have diseases and restrictions for physical education, the microsomal constitution type is 3.05 times less common, megalomacrosomal and mesosomal somatotypes are 3.4 and 3.0 times more common, respectively, than in the IIIrd functional health group, where students had restrictions on the volume and intensity of physical activity. The number of girls with micromegalosomal somatotype is approximately the same in both groups observed. It was found that there are more girls with a physiological (banal) biological maturation period in the Ist health group. In both groups, the content of fat and muscle tissue in the body is higher in girls, having macrosomal somatotype and less in girls with microsomal somatotype. In both health groups, the muscle component content in the body is greater in girls with the macrosomal constitution type and less in girls having the microsomal somatotype. The bone component content in the body weight of girls of different somatotypes and different health groups is approximately the same. In the population of all the examined female students, mesomembral somatotype girls with an average lower extremities length are more common. *Conclusions.*The analysis of the girls with different amounts of physical activity intensity types of constitution showed significant differences. More than 35% of all examined girls have transitional somatotypes, which indicates their disharmonious physical development and a possible risk of developing non-communicable diseases. It was found that the number of girls with a physiological (banal) period of biological maturation is 15.1% more than in the IIIrdhealth group. In both functional health groups, girls with the microsomal somatotype have the lowest content of fat and muscle components in the body. In girls with the microsomal somatotype, the fat mass and muscle content in the body is greater than in girls with other somatotypes. There were no significant differences in the bone component content in body weight between girls with different somatotypes. To increase the effectiveness of physical culture and health technologies in educational institutions and students' health level, it is necessary to take into account the results of students' body somatotyping. The materials of the conducted research can be used in PE training programs designing and young people's state of physical health monitoring.
Key Words: **somatotype, body constitution, functional health groups, physical education (PE)**

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Introduction

A person's body constitution characteristic serves as a criterion for physical development, the state of metabolism and its hormonal status (Klochkova et.al., 2017), it is also a marker of some population groups' morphological and functional state (Tunnemann, 2013).

In recent decades, researchers have been studying the relationship between the motor qualities of individuals engaged in physical exercise and their constitution type (Druz et.al., 2017). For example, the results of constitution types assessment are used in the sports selection of children and adolescents (Vovkanych et.al., 2015).

Some authors note an athlete's body constitution influence over his sports performance (Ramon-Jimenez et.al., 2018; Kutseryb et.al., 2019; Rybakova et.al., 2020). The constitutional typology basics are taken into account when creating individual fitness programs (Chwalczynska et.al., 2017).

Physical education of the population requires constant modernization (Drachuk et.al., 2018). Modern students' hypodynamia leads to the emergence of diseases and their quality of life decreasing (Potop et.al., 2017; Zhang et.al., 2019; Zurita-Ortega et.al., 2019). Some authors suggest to design students' PE educational programs taking into accountthe students' individual typological features (Miroshnichenko et.al., 2019). Other researchers (Bidaurrazaga-Letona et.al., 2016) report on the increase in PE classes effectiveness, taking into account the types of human constitution. It was found that representatives of different types of body constitution have different levels of basic motor qualities development, so the educational process for students should be individualized (Kolokoltsev, 2017).

There are reports on young people's (students') state of health and constitutional characteristics (Pop, 2018; Yıldız, 2018). We consider it relevant to conduct a comparative integrative analysis of the relationship between the features of constitution types and the state of health of girls assigned to different functional health groups for PE classes at the university.

Research in the field of constitutional typology has a scientific and practical interest in improving young people's PE educational process effectiveness in an educational institution. This is especially important for female students, as future mothers, whose health depends on their descendants' gene pool quality (Komissarova et.al., 2016). However, the literature does not sufficiently reflect the issues of comparative assessment of the types of constitution of girls belonging to different functional health groups.

Material & methods

Research aim is to conduct a comparative analysis of the girls' with different volume and intensity of physical activity body types. The research work was carried out in 2018-2019 academic year. 707 girls of the Technical University of Irkutsk (Russia) aged 18 - 21 (19.3 ± 0.34), who were natives of the region, were under screening observation. Of these, 499 students did not have any diseases and restrictions for PE classes at the university and were assigned to the Ist functional health group. The remaining 208 students had restrictions on the volume and intensity of physical activity and were assigned to the IIIrd functional health group.

According to the International Standards for Anthropometric Assessment (2001) and the ethical standards of the Helsinki Declaration of the Human Rights Committee of 2008 (WMA Declaration of Helsinki, 2013), an anthropometric survey of girls was conducted. Body weight (kg) was determined on a medical scale. Body length (cm) was measured with a height meter, the diameters (cm) of the chest transverse at rest and limbs were measured with a spreading caliper, the length (cm) of the trunk, upper and lower limbs, the girth (cm) of the shoulders, pelvis, chest on exhalation, the upper and lower third of the limbs - with a centimeter tape. The size of the skin-fat folds (cm) of the back and abdomen, upper and lower extremities was measured with a caliper.

The method of body types integrative metric determination was used in our research. Each girl's somatotype characteristics showed the size of the overall, component, proportional levels of variation of anthropometric characteristics and the biological variant of the development of the organism in conventional units (Dorokhov, Petrukhin, 1990; Kolokoltsev, 2017).

The arithmetic mean of the indicators value (M) and its error (m), the standard deviation (□) were determined using the application software package «Microsoft Excel» and «StatSoft Statistica 6.1». The statistical significance of the differences was determined by parametric methods with the calculation of the Student's t-test. At $p<0.05$, the differences were considered significant.

Results

The overall level calculation of anthropometric characteristics variation allowed to determine the female students' somatotype (Table 1).

Table 1. **The girl's distribution by the overall level of anthropometric indicators variation (%)**

Age	Health group	Somatotype						
		1	2	3	4	5	6	7
18	I (n=100)	-	20,0	28,0	30,0	15,0	7,0	-
	III (n=39)		5,1	5,1	7,7	38,5	41,0	2,6
19	I (n=164)	1,8	11,6	20,1	26,8	25,1	14,6	-
	III (n=57)	-	3,5	5,3	8,8	29,8	49,1	3,5
20	I (n=165)	-	12,1	18,8	19,4	30,9	18,8	-
	III (n=59)	-	5,1	6,8	8,4	27,1	42,4	10,2
21	I (n=70)	-	15,7	20,0	24,3	27,1	12,9	-
	III (n=53)	-	5,7	7,5	7,5	26,4	41,5	11,4
Всего	I (n=499)	0,6	14,0	21,2	24,6	25,3	14,3	-
	III (n=208)	-	4,8	6,2	8,2	29,8	43,7	7,2

Note. Somatotypes: 1- megalosomal; 2-macrosomal; 3-megalomacrosomal; 4-mesosomal; 5-micromegalosomal; 6-microsomal; 7-nanosomal.

It was found that in girls of Ist health group, megalosomal body type (gigantism) occurs only at the age of 19 - 3 cases (0.6%). Girls with a nanosomal body type (dwarfism) were not registered. Gigantism is absent in girls of the IIIrd group of health, dwarfism occurs in 7.2% of students at all ages - from 2.6% (aged 18) to 11.3% (aged 21). Most often, microsomal stomatitis occurs in girls, aged 19, of the IIIrd health group (49.1%), which is 3.3 times more than the number of girls of this age in the Ist health group.

The distribution of somatotypes among girls in each of the study groups differ (Fig. 1).

The girls of the Ist functional health group (n=499), where students of all ages had no diseases and limitations for PE classes, microsomal constitution type ,is found 3.05 times less megalomacrosomal and mesosomal somatotypes 3.4 and 3.0 times higher, respectively, than in group IIIrd, where students had limitations on the volume and intensity of physical activity.

The number of girls with micromegalosomal somatotype is approximately the same in both groups observed. Compared to group IIIrd, the macrosomal, megalomacrosomal, and megalosomal somatotypes were significantly more common in group Ist girls.

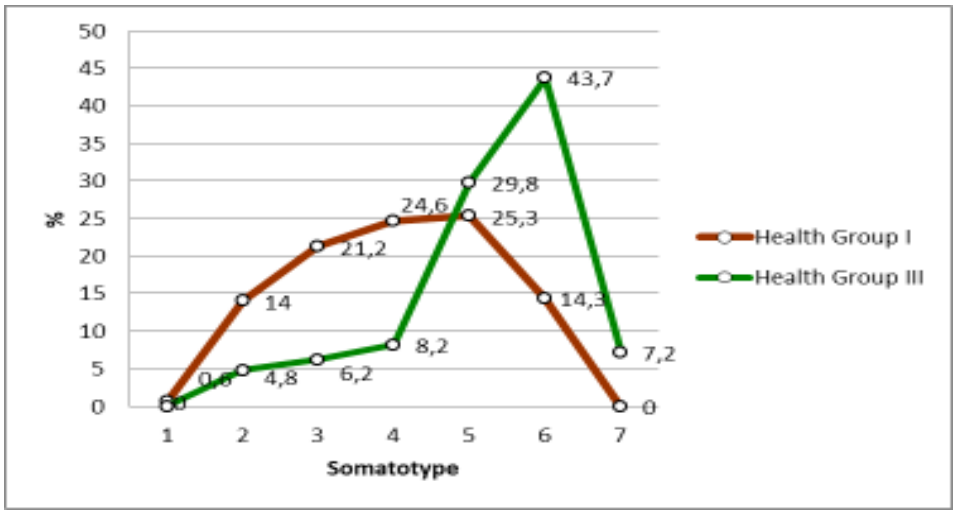

Fig. 1. The number of girls of different somatotypes in functional health groups (%)

Note. Somatotypes: 1- megalosomal; 2-macrosomal; 3-megalomacrosomal; 4-mesosomal; 5-micromegalosomal; 6-microsomal; 7-nanosomal.

In both functional health groups, the presence of female students of all ages with transitional body types (micromegalosomal and megalomacrosomal) may indicate the continuation of the examined adolescent girls' growth processes of the body.

When studying the types of human constitution, the organism's development variant characteristics determine its biological maturity. The examined girls' of both groups variants of the age development of the body are presented in Table 2.

Table 2. **The number of girls with different variants of body development (%)**

Age	Health group	Biological variant of the organism development		
		Accelerated (shortened) type «A»	Banal (normal) type «B»	Retarded (stretched) type «C»
18	I (n=100)	25,0	48,0	27,0
	III (n=39)	24,5	52,4	23,1
19	I (n=164)	24,4	54,2	21,4
	III (n=57)	13,8	66,9	19,3
20	I (n=165)	0,70	99,30	-
	III (n=59)	13,3	66,5	20,2
21	I (n=70)	20,5	49,2	30,3
	III (n=53)	14,2	68,9	16,9
Total	I (n=499)	12,4	74,2	13,4
	III (n=208)	16,3	63,9	19,8

In the Ist functional health group, the number of students of all ages with accelerated «A» and retarded «C» variants of the body development is 5.9 and 5.5 times less, respectively, than students with a banal «B» variant of it. In the IIIrd group of health, the number of students with the variants of the body development «A» and «C» is 3.9 and 3.2 times less, respectively, than students with a «B» variant of the body development.

The variant «A» of the girls' body development is more often registered in both functional groups at the age of 18. In the Ist functional health group, girls with the «B» body development variant were more at the age of 20 (99.3%), with the «C» body development variant were more at the age of 21 (30.3%). In the IIIrd functional group of health, girls with the «B» body development variant were more at the age of 21 (68.9%), with the «C» body development variant were more at the age of 18 (24.0%).

Girls of the Ist functional health group with the «B» body development variant, who do not have contraindications to perform a significant amount and intensity of physical activity in PE classes, are 15.1% more than girls of the IIIrd functional health group with the same body development variant, but having restrictions on the volume and intensity of physical activity.

The component composition of the human body reflects the peculiarities of metabolic processes course in the body and can affect its physical development. The characteristics of the examined girls' component composition of the body are given in Table 3.

Table 3. **The girls' body component composition (kg)**

Age	Health group	The components content in the body of girls (kg)		
		Fat mass	Muscle mass	Bone mass
18	I (n=100)	9,9±0,46	23,2±0,30	11,4±0,12
	III (n=39)	12,5±0,55*	18,7±0,45*	11,4±0,22
19	I (n=164)	10,3±0,41	24,0±0,27	11,1±0,11
	III (n=57)	12,7±0,34*	18,3±0,38*	11,7±0,23
20	I (n=165)	10,3±0,35	23,2±0,22	11,1±0,09
	III (n=59)	13,1±0,37*	18,4±0,28*	12,3±0,29
21	I (n=70)	10,0±0,55	24,1±0,41	11,4 ±0,15
	III (n=53)	13,5±0,67*	18,3±0,76*	12,02±0,32
Total	I (n=499)	10,1±0,21	23,8±0,14	11,1±0,05
	III (n=208)	13,3±0,32*	18,4±0,18*	11,8±0,22

Note: * - indicators values between the Ist and IIIrd health groups are significant ($p < 0.05$)

At all ages, there was a difference in body fat and muscle mass content between girls of the Ist and IIIrd health groups, $p < 0.05$. In girls of the Ist group of health, fat mass content is 1.3 times less, and the muscle component is 1.29 times more than in girls of the IIIrd group of health ($p < 0.05$). There are no differences in the content of the bone component in the body between the girls of different functional groups ($p > 0.05$). All the girls' body component composition in per cents is shown on Fig. 2.

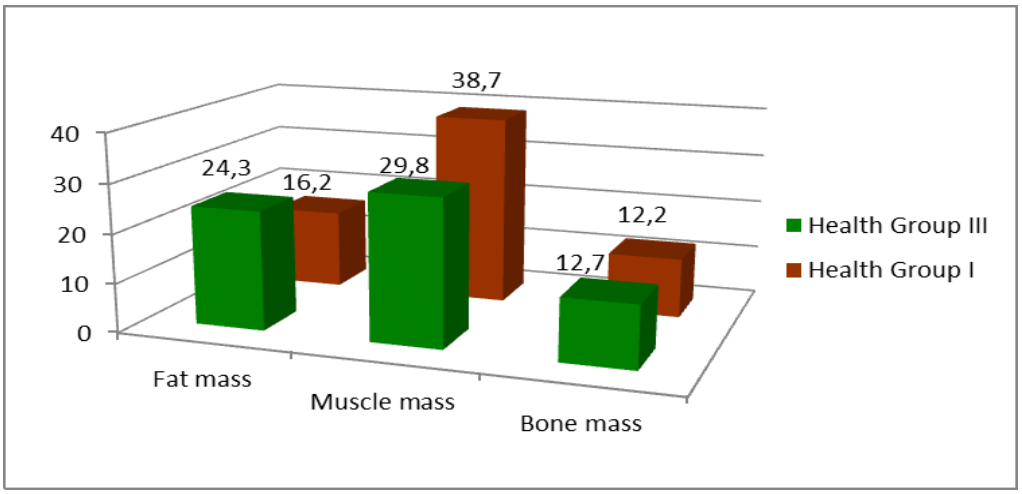

Fig. 2. Basic component composition content in the girls' body (%)

All girls of the III[rd] group of health have a fat mass content of 50.0% more, and a muscle component of 22.9% less than all girls of the I[st] group of health. The percentage of bone mass in the body of girls is the same in both groups.

The content of body weight components of the of girls with different somatotypes and of all health groups is shown in Figure 3.

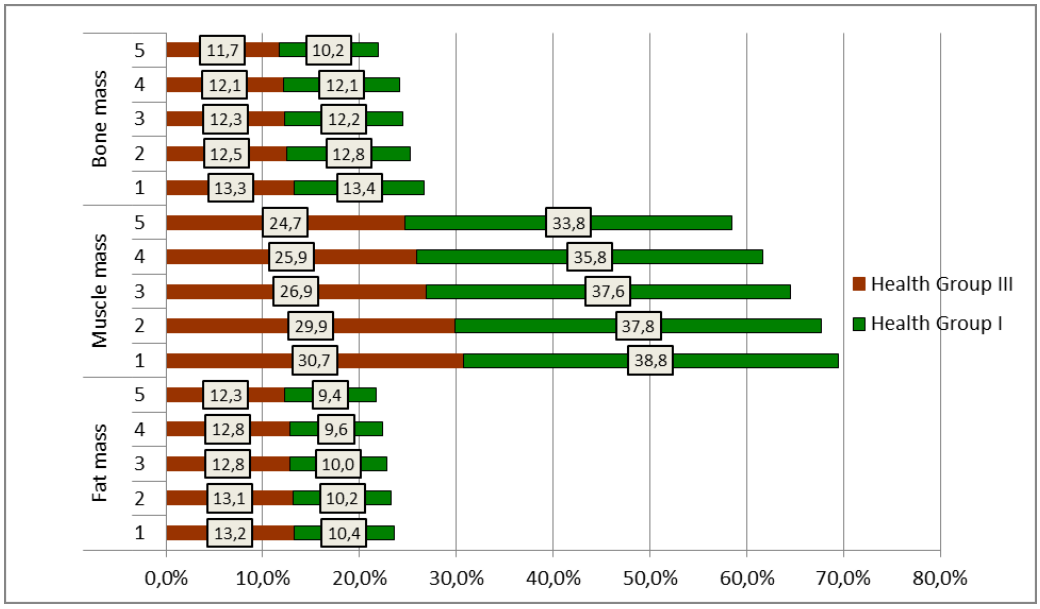

Fig. 3. Basic component content in the girls' of different somatotypes and health groups body (%)

Note. Somatotypes: 1 - microsomal; 2 - micromegalosomal; 3 - mesosomal; 4 — megalomacrosomal; 5 - macrosomal.

It was found that in both functional health groups, the body fat mass is higher in girls with the macrosomal somatype, and less in girls with the microsomal one. There is a trend to increase the fat mass content in the body of girls from the microsomal to the macrosomal constitution type (Fig. 3).

Both functional health groups contain more muscle components in the body of girls with the macrosomal constitution type (38.8% in girls of the I[st] health group and 30.7% in girls of the III[rd] health group) and less muscle tissue in girls with the microsomal somatotype. The bone component content in the body weight between girls with different somatotypes within each health group is practically the same.

The ratio of different anthropometric dimensions of the human body allows assessing the proportional level of body development. Table.4 shows the distribution of all girls according to the **proportional sign of the somatotype.**

Table 4. Girls' distribution according to the proportional level of variation of anthropometric indicators (%)

Age	Health group	Somatotype						
		1	2	3	4	5	6	7
18	I (n=100)	-	7,0	21,0	49,0	14,0	9,0	-
	III (n=39)	-	12,1	11,4	47,6	11,6	17,3	-
19	I (n=164)	1,8	0,7	11,6	76,2	7,9	1,8	-
	III (n=57)	-	8,0	16,4	51,2	2,8	21,6	-
20	I (n=165)	-	9,0	20,1	44,1	18,9	7,9	-
	III (n=59)	-	2,3	16,1	61,0	14,5	6,1	-
21	I (n=70)	-	8,4	11,6	58,6	10,0	11,4	-
	III (n=53)	-	8,5	13,2	56,6	8,5	13,2	-
Total	I (n=499)	0,6	3,8	12,6	63,0	15,2	4,8	-
	III (n=208)	-	5,8	16,1	57,6	11,0	9,5	-

Note. 1-megalomembral; 2-macromembral; 3-megalomacromembral; 4-mesomembral; 5-micromegalomembral; 6-micromembral; 7-nanomembral

In the population of all examined girls of all ages, girls with an average length of the lower extremities (mesomembral somatotype) are most often found. In the group IIIrd, the health of girls with such a somatotype is 8.7% less, short-legged (micromembral somatotype) and long-legged (macromembral somatotype) is 97.9% and 27.7% more, respectively, than in the Ist group of health. According to the results of the screening, it was found that more than half of the examined girls have a body shape formed proportionally.

Dicussion

Low physical activity of the population in a number of European countries (WHO Fact Sheet-Physical Activity, 2015; Potop et.al., 2017), USA (Basset et.al., 2013) and in Russia (Kolokoltsev et.al., 2020) is associated with teachers' and coaches' disregard of students' constitutional typology of physical education knowledge (Boutcher, 2018). In this regard, the study of this issue is particularly relevant and is of great practical importance in the planning of students' PE educational process. Such studies are of particular importance for the physical education of girls as expectant mothers. We believe that this study of girls' of different functional health groups somatotypes characteristics, which differ in the volume and intensity of physical activity, has an important scientific and practical focus. It is known that in the process of body growth and development under the influence of constantly changing living conditions of the individual, accelerated or delayed body development, migration and other processes in adolescence, the final type of the human constitution is formed (Satarov, Karelina, 2018).

In our study, the low values of somatotypes' overall dimensions in a significant number of girls in IIIrd group of health, where the volume and intensity of physical activity is limited, confirm the data on their physical health violation and disharmonious physical development. We believe that this feature may be a marker of the delayed maturation of girls with IIIrd health group who have somatic diseases. Indirect evidence of this fact is the identification of a significant number of girls with micromegalosomal and megalomacrosomal transitional body types and the presence of a delayed version of the body biological development in almost 20% of the examined girls. We agree with the statement that young people's asthenization is a manifestation of the processes of slowing down physical development associated with the body adaptation to negative environmental factors (Sindeeva et.al., 2019).

A comparative analysis of the body component composition of the girls examined by us indicates a significantly low content of muscle and high content of fat mass in the body of girls of IIIrd group of all constitution types, compared with the results of girls of group Ist with the same somatotypes. The highest content of fat mass (13.2%) was found in girls of the IIIrd group of the macrosomal constitution type, the lowest in girls with microsomal somatotypes. The highest content of muscle mass was recorded in both groups in girls with macrosomal somatotype. Girls with this somatotype have higher strength abilities, as we reported earlier (Kolokoltsev et.al., 2020).

The research materials are consistent with the results of identifying the correlation between motor qualities and body composition in European female students (Karol Görner, Alexa Reineke, 2020) and low physical activity of modern youth (Basset et.al., 2013; Potop et.al., 2017; Zhang et.al., 2019). We believe that girls with low overall body size and transitional types of constitution, with deviations in the component composition of the body should be allocated to the risk group for non-communicable diseases.

We believe that the results of our research of somatotypes and the component body composition of girls in different functional health groups will help in training programs for physical activity formation in the discipline «Physical culture and Sports» in educational institutions. Teachers in the classroom should pay special

attention to girls with low overall body size and with transitional types of constitution, as persons with disharmonious physical development. Girls with a high content of fat mass in the body should be recommended to perform an independent program for body weight normalization using low-calorie diets and performing aerobic exercises (swimming, long walking, crossfit). Girls with a low content of muscle tissue in the component composition of the body should be recommended for strength physical activity aimed at increasing the growth of muscle mass and correcting the protein component of nutrition with an increase in the diet of animal and vegetable proteins.

Our opinion is that the integration of somatotypology and human physical activity is a promising direction in the scientific and practical study of population physical education.

Conclusions

A comparative analysis of girls' with different amounts of physical activity intensity constitution types showed significant differences. More than 35% of all examined girls have transitional somatotypes, which indicates their disharmonious physical development and a possible risk of developing non-communicable diseases. It was found that the girls in the Ist functional group of the health no girls with nanosomal body type (dwarfism) were registered. Girls of IIIrd health group do not have a megalosomal body type (gigantism). It was found that the number of girls with a physiological (banal) period of biological maturation is 15.1% more than in the IIIrd health group.

In both functional health groups, girls of the microsomal somatotype have the lowest body fat content, while girls with the macrosomal somatotype have a higher body fat content than students with other somatotypes. The trend of increasing the body fat content is directed from girls with small weight and height sizes to girls with large overall body sizes.

The highest content of the muscle component in body weight was observed in girls with the macrosome constitution type (38.8% in girls of the Ist health group and 30.7% in girls of the IIIrd health group). In both health groups, girls with microsomal somatotype have less muscle tissue, which impairs their strength and endurance. Within each functional group, there were no significant differences in the bone component content in body weight between girls with different somatotypes. The results of the proportional variation level analysis showed that in both health groups, more than half of the girls belong to the mesomembral somatotype and have an average lower limbs length, which indicates a harmonious physical development of the girls' population.

In planning PE in educational institutions, it is necessary to include the results of students' body somatotyping. It will increase sports and recreation technologies effectiveness in educational institutions and students' health level. The results and conclusions of such research works can be used in monitoring young people's physical health.

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