

Motor qualities of girls from different populations and evolutionary constitution types

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Abstract:

Increasing the effectiveness of physical education classes in educational institutions continues to be an urgent problem. Physical activity individualization issues, based on the account of the human constitution evolutive types remain not fully studied. *Research aim is:* to conduct a comparative characterization of the relationship between the constitutional types of age evolution and the motor qualities of girls in different populations. *Research materials and methods.* The participants of the research work were 443 girls, aged 18, university students (Russia). In 2009, 229 girls were examined, in 2020 - 214 people. Anthropometry was performed to determine the length of the body and lower limbs and motor qualities testing. The trochanter index was calculated to determine the girls' evolutionary type of constitution and their sexual development rate. *Research results.* It was found in 2020, that after 11 years, the number of long-legged girls with a hypo-evolutive type and a timely sexual development rate increased by 5.2 times, with a disevolutive type ($TrI = 1.86-1.91$) and a delayed sexual development type increased by 2 times. The number of girls with normevolutive, hyperevolutive types of constitution decreased by 2.9 times. The number of short-legged girls with a disevolutive ($TrI = 2.04-2.08$) constitution type and a slow sexual development rate decreased. As in 2009, no girls with pathological types of constitution were identified. In both populations, representatives of the hypoevolutive and normevolutive constitution types turned out to be more physically prepared; the motor qualities of girls of the disevolutive type with a trochanter index value of 2.04-2.08 were poorly developed. The values of the girls' motor tests (except for the flexibility test) were significantly lower in 2020 compared to 2009. *Conclusions.* To assess the motor qualities of girls, taking into account the results of the study of the trochanter index, the type of evolutionary body constitution and the sexual development rate.

Key Words: physical education, evolutive constitution type, sexual development rate, motor qualities

Introduction

A person's physical development is an integral indicator of the health state and adaptive capabilities of his body and depends on heredity and life environment (habitat) (Luo et al., 2019; Ignatenko et al., 2021). It is known that adverse factors can reduce the physical development level or form a harmonious state of morphometric and functional characteristics. Due to the negative characteristics of the younger generation's physical health in some countries (Zhang et al., 2019; Zurita-Ortega et al., 2019), the solution of this issue is relevant and requires in-depth study (Rueggsegger, & Booth, 2018). The number of students with serious health disabilities for physical education is increasing in student groups (Gerber et al. 2017; Glazkova et al., 2020).

One of the controlled environmental factors is human physical activity (Zhamardiy et al., 2020; Mazin et al., 2021; Syamsudin et al., 2021), which can affect somatometric and physiometric characteristics of the body, especially in the adolescent period of human ontogenesis (Yildiz, 2018; De la Camara et al., 2021). A close relationship of morphofunctional features of the organism with the peculiarities of human motor qualities manifestation has been established (Alarkon et al., 2015; Druz et al., 2017).

Determining the vector of constitution type changes, anthropometric and motor qualities of modern youth, allows researchers, specialists, PE teachers and coaches to create a basis for pedagogical approaches to physical education. Such studies are important for girls of reproductive age as expectant mothers (Broughton, & Moley, 2017). One of the important problems of students' physical education content is to increase the effectiveness and individualization of the training regime (Ashanin et al., 2018; Gumenyuk et al., 2021). There is data in the literature on the use of various means and methods to increase the PE classes effectiveness related to the peculiarities of the type of the body constitution (Kolokoltsev et al., 2021). A promising direction in physical culture and sports is to determine the constitutional type of age evolution in students, which reflects the adaptive capabilities of the body to external influences, including physical loading (Shchankin, 2011).

The type of human evolutionary constitution can be determined by finding the trochanter index (TrI), which shows the ratio of a person's body length to the length of his lower limb. This index correlates with the rate of sexual development and the individual-typical characteristics of the examined people's constitution. In the scientific works of Shchankin (2011), the dependence of the trochanter index on the climatic and ecological features of one of the regions of Russia was established. The author shows that in persons with extreme types of constitution (disevolutive and pathological), the functional systems of the body work with considerable stress.

The analysis of scientific literature has shown the insufficiency of studying the issues of changing the nature of the relationship between the constitutional type of age evolution, the sexual development and the motor qualities pace of girls in different populations. This is necessary for the correction of training programs of physical education and sports activities.

Research aim is to conduct a comparative characterization of the relationship between the constitutional types of age evolution and the motor qualities of girls in different populations.

Material & methods

443 girls, university students aged 18 aborigines of Eastern Siberia (Russia) took part in the research project. Two surveys were organized: in 2009 - 229 girls and in 2020 - 214 girls were surveyed. To characterize all the girls' rates of sexual development and determine the constitutional type of age evolution, anthropometric measurements of standing body length (BL), leg length (LL), cm (International Standards for Anthropometric Assessment, 2001) were performed, the trochanter index (TrI) was calculated using the formula: $TrI = BL/LL$, where BL is body length, cm, LL – leg length, cm (Shchankin, 2011). The types of the girls' constitution were determined by the trochanter index value. The value of $TrI < 1.85$ conventional units corresponds to the pathological type of constitution, from 1.86 to 1.91 – disevolutive, from 1.92 to 1.94 – hypoevolutive, from 1.95 to 2.0 – normoevolutive, from 2.01 to 2.03 – hyperevolutive, from 2.04 to 2.08 – disevolutive, >2.09 - pathological. The normoevolutive type is considered to be the optimal type of the evolutionary constitution. The value of TrI was also used to determine the sexual development rate. In this case, the TrI value <1.94 conventional units corresponds to a slow rate of sexual development, from 1.94 to 2.01 - a timely rate of sexual development, >2.01 - an accelerated rate of sexual development (Vasilchenko et al., 1990).

All the girls' motor qualities were determined by the value of motor test indicators, Table 1.

Table 1. Design of a scheme for the girls' motor qualities testing

Agility	Quickness	General endurance	Strength			Flexibility
			upper shoulder girdle muscles	torso flexor muscles	lower extremities muscles	
Tests						
№ 1	№ 2	№ 3	№ 4	№ 5	№ 6	№ 7
Shuttle run 10 times x 5 m, s	Run 100 m, s	Run 1000 m, min/s	Hang on a high bar, s	Abdominal crunch, number of times	Standing long jump, cm	Sit and reach, cm

Methods of variational and statistical processing of the obtained data were used. The arithmetic mean (M) and standard error (m) were calculated. The statistical significance of the differences in characteristics was determined by the parametric criterion t-Student's criterion. The differences in the values of the studied parameters were considered reliable at a threshold of 95% probability ($p < 0.05$). The application software package «Microsoft Excel» and «Statistica 6.0» were used. The conducted research does not violate the rights of the examined girls, according to the ethical standards of the Helsinki Declaration of the Committee on Human Rights of 2008 (WMA Declaration of Helsinki, 2013)

Results

The results of anthropometric measurements and the determination of TrI in girls of different generations are presented in Table 2.

Table 2. Values of anthropometry and TrI indicators in girls of different populations (M±m)

Indicators	Population	
	2009 year (n=229)	2020 year (n=214)
Body length, cm	165.69±1.46	166.72±1.62
Lower extremity length, cm	83.17±0.81	88.07±0.99*
Trochanter index (TrI), conditional units	1.99±0.12	1.89±0.14*

Note. * - the difference is significant ($p<0.05$)

It was found that the lower extremity length in the girls of the 2020 population is 5.9% longer, the value of the trochanter index is 5.0% greater than in the girls of the 2009 population ($p<0.05$). Figure 1 illustrates the results of the girls' distribution by types of evolutionary constitution (by TrI values).

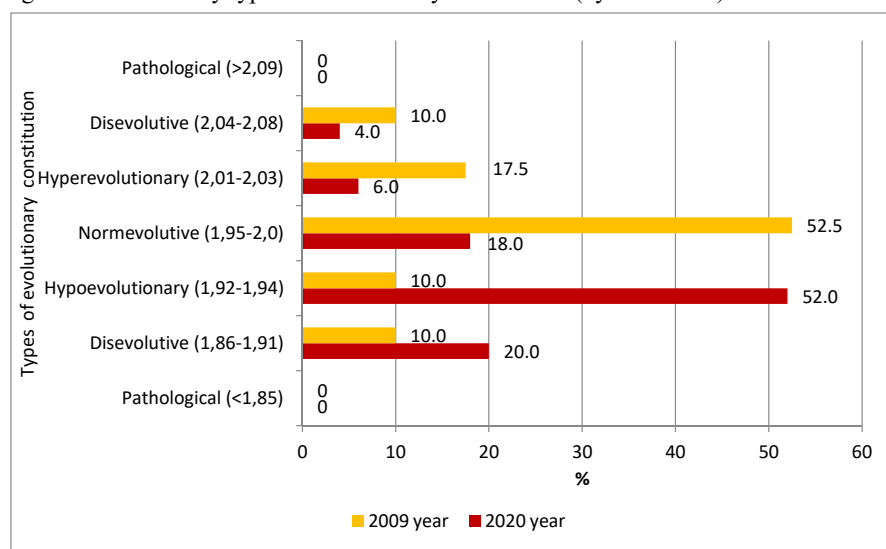


Fig. 1. The number of girls in different populations with different evolutionary constitution types

In 2009, the number of girls with a normoevolutive constitution type was 52.5%, with a hyperevolutive one - 17.5%. The remaining types of constitution were found in 10% of girls. No girls with pathological types of constitution have been identified. Analysis of the survey results in 2020 showed that the number of girls with the normoevolutive type of constitution decreased by 2.9 times, with the hypoevolutive type increased by 5.2 times, with the disevolutive type ($TrI = 1.86-1.91$) increased by 2 times, with the hyperevolutive type decreased by 2.9 times, with the disevolutive type ($TrI = 2.04-2.08$) decreased by 2.5 times compared to similar types of girls surveyed in 2009. No girls with pathological types of constitution have been identified.

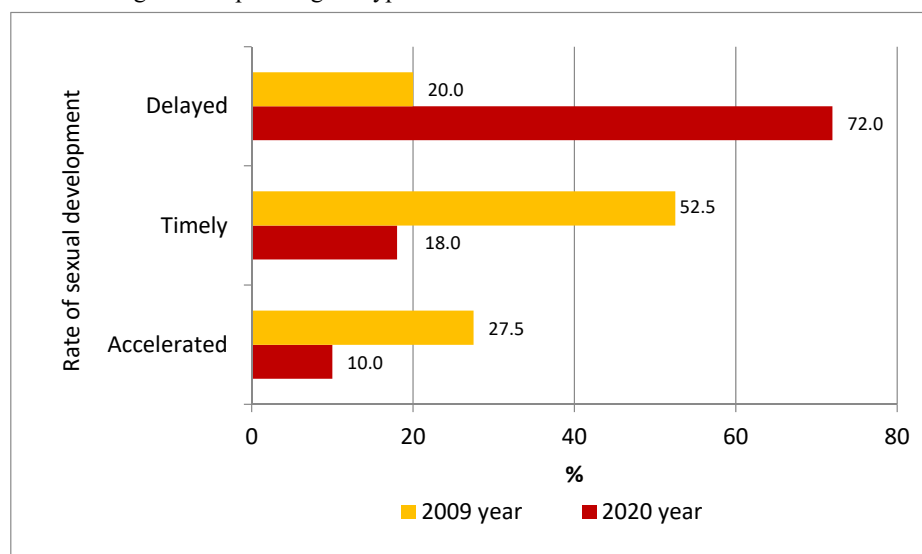


Fig. 2. The number of girls in different populations with different sexual development rates

In the 2009 population, more than half of the girls had a timely rate of sexual development, 27.5% accelerated and 20.0% - a slow rate of it. In the population of 2020, the number of girls with a timely rate of sexual development decreased by 2.9 times, with an accelerated rate decreased by 2.75 times, with a slow rate increased by 3.6 times, compared with similar rates of sexual development of girls in the population of 2009. To establish the relationship of the girls' evolutive types of the constitution with their motor qualities, physical fitness testing was conducted, Table 3.

Table 3. Values of motor tests indicators in girls of different populations and evolutionary constitution types (M±m)

№/test	Constitutional types of age evolution/ sexual development rate									
	Disevolutive /accelerated <i>TrI</i> = 2,04-2,08		Hyperevolutive/ accelerated <i>TrI</i> = 2,01-2,03		Normevolutive/ timely <i>TrI</i> = 1,95-2,0		Hypoevolutive/ timely <i>TrI</i> = 1,94-1,92		Disevolutive/ delayed <i>TrI</i> = 1.91-1,86	
	Population (year)									
	2009	2020	2009	2020	2009	2020	2009	2020	2009	2020
Agility										
1. Shuttle run, s	18.48±0.08	19.82±0.07*	17.3±0.07	19.6±0.08*	17.20±0.07	19.4±0.08*	16.45±0.06	17.23±0.07*	17.25±0.06	19.5±0.08*
Quickness										
2. Run 100 m, s	17.72±0.07	18.68±0.09*	16.40±0.07	17.60±0.08*	16.39±0.07	17.38±0.08*	16.16±0.09	16.78±0.06*	16.49±0.07	17.46±0.08*
General endurance										
3. Run 1000 m, min/s	6.50±0.07	6.90±0.08*	5.50±0.07	6.20±0.06*	5.20±0.06	6.19±0.07*	5.10±0.05	5.80±0.07*	5.27±0.06	6.22±0.07*
Strength										
4. Hang on a high bar, s	8.70±0.63	7.51±0.45	9.22±0.48	8.0±0.34*	9.68±0.52	8.60±0.43*	9.85±0.45	8.84±0.42	8.93±0.52	7.60±0.43*
5. Abdominal crunch, number of times	23.56±0.05	22.86±0.03*	24.45±0.04	23.20±0.03*	26.65±0.04	24.40±0.05*	27.24±0.04	25.29±0.03*	26.75±0.04	24.40±0.05*
6. Standing long jump, cm	170.4±0.7	171.2±0.8	171.4±0.8	169.5±0.6	172.9±0.9	170.2±0.8*	175.4±0.8	171.5±0.7*	170.9±0.9	168.2±0.8*
Flexibility										
7. Sit and reach, cm	15.23±0.18	15.76±0.19	15.35±0.17	15.10±0.15	15.58±0.29	15.25±0.31	15.47±0.27	15.32±0.26	15.64±0.31	15.35±0.30

Note. * - the difference is significant (p<0.05)

In 2009, the highest indicators of all motor qualities in the tests (with the exception of the flexibility test) were reliably established in girls with a hypoevolutive type of constitution and a timely rate of sexual development. Close to them were the results of motor qualities testing in girls with a normevolutive type of constitution and the same rate of sexual development. In girls with a disevolutive type of constitution (TrI = 1.91-1.86) and a delayed type of sexual development, the results of motor tests were worse than in girls of normevolutive and hypoevolutive types of constitution with the same type of sexual development. In girls with a hyperevolutive type of constitution and an accelerated rate of sexual development, the indicators of testing motor qualities were lower than in girls with normevolutive and hypoevolutive types of constitution and a timely rate of sexual development.

Girls with a disevolutive type of constitution (TrI = 2.04-2.08) and an accelerated rate of sexual development have the lowest results of testing motor qualities relative to other types of evolutionary constitution and rates of sexual development. The data obtained by us indicate the presence of a reliable relationship between motor qualities and types of evolutionary constitution in adolescent girls with different rates of sexual development.

In the girls surveyed in 2020, the values of all motor qualities indicators (except flexibility) were significantly lower than in the girls of the 2009 population with the same types of evolutionary constitution and rates of sexual development. This may indicate deterioration in the physical health of girls in the 2020 population.

Dicussion

Significant changes in human living conditions associated with the influence of various endo- and exo-factors leads to the formation of a certain type of human constitution. It is known from literature sources that the indicators of the physical qualities development of the human body depend largely on its constitutional type (Druz et al., 2017). In the practice of students' physical education, there is a constant need for in-depth study of physical activity relationship with the anthropometric, functional characteristics of their body and body type. Therefore, it is important to conduct surveys with long time intervals, which assess the vector of variability of types of constitution and allow more effective use of the principle of physical activity individualization (Ashanin et al., 2018; Gumenyuk et al., 2021). A promising direction for improving PE effectiveness is the use of evolutive constitution knowledge based on the trochanter index calculation (Shchankin, 2011). Comparative observations of youth populations with a long time interval are needed to determine the relationship between the constitutional type of age evolution, the rate of sexual development and the physical fitness of a young organism (Kolokoltsev et al., 2021).

The female students' of different generations survey allowed the authors of this publication to identify comparative features of the evolutionary constitution types distribution, the rate of sexual development of girls aged 18, which is important when planning PE classes for young people to improve the effectiveness of the educational process of physical culture at the university. The results of the research work showed that the girls of the later population of 2020 have a value of the trochanter index significantly higher than that of the girls surveyed in 2009. This indicates the process of gracilization of the physique of girls of the 2020 generation and the tendency to continue the process of asthenization of modern youth.

There is information in the scientific literature about the close relationship of a person's motor qualities with his morphofunctional characteristics (Yıldız, 2018; De la Camara et al., 2021). We have established the features of the motor qualities of girls with different types of evolutionary constitution and rates of sexual development. In both populations, the highest indicators of motor qualities were found in girls with normevolutive and hypoevolutive types of constitution and a timely rate of sexual development, in whom the value of the trochanter index shows a continued increase in the lower extremities length. We regard this situation as optimal and agree with the opinion of Vasilchenko et al. (1990). Such a combination of anthropometric and constitutional data in humans is considered comfortable for sports (Martirosov et al., 2010).

The lowest indicators in the motor qualities testing were noted by us in girls with a disevolutive type of constitution ($TrI = 2.04-2.08$), a slow rate of sexual development and shortened lower extremities. This is consistent with the opinion of Shchankin (2011), who established the lowest characteristics of the adaptive capabilities of the body in girls with the disevolutionary type of constitution.

Our results of the girls' survey in 2020 are consistent with numerous data from other research papers, which noted a decrease in the physical, somatic and mental health of modern youth (Zhang et al., 2019; Zurita-Ortega et al., 2019; Chekhovska et al., 2020).

Conclusions

Individualization of physical activity, based on the definition of the human constitution type, refers to an important methodological principle of PE classes' organization in educational institutions. The results of our comparative observation of the girls' aged 18 type of evolutionary constitution formation in different populations showed a tendency to change the modern girls' physique. After 11 years (2020), the number of examined long-legged girls with a hypo-evolutive type and a timely rate of sexual development increased by 5.2 times, with a disevolutive type ($TrI = 1.86-1.91$) and a delayed type of sexual development increased by 2 times. The number of girls with normoevolutive, hyperevolutive types of constitution decreased by 2.9 times. The number of short-legged girls with a disevolutive ($TrI = 2.04-2.08$) type of constitution and a slow rate of sexual development decreased by 2.5 times. As in 2009, no girls with pathological types of evolutionary constitution were identified.

The difference in the motor qualities development of girls with different evolutionary types of constitution and observation years has been established. The most developed motor qualities were found in girls of the 2009 population with hypoevolutive and normevolutive types of constitution. The lowest values of motor qualities were registered in girls classified as a disevolutive type ($TrI 2.04-2.08$). In 2020, in girls of all types of evolutionary constitution, the values of motor qualities testing indicators (except for flexibility) were lower than in girls surveyed in 2009.

In pedagogical sports practice, it is important to increase the effectiveness of the educational and training process. Therefore, the use of the results of the examination of the necessary characteristics of the body of people who regularly perform physical activity is the basis for planning and organizing population training programs.

Conflicts of interest. The authors declare no conflict of interest.

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