

Original Article

Screening system of the physical condition of boys aged 15-17 years in the process of physical education

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Abstract

The article is devoted to the substantiation of the technology of screening of the physical condition of boys aged 15-17 years in the system of pedagogical control; it was developed the structure of the technology, the main components and their contents on the basis of determining of the informative indicators of physical development, morphofunctional state, physical fitness and working capacity of boys. On the basis of the results of the factor and correlation analysis, there were identified the informative indicators mostly characterizing the physical condition of boys. With the help of regression analysis, it was developed an express system for assessment of the physical condition of boys, its informativeness and validity were determined.

The proposed screening system provides for an in-depth and express assessment of levels of the physical condition of boys aged 15-17 years and provides the opportunity to carry out the previous and current pedagogical control, to differentiate and individualize physical loads, to provide theoretical and practical recommendations, to select adequate means and methods for increasing the physical condition level.

Key words: screening, physical condition, boys, physical education.

Introduction

At the current stage of the development of national school in Ukraine, the important strategic objectives of the reforming of the content of education are the necessity to promote the physical and mental health of young people, taking into account the needs of the individual correction-compensatory orientation of the education and upbringing of pupils, the definition of the priorities of a healthy lifestyle (Dutchak, 2012; Arefiev, 2013; Dubohai, 2016; Andrieieva, 2017; Galan, 2017; Ivashchenko, 2017; Gorshova, 2017).

However, according to many authors, there is a negative tendency to increase of the number of pupils with low and lower than average levels of physical health (Borysova, 2016; Blahii 2016; Bohuslavskaya, 2017). Most students have a low level of physical fitness and are not able to comply with school curricula standards for positive assessments (Yarmak, 2014). One of the socially significant causes of this phenomenon is increased mental loads and reduced motor activity of a modern person - hypodynamia (Dutchak, 2016).

In spite of significant scientific and methodological work, the implementation of recreational activities in educational institutions has not developed into a single integrated system today. One of the reasons for this is the lack of regular systematic reliable and objective information about the dynamics of health and psychophysiological condition of adolescents (Krutsevych, 2008).

Many authors believe that one of the main components of the management of the physical education process is pedagogical control of physical condition of schoolchildren. According to available literary data, the most simple and accessible criteria for evaluating the physical condition are the results of testing physical performance (Blahii, 2015). Maximum energy potential, expressed by maximum oxygen consumption ($VO_{2\max}$), is considered by scientists to be a key indicator of physical condition (Apanasenko, 2010).

In this regard, scientists have taken certain measures to create an assessments system which is based on a set of various indicators that have positive correlation with the results of studies of the oxygen-transport system (Krutsevych, 2000; Apanasenko, Popova, 2011). The question of the use of anthropometric indicators characterizing the physical condition, specifically, the length and weight of the schoolchildren's body, is particularly relevant. (Davydenko, 2006; Krustevych, 2009).

Studies have shown that the quantitative assessment of the physical condition is associated with the morbidity. Thus, in mass studies of the population it was found that the morbidity increases in parallel with the decrease in the level of physical condition (Blahii, 2007). Most authors distinguish the following components of physical condition: the level of physical growth and development, its harmony, the correspondence of the biological age to the calendar; the level of functioning of the basic systems of an organism; the level of physical

fitness; the degree of resistance of an organism to adverse environmental factors; the presence or absence of chronic diseases.

In the theory of physical education there is an intensive search for modern means of increasing the efficiency of school physical education. According to many scientists, the possibility of tackling this issue is related to the use of computer technology (Blahii, 2010; Kashuba, 2016).

However, the issue of the physical condition controlling has not yet been properly solved due to the complexity of unification and objectification of the physical condition assessment tests. There are contradictory points of view regarding the criteria and methods for determining its levels. Available programs do not cover the entire post-puberty period, and that determines the relevance of the study.

Purpose of the Research

To substantiate and develop the technology of screening of the physical condition of boys aged 15-17 years, aimed at the improvement of the pedagogical control system in the process of physical education.

Materials and Methods

Analysis and generalization of special scientific-methodical literature and documentary materials; pedagogical methods of research; anthropometric, physiological methods; methods of determining the morbidity indicators; methods of mathematical statistics.

In order to determine the indicators of physical development of boys aged 15-17 years, there were performed anthropometric measurements that reflect the level of morphological characteristics (body length (BL) and body weight (BW), size of the various parts of the body, skin and fat folds, the dynamometry of the hand, posture). Physiological methods of research were used to assess the state of the cardiovascular system of adolescents (Resting Heart Rate (HR_{rest}), Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP), Systolic Blood Volume (Stroke Volume) (SV), and Minute Volume of Blood (Cardiac Output) (CO)), Robinson index; for assessment of the respiratory system - Vital Lung Capacity (VC), Shtange test (breath holding at inhalation), Genchi test (breath holding at exhalation), Skibinski index; for evaluation of the functional state of the central nervous system (CNS - Yarotskyi test, Romberg test and dynamic coordination; for assessment of Physical Capability (Ruffier-Dicson Index, PWC₁₇₀).

The morbidity of boys was determined by the method of copying from the medical cards of the frequency and severity of diseases with an assessment of the disease class (according to the methodology of the International Statistical Classification of Diseases and Related Health Problems, WHO).

Pedagogical methods of research included pedagogical observation, pedagogical testing and pedagogical experiment, which were conducted in order to substantiate the screening technology of the physical condition of boys aged 15-17 years.

The obtained results were processed using methods of mathematical statistics such as the method of averages; the selective method; dispersion, correlation, factor and regression analyses.

The research work was carried out on the basis of the Humanities and Pedagogical College of the Kyiv Regional Institute of Postgraduate Education of Pedagogical Personnel and the Specialized School No. 9 of Bila Tserkva with boys aged 15-17 years. The study involved 102 boys of the main group and 30 boys of the control group. The study was conducted in several stages.

Results

In the process of our study, the data of the summative experiment was analysed. 102 youths aged 15-17 years have taken part in the experiment. According to the results of the medical examination at the beginning of the academic year, they are all classified into the main and preparatory medical groups. The main criterion for determining the sample of recipients was the personal desire of young people to participate in the study.

In order to study the parameters of physical condition, there were studied morphofunctional parameters, physical work capability, physical fitness, morbidity.

In the process of studying of morphological parameters it was not indicated the differences between age groups, the variation coefficient was in the range from 2.82% to 14.63%, that shows the homogeneity of the sample, and the variability was observed only by the BW and the dynamometry of the hand (V% = 15.10% and 21.92% respectively). The largest shoulder girth volume $\bar{x} = 29.3$ cm, S = 3.7 cm; Hip girth volume $\bar{x} = 48.9$ cm, S = 5.3 cm and waist girth volume $\bar{x} = 75.6$ cm, S = 8.2 cm recorded in boys aged 16 years (Table 1). There is a clear dynamic to increase of the rates of physical development with increasing of the age. Thus, BL in boys aged 15 years $\bar{x} = 176.3$ cm, S = 5.8 cm, in boys aged 16 years $\bar{x} = 177.4$ cm, S = 4.6 cm, and in boys aged 17 years $\bar{x} = 178.3$ cm, S = 4.8 cm. BW in 15-year-old boys $\bar{x} = 65.1$ kg, S = 10.9 kg; in 16-year-old boys $\bar{x} = 67.6$ kg, S = 12.9 kg, and in 17-year-old boys $\bar{x} = 68.3$ kg, S = 7.0 kg. This fact is confirmed by literature data about the age peculiarities of boys' development at the stage of the completion of puberty and postpuberty phase. At these stages, a hereditary program of the organism development, including its growth processes, is being implemented. The values of the investigated anthropometric characteristics of boys according to their indicators approached to the adult age status.

We studied the body fat composition of the boys, skinfold measurements of five standard measurements sites were taken: triceps, bicep, subscap (under the shoulder blade), supraspinale (over the ilium bone), calf and their total sum.

The nature of activity and nutrition is reflected in changes of body composition, which in its turn is one of the characteristics of physical development and the indicator of health. Analysing the obtained results, it was found that in young men with age the bicep skinfold, mm, the supraspinale skinfold, mm, and the calf skinfold, mm, decrease. The largest volumes of the triceps skinfold $\bar{x} = 5.7$ mm, $S = 3.5$ mm and of subscap skinfold $\bar{x} = 8.1$ mm, $S = 4.9$ mm are observed in boys aged 16 years. Analysing the results of the total amount of skin and fat folds, it was established that in the 16-year-old boys the highest figure $\bar{x} = 46.6$ mm, $S = 27.0$ mm, while in boys 17-year-old - the lowest $\bar{x} = 37.1$ mm, $S = 16.3$ mm.

Table 1. Indicators of the morphological condition of boys aged 15-17 years (n = 102).

Indicators	Age, years										
	15		16		17		15-17				
	n= 34		n= 36		n=32		n=102				
	\bar{x}	S	\bar{x}	S	\bar{x}	S	\bar{x}	S	ME	25 %	75 %
BL, cm	176.3	5.8	177.4	4.6	178.3	4.8	177.3	5.1	177.5	1740	1810
Chest girth, cm	86.9	7.5	89.5	8.6	92.1	5.0	89.5	7.2	89.0	87.7	94.0
Shoulder girth, cm	28.8	3.4	29.3	3.7	28.4	2.4	28.8	3.1	290	27.0	31.0
Pelvis girth, cm	93.2	7.1	93.8	6.9	93.2	4.0	93.4	5.9	939	900	96.5
Thigh girth, cm	47.6	2.8	48.9	5.3	48.8	3.7	48.8	4.1	485	460	51.0
Waist girth, cm	75.3	6.4	75.6	8.2	75.5	4.2	75.5	6.2	760	72.0	78.0

The indicators of the fat component have a deviation between age groups, the variation coefficient ranges from $V = 50\%$ to $V = 62\%$.

To determine the static physical force of the hand muscles, it was used the "Carpal Dynamometry" test. In determining the physical force of the right hand muscles, the highest rates are recorded in boys aged 16-17 years. The most successful rates of the physical force of the left hand were also found in boys aged 16-17 years. Average values of muscle force were in the range from $\bar{x} = 35.3$ kg, $S = 9.6$ kg to $\bar{x} = 41.7$ kg, $S = 9.7$ kg. The dynamometer indicators had a deviation between age groups ($V = 21.9\%$), that proves the heterogeneity of the sample. A comparative analysis of changes in the results of dynamometry of the hand among boys aged 15-17 years showed a tendency to increase of the value of the indicator with age.

In the course of the study, we found that the absence of any postural disorders was observed only in 3.92% of boys. Postural abnormality in the sagittal plane, namely: round back (Kyphosis) in 37.20% of boys; kyphotic-lordotic back was observed in 6.82% of the subjects; flat back in 9.81% of boys. There were also postural disorders in the frontal plane, in particular, scoliotic posture in 66.70% of boys. The highest percentage (59.82%) of boys had one disorder, 30.42% of boys had two disorders, and 5.93% of boys had more than two postural disorders.

To characterize the condition of the cardiovascular system, the following functional parameters were determined in the work: heart rate at rest (HR_{rest}), Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP), Systolic Blood Volume (Stroke Volume) (SV), and Minute Volume of Blood (Cardiac Output) (CO); functional tests to assess the degree of stability of the cardiovascular system.

The volumes of the parameters HR_{rest} , SBP, DBP, SV and CO corresponded to the specific age standards given in the special literature and did not have significant differences between age groups, the coefficient of variation was in the range from 6.50% to 14.31%, which indicates the homogeneity of the sample. There is no regularity in changes of parameters values with increase of the age of the study subjects. Boys with overweight have an elevated SBP that corresponds to the laws of development of risk of cardiovascular diseases. The increase of the of SBP values of the studied boys of 15-17 years was noted in 63.7%, only 36.3% of the young men were within average age ratios. The study subjects showed signs of juvenile hypertension, when the SBP reached 130-140 mm Hg. It should be noted that they had no complaints about their health during the school year.

Robinson index values in boys aged 15-17 years were estimated at the level lower than the average - 63.72% and at the average level - 36.31%.

Analysing the state of the respiratory system and the central nervous system, it was found a low level of values of LC, Genchi and Yarotskyi tests and it was observed the dynamics of their increase with age. The range of LC values in the age groups from the minimum to maximum values was as follows: in the group of 15-year-old boys - from 1,700 to 4,100 ml; the same values are observed in 16-year-old boys, but in 17-year-old boys it varied from 2,100 ml to 4,800 ml. Thus, the minimum LC value in 15-16-year-old boys is 1,700 ml, and in 17-

year-old boys – 2,100 ml. The maximum LC values are highest in boys aged 17 years – 4,800 ml, and in boys aged 15-16 years – 4,100 ml.

A similar picture was obtained with the results of the tests on breath holding during inhalation and exhalation, which described the state of oxygen supply of the bodies of the subjects under study. The increase of these indicators is observed in boys of 17 years, so according to the results of research, the Shtange test volume is

$\bar{x} = 52.1$ sec., $S = 15.2$ sec. At the same time, boys aged 15-16 years did not show an increase in the results of the Shtange test, in young men of 15 years the rate is $\bar{x} = 48.5$ sec., $S = 14$ sec. and in boys aged 16 years $\bar{x} = 45.3$ sec., $S = 12.7$ sec. In our study, we observed an increase in the Genchi test rates with age. Indicators of the state of the respiratory system, namely, LC and the Shtange test rates in young men between age groups were varied, $V = 17.4\%$ and 27.9% , respectively, indicating heterogeneity of the sample.

In the analysis of indicators of physical capacity there were registered low average values with a clearly expressed positive dynamics with age (Table 2).

Table 2. Indicators of the functional state of boys aged 15-17 years (n = 102)

Indicators	Age, years										
	15		16		17		15-17				
	n= 34		n= 36		n=32		n=102				
	\bar{X}	S	\bar{X}	S	\bar{X}	S	\bar{X}	S	ME	25 %	75 %
HR, beats /min ⁻¹	82	6,2	80,5	7,2	76.1	6.0	80	7.1	80	76	83
SBP, mmHg	115.9	8.7	121	8.7	116.3	5.5	117.6	7.7	120	110	120
DBP, mmHg	73.8	7.3	76.8	5.4	76.1	5.0	75.5	6.1	80	70	80
Genchi test, sec	24.2	4.2	25.4	3.0	27.0	2.4	25.6	3.02	23.0	21.0	29.0
Yarotskyi test, sec	13.6	2,0	14.6	2.7	16.6	1.3	14.9	2.0	13.4	9.0	14.0
PWC ₁₇₀ kg·min ⁻¹	666.9	104.8	719.8	95.7	793.2	66.3	724.3	103.6	735.0	649.0	809.0
VO _{2 max} ml·min ⁻¹	2,132.6	279.7	2,210.0	298.3	2,386.3	233.7	2,238.4	290.1	2,231.0	2,108.0	2,439.0

To characterize the physical fitness of boys, 6 motor tests were used (running 60 m race, 100 m race, 1500 m race, 3000 m race, shuttle running 4×9 m, bending forward from the sitting position, flexion and extension of arms in front lying support, standing long jump). They all belonged to the State tests and norms of physical fitness assessment of Ukraine's population, which was the basis of normative requirements.

The results of separate motor tests indicate a low level of development of most physical qualities, in particular, a low level of endurance was observed in 88.31 % of cases; flexibility - 82.22 %; strength - 47.11 %. There was a high variation of flexibility among age groups ($V = 97.60$ %).

It has been established that the state of health of boys is characterized by a high level of morbidity and a tendency to grow with age. The most common among the boys of 15-17 years are respiratory diseases, in particular, acute respiratory diseases more than 2 times a year had 20.6 % of boys.

On the basis of the results of the assessment of the physical condition of the boys which we presented, we propose the substantiation of the screening technology of the physical condition of boys aged 15-17 years by the following algorithm:

- determination of the main factors identifying the physical condition of a person based on the materials of scientific methodological literature and the factor structure of the physical condition of boys aged 15-17 years, with the calculation of the contribution of each factor to the overall dispersion;
- definition of a group of indicators that largely reflects the physical condition of boys aged 15-17 years on the basis of studying of the correlation between the indicators within the factors and between separate factors;
- development and substantiation of the express system for assessment of the physical condition and determination of its informativity and validity;
- development of an automated screening system for the physical condition of boys aged 15-17 years.

Taking into account the results of correlation and factor analysis, we have identified the most informative and acceptable indicators for practical application in educational establishments that fully characterize the physical condition of boys aged 15-17 years.

Factor I, which represents 26.25% of the total dispersion, was identified with the physical development of boys aged 15-17 years; it demonstrates the factor load of the indicators: BW ($r = 0.957$ at $p < 0.01$); chest girth ($r = 0.816$ at $p < 0.01$), waist girth ($r = 0.936$ at $p < 0.01$), pelvis girth ($r = 0.965$ at $p < 0.01$), shoulder girth ($r = 0.824$ at $p < 0,01$).

The ease of these indicators measurements and the availability of application of the research methods in practice of physical education further enhance their value. Correlation coefficients exceed $r = 0.321$ at the level of significance $p = 0.01$. Consequently, it can be affirmed that these indicators are informative.

Due to the lack of approaches to assessment of the body structure proportionality for this age in the special scientific literature, we have defined coefficients for determining the standards of the girth of different

parts of the body of boys aged 15-17 years. The assessment is carried out by means of the ratio of the individual girth of separate parts of the body to the average standard for a given person. To do this, it is necessary to multiply the value of pelvic girth by the corresponding average standard ratio presented in Table 3.

The proposed method can be used in the practical activity of a teacher of physical education, a trainer, as well as for self-control.

Table 3. Ratios for determining the norms of the girth of different parts of the body of boys aged 15-17 years

Indicators	Average standard of proportion of body				Δ, cm
	15 years	16 years	17 years	15-17 years	
Chest girth, cm	0.932	0.954	0.988	0.958	0.15
Shoulder girth, cm	0.309	0.312	0.304	0.308	0.03
Thigh girth, cm	0.510	0.521	0.523	0.522	0.02
Waist girth, cm	0.807	0.805	0.810	0.808	0.20

Note. Δ - the difference between the rates of boys of 15 years and of 17 years.

The proposed method can be used in the practical activity of a teacher of physical education, a trainer, as well as for self-control.

The indicators characterizing the activity of the cardiovascular, respiratory, and central nervous systems form the basis of the II, III, and IV factors, contributing -30.38 % to the total dispersion. They demonstrate the factor load of indicators: HR_{rest} (r = -0.843 at p < 0.01), SBP (r = 0.823 at p < 0.01), DBP (r = 0.855 at p < 0.01); Genchi test rate (r = 0.778 at p < 0.05); Shtange test rate (r = 0.791 at p < 0.05); the Robinson index rate (r = 0.707 at p < 0.05); the Skibinskyi index rate (r = 0.704 at p < 0.05); the Romberg test rate (r = 0.723 at p < 0.05); the Yarotskyi test rate (r = 0.714 at p < 0.05). The obtained data allow us to affirm that the indicators of the functional state provide high informativity with a comprehensive approach to assessment of the physical condition of boys aged 15-17 years.

The indicators characterizing physical performance are the basis of the V factor, contributing to a total dispersion of -10.38%. They demonstrate the factor load of the indicators PWC₁₇₀ (r = 0.772 at p < 0.05) and Ruffier-Dicson Index rate (r = 0.730 at p < 0.05). They have high correlations with other factors (r = 0.341 to r = 0.585 at p < 0.05), correlation coefficients exceed r = 0.321 at the significance level p = 0.01 for the sample n = 100. Consequently, the content of these indicators allows us to conclude that the indicators of physical performance provide high informativity in the development of a comprehensive system.

Factor VI has a contribution of 5.75% in the total dispersion with the factor load of the run parameters of 60 m race, 100 m race (r = 0.84 at p < 0.01), running 1500 m race and 3000 m race (r = 0.901 at p < 0.01), the result of standing long jump (r = 0.721 at p < 0.05).

Thus, on the basis of correlation and factor analysis, 17 indicators of direct measurement and 8 first-order indicators, which characterize the physical condition of boys, were selected.

To determine the index of the physical condition of boys aged 15-17 years, using the regression analysis, an express system was developed in the form of a regression equation:

$$I\text{PhCB} = 13.6 + 4.990x_1 + 4.118x_2 + 0.552x_3 - 842x_4 + 2.223x_5 + 1.318x_6 + 0.36x_7,$$

Where: IPhCB - the index of the physical condition of the boy; X₁ - BW, kg; X₂ - Chest girth, cm; X₃ - Pelvis girth, cm; X₄ - HR_{rest} beats per min⁻¹; X₅ - Genchi test rate, sec; X₆ - Yarotskyi test rate, sec; X₇ - standing long jump, cm; The multiple correlation coefficient R = 0.762; The determination coefficient R² = 0.781; significance level p < 0.0001; Standard error of model estimation 0.253 kg·min⁻¹.

To verify the suitability of the proposed equation, we used a control sampling of 30 boys aged 15-17 years. As a result of the verification, the validity coefficient was 0.904 at p < 0.001. The difference between the dispersions of the actual value and the model value PWC₁₇₀ kg·min⁻¹ is also statistically insignificant at the level p > 0.05, which was checked by Fisher's criterion.

Basing on the results of the conducted research and following the basic principles of the construction of the technological process, namely: conformance, consistency, efficiency, systematicity, accessibility, it was developed the screening technology of the physical condition of boys aged 15-17 in the process of physical education.

This technology includes an information and methodological unit, the main purpose of which is to provide teachers, specialists in the field of physical culture and sports, medical workers and schoolchildren with the necessary methodological recommendations on the implementation of basic measurements and tests for the physical condition assessment. Diagnostic unit is the next stage of the technology. This block envisages registration of the research object and a detailed survey of indicators of physical development, functional state, physical capacity and preparedness, as well as the level of morbidity of boys. In this unit, indicators for the express system are selected, the obtained results are sent to the database.

The next part of the screening technology is the analytical and forecasting unit, which processes the obtained results, calculates the coefficients of the indices, scores and levels by comparing absolute scores with

scales that are divided into functional classes and qualitative levels. Individual and group profiles are defined

The purpose of the correctional and prophylactic unit is to provide practical recommendations for improvement of the physical condition. This unit is activated only after one type of tests or all tests are conducted and the results are entered. In this unit, great attention is devoted to exercises for the development of basic physical qualities in boys of the senior school age.

Discussion

When discussing the problem of screening of the physical condition of boys, it should be remembered that it is not limited to creating a unified and adequate suit of tests, which in itself is very important. Creation of a network of consultation and methodological centres, on the basis of which research and physical culture and health improving work should be conducted; availability of modern equipment and qualified personnel; creation of computer information processing system, assessment, issuance of recommendations and transfer of received data to the information gathering centre – all these issues require investigation and experimental confirmation.

In practice, it has been proved that mass screening require a minimum but sufficient test suite, which is appropriate for this age range, informative value of tests, and measurements, objectively assessing the physical state. The results of our study confirmed and supplemented already known developments, and also contributed to the acquisition of completely new data in terms of the problem studied.

The results of our studies confirm data (Sonkina, 1998; Nosova, 2008; Borysova, 2010) about the close relationship between the components of the physical condition of boys aged 15-17 years; about the low level of physical fitness of boys (Suvorova, 2002; Krutsevych, 2008). It was confirmed the data (Loshitskaya, 2007), that the genetically determined morphological feature – pelvis girth - not only determines the morphological composition of the body of a young man, but also has a connection with the functional state, which opens up the possibility to predict the proper physical capabilities of the individual. The data on age dynamics of indicators of physical development (Melnik, 2007), indicators of functional and physical preparedness was supplemented (Yarmak, 2010; Palchuk, 2013; Berezovskyi, 2016). It was supplemented (Goncharova, 2009; Yarmak, 2011; Kashuba, 2016) the data about the peculiarities of the use of computer information and diagnostic programs in the physical education of schoolchildren. The data on theoretical formulation and experimental substantiation of the screening technology of the physical condition of boys aged 15-17 years are completely new; The structure, the main components and their contents were developed on the basis of the determination of informative indicators of physical development, morpho-functional state, physical preparedness and physical capacity of boys. It was developed the screening system of physical condition, which provides for an in-depth and express evaluation of its level in boys aged 15-17 years, and also contains theoretical and practical recommendations aimed at raising of the physical condition level.

Conclusions

As a result of the comprehensive study of the physical condition of boys aged 15-17 years, it was found that average age values of morphofunctional parameters were within the limits of the physiological norm, while their positive dynamics with age were observed, the coefficient of variation was within 2.8% - 14.6 %, indicating the homogeneity of the sample. There were no significant differences in the value of SBP and DBP in boys of different age groups, and there is no regularity in changing their significance with increase of the age. In some young men, signs of hypertension were detected. Robinson index rates in boys aged 15-17 years were estimated at a level below the average in 63.72 % of studied and at average level in 36.31 %.

In the analysis of indicators of physical working capacity, the low average statistical values ($724.3 \pm 103.6 \text{ kg}\cdot\text{min}^{-1}$) were registered with a clearly pronounced positive dynamics of them with age. Physical development has been identified as a leading among the factors that determine the physical condition of a person. The most informative indicator of the physical development of boys is the girth of the pelvis with factor load $r = 0.965$ at $p < 0.01$, which has close correlation relationships with functional indicators, indicators of physical working capacity and preparedness ranging from $r = 0.293$ to $r = 0.896$, with $p < 0.05$; $p < 0.01$. The conducted studies allowed to substantiate the coefficients for the definition of average age standards of the girth of different parts of the body of boys aged 15-17 years.

Competing Interests

The authors declare that they have no competing interests.

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