Journal of Physical Education and Sport ® (JPES), Vol. 21 (2), Art 93, pp. 748- 756, March 2021
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Morpho-functional screening of primary school students during the course of physical education

VITALII KASHUBA[1], OLENA ANDRIEIEVA[2], OLENA YARMAK[3], IGOR GRYGUS[4], MAREK NAPIERAŁA[5], OLGA SMOLEŃSKA[6], MAŁGORZATA OSTROWSKA[7], MAGDALENA HAGNER-DERENGOWSKA[8], RADOSŁAW MUSZKIETA[9], WALERY ZUKOW[10]
[1,2]National University of Ukraine on physical education and sport, Kyiv, UKRAINE
[3]Bila Tserkva National Agrarian University, Bila Tserkva, UKRAINE
[4]National University of Water and Environmental Engineering, Rivne, UKRAINE
[5]University of Economy, Bydgoszcz, POLAND
[6,7,8,9,10]Nicolaus Copernicus University, Torun, POLAND

Published online: March 31, 2021
(Accepted for publication March 15, 2021)
DOI:10.7752/jpes.2021.02093

Abstract
Background. The article presents the findings of physical development and functional status screening in school children aged 8-9 years. The objective of the study was to determine factor structure of morpho-functional status in primary school students. Material and methods. The study involved 229 primary school children including 116 students aged 8 and 113 students aged 9. The following methods were used: theoretical methods (analysis and synthesis, generalization, induction and deduction), medical and biological methods (somatometry, somatoscopy, and physiometry), and methods of mathematical statistics. The factor structure of morpho-functional state of 8-9-year-old boys and girls was determined: physical development had the largest contribution to the total variance (32.74% in boys and 33.38% in girls); the functional state of the cardiovascular and respiratory system together contributed 35.87% in boys and 38.27% in girls. Results. In 8-9-year-old boys, the most informative parameters were the body measurements such as body weight ($r = 0.987$at $p<0.01$), waist circumference ($r = 0.981$ at $p<0.01$), and hip circumference ($r = 0.974$ at $p<0.01$), as well as the functional indicators of the cardiovascular and respiratory systems such as diastolic blood pressure ($r = 0.864$ at $p<0.01$), heart rate at relative rest ($r = -0.856$ at $p<0.01$), and breath-holding tests ($r = 0.799$ at $p<0.01$; $r = 0.730$ at $p<0.01$).In 8-9-year-old girls, the most informative morpho-functional screening indicators also included the body measurements: BW ($r= 0.984$ atp<0.01) and waist circumference ($r= 0.984$ atp<0.01); as well as the indicator sof body fat such as suprailiac skinfold ($r=0.973$atp<0.01) and subscapular skinfold ($r=0.955$ at $p<0.01$). Conclusion. The obtained results have a prognostic value for individualization and differentiation of pedagogical process, and also for evaluation of the influence of basic pedagogical means and methods in the process of physical education of primary school students.
Key words: physical development, body fat, cardiorespiratory system, adaptive reserve capacity

Introduction

The problem of maintaining and improving the health in primary school children is of global relevance. Numerous studies have shown that starting school is a difficult stage in a child's life (Kashuba et al., 2020; Savliuk et al., 2020). The initial stage of adaptation to school can be accompanied by multidirectional changes in the morpho-functional characteristics of the body of a child (Andrieieva et al., 2020; Butenko et al., 2017). These changes may go beyond the age- and gender-related normal ranges or fluctuate within them that may further influence the development of pathogenetic processes. The findings of recent studies have indicated an increase in chronic health conditions and psychosomatic disorders among children and youth during school study (Abramova et al., 2020; Solohubova et al., 2020). Negative features of the modern educational process, such as increasing static load, limited physical activity of students combined with intensified learning activities lead to the development of premature fatigue and stress in students, tension of the adaptive mechanisms of the body and, consequently, deteriorating children's health (Gozak, Yelizarova, 2012). There are negative trends in the morpho-functional development of children, such as growth retardation, decreased vital capacity of the lungs and strength of the hand muscles (Andrieieva, Sainchuk, 2014). It has been reported that significant negative changes in the health status and morpho-functional development of school students, which have been observed in recent years are associated, on the one hand, with increasing educational load combined with inappropriate learning conditions and organization of educational process, and on the other, with a reduction in functional reserves,

Corresponding Author: . WALERY ZUKOW, E-mail: w.zukow@wp.pl

which determine the level of adaptive capacity of the child's body, and insufficient medical and pedagogical control by teachers and parents (Chanchaeva et al., 2019; Meijer et al., 2020b; Verloigne et al., 2020). Many authors have focused their works on the substantiation of the organizational and methodological system of control in physical education (Tanakaet al., 2018; Yarmak et al., 2017). They are united in the opinion that the harmonious development of a child requires constant monitoring of physical condition (Gozak, Yelizarova, 2012; Kashuba et al., 2018). Researchers consider it important to select the means and methods of control, which ensure the completeness of the indicators being studied (Solohubova et al., 2020).

The study by Yarmak et al., (2017) indicate that, when assessing the functional state of school children, the main criterion for sound recommendations for exercise load and physical activity regimen is the ability of the body to most effectively and quickly adapt to increased requirements. The results of monitoring studies of physical condition of school children over the past 5 years have suggested that the nature of the response to exercise is the most informative manifestation of functional disorders; and exercise tolerance is the main criterion for dosing exercise in the process of physical education of school children (Abramovaet al., 2020; Andrieieva et al., 2020; Ivashchenko, 2020).

Galan et al., (2019) believe that in order to obtain objective information about the morpho-functional state it is necessary to use evaluation systems, which are based on a set of clinical and physiological indicators, which in turn have positive correlations with maximum aerobic capacity. In their opinion, this approach will make it possible to determine the level of physical working capacity, which indicate the real capabilities of the child's body.

The relevance of the chosen topic is due to the fact that the availability of information about the morpho-functional state will allow to develop a set of corrective measures that will contribute to its maintenance, improvement, and harmonious development. Therefore, systematic assessment of physical development and functional status of children is important for raising a healthy child. However, there is a lack of research on the indicators of physical and functional development of primary school children, which would allow to minimize time spent for assessment and provide valuable diagnostic information, as well as to assess the adequacy of the load and the effectiveness of the learning.

Materials and Methods

Participants. The study involved 62 boys aged 8 and 54 boys aged 9, 60 girls aged 8 and 53 girls aged 9, who were classified as healthy.

Procedure / Test protocol / Skill test trial / Measure / Instruments. To achieve the goal a research plan was developed that enabled obtaining sufficiently complete and reliable information on each objective, as well as their sequential achievement. Anthropometric studies included an assessment of somatometric, somatoscopic, and physiometric parameters. Somatometric parameters included the following body measurements: body height (cm), body weight (kg), chest waist, and hip circumferences (cm). The height measurement was performed using stadiometer. Body weight was measured using a medical scale to the nearest 0.05 kg. Chest, hip, and waist circumferences were measured with an anthropometric tape.

To assess body weight-to-height ratio, the Quetelet index (g/cm) was calculated. Somatoscopy included measuring thickness of skinfolds at three sites with an accuracy of 0.01. The measurements were performed as follows. The triceps skinfold was measured on the mid-line of the posterior surface of the arm over the triceps muscle. The arm should be relaxed with the palm of the hand facing forwards. The subscapular skinfold was assessed at the lower angle of the scapula; the pinch was made following the natural fold of the skin, approximately on a line running laterally and downwards at about 45 degrees. The suprailiac skinfold was measured immediately above the iliac crest (top of hip bone), on the most lateral aspect. The fold was directed anteriorly and downward in line with the natural fold of the skin above the ileum at about 45 degrees.

Data collection and analysis / Statistical analysis. The level of physical development was determined by several methods: using the method of standards (Table 1), by comparing individual anthropometric data with scoring tables and percentiles. In the method of standards, the development of each measured parameter (height, body weight, and chest circumference) was scored on five levels: low, below average, average, above average, and high.

Results

The values of the parameter were scored as follows: values within the range of x±0.67S – average, from x+0.68S to x+1.5S – above average, from x+1.6S and above – high, from x-0.68S to x-1.5S – below average, and from x-1.6S and below – low (S – standard deviation). Knowing the gender and age of the student, the value of the scored parameter was found in the appropriate table and classified into one of five levels: average, above average, below average, high, or low.

Table 1. Anthropometric standards of physical development of boys and girls aged 8-9 years

Age, years	Parameter					
	Height, cm		Body weight, kg		Chest circumference, cm	
	M	S	M	S	M	S
Boys						
8	131.6	5.23	28.0	3.12	65.1	2.73
9	137.7	4.39	31.6	4.57	67.2	3.58
Girls						
8	129.6	5.20	25.4	3.30	62.2	3.65
9	134.2	5.45	28.8	3.64	64.1	3.00

Physiometric methods were used to determine functional parameters. The functional state of the respiratory system was assessed by vital capacity of the lungs using a portable dry spirometer SSP according to a conventional method. The functional state of the muscular system was assessed by dynamometry using a spring handgrip dynamometer DRP-30. The evaluate the handgrip strength, the absolute values according to age and gender and the strength index were used. The functional state of the respiratory system was assessed using breath holding tests at inhalation (Shtange test) and at exhalation (Hench test) according to accepted recommendations. These tests allow assessing the hypoxia tolerance and reserve capacity of the respiratory system. The functional state of the cardiovascular system was assessed by the heart rate response and heart rate recovery time after dosed exercise stress (Ruffier functional test). Index score: less than 3 – high working capacity; 4-6 – good; 7-9 – average; 10-14 – satisfactory; 15 and above – poor. To assess the adaptive reserve capacity of the body, the indices were used, which indirectly characterize the aerobic capacity, regulatory mechanisms, and metabolism, i.e. those processes that underlie adaptation. The methodological approach for assessing the level of adaptive reserve capacity of school students includes three indices that were suitable for calculating the integrated indicator after the statistical analysis. These are the Robinson index, which characterizes the functional state of the cardiovascular system and aerobic capacity of the body; Rohrer index, which describes physical development and metabolism; and Kerdo autonomic index, which characterizes regulatory mechanisms. The obtained data were scored according to Table 2.

Table 2. Rating scale for indices that characterize the level of adaptive reserve capacity of school students (Gozak, Yelizarova, 2012)

Index	Calculation formula	1 point	2 points	3 points
Rohrer index, kg·m^{-3}	$RI = \frac{P}{L^3}$, where P is body weight (kg) and L is height (m).	<10.6 or >13.7	–	10.6-13.7
Robinson index, arb. un.	$RbI = \frac{HR \times BPsys}{100}$, where HR is heart rate and BPsys is systolic blood pressure.	>85	76-85	<75
Kerdo autonomic index, arb. un. (for children aged 6-11 years)	$KAI = \left(1 - \frac{BPdia}{HR}\right) \times 100$, where HR is heart rate and BPdia is diastolic blood pressure (mmHg).	>+20	< 0	from 0 to +20

These indices allow to assess the adaptive reserve capacity (ARC) of the body in school students based on the following initial data: age (years), height (m), body weight (kg), heart rate (bpm), systolic and diastolic blood pressure at rest (mmHg). The integral score of the adaptive reserve capacity is calculated as the arithmetic mean of the scores for the three indices. The adaptive reserve capacity was scored using Table 3.

Table 3. Rating scale for the level of the adaptive reserve capacity of school children

Score	Value in points	Level of function
Critically low	<1.34	Failure of adaptation
Low	1.35-1.66	Unsatisfactory adaptation
Average	1.67-2.66	Tension of adaptation mechanisms
High	>2.67	Satisfactory adaptation

Mathematical and statistical analysis was conducted to interpret the results of the study. The following methods were used: the method of mean values, method of sampling, analysis of variance, and factor analysis.

The descriptive statistics for parameters of different age groups was calculated including: the arithmetic mean of the sample (M), standard deviation (S), and representativeness error (R). The significance of the difference between the samples was tested at the confidence level of P=95% (significance level of 0.05). Some hypotheses were tested at the higher confidence level of P=99% (the significance level of 0.01). The Shapiro-Wilk test was used to assess the deviation of the sample distribution from normality. Analysis of variance was used to assess the changes in morpho-functional status of children aged 8-9 years. For samples with normal distribution, parametric analysis of variance was performed. For samples without normal distribution, the non-parametric Kruskal-Wallis analysis of variance was used (Byshevets et al., 2019). In order to improve the process of physical education of primary school children, it is important to determine the relationships among the parameters of morpho-functional status of schoolchildren and to identify the most significant factors. The results of the factor analysis are presented in Table 1 as correlation matrices.

Table 1. Factor structure of morpho-functional status of school students aged 8-9 years

	Boys (n=116)				Girls (n=113)			
	factor 1	factor 2	factor 3	factor 4	factor 1	factor 2	factor 3	factor 4
Height, cm	0.708	0.023	0.215	0.122	0.704	0.195	0.132	0.613
Body weight, kg	0.987	0.191	-0.119	-0.394	0.984	-0.062	0.319	0.257
Chest circumference, cm	0.889	0.451	-0.023	0.246	0.875	0.195	0.514	0.315
Waist circumference, cm	0.981	0.419	0.014	-0.304	0.948	-0.504	0.438	0.264
Hip circumference, cm	0.974	0.568	0.218	-0.215	0.428	-0.206	0.195	0.431
Upper arm circumference, cm	0.831	0.441	0.031	0.402	0.351	0.250	0.491	-0.152
Triceps skinfold, mm	-0.340	-0.423	0.441	0.244	0.918	-0.231	0.261	-0.388
Subscapular skinfold, mm	0.128	-0.584	-0.455	-0.522	0.955	-0.253	0.472	-0.211
Suprailiac skinfold, mm	0.082	-0.312	-0.101	-0.450	0.973	-0.312	0.476	-0.094
Heart rate, bpm	-0.413	-0.856	-0.106	-0.316	-0.613	-0.845	0.386	0.568
BPsys	-0.358	0.842	0.184	0.253	-0.324	0.831	0.125	0.399
BPdia, mmHg	-0.507	0.864	-0.070	0.285	-0.225	0.721	0.109	0.517
VC, mL	0.771	0.311	0.571	0.119	0.399	0.327	0.728	0.427
Hench test, s	0.570	0.138	0.730	0.373	0.576	0.406	0.827	0.142
Shtange test, s	0.556	0.452	0.799	0.371	0.261	0.359	0.852	0.218
Rohrer index, $kg \cdot m^{-3}$	0.711	0.125	0.582	0.411	0.714	0.417	0.269	0.414
Robinson index, arb. un.	0.432	0.652	0.773	0.128	0.316	0.735	0.315	0.416
Kerdo index, arb. un.	0.412	0.787	0.384	0.325	0.315	0.813	0.416	0.236
Ruffier test, arb. un.	0.287	0.372	0.529	0.821	0.521	0.364	0.518	0.827
Contribution of the factor to the total variance, %	32.74	23.41	12.46	8.91	33.38	25.75	12.52	7.04
Total contribution of the factors, %	77.52				78.69			
Contribution of other factors, %	22.48				21.31			

Factor analysis allowed to reduce the number of parameters and to identify a few factors that contribute significantly to the total variance and are based on 21 variables. Four factors were identified that account for 77.52% to 78.69% of the total variance in boys and girls, respectively. The analysis of the factor structure of morpho-functional status of school students aged 8-9 years confirmed that physical development takes a leading place among the factors determining the physical condition. In boys, the first factor found to correlate with physical development was loaded by the anthropometric measurements of the body such as BW (r= 0.987 at p<0.01); waist circumference (r= 0.981at p<0.01); hip circumference (r= 0.974 at p<0.01); chest circumference (r= 0.889 at p<0.01); upper arm circumference (r= 0.831 at p <0.01); and height (r=0.708 at p<0.01). The first factor was also loaded by vital capacity (r=0.771 at p<0.01) that characterize the respiratory system. In girls, the first factor, which correlated with physical development, also was loaded by the anthropometric measurements of the body and body fat indicators: BW (r= 0.984 at p<0.01); waist circumference (r= 0.948 at p<0.01); chest circumference (r= 0.875 at p<0.01); height (r=0.704 at p<0.01); suprailiac skinfold (r=0.973 at p <0.01); subscapular skinfold (r=0.955 at p<0.01); and triceps skinfold (r=0.918 at p<0.01). It should be noted that the Rohrer index is calculated from body weight and body height. Its contribution was (r= 0.711 at p<0.01) in boys and (r= 0.714 at p<0.01) in girls. The first factor contributed to the total variance 32.74% in boys and 33.38% in girls. This can be explained by the fact that the studied school children aged 8-9 years are in a sensitive period of active formation of physical and functional capacities of the body. It should be noted that lack of physical activity in this age period may have the negative impact manifested in the impaired development of motor analyzer of the brain at the subsequent stages of a child's development that is almost impossible to compensate

later in life. In the primary school age, relatively uniform development of the musculoskeletal system occurs, however different body measurements increased with differed intensity. For example, the body height increases to a greater extent than the body weight during this period. The proportions of the body are also changed: the chest circumference-to-body height ratio changes. Analysis of variables that were included in the first factor are shown in Table 2.

Table 2. Average values for the indicators of physical development of school children aged 8-9 years

Indicator	8-year-old boys (n=62)		8-year-old girls (n=54)		9-year-old boys (n=60)		9-year-old girls (n=53)	
	M	S	M	S	M	S	M	S
Height, cm	132.1	4.12	129.4	7.22	134.1	6.11	133.7	7.22
Body weight, kg	29.2	3.15	26.7	3.18	31.0	4.28	30.5	4.86
Chest circumference, cm	65.3	3.81	63.5	4.06	66.7	4.53	66.4	3.72
Waist circumference, cm	57.3	3.66	56.1	4.26	59.7	3.89	57.8	3.28
Triceps skinfold, mm	9.1	0.72	10.7	0.63	9.2	0.86	12.5	0.47
Subscapular skinfold, mm	5.4	0.78	7.5	1.05	6.3	0.42	8.8	0.52
Suprailiac skinfold, mm	7.6	0.89	11.2	0.58	8.7	0.47	13.6	0.32

Comparative analysis of body height, body weight, and chest circumference values with age standards showed that the average parameters of studied 9-year-old boys were lower than the normal range. The study sample demonstrated an increase in the body weight, height, and circumferences with age. We found that the thickness of skinfolds measured at three sites in girls aged 8 and 9 years was significantly (at $p < 0.05$) higher than in boys of the same age. Next, the harmony/disharmony of physical development was determined using scoring tables. Harmony of physical development is an integrated indicator, which includes the anthropometric and functional parameters of somatic development of a child in a given period of its growth. Physical development is considered harmonious, when body weight and chest circumference (in relation to body height) are within one standard deviation of regression, and disharmonious, when body weight and chest circumference are within the wider range. Disharmonious development may be due to a deficit or excess of body weight and a corresponding decrease in the functional capabilities of the body. Physical development is considered excessively disharmonious when the range exceeds two standard deviation of regression. This may be caused by exhaustion or obesity combined with a sharp decrease in functional capabilities.

The somatometric parameters obtained by us were calculated according to the standards of physical development of school children. Boys and girls aged 8 years were found to have harmonious average physical development. The standard deviations of body weight (boys ±0.26 and girls ±0.61) and of chest circumference (boys -0.39 and girls -0.21) were within the average range relative to body height. Boys aged 9 years had a below average level of physical development. Their physical development was evaluated as harmonious because the standard deviations of body weight (-1.21) and chest circumference (-0.69) were similar to body height within the range narrower than the average. Nine-year-old girls had an average level of physical development (body height was average, standard deviations of R for body weight (0.06) and for chest circumference (0.51) were also within the average range). Their physical development was evaluated as harmonious. Analysis of the factor structure, which is presented in Table 1, indicates that the second and third factors included indicators of the functional state of the cardiovascular and respiratory systems. First and second factors together contributed to the total variance 35.87% in boys and 38.27% in girls. The study of the patterns of development of the cardiovascular system in children is the most important task for maintaining and improving their health, because the cardiovascular system occupies a special place in the child's adaptation to the effects of various physical activities. Analysis of variables that were included in the second and third factors are shown in Table 3.

Table 3. Average values for the indicators of functional state of the respiratory and cardiovascular systems of primary school children

Indicator	8-year-old boys (n=62)		8-year-old girls (n=54)		9-year-old boys (n=60)		9-year-old girls (n=53)	
	M	S	M	S	M	S	M	S
VC, mL	1421.4	208.1	1336.1	213.4	1495.8	181.5	1398.2	175.4
Shtange test, s	22.3	4.12	19.3	4.27	22.1	5.14	19.1	4.06
Hench test, s	14.1	2.11	13.6	2.18	14.0	3.07	12.9	3.41
Heart rate, bpm	84.9	5.25	87.6	5.38	89.5	6.58	88.4	7.84
BPsys, mmHg	108.5	9.27	102.1	7.84	119.7	9.35	105.8	9.84
BPdia, mmHg	66.4	5.24	66.8	4.58	69.5	5.18	67.9	6.27

The functional parameters of the respiratory and cardiovascular systems of primary school children clearly demonstrate the wave-like changes in the reserve capacity of the respiratory system depending on the age of children. We found that 9-year-old children of both genders had the least tolerance to hypoxia. However, their vital capacity showed the normal increase during growth and development of the body. In functional breath holding tests at inhalation (Shtange test) and at exhalation (Hench test), 9-year-old children showed the results comparable or even insignificantly lower than 8-year-children.

The fourth factor was loaded by the Ruffier test; its contribution to the total variance was 8.91% for boys and 7.04% for girls. We analyzed the derived indices, which were included in three factors for boys and girls aged 8-9 years. It should be noted that all of them had a high contribution and can be used in the practice of health screening studies of school children. The assessment system for adaptive reserve capacity of the body developed by Ukrainian researchers (Gozak, Yelizarova, 2012) is based on the use of the Robinson index, Rohrer index, and Kerdo index, which indirectly characterize the aerobic capacity, regulatory mechanisms, and metabolism, i.e. those processes that underlie adaptation. The results of the assessment of the level of adaptive capacity are shown in Table 4.

Table 4. The level of the adaptive reserve capacity of primary school children

Index	Statistics							
	Boys, 8 years (n=62)		Girls, 8 years (n=54)		Boys, 9 years (n=60)		Girls, 9 years (n=53)	
	M ± S	Score	M ± S	Score	M ± S	Score	M ± S	Score
Rohrer index, kg·m^{-3}	12.1±0.34	3	12.2±0.44	3	12.4±0.26	3	12.7±0.29	3
Robinson index, arb. un.	89.3±6.11	1	85.7±5.24	1	96.1±7.34	1	91.0±4.55	1
Kerdo index, arb. un.	21.0±0.10	1	20.0±1.16	3	20.0±0.67	3	24.0±1.16	1
∑ of scores	5		7		7		5	
Level of adaptive reserve capacity	average		average		average		average	

According to the scoring scale for assessment of adaptive reserve capacity in primary school students, the values of the Robinson index indicated the tension of adaptation mechanisms that corresponds to the prenosological state. The functional capabilities of the body at rest are not reduced, but it is recommended functional exercise testing and monitoring of adaptive reserve capacity 2-3 times a year, as well as the development of individual and group programs to maintain and improve health reserves. The study of the dynamics of morpho-functional development of children is an important indicator of long-term adaptation to learning. Given the results of the study, it is quite obvious that the evaluation in the process of morpho-functional screening should be based on the assessment of the changes in individual parameters during the school year, and not only on the comparison with age- and gender-related norms and standards. The results of morpho-functional screening of children aged 8-9 years in 2019-2020 made it possible to individualize and differentiate the process of physical education.

Discussion

One of the main objectives of the first cycle of primary education is the successful adaptation of a child to school life (Andrieieva, Sainchuk, 2014; Meijer et al., 2020). Research findings on the physical development and health of modern children are ambiguous (Bodnarchyk et al., 2017; Kashuba, et al., 2019, 2020; López-Gil et al., 2020; Chanchaeva et al., 2019; Lisowski et al., 2020). The deterioration of somatic health and delayed physical development has been reported (Andrieieva et al., 2019; Galan et al., 2019; Khudolii et al., 2015; Nesterchuk et al., 2020). The authors point to the dominance of children with average parameters of physical and psychophysiological development in the studied populations of school children (Butenko et al., 2017; Siniarska et al., 2021). In modern educational conditions, a physical education teacher cannot implement teaching, educational., and health-promoting tasks of the pedagogical process to the full extent without knowledge of the level of morpho-functional development of the students. The commonly assessed parameters include indicators of physical fitness, anthropometric measurements, in particular, height and weight of the body, as well as the response of the cardiovascular system to dynamic exercise load (Rodriguez-Ayllon et al., 2019). The physical education teacher should ideally focus on the somatometric and physiometric parameters of an individual child instead of an average school student with average body height, average body weight, average level of physical fitness, etc. (Galan et al., 2019; Imhof et al., 2016; Ivashchenko, 2020). The factor analysis conducted in this study showed that the anthropometric measures, fat percentage (in girls), heart rate, blood pressure, breath-holding tests, as well as the indices of adaptive capacity of the body are informative for screening of physical

development and functional status in primary school children. These results are consistent with the findings reported earlier (Yarmak et al., 2017). The results of our research are in agreement with the findings showing that the assessment of a child's physical development may help to identify an inconsistency and a certain imbalance in the processes of growth and development of functions and systems of the body. Our data on anthropometric measures are consistent with the findings of other studies (Abramova et al., 2020; Kozina et al., 2016; Siniarska et al., 2021), which indicate the unevenness of the changes in somatometric indicators of physical development associated with heterochrony of the development of the child's body (Tanaka et al., 2018). The results of this study confirm the data obtained earlier on the need for regular assessment of the indicators of morpho-functional status, which in childhood characterize the level of health of school students (Gozhenko at al., 2018a; Gozhenko at al., 2018b; Abramova et al., 2020; Savliuk et al., 2020).

This research adds to the data of Galan et al., (2018) on the dynamics of physical development of primary school children and the functional state of the cardiovascular and respiratory systems of 8-9-year-old school children and on the feasibility of conducting systematic assessments in the process of physical education (Yarmak et al., 2017).

Conclusions

The factor analysis conducted in this study allowed to reduce the number of parameters of morpho-functional status of primary school-age children and thus to minimize time spent for assessment and to provide valuable diagnostic information. The assessment of the morpho-functional status of schoolchildren aged 8-9 years showed that the studied indicators of physical development are changing in accordance with the general biological patterns typical of 8-9-year-old children. The analysis of individual values of body weight indicated a negative trend in the number of overweight students. This fact is worrying because 33.9% of 8-year-old boys and 35.0% of 9-year-old boys were overweight. A similar situation was observed among girls of both age groups. The average parameters of the functional status of the studied school children aged 8-9 were within the age norms, and the positive changes in these parameters were observed with age. A mainly low level of physical working capacity found in schoolchildren aged 8-9 years indicates the development of the adaptive capacity of the cardiovascular system to dynamic exercise loads.

The practical significance of the obtained results is to identify the most informative indicators for morpho-functional state screening in 8-9-years-old boys and girls in the process of physical education. With the help of screening, physical education professionals can perform the following functions: educational., stimulating, upbringing, developing, corrective, prognostic, diagnostic, and methodological., The main purpose of morpho-functional screening is to identify the adequacy of pedagogically oriented influences and their effects on the planned results, and, in case of inconsistency between them, to make appropriate decisions to adjust managing influences. Management of the process of physical education of primary school children is considered as an open system that actively interacts with its environment, takes into account the feedback and motives of its participants that allows to analyze the quality of physical education and predict the final outcomes using the system of control.

Compliance with Ethical Standards

Conflict of Interest. The authors declare that there is no conflict of interest that could be perceived as interfering with publication of the article.

Competing Interests. The authors declare that they have no competing interests.

Ethical Approval. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent. Informed consent was obtained from all individual participants included in the study. All subjects of the institutional survey gave consent for anonymized data to be used for publication purposes.

Funding sources. This study has not received any financial support from any government, community or commercial organization.

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