

БИОЛОГИЯ



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Morphofunctional development of 13-15-year old girls of different somatotypes

Abstract: The present article provides a comparative analysis of the morphofunctional indicators of 13–15 year old girls of different types of constitution, living in the cities of Pavlodar and Kyzylorda. Most of the studied schoolgirls belonged to the thoracic and muscular types of constitution. Considerable attention is paid to the comparison of such morphological parameters as body length (BL), body mass (BM), chest circumference (CC), wrist strength (WS), cardio-respiratory system indices at rest and after dosed load. The study found that morphological parameters (BL, BM, CC) in girls of two regions increase from asthenoid type to digestive. The results show that the capacity of the cardio-respiratory system of girls of the digestive type is less compared with schoolgirls of other somatotypes.

Keywords: morphofunctional development, types of constitution, cardio-respiratory system, physical development.

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Human health is formed in ontogenesis and at its each stage is determined by a set of different reactions for the realization of the innate characteristics of the organism. Nowadays requirements for the pedagogical and health process require ever more in-depth study of individual-typological (constitutional) differences at each stage of individual human development. Typological differences of children and adolescents should be the basis of a differentiated approach in the upbringing, education and conduction of therapeutic and recreational activities [1]. This problem is of particular relevance in assessing the dynamics of the development of children and adolescents, since only the value of the child's individual capabilities and the prediction of his ontogenesis is a necessary prerequisite for successful education and upbringing without compromising health [2].

The problems of constitutional science in Kazakhstan have not been well studied, except for the works of Z.M. Aliakbarova [3, 4]. Therefore, the study of the characteristics of the physical development of children, taking into account the individual-typological features, is relevant.

The present study aimed to investigate the morphological and functional indicators of 13–15 year old schoolgirls of different types of constitution, living in cities of Pavlodar and Kyzylorda.

Materials and methods

The research was conducted on the basis of schools in the cities of Pavlodar and Kyzylorda. In total, 120 children aged 13–15 years old of different types of constitution took part in the study.

Types of the constitution were determined by the method of V.G. Shtefko and A.D. Ostrovskiy [5]: asthenoid (A), thoracic (T), muscular (M), digestive (D). Among the main anthropometric indicators of physical development the following were investigated: body length (BL), body mass (BM), chest circumference (CC), wrist strength (WS). According to the length, body mass and chest circumference the Quetelet index (QI) and stenia index (SI) were determined: $QI = BM, \text{ kg} / BL, \text{ m}^2$; $SI = BL, \text{ cm} / (2 \times BM, \text{ kg} + CC, \text{ cm})$ [6]. The function of external respiration was assessed by the indicator of vital capacity of the lungs (VC) using a dry spirometer [7], and the vital index (VI =

VC / BM) was also calculated [8]. In order to study the adaptation to physical loads and assess the functional reserves of the body, a step ergometric testing was conducted [9]. Heart rate (HR) was determined using an electrocardiograph "Axion EC 1T-07"; blood pressure (BP) was measured by the Korotkov auscultatory method [10].

The significance of differences was assessed by Student's t-test, the differences were considered significant at $p < 0.05$ [11].

Results and discussion

Analyzing the data obtained, the following distribution of types of constitution of schoolgirls living in Pavlodar city was revealed: asthenoid type – 15%, thoracic type – 59%, muscular type – 23%, digestive type – 3%. Among schoolgirls living in Kyzylorda, the following distribution of somatotypes was noted: asthenoid type – 48%, thoracic type – 45%, muscular type – 7%, while schoolgirls with digestive type constitution were not detected (Fig. 1).

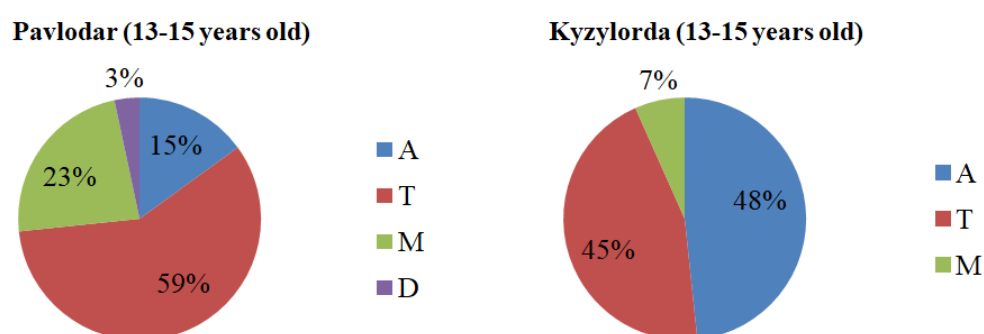


FIGURE 1 – Distribution of types of constitution of schoolgirls (13-15 years old) in Pavlodar and Kyzylorda

The main anthropometric indicators (BL, BM, CC), as well as the Quetelet index, which characterizes body build obesity, in this age group tended to increase from asthenoid to digestive type. It is worth noting that, in terms of body length, schoolgirls in Kyzylorda were ahead of schoolgirls in Pavlodar. Significance was noted in children of the astenoid and muscular types of the constitution. For the rest of the indicators (BM, CC, QI) schoolgirls in Pavlodar were ahead of their peers in Kyzylorda (table 1).

Table 1. Indicators of physical development of 13-15 year old girls of different types of constitution living in the northern and southern regions of Kazakhstan

Indicators		Age, years old			
		13-15			
		A	T	M	D
N (number)	P	n=9	n=35	n=14	n=2
	K	n=29	n=27	n=4	
Body length, cm	P	158,1±1,4	160,2±1,1	158,9±1,6	166,0±1,5 *
	K	162,4±1,2 #	162,8±0,8	166,5±1,5 *#	
Body mass, kg	P	50,7±1,0	51,6±0,8	55,3±0,9 *	67,5±1,8 *
	K	48,2±1,0	51,8±0,6 *	54,8±2,0 *	
Chest circumference, cm	P	75,8±1,5	76,4±0,7	79,7±1,2	87,0±0,5 *
	K	73,8±0,7	76,2±0,8 *	79,4±2,0	
Quetelet index cu	P	20,3±0,2	20,1±0,2	21,9±0,4 *	24,5±0,2 *
	K	18,3±0,3 #	19,5±0,2 *#	19,7±0,6 #	
Stenia index cu	P	0,89±0,01	0,89±0,01	0,84±0,01 *	0,75±0,01 *
	K	0,96±0,01 #	0,91±0,01 *	0,88±0,02	
% of fat reserve	P	16,9±0,9	22,6±0,5 *	26,2±1,1 *	28,8±0,5 *
	K	17,3±0,5	21,7±0,5 *	24,3±0,3 *	

Fat reserve, kg	P	8,6±0,6	11,7±0,4 *	14,5±0,7 *	19,4±0,2 *
	K	8,4±0,4	11,2±0,3 *	13,3±0,5 *	
Active body mass, kg	P	42,1±0,8	39,9±0,5 *	40,7±0,7	48,1±1,6 *
	K	39,8±0,7 #	40,6±0,6	41,5±1,6	
Wrist strength (R+L), kg	P	41,8±1,5	41,4±0,8	43,8±2,0	41,0±4,5
	K	35,9±0,8 #	36,6±0,7 #	41,3±2,6	
Wrist index, kg/kg	P	0,82±0,02	0,81±0,02	0,79±0,03	0,61±0,1
	K	0,75±0,01 #	0,71±0,01 *#	0,75±0,03	
Notes - Significance of differences in mean values for non-parametric independent samples: * - in relation to the previous type of constitution (P<0,05); # - when comparing schoolgirls living in the northern and southern regions (P<0,05)					

Evaluation of the results of the wrist strength showed that schoolgirls in Pavlodar exceeded the values of schoolgirls in Kyzylorda (table 1). Analysis of the function of external respiration showed that the vital capacity of the lungs, both in the girls of Pavlodar and in the girls of Kyzylorda, is unevenly increasing from the asthenoid type to the digestive (table 2). In southern schoolgirls, the asthenoid and thoracic types of life indicator (LI) are lower in comparison with northern peers, which indicates a large reserve of the respiratory system of northern girls.

In the study of the functions of the cardiovascular system of girls at rest, higher values of heart rate, systolic and diastolic blood pressure were found in schoolgirls living in Pavlodar (table 2). The physiological meaning of a decrease in heart rate at rest contributes to an increase in the chronotropic reserve of the heart. This indicated a less economical functioning of the cardiovascular system in northern girls in a state of relative rest [12].

Table 2. Indicators of the cardio-respiratory system at rest of 13–15 year old girls of different types of constitution living in the northern and southern regions of Kazakhstan

Indicators		Age, years old			
		13-15			
		A	T	M	D
N (number)	P	n=9	n=35	n=14	n=2
	K	n=29	n=27	n=4	
<i>Respiratory system indicators</i>					
Vital capacity, liters	P	2,52±0,08	2,45±0,04	2,60±0,1	2,70±0,2
	K	2,27±0,04 #	2,30±0,05 #	2,75±0,1 *	
Life index, ml/kg	P	49,7±1,0	47,8±1,0	47,0±1,0	40,0±3,4
	K	42,9±3,4	44,4±0,8 #	50,3±1,7 *	
<i>Cardiovascular system indicators</i>					
Heart rate, bpm	P	83,2±0,9	83,5±0,5	83,4±0,7	85,0±0,5
	K	81,6±0,5	81,4±0,5 #	81,8±1,4	
Systolic pressure, mmHg	P	112,2±1,5	110,0±1,3	111,4±1,8	110,0±5,0
	K	107,0±1,3 #	107,4±0,9 #	107,5±2,5	
Diastolic pressure, mmHg	P	71,1±2,0	68,2±1,4	67,9±1,5	60,0±5,0
	K	62,5±1,4 #	62,6±1,6 #	62,5±2,5	
Pulse pressure, mmHg	P	41,1±1,1	41,8±0,8	43,6±1,3	50,0±0,0 *
	K	44,5±1,1 #	44,8±1,1 #	45,0±5,0	
Robinson index, cu	P	93,4±1,9	91,9±1,4	92,9±1,5	93,5±4,9
	K	87,4±1,4 #	87,4±0,9 #	88,0±3,4	
Stroke volume, mL	P	59,5±1,6	64,8±1,1 *	69,1±1,3 *	77,0±3,0 *
	K	66,4±1,3 #	68,8±1,4 #	71,4±3,8 #	
Cardiac output, L	P	4,95±0,1	5,41±0,1 *	5,77±0,1 *	6,5±0,2 *
	K	5,41±0,1 #	5,60±0,1	5,85±0,4	

Notes - Significance of differences in mean values for non-parametric independent samples:
 * - in relation to the previous type of constitution ($P < 0,05$); # - when comparing schoolgirls living in the northern and southern regions ($P < 0,05$)

Under the conditions of a step ergometric load with a capacity of 12 kg / min kg, in the studied schoolgirls, in terms of heart rate, systolic pressure, diastolic pressure and Robinson index, there was an increase from asthenoid to digestive type, while in the case of southern peers – to muscular. The adaptive cardiovascular system response to physical activity was accompanied by an increase in cardiac output. Blood pressure, stroke volume and cardiac output in girls of the digestive constitutional type were significantly higher compared with schoolgirls of other somatotypes (table 3).

Table 3. Indicators of the cardio-respiratory system under load of 13–15 year old girls of different types of constitution living in the northern and southern regions of Kazakhstan

Indicators		Age, years old			
		13-15			
		A	T	M	D
N (number)	P	n=9	n=35	n=14	n=2
	K	n=29	n=27	n=4	
Heart rate, bpm	P	161,2±0,9	162,3±0,7	162,6±0,8 *	165,0±2,0
	K	149,7±0,7 #	150,5±0,6 #	152,5±1,2 #	
Systolic pressure, mmHg	P	147,8±1,5	147,7±1,1	152,1±1,9	140,0±5,0
	K	143,5±1,1 #	145,2±1,2	147,5±2,5	
Diastolic pressure, mmHg	P	72,2±1,5	68,2±1,6	68,6±1,8	60,0±5,0
	K	63,0±1,3 #	63,0±1,6 #	62,5±2,5	
Pulse pressure, mmHg	P	75,6±1,8	79,5±2,0	83,6±2,0 *	80,0±0,0 *
	K	80,5±1,7	82,2±1,7	85,0±2,9	
Robinson index, cu	P	238,2±2,1	239,7±1,7	247,5±3,5	231,0±5,3
	K	214,7±1,9 #	218,5±1,9 #	225,0±4,8 #	
Stroke volume, mL	P	76,0±1,6	83,7±1,9 *	88,6±1,8	92,0±3,0
	K	85,7±1,6 #	87,2±1,7	91,4±2,3	
Cardiac output, L	P	12,3±0,3	13,6±0,3 *	14,4±0,3	15,2±0,7
	K	12,8±0,2	13,1±0,2	13,9±0,4	

Notes - Significance of differences in mean values for non-parametric independent samples:
 * - in relation to the previous type of constitution ($P < 0,05$); # - when comparing schoolgirls living in the northern and southern regions ($P < 0,05$)

When studying the values of the reaction of the cardiovascular system to physical activity in comparison with the state of rest, there was a noticeable increase in heart rate, systolic pressure, diastolic pressure and Robinson index in the northern representatives of all types of constitution, which demonstrates a high "price" of adaptation to physical activity. The study of physical performance (PWC170) of 13–15 year old girls showed higher values for southern schoolgirls, which proves greater endurance for girls living in Kyzylorda (table 4).

Table 4. Indicators of absolute and relative physical performance and maximum aerobic performance of 13-15 year old girls of different types of constitution living in the northern and southern regions of Kazakhstan

Indicators		Age, years old			
		13-15			
		A	T	M	D
N (number)	P	n=9	n=35	n=14	n=2
	K	n=29	n=27	n=4	
PWC170, kg·m /min	P	666,3±16,7	671,7±9,5	715,7±11,7 *	847,5±1,4 *
	K	708,3±14,5 #	759,1±13,7 #	775,5±28,0	
PWC170/kg,	P	13,14±0,1	13,03±0,1	12,96±0,1	12,60±0,4

kG·m /min· kg	K	14,69±0,1 #	14,64±0,1 #	14,17±0,2 *#	
VO2 max, L/min	P	2,02±0,04	2,02±0,02	2,11±0,03 *	2,40±0,01 *
	K	2,06±0,03	2,14±0,03 #	2,20±0,07	
VO2 max /kg, mL/min/kg	P	39,8±0,3	39,2±0,4	38,2±0,4 *	34,8±0,8 *
	K	42,9±0,4 #	41,4±0,2*#	40,3±0,4 #	
Notes - Significance of differences in mean values for non-parametric independent samples: * - in relation to the previous type of constitution (P<0,05); # - when comparing schoolgirls living in the northern and southern regions (P<0,05)					

Conclusions

1. Among schoolgirls living in Pavlodar, the most frequent are representatives of the thoracic and muscular constitutional types, and the rarest type is the digestive. Among Kyzylorda schoolgirls, asthenoid and thoracic types prevail, while the digestive type is absent.

2. Representatives living in Pavlodar are ahead of Kyzylorda peers in terms of physical development. Schoolgirls living in Kyzylorda have higher cardiovascular system functionality.

Список литературы

- 1 Мукатаева Ж.М. Морфофункциональное развитие детей разных соматотипов, проживающих в сельской и городской местности // Вестник карагандинского университета. Сер. Биология. – 2008. – № 1(49). – 29 с.
- 2 Айзман Р.И. Здоровье населения России: Медико-социальные и психолого-педагогические аспекты его формирования. – Новосибирск: СО РАМН. – 1996. – 27 с.
- 3 Алиакбарова З. М. Возрастные особенности физического развития детей // Функциональная морфология. Тез. докладов Всесоюзн конф., – 5-7 июня 1984 г., г. Новосибирск. – 1984. – 72 с.
- 4 Мукатаева Ж.М., Даирбаева С.Ж., Муханова А.А., Рубанович В.Б., Айзман Р.И. Морфофункциональное развитие детей разных соматотипов // Сибирский педагогический журнал. – 2008. – № 2. – 402 с.
- 5 Штефко В.Г., Островский А.Д. Схема клинической диагностики конституциональных типов. – М.-Л.: Госмедиздат, 1929. – 79 с.
- 6 Айзман Р.И., Айзман Н.И., Лебедев А.В., Рубанович В.Б. Методика комплексной оценки здоровья учащихся общеобразовательных школ (методическое пособие). – Новосибирск: НГПУ, 2008. – 17 с.
- 7 Даирбаева С.Ж., Муханова А.А., Мукатаева Ж.М. Состояние кардио-респираторной системы детей и подростков разных соматотипов // Вестник Семипалатинского государственного университета имени Шакарима. – 2007. – № 4. – 152 с.
- 8 Мартынов И.Ф. Функциональные методы исследования внешнего дыхания. – М., 1971. – 142 с.
- 9 Рубанович В.Б. Врачебно-педагогический контроль при занятиях физической культурой // Учебное пособие. – 2-е изд., доп. и переработ. – Новосибирск, 2003. – 262 с.
- 10 Мукатаева Ж.М., Кабиева С.Ж. Мониторинг физического развития и здоровья учащихся Г. Павлодар // Вестник Новосибирского государственного педагогического университета. – 2014. – № 1(17). – 53 с.
- 11 Лакин Г.Ф. Биометрия // Учебное пособие для биологич. спец. вузов. – 3-е изд; перераб. и доп. – М.: Высш. школа, 1980. – 293 с.
- 12 Рубанович В.Б. Морфофункциональное развитие детей и подростков разных конституциональных типов в зависимости от двигательной активности. – Новосибирск, 2004. – 406с.

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13-15 жастағы қыздардың әртүрлі соматотиптерінің морфофункционалды дамуы

Аннотация: Бұл мақалада Қазақстанның Павлодар және Қызылорда облыстарында тұратын конституцияның түрлеріне байланысты 13-15 жастағы қыздардың морфофункционалды көрсеткіштеріне салыстырмалы талдау келтіріледі. Зерттелген қыздардың көбісі астеноидтық және торакалдық конституция түрлеріне жатқан. Дене ұзындығы (ДҰ), дене салмағы (ДС), кеуде қуысының шеңбері (КҚШ), білек күшіне, тыныштық күйіндегі және мөлшерленген жүктемеден кейінгі кардио-респираторлық жүйенің көрсеткіштері сияқты морфологиялық көрсеткіштерге елеулі көңіл бөлінеді. Зерттеу барысында екі облыстағы қыздардың астеноидты түрден дигестивті түрге қарағанда морфологиялық көрсеткіштері (ДҰ, ДС, КҚШ) ұлғаюда. Алынған нәтижелер көрсеткендей, дигестивті түрдегі қыздардың кардиореспираторлық жүйесінің мүмкіндіктері басқа соматотиптердің қыздары мен салыстырғанда аз.

Түйін сөздер: морфофункционалды даму, конституция түрлері, антропометриялық көрсеткіштер, кардио-респираторлық жүйе, дене дамуы.

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*Евразийский национальный университет им. Л.Н.Гумилева, Астана, Казахстан***Морфофункциональное развитие девочек 13-15 лет разных соматотипов**

Аннотация: В данной статье приводится сравнительный анализ морфофункциональных показателей девочек 13-15 лет разных типов конституции, проживающих в г. Павлодар и г. Кызылорда. Большинство исследованных школьниц относились к торакальному и мышечному типам конституции. Значительное внимание уделяется сравнению таких морфологических показателей, как длина тела (ДТ), масса тела (МТ), окружность грудной клетки (ОГК), кистевая сила (КС), показатели кардио-респираторной системы в состоянии покоя и после дозированной нагрузки. В ходе исследования было установлено, что морфологические показатели (ДТ, МТ, ОГК) у девочек двух областей от астеноидного типа к дистигивному увеличиваются. Полученные результаты показывают, что возможности кардио-респираторной системы девочек дистигивного типа меньше по сравнению с школьницами других соматотипов.

Ключевые слова: морфофункциональное развитие, типы конституции, кардио-респираторная система, физическое развитие.

References

- 1 Mukataeva Zh.M. Morfofunktsionalnoe razvitiye detey raznykh somatotipov, prozhivayuschih v selskoy i gorodskoy mestnosti [Morphofunctional development of children of different somatotypes living in rural and urban areas] Vestnik karagandinskogo universiteta. Ser. Biologiya [Bulletin of Karaganda University. Ser. Biology.], 29 49, (1)(2008).[in Russian]
- 2 Ayzman R.I. Zdorove naseleniya Rossii: Mediko-sotsialnyie i psihologo-pedagogicheskie aspekty ego formirovaniya [Health of the Russian population: Medical, social, psychological and pedagogical aspects of its formation].(SO RAMN Novosibirsk, 1996). [in Russian]
- 3 Aliakbarova Z. Vozrastnyie osobennosti fizicheskogo razvitiya detey [Age peculiarities of physical development of children],Funktsionalnaya morfologiya. Tez. Dokladov Vsesoyuzn konf., – 5-7 iyunya [Functional morphology. Abstracts of the all-union conference 5-7 June]. Novosibirsk, 1984, 72 p.[in Russian]
- 4 Mukataeva Zh.M., Dairbaeva S.Zh., Muhanova A.A., Rubanovich V.B., Ayzman R.I. Morfofunktsionalnoe razvitiye detey raznykh somatotipov [Morphofunctional development of children of different somatotypes], Sibirskiy pedagogicheskiy zhurnal [Siberian pedagogical journal], 2, 402 (2008). [in Russian]
- 5 Shtefko V.G., Ostrovskiy A.D. Shema klinicheskoy diagnostiki konstitutsionalnykh tipov [Scheme of clinical diagnosis of constitutional types]. (Gosmedizdat,M.-L.: 1995).[in Russian]
- 6 Ayzman R.I., Ayzman N.I., Lebedev A.V., Rubanovich V.B. Metodika kompleksnoy otsenki zdorovya uchashchihsya obscheobrazovatelnykh shkol (metodicheskoe posobie) [The technique of a complex estimation of health of pupils of comprehensive schools], (Novosibirsk, 2008). [in Russian]
- 7 Dairbaeva S.Zh., Muhanova A.A., Mukataeva Zh.M. Sostoyaniye kardiorespiratornoy sistemy detey i podrostkov raznykh somatotipov [The state of the cardiorespiratory system of children and adolescents of different somatotypes], Vestnik Semipalatinskogo gosudarstvennogo universiteta imeni Shakarima, 4, 152 (2007). [in Russian]
- 8 Martynov I.F. Funktsionalnyie metody issledovaniya vneshnego dyhaniya [Functional methods of study of external respiration] (Moscow, 1971).[in Russian]
- 9 Rubanovich V.B. Vrachebno-pedagogicheskiy kontrol pri zanyatiyakh fizicheskoy kulturoy [Medical-pedagogical control over employment by physical culture] (Novosibirsk, 2003).[in Russian]
- 10 Mukataeva Zh.M., Kabieva S.Zh. Monitoring fizicheskogo razvitiya i zdorovya uchashchihsya Pavlodarskoy oblasti [Monitoring of physical development and health of students of Pavlodar region], Vestnik Novosibirskogo gosudarstvennogo pedagogicheskogo universiteta, 17(1), 53(2014). [in Russian]
- 11 Lakin G.F. Biometriya [Biometrics] (Moscow, 1980).[in Russian]
- 12 Rubanovich V.B. Morfofunktsionalnoe razvitiye detey i podrostkov raznykh konstitutsionalnykh tipov v zavisimosti ot dvigatelnoy aktivnosti [Morphofunctional development of children and adolescents of different constitutional types depending on motor activity] (Novosibirsk, 2004). [in Russian]

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