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THE RELATIONSHIP BETWEEN PHYSICAL DEVELOPMENT AND CARDIORESPIRATORY FITNESS IN GIRLS OF KAZAKHSTAN AGED 10-13 YEARS

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The relationship between physical development and cardiorespiratory fitness in girls of Kazakhstan aged 10-13 years

Abstract. The aim of this study is to identify the relationship between indicators of physical development and cardiorespiratory fitness in female children of Kazakhstan aged 10-13 years (n=236). Physical development of children was assessed using indicators of height, weight, waist circumference, body fat percentage, as well as such integral indicators as body mass index and waist-to-height ratio. Cardiorespiratory fitness was assessed by the results of the "progressive 20 m shuttle run" test. The results of the study showed that there is a negative weak and moderate range correlation between the indicators characterizing the body mass index, waist circumference, waist-to-height ratio, body fat percentage and cardiorespiratory readiness of Kazakhstani children. The relationship between body fat percentage indicators and other indicators of physical development was also revealed. This fact suggests that in the absence of the possibility of using caliperometry, it is possible to use indicators of the ratio of body mass index, waist circumference, waist-to-height to determine the prevalence of overweight and obesity in the population of children.

Key words: children, physical development, anthropometric data, body mass index, cardiorespiratory fitness.

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10-13 жас аралығындағы Қазақстан қыз балалардың дене дамуы мен кардиореспираторлық дайындығы арасындағы байланысы

Аңдатпа. Зерттеудің мақсаты – Қазақстанның 10-13 жас аралығындағы қыз балаларының (n=236) дене даму көрсеткіштерімен кардиореспираторлық дайындық арасындағы байланысын анықтау. Балалар дене дамуы бой, салмақ, бел шеңбері, дене майының пайыздық көрсеткіштері, сондай-ақ бой-салмақ индексі мен белдің боймен арасындағы арақатынасы сияқты интегралды көрсеткіштерді талдау арқылы бағаланды. Кардиореспираторлық даярлық «20 м прогрессивті қайталап жүгіру» сынағының нәтижелері бойынша бағаланды. Зерттеу нәтижелері Қазақстандық балалардың бой-салмақ индексі, бел шеңбері, бел мен бойдың арақатынасы, дене майының пайызы және кардиореспираторлық дайындығын сипаттайтын көрсеткіштер арасында әлсіз және орташа деңгейдегі теріс корреляция бар екендігін көрсетті. Сондай-ақ, дене майының пайыздық көрсеткіштері мен дене дамуының басқа көрсеткіштері арасындағы байланыс анықталды. Бұл факт калиперометрияны қолдану мүмкіндігі болмаған кезде балалар популяциясында артық салмақ пен семіздіктің таралуын анықтау үшін дене салмағының индексінің, бел шеңберінің, белмен бой арасындағы арақатынасының көрсеткіштерін қолдануға болатындығын көрсетеді.

Түйін сөздер: балалар, дене дамуы, антропометриялық деректер, бой-салмақ индексі, кардиореспираторлық даярлық.

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Связь между физическим развитием и кардиореспираторной подготовкой девочек Казахстана в возрасте 10-13 лет

Аннотация. Целью данного исследования является выявление связи между показателями физического развития и кардиореспираторной подготовкой девочек Казахстана в возрасте 10-13 лет (n=236). Физическое развитие детей оценивалось с использованием показателей роста, веса, окружности талии, процентного содержания жира в организме, а также таких интегральных показателей, как индекс массы тела и отношение талии к росту. Кардиореспираторная подготовка оценивалась по результатам теста «прогрессивный челночный бег на 20 м». Результаты исследования показали наличие отрицательной корреляции слабого и умеренного диапазона между показателями, характеризующими индекс массы тела, окружность талии, соотношения талии к росту, процентного содержания жира в организме и кардиореспираторной подготовкой казахстанских детей. Также была выявлена взаимосвязь между показателями процентного содержания жира в организме и другими показателями физического развития. Этот факт говорит о том, что при отсутствии возможности применения калиперометрии можно использовать показатели соотношения индекса массы тела, окружности талии, отношения талии к росту для выявления распространенности избыточной массы тела и ожирения в детской популяции.

Ключевые слова: дети, физическое развитие, антропометрические данные, индекс массы тела, кардиореспираторная подготовка.

Introduction. Monitoring is an integral part of the process of physical education of children and adolescents, which allows you to obtain reliable and valid information about the level of physical condition, assess and predict health status, and evaluate the effectiveness of the training program.

In the practice of monitoring the physical health of children and adolescents, tests are used that evaluate the five most informative indicators related to the health of children and adolescents: body composition, strength, flexibility, muscle endurance, and cardiorespiratory fitness [1, 2].

The inclusion of the above indicators in the structure of fitness tests is not accidental, there is a significant correlation between physical fitness indicators and somatometric indicators [3]. On the other hand, as the results of studies prove the existence of a link between physical development indicators such as BMI, fat percentage and the risk of chronic non-communicable diseases such as type 2 diabetes, cardiovascular and metabolic pathologies, cancer in adults [4-6]. Timely detection and correction of increased fat deposition, reduced physical fitness in children and adolescents can help reduce the risk of chronic non-communicable diseases and impaired health in the future. The progressive 20-meter shuttle run has the greatest value in assessing the health of children and adolescents, the reliability and informativeness of which has been proven by many researchers [7-12].

According to a number of authors, all components of fitness tests, such as body composition, BMI, cardio-respiratory fitness, muscle strength, speed, agility, flexibility and coordination abilities are directly related to physical fitness and can be used to monitor the health of children and adolescents [13, 14] as they have a statistically significant correlation with the main biomarkers of health are easy to use and do not require expensive equipment. However, it has the greatest diagnostic significance in assessing the health of children and adolescents has cardiorespiratory fitness [15].

B.O. Toyo et al. (2020) [16] devoted their research to studying the relationship between indicators of physical development of children and adolescents and the results of physical fitness tests. Thus, the authors revealed a high correlation between BMI, body fat percentage, and other indicators of physical development of children and adolescents and the results of progressive 20 m shuttle running.

Other authors have found a high positive correlation between the growth and weight of adolescents and the results in the long jump and arm muscle strength [17, 18], between BMI and the ratio

of muscle mass to fat mass with the results in squats for 30 seconds, 4x10 m shuttle run [19], between BMI and results in squats for 1 min and push-ups [20], between BMI and tests characterizing anaerobic-alactate and lactate performance [21]. The severity of these relationships depends on the age, gender, and regional characteristics of the subjects.

The analysis showed that most of the studies are related to testing of children from the European and American continents. To date, there is a lack of research aimed at studying the physical development and physical fitness of children in Central Asia, including in Kazakhstan. The available publications are devoted to the study of a narrow range of problems related to the level of motor activity, assessing the health of schoolchildren from the point of view of studying their psycho-physical condition. So, S.I. Rogova et al. (2019) analyzing the results of the survey, they conclude that school-age children have low motor activity, and the prevalence of hypokinesia among girls is higher than among boys [22]. R.Z. Boranbayeva et al. agree with these conclusions. (2020), they believe that the majority of children do not complete their daily physical activity during their studies. During the school holidays, children become more active, this applies more to boys than girls, and about a third of children's physical activity remains unchanged [23].

The results of the study indicate insufficient coverage of the problems of physical development and physical fitness of children in Kazakhstan.

In this regard, the purpose of this study is to identify the relationship between indicators of physical development and cardiorespiratory endurance in children and adolescents aged 10-13 years in Kazakhstan.

To achieve the research goal, we need to answer 3 key research questions:

1. Do the physical development parameters of girls in Kazakhstan aged 10-13 years correspond to the global average;
2. Is there a connection between indicators of physical development;
3. Is there a relationship between the indicators of physical development and cardiorespiratory training in girls aged 10-13 years in Kazakhstan.

Material and methods.

1. Procedure.

The study protocols were approved by the Ethics Commission of the Kazakh Academy of Sports and Tourism (Protocol № 1 dated November 25, 2022). Informed consent to participate in the study was received from the school principal, school teachers, children and their parents.

A preliminary research program has been developed with a detailed description of the measurement procedure and common measurement errors. The briefing was conducted by 6 researchers who, in collaboration with physical education teachers, conducted research during physical education lessons. Each researcher monitored the measurement of one indicator. All the researchers had knowledge about the age characteristics of the studied population (physiological features and physical fitness characteristics of children).

At the initial stage, a review of the literature on the problem of research was conducted. The criteria for selecting sources were: research on the scientific justification of fitness tests related to health; conducted from 2005 to 2025; devoted to the study of physical development and physical fitness of school-age children; the language of publication is English, Kazakh, Russian.

The literature was searched from 2023 to 2025 in databases such as Scopus, Web of Science, PubMed, MedLine, and Reschgate using the following keywords: children, physical development, physical fitness, health-related fitness tests, fitness testing, and a secular trend in physical fitness. The analysis included scientific articles, systematic reviews, the results of scientific projects devoted to the scientific justification of fitness tests related to health, as well as fundamental works describing the research methods used in this work.

After a preliminary analysis of literary sources and a study of the practice of foreign countries where monitoring systems for the physical health of children and adolescents are successfully implemented, tools have been identified that show high validity and are reliable tools for assessing physical development and the level of endurance development. In the course of the study, we measured the following indicators characterizing the physical development of children and adolescents: height (cm), weight (kg), waist circumference (cm), body fat percentage at two points on the body (in the triceps and subcapular area) [24]. In the course of the study, we calculated the body mass index (kg/m²) and the waist-to-height ratio [25].

As a tool for assessing cardiorespiratory fitness, we used the «20 m progressive shuttle run» test, the reliability and effectiveness of which have been proven by the research of O. Lee, J-W. Chung (2019) [26].

2. Participants.

The study involved female children (n=236) studying in secondary education institutions in four regions of Kazakhstan (Aktobe and Aktobe region, Pavlodar and Pavlodar region, Taraz and Zhambyl

region, Almaty and Zhetysu region). The study participants were selected by independent random selection.

According to age, the study participants were divided into 4 age categories: 10 years old (n=57), 11 years old (n=64), 12 years old (n=56) and 13 years old (n=59). All participants are healthy, they are engaged in the main medical group, and they have no contraindications to physical exercise.

3. Measurements

Anthropometric measurements.

Anthropometric measurements were performed in the medical office of the school, in the presence of a medical worker. Body height and body mass were measured using a BSM370 Automatic BMI Measuring Stadiometer with the function of measuring length, body mass and BMI [27].

Waist circumference (WC) was measured using a centimeter tape at the narrowest part of the torso, the soft area between the upper thighs and the base of the rib cage. The measurement was performed three times and the average of the three measurements was recorded.

The thickness of the skin folds was measured in accordance with the ISAK standardized protocol [28]. It is based on the two-component model of Slaughter et al. (1988) [29].

The calculation of the percentage of subcutaneous fat was carried out according to the formula:

$$\%W(\text{ScF}) = 1.33 \times (T+SS) - 0.013 \times (T+SS)^2 + 0.8$$

When the sum of skin-fat folds is more than 35 cm, the calculation was carried out according to the formula:

$$\%W = \% = 0.546 \times (T+SS) + 9.7,$$

where T and SS are the thickness of the skin-fat fold in the triceps and subcapular area in mm.

When interpreting the results, we were guided by the boundaries used in pediatric practice and sports medicine, where a fat percentage of <15% indicated an insufficient body weight, 15-25% was normal, 26-30% was an increased fat content, >30% was excessive fat deposition, and the risk of obesity.

Progressive shuttle run for 20 m. The testing was conducted to identify the cardiorespiratory fitness of children and adolescents during a physical education lesson. Beep Shuttle Advanced Rev:3 software was used for the test.

At a distance of 20 m, two lines were marked, which were fixed with restrictive cones. The data of the subjects (last name, first name, date of birth, height, weight) were entered into the research protocol in the program. After a light warm-up for the main muscle groups and an explanation of the

testing procedure, the subjects began the race. At the same time, 2-3 subjects took part in the race. The test results were interpreted automatically in the program after the end of the test. Such indicators as the number of stages, the number of shuttles, the distance traveled, the total operating time and the values of maximum oxygen consumption (VO₂ max) were recorded. VO₂ max indicators were compared with the centile tables developed by S. Kolimechkov, L. Petrov, A. Alexandrova (2019) [10, p. 12] to assess the cardiorespiratory endurance of European children and adolescents.

4. Statistical analysis.

Statistical analysis was carried out in the IBM SPSS STATISTICS software package (version 27), suitable for research in the field of humanities.

The statistical processing was preceded by an initial check of the quality and structure of the data. To identify the central trend of the sample, the spread of data and the most common values of the indicator, we calculated the arithmetic mean and standard deviation (SD), Median (Me).

In indicators with a pronounced range of values, we calculated percentiles to assess the distribution of data and conduct individual and group interpretation.

After a preliminary check for missing values and the presence/absence of duplicates that impede interpretation, a procedure was carried out to check the degree and direction of the monotonic relationship between the studied variables using Spearman's paired rank correlation coefficient.

The relationship between the indicators was considered significant at $p < 0.05$. When interpreting the results of the statistical analysis, the direction of the relationship (positive or negative) and the strength of the correlation were taken into account: at $p < 0.3$, the relationship is weak; 0.3-0.6 – moderate; 0.6-0.9 – strong; above 0.9 – very strong.

Results. Table 1 shows the somatometric measurements of girls aged 10-13 years. A tendency towards an increase in physical development indicators with an increase in the age of the subjects was revealed. The exception is the values of the waist-to-height ratio, for which no significant dynamics have been identified.

Table 1 - Somatometric measurements and the results of the «Progressive shuttle running for 20m» test in Kazakhstani girls aged 10-13 years

Parameters	Age, Mean±SD			
	10, (n=57)	11, (n=64)	12, (n=56)	13, (n=59)
Age, years	10.50±0.2828	11.52±0.26	12.49±0.32	13.483±0.31
Height. cm	142.65±8.27	151.13±7.87	154.57±7.21	159.81±5.79
Weight. kg	36.67±9.04	42.17±8.67	43.05±7.91	50.22±11.11
BMI. kg/m ²	17.84±3.08	18.33±2.87	17.97±2.83	19.55±3.54
WC. cm	60.81±7.29	63.58±8.22	62.05±6.61	65.17±8.55
W/H. cm/cm	0.42±0.05	0.42±0.05	0.40±0.04	0.41±0.05
ScF	19.13±7.27	20.55±6.37	18.64±6.05	21.22±6.73
Number of stages	3.19±0.85	3.20±1.13	3.29±0.99	3.25±1.06
Number of shuttles	12.82±7.48	13.28±8.22	16.30±9.13	13.18±10.78
Distance covered. m	414.04±141.17	422.81±183.37	449.29±162.84	422.73±184.81
Total working hours. s	148.56±51.39	155.45±69.51	159.35±59.59	155.70±65.76
VO ₂ max	44.38±1.99	42.17±4.71	41.43±2.43	39.35±2.72

Analysis of the Spearman test results revealed a negative correlation between such indicators of physical development as BMI, waist circumference, waist-to-height ratio and fat percentage and the results of the “20m progressive shuttle run” test in

girls aged 10-13 years. The results of the analysis are presented in Tables 2, 3, 4 and 5.

In the group of 10-year-old girls, a moderate negative correlation was found between BMI, waist circumference, waist-to-height ratio and

body fat percentage with the results of 20m progressive shuttle running, namely the number of levels, distance covered, total work time and VO₂ max (Table 2). The correlation coefficient between these indicators is in the range of 0.227-0.487.

Table 2 – The values of the correlation coefficient between the indicators of physical development and cardiorespiratory endurance of 10-year-old girls according to Spearman's paired rank correlation criterion

	Body height	Body weight	BMI	WC	W/H	ScF	Number of levels	Number of shuttles	Covered distance. m	Total time
Height	1.000									
weight	0.730* *	1.000								
BMI	0.289*	0.836**	1.000							
WC	0.294*	0.635**	0.673**	1.000						
W/H	-0.146	0.300*	0.525**	0.856**	1.000					
ScF	0.164	0.526**	0.599**	0.746**	0.667**	1.000				
Number of levels	0.054	-0.209	-0.312*	-0.441**	-0.487**	-0.330*	1.000			
Number of shuttles	-0.036	-0.046	-0.173	0.076	0.157	-0.236	-0.281	1.000		
Distance covered. m	-0.001	-0.254	-0.330*	-0.417**	-0.437**	-0.306*	0.931**	0.554**	1.000	
Total time	0.013	-0.242	-0.324*	-0.416**	-0.444**	-0.227*	0.900**	0.552**	0.970**	1.000
VO ₂ max	-0.037	-0.265*	-0.311*	-0.426**	-0.437**	-0.353**	0.886**	0.514**	0.926**	0.859**

In the group of 11-year-old girls, a mild to moderate relationship was found between indicators characterizing physical development (BMI, waist-to-height ratio, body fat percentage) and the results of 20m progressive shuttle running (number of levels, distance covered, total running time) (Table 3).

Table 3 – The values of the correlation coefficient between the indicators of physical development and cardiorespiratory endurance of girls aged 11 according to Spearman's paired rank correlation criterion

	height	weight	BMI	WC	W/H	ScF	Number of stages	Number of shuttles	Covered distance. m	Total time
Height	1.000									
Weight	0.712* *	1.000								
BMI	0.346**	0.879**	1.000							
WC	0.358**	0.673**	0.659**	1.000						
W/H	-0.087	0.345**	0.521**	0.861**	1.000					
ScF	0.171	0.571**	0.598**	0.643**	0.600**	1.000				
Number of stages	0.020	-0.078	-0.292*	-0.144	-0.259*	-0.179	1.000			
Number of shuttles	-0.055	-0.135	-0.194	-0.013	-0.031	-0.09	-0.347**	1.000		

Distance covered. m	0.020	-0.103	-0.349**	-0.230	-0.282*	-0.227	-0.960**	0.590**	1.000	
Total time	0.089	-0.091	-0.347**	-0.240	-0.320*	-0.306*	0.945**	0.588**	0.998**	1.000
VO _{2 max}	-0.001	-0.137	-0.189	-0.228	-0.250*	-0.257*	0.886**	0.587**	0.926**	0.969**

A weak relationship was found between VO_{2 max} and waist-to-height ratio and body fat percentage. In the group of 12-year-old girls, BMI

was associated with the results of 20m progressive shuttle running (number of levels, distance covered, and VO_{2 max}) (Table 4).

Table 4 – The values of the correlation coefficient between the indicators of physical development and cardiorespiratory endurance of girls aged 12 according to Spearman’s paired rank correlation criterion

	Body height	Body weight	BMI	WC	W/H	ScF	Number of stages	Number of shuttles	Covered distance. m	Total time
Height	1.000									
Weight	0.580* *	1.000								
BMI	0.072	0.806**	1.000							
WC	0.262	0.683**	0.659**	1.000						
W/H	0.221	0.386**	0.659**	0.848**	1.000					
ScF	0.125	0.509**	0.598**	0.643**	0.582**	1.000				
Number of stages	-0.040	-0.277*	-0.292*	-0.228	-0.259	-0.208	1.000			
Number of shuttles	-0.409**	0.106	-0.173	0.002	0.166	0.065	-0.095	1.000		
Distance covered. m	0.059	0.257	-0.349**	-0.230	-0.218	-0.227	0.946**	0.205	1.000	
Total time	0.053	-0.259	-0.347**	-0.240	-0.239	-0.194	0.945**	0.203	0.998**	1.000
VO _{2 max}	-0.008	-0.306*	-0.357**	-0.270*	-0.229	-0.228	0.919**	0.202	0.972**	0.969**

For other indicators of physical development, there was no reliable relationship with the results of the cardiorespiratory fitness test. In the group of 13-year-old girls, a weak negative relationship was found with BMI and the number of levels, distance traveled, total work time, and VO_{2 max} (Table 5).

Discussion. The results of the study are important for a better understanding of the characteristics of health-related components, such as physical development and cardiorespiratory endurance, as well as the associations between these indicators in different age groups of girls in

various socio-cultural contexts. In addition, today it is known that the 20m progressive shuttle run is one of the most sensitive tools for detecting cardiorespiratory endurance related to health, which is used in many fitness tests in Europe and the USA. Research evaluating the prospects for its use may help teachers consider using the new test to measure students’ cardiorespiratory endurance. Adapting this test to the climatic and geographical conditions of different regions of the country will provide up-to-date information on physical fitness and health of children in all schools of Kazakhstan.

Table 5 – The values of the correlation coefficient between the indicators of physical development and cardiorespiratory endurance of girls aged 13 according to Spearman's paired rank correlation criterion

	Body height	Body weight	BMI	WC	W/H	ScF	Number of stages	Number of shuttles	Covered distance. m	Total time
Height	1.000									
Weight	-0.225	1.000								
BMI	-0.311*	0.911**	1.000							
WC	-0.100	0.789**	0.820**	1.000						
W/H	-0.136	0.678**	0.802**	0.958**	1.000					
ScF	-0.329*	0.758**	0.746**	0.688**	0.638** -1.000	1.000				
Number of stages	0.079	-0.333**	-0.293*	-0.242	-0.193	-0.256	1.000			
Number of shuttles	0.078	0.090	0.078	0.020	0.123	0.100	0.079	1.000		
Distance covered. m	0.103	-0.316*	-0.295*	-0.221	-0.164	-0.197	0.960**	-0.336**	1.000	
Total time	0.102	-0.320*	-0.297*	-0.216	-0.158	-0.195	0.958**	-0.341**	0.997**	1.000
VO ₂ max	-0.134	-0.258*	-0.143	-0.192	-0.112	-0.149	0.937**	0.304*	0.966**	0.965**

When studying the relationship of various components of PF (physical fitness) with health, the strongest and most stable associations were found between health and cardiorespiratory fitness and muscle strength [30, 31]. Thus, they are considered key components of physical fitness related to health. A study by S. Mintjens et al. (2018) [32] suggests that BMI (body mass index) is an independent predictor of cardiovascular disease in children and mediates the relationship between overall cardiorespiratory fitness and cardiovascular disease. Therefore, the analysis of the relationship between physical development and cardiorespiratory fitness in children is relevant.

Since the PF assessment reflects the influence of genetic and environmental factors on the health-related components of PF and, consequently, on health indicators [33], monitoring and analysis of various PF indicators in local, regional, national and global populations is relevant. The results of this study may be relevant, since PF indicators can be used to determine appropriate strategies and measures to improve the health of schoolchildren not only in educational institutions, but also in planning public health strategies and policies. In addition, they can help to better understand how physical

development indicators in early adolescence relate to cardiorespiratory fitness.

An analysis of the individual growth indicators of girls aged 10-13 years and their comparison with the World Health Organization (WHO) centile tables showed a tendency towards outstripping the physical development of children in Kazakhstan, compared with the global average. In all the age categories under consideration, the median height values exceeded the 50th percentile of WHO by 4-7cm and corresponded to the level of the 75th-90th percentile and above (Table 1).

Thus, an analysis of the height distribution of 10-year-old girls showed a bias towards higher values compared to WHO standards. The average height in the sample was 142.65±8.27 (122-163, the median is 143cm), which corresponds to the 85-90 percentile for girls of this age.

This trend is particularly noticeable in the 11-13-year-old age group. So, in the group of girls aged 11, the average height values were 151.13±7.87cm (131-166), the median values (Median 153-154cm) significantly exceed the median values according to the WHO centile tables and correspond to the 90th percentile. Values corresponding to the 25th percentile were found only in two cases.

In the group of 12-year-old subjects, the majority of girls demonstrated normal or advanced growth (75-85 percentile), and 16% of girls had a height exceeding 161 cm and corresponded to the 97th percentile. The values corresponding to the 3rd percentile were detected only 1 time.

In the group of 13-year-old girls, the average height values (159.81 ± 5.79), as well as the median height (160-161cm), exceed the corresponding indicators according to WHO normative tables and correspond to the 75-85th percentile. The height values of 17% of girls correspond to the 97th percentile. Only 3 girls' height values were rated as "low" and corresponded to the 10th percentile.

An analysis of the body weight of girls aged 10-13 years revealed a persistent excess in comparison with WHO standards.

Thus, the average weight of 10-year-old girls was 36.67 ± 9.04 kg (23-60kg), and the median values (35 kg) exceeded the WHO values by 3kg. The most significant deviation from the values of WHO standards was observed in the group of 11-year-old girls (~6 kg). A high concentration of weight values in the range of 40-55kg was revealed, which corresponds to the 75-90 percentile according to WHO tables. No underweight girls were identified.

Thus, the data obtained demonstrate a tendency towards higher height and weight in girls aged 10-13 years compared with international standards and require further analysis taking into account environmental factors, genetics and lifestyle.

In the studies of M.U.Mushtaq et al. (2012) [34], on the contrary, the average values of height and weight coincided with WHO standards, however, the prevalence of body mass deficiency, as well as overweight and obesity in Pakistani children was lower than in the standards proposed by WHO.

An analysis of the frequency distribution and a comparison of BMI indicators with WHO normative tables also showed that in the majority of girls aged 10-13, the values of this indicator correspond to normal values.

Thus, in the group of 10-year-old girls, BMI values in the range of 25-75 percentiles occur in 75.4%, 5.3% have low values of this indicator in the range of 3-5 percentile, and 5.3% showed signs of overweight (85-90 percentile), obesity was detected in 14% of girls.

That is, the distribution of BMI among 10-year-old girls in the study sample has a two-way deviation from the norm: on the one hand, there is a body weight deficit in some children, on the other hand, there is a tendency towards increased BMI and obesity. This highlights the need for an

individual assessment of the nutritional status and possible intervention to prevent weight disorders in both directions.

In the group of 11-year-olds, the majority of girls have normal BMI values, however, the median BMI values slightly exceed the WHO normative values, which indicates a general shift towards increased body weight. High BMI values (percentile 90 and above) were found in 12.5% of girls, and in 4.7% of girls, on the contrary, there are signs of body weight deficiency.

That is, the BMI distribution among 11-year-old girls in the study sample has a two-way deviation from the norm: on the one hand, there is a body weight deficit in some children. On the other hand, there is a tendency towards an increased BMI and obesity. This highlights the need for an individual assessment of the nutritional status and possible intervention to prevent weight disorders.

In the group of 12-year-olds, 71.4% of girls had normal BMI values, 23.2% had higher than normal values, and 5.3% showed signs of body weight deficiency.

In the group of 13-year-olds, the BMI values of the majority of girls (65.9%) are in the range of 10-75 percentiles, 27.6% have signs of overweight, and 6.4% of girls are in the range of 3-5 percentiles, indicating a body weight deficit.

Similar results have been described N.T. Dzhainakbaev et al. (2021), in studies which revealed that 28 school-age children have deviations in BMI [35].

The results of our research are consistent with a study by M. Yackobovitch-Gavan et al. (2025) [36], who analyzed the weight-height ratio of 1.5 million Israeli children. The researchers concluded that Israeli children have significantly higher BMI values than the data provided by WHO. These differences are especially pronounced in the group of girls.

The authors conclude that WHO standards are most sensitive for BMI assessment only in the group of children under 5 years of age. In the older age group, in order to more adequately classify overweight or obesity, or, conversely, to identify underweight in the child population, it is necessary to take a more careful approach to the choice of assessment criteria. The effectiveness of early detection of childhood obesity and intervention by policy makers depends on this.

All this indicates the presence of regional, socio-cultural, and medical characteristics of a regional or ethnic population. On the other hand, this fact highlights the relevance of developing regional standards for the assessment of anthropometric

indicators. because WHO international standards do not always reflect the real picture of the physical status of specific groups.

An analysis of the reliability of the BMI difference in the study group showed statistically significant dynamics observed only when comparing BMI values in 12 and 13-year-old girls.

Similar data were revealed as a result of longitudinal studies of the dynamics of anthropometric indicators of children in the USA, Great Britain, Japan and Singapore aged 8-18 years [37]. Studies have shown that the greatest increase in BMI values was observed in the age period of 12-13 years.

Such changes are probably related to hormonal changes during puberty.

Correlation analysis also revealed. that the percentage of body fat correlates with BMI and waist circumference. the ratio of waist to height. This indicates that in this age-sex group, indicators can be used to determine the degree of obesity in children and adolescents if it is not possible to determine the percentage of fat.

A.O. Agbaje (2024) believes that the waist-to-height ratio is a more preferable indicator than BMI for predicting body fat percentage in both children and adults [25, p. 1378].

According to the VO₂ max indicators, a tendency to a steady decrease was revealed with increasing age of the subjects. A comparison of the data we obtained with the normative tables of VO₂ max proposed by S. Kolimechkov, L. Petrov, A. Alexandrova (2019) [10, p. 12] for European children and adolescents showed a leftward shift of Me, as well as the maximum and minimum values of this indicator in Kazakhstani girls, compared with the authors' research data.

So, in the age group of 10 years, the VO₂ max values in 56.2% of the surveyed corresponded to the 27-75 percentile, and 42.1% have - 20 percentiles (15.8% – 20 percentile; 22.8% – 10 percentile; 3.5% - 3 percentile). Only 1.7% of 10-year-old girls had high VO₂ max values corresponding to 80 percentiles.

In a group of 11-year-old girls. More than half of the subjects (62.5%) had VO₂ max values not exceeding the 20th percentile (18.7% - the 20th percentile; 34.4% - the 10th percentile; 7.8% - the 3rd percentile and 1.6% - the 1st percentile), and only 37.5% of the subjects in this age group had MOC values in the 25-75 percentiles.

In the group of 12-year-olds, half of the subjects (50.0%) had VO₂ max values corresponding to the 25-75 percentile, while the rest of the girls had

VO₂ max values not exceeding the 20th percentile (14.3% - 20th percentile; 26.8% - 10th percentile; 8.9% - 3rd percentile). There were no subjects with high VO₂ max values in this age group.

In the group of 13-year-old subjects, the VO₂ max values of the majority of girls (74.6%) did not exceed the 20th percentile (17.0% - 20th percentile; 39% - 10th percentile; 18.6% - 3rd percentile), values in the range of 25-75 percentiles were found only in 23.7% and only one of the examined girls had VO₂ max values that exceeded normal values and corresponded to the 80th percentile.

An analysis of the results of Spearman's paired rank correlation between indicators characterizing physical development and cardiorespiratory endurance of girls aged 10-13 showed the presence of a negative correlation between these indicators. However, the degree of correlation was different in each age group.

The most significant correlations were found in the group of 10-year-old subjects. In this group, a moderate negative correlation was found between BMI, waist circumference, waist-to-height ratio on the one hand and the number of levels, values of total distance covered, total running time and VO₂ max (Table 2).

In the group of 11-year-old participants (Table 3), a weak negative correlation was found between waist-to-height ratio and number of levels and distance traveled (r_s ranging from 0.259-0.282; $P < 0.05$). The analysis showed a weak negative correlation between waist-to-height ratio and body fat percentage on the one hand and VO₂ max indicators on the other (r_s 0.250-0.257; $P < 0.05$), as well as a negative correlation of moderate strength between the above-mentioned physical development indicators and total work time (r_s 0.306-0.320; $P < 0.05$).

In the group of 12-year-olds (Table 4), a statistically significant relationship was found only between BMI indicators, on the one hand, and the number of levels (r_s .292; $P < 0.05$) of the 20m progressive shuttle test. In addition, a moderate relationship was found between BMI and distance traveled, total operating time and VO₂ max indicators (r_s 0.347-0.357; $P < 0.01$). Waist circumference indicators also correlated with VO₂ max values (r_s 0.270; $P < 0.05$).

In the group of 13-year-old female children, a weak negative relationship was found between BMI indicators (Table 5) on the one hand. and the number of levels covered by the distance and the total operating time (r_s 0.293-0.297; $P < 0.05$). Between the number of levels covered by the distance. the

total working time, VO₂ max values and weight indicators of the subjects showed a dependence from mild to moderate (rs 0.258-0.333; P<0.05-0.01).

Despite the fact that the results of the study provide valuable information about health indicators in the population of Kazakhstani girls aged 10-13 years and are important for predicting the directions of health promotion, it has a number of limitations. Firstly, the study was designed for a specific gender and age group, so it should be expanded. Secondly, despite the fact that the testing was conducted by trained instructors, in individual schools where testing was conducted, there could be different conditions (for example, climate, testing surfaces). Thirdly, the percentile values were calculated using a cross-sectional approach, that is, when comparing girls of different age groups. More accurate data could be obtained by tracking changes in physical fitness indicators over the long term.

Conclusion. An analysis of the results of the study showed that the anthropometric indicators of girls in Kazakhstan aged 10-13 years significantly differ from the global average standards proposed by WHO. The median height, weight, and BMI shifted towards higher values in the analyzed age group. The trend of increasing overweight and obesity with age, especially significant at age 12-13 years is concerning. However, further research involving a wider age group of children and adolescents is needed to form a clear position on the organization of preventive measures. It is also necessary to organize anthropometric studies taking into account environmental factors, genetics and lifestyle of children and adolescents, as well as the development of regional standards for physical development.

There is also a high correlation between the values of body fat percentage on the one hand and BMI, waist circumference and waist-to-height ratio

on the other. This indicates that the latest indicators provide objective information about the prevalence of overweight and obesity and can be used in mass research, including in schools.

Since cardiorespiratory fitness is considered one of the most important components of physical fitness related to health, a decrease in the cardiorespiratory fitness of the examined girls is a dangerous tendency. TMedian values of VO₂ max of more than half of Kazakhstani girls of 10-13 years old, revealed by the results of progressive shuttle run for 20 m did not exceed the 20th percentile, and with increasing age the situation worsened. The lowest VO₂ max values were found at the age of 13 years.

Studies have also shown that in the group of girls aged 10-13, a relationship was found between BMI and waist circumference, the ratio of waist to height and body fat percentage and VO₂ max values. The markedness of this dependence is based on the age of the girls.

The results of this study are important for the practice of physical education because they help to identify individuals with certain physical fitness characteristics (e.g., identifying gifted children) and to quantify age differences. The provided percentile values for age groups can be used by teachers to monitor and assess the health status of young adolescent children and girls and to make further pedagogical recommendations. They can also be useful for finding appropriate strategies and interventions to improve the health of students not only in educational facilities but also in planning public health strategies and policies.

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