

## CHAPTER «PHYSICAL EDUCATION AND SPORT»

### MORPHOFUNCTIONAL SCREENING OF 17-19 YEARS OLD YOUNG MEN IN THE PROCESS OF PHYSICAL EDUCATION

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**Abstract.** The scientific work presents a detailed analysis of the 17-19 years young men morphofunctional status screening studies. The young men who took part in the research did not have any pathologies in their health and belonged to the main medical group. To effectively address the goal of the study, a wide range of methods typical of researches in the field of physical culture and sports was used. A total of 34 indicators were studied, including 23 direct measurements. The reliability of the obtained results is confirmed by adequate theoretical substantiation of scientific positions and research apparatus, highly informative and reliable research methods, optimal duration, correctness of processing, analysis and interpretation of the obtained data. The relevance of the chosen topic is confirmed by the results of the study, which were based on knowledge of age anatomy, age physiology, hygiene of physical culture and sports.

Analysis of the young men morphological condition individual results in pre-prescription age indicates incomplete formation of the musculoskeletal system, and the circumferential size of the waist and hips, which exceeded physiological norms indicate the presence of excess body weight. There is a significant asymmetry between the results of wrist dynamometry, the difference between the strength of the right hand and the left hand is 6.2 kg. Studies of the body composition revealed that the average group performance

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of muscle and bone components of the young men aged 17-19 years is below the physiological norm. The range of muscle component values ranges from a minimum of 36.2% to a maximum of 78.7%, indicating sample heterogeneity. Studies of cardiovascular parameters revealed: heart rate at rest, which exceeded the physiological norm in 26.3% of test subjects, signs of bradycardia in 7.6% of test subjects, signs of hypotension were found in 4.7% of test subjects, signs of hypertension were found in 18.4% of test subjects. We found 7.6% of young men with the pulse pressure exceeded the permissible threshold. The vast majority, which is 70.7% of the studied young men of pre-prescription age, had individual results of endurance coefficient in the range of 17-29 s.u., which indicates a weakened activity of the cardiovascular system. Low individual indicators of lung vital capacity are observed at 8.3% of young men, and are in the range of 2.6-2.9 l. 10.1% of young men with individual respiratory rate results significantly higher than the age norm were also found. In the course of the study, we found that only 19.1% of pre-prescription youth had individual results of the hypoxia index which corresponded to the age norm. The individual results of the Ruffier test in pre-prescription young men were distributed as follows: 7.9% have above average level of physical working capacity, 37.2% have average level of physical working capacity, 42.3% have satisfactory level, 12.6% have low level of physical working capacity. It should be noted that as a result of the study we did not find any young men who would have a high level of physical capacity.

*The practical significance* of the obtained results is to develop recommendations for morphofunctional screening of young men aged 17-19 in the process of physical education, which can be used in the practical activities of physical education teachers and self-training classes. The research results were introduced into the educational process of the Bila Tserkva National Agrarian University students, the content of lectures and seminars for the physical training in the military forces specialists retraining courses was updated, the educational and professional program of the first (bachelor) level education for cadets in the specialty «Physical Culture and Sports» of the educational and scientific institute of physical culture, sports and health technologies in the National Defence University of Ukraine named after Ivan Chernyakhovsky was also updated.

### 1. Introduction

Analysis of scientific and methodological literature and documentary materials indicates that there is a marked decrease in the level of physical fitness and efficiency of young men of conscription age, deterioration of their physical and mental health, functional status of leading physiological systems, and steady increase of health issues [2, p. 27–32; 3, p. 39–42]. The urgency of the problem is exacerbated by the fact that the negative tendencies to reduce the main components of young men physical condition physical condition are manifested in the process of their education in educational institutions of various specializations [8, p. 1939–1944]. A number of studies indicate that innovative educational loads with a high level of psycho-emotional and intellectual load, increasing demands on the volume and quality of knowledge, intensive use of computer technology in the educational process negatively affect the morphofunctional capabilities of the body [1, p. 2110–2117]. Due to this, most young men of pre-conscription age have a prominent tension of all regulatory mechanisms and a decrease in the functional capabilities of the body on the background of a clear physical activity deficit. Given that over the past ten years [14, p. 7–12; 15, p. 1017–1023] there has been a negative dynamics of the young men of conscription age physical condition main components, the issue of conducting annual morphofunctional screening becomes relevant. Taking into account the fundamental provisions of biology and physiology of motor activity, functional systems, conditions of adaptation and physical health, morphofunctional state is characterized by a set of indicators that reflect the anthropometric profile, functional state of muscular and cardio-respiratory system [10, p. 1050–1054; 15, p. 1017–1023]. The contribution of these variables into the formation of a person's physical status is constantly changing in the process of the individual development. The necessity to conduct such control is even more acute when a human organism is exposed to the artificially directed influences in the process of implementing certain social, biological, physical or other programs to improve the organism individual functions or the system as a whole (screening article). In this context control is considered as a component of pedagogical activity, which has its purpose, objectives, principles, structure and tools, and is aimed at correcting the content component of the educational process in higher education. The necessity for a constant pedagogical control of certain

components of the physical condition of pre-service youth arises in the process of the natural biological development and improvement of motor functions in difficult conditions of interaction with the environment.

According to many scientists [11, p. 2348–2354], the results of screening studies will allow to monitor the dynamics of the physical development indicators, functional status, physical performance of young men of conscription age, and thus can be used as an effective tool for an individual approach to physical education, finding ways to optimize learning and maintenance of individual's health. At the same time, a systematic morphofunctional screening of young men should also be carried out to identify the at risk-groups and to find out the causes of deviations from the physiological norms of the main studied indicators. According to [5, p. 87–91], creation of the information databases in higher education institutions, which will allow to systematize information about the physical condition of student youth, is topical. Such databases allow you to analyse the results of pedagogical influence on the principle of feedback, and allow to correct them in the process of physical education.

Simple informative indicators and understandable for everyone (a doctor, nurse, physical education teacher, coach) are required to screen a morphofunctional state of pre-conscription youth. These indicators should not be based on a complex diagnostic equipment, should not require much time and pre-training. These will allow conducting an operational and objective control of a physical condition, analysis of the dynamics of the individual level and the group as a whole, and correcting the training process in time [15, p. 1017–1023].

According to A. Pashyn [9, p. 54–86], it is necessary to create the evaluation systems based on a set of clinical and physiological indicators of the “battery of screening tests” to obtain objective information about the degree of process efficiency of physical development, as well as the level of somatic health of the individual, which correlate with maximum aerobic productivity. Therefore, screening of a morphofunctional condition of pre-conscription youth should contain a set of easy and at the same time informative large-scale testing methods which provide a quantitative evaluation of physical development, functional state of cardiovascular and respiratory systems, physical performance to optimize the educational process, conducting timely preventive and correctional measures, as well

as to conduct experimental, research activities on the basis of the general educational institutions of any type.

**The purpose of the research** is to screen a morphofunctional state of young men aged 17-19, which is aimed at improving the pedagogical control system in the process of physical education.

**The object of the research** is the morphofunctional state of young men aged 17-19.

**The subject of the research** is the process of physical education of young men aged 17-19.

**Methods of the research.** Theoretical methods have been used for the analysis and generalization of special scientific and methodical literature, anthropometric, somatometric methods have been used to establish the total size of the body; bioimpedance methods have been used for the composition of the body; physiological methods have been used for the study of the cardiovascular and respiratory systems; mathematical statistics methods have been used for objectify of the results.

During the scientific research within the framework of existing international conventions and legislation of Ukraine, the principles of bioethics in pedagogical research were observed and all legal issues were agreed. The scientific work was carried out in accordance with the requirements of the European Convention, the Charter of the Ukrainian Association for Bioethics and GLP standards (1992), In accordance with the requirements and norms of the ICH GCR (2002) and the typical Regulations on Ethics of the Ministry of Health of Ukraine No. 281 dated 01.11. 2008 m. and was considered by the commission on bioethics of the Bila Tserkva National Agrarian University.

### **2. Characteristics of the physical development of young men aged 17-19**

The scientific research was carried out on the basis of the Bila Tserkva National Agrarian University. The study involved 277 young men, 17-19 years old, who study at the agro biotechnological, economic, environmental faculties and the faculty of veterinary medicine. Young men do not go in for sports, all of them are first and second year full-time students, for health reasons they are assigned to the main medical group. Scientific research was carried out during the 2018–2019 academic year.

In accordance with the set goal of the work, we conducted a screening study of the morphological and functional state of 17-19 year old boys, in particular: physical development, functional state of the cardiovascular and respiratory systems.

Physical development reflects the formation of structural and functional characteristics of the organism in ontogenesis. Phenotypic traits of an organism are formed under the influence of the hereditary nature of man and the environment. In a broad sense, development is called the process of qualitative and quantitative changes that occur in the human body and cause an increase in the level of complexity of the organization and interaction of all its systems. Development includes three main factors: growth, differentiation of organs and tissues, morphogenesis. They are closely related and interact. Systematic anthropometric measurements make it possible to timely identify violations of physical development (lag in body length, lack of weight gain), which are early signs of illness or indicate a violation of the lifestyle.

According to the scientific and methodological literature, the processes of the formation of the body are completed in young men 17-19 years old. During this period, the structural and functional maturity of all body systems occurs.

In the course of the study of the physical development of young men, the following indicators were determined: body length (BL), body weight (BW), girth dimensions of the chest (GDC), shoulder, waist, pelvis, hip. Additionally, the thickness of five skin and fat folds and their sum were measured. Average statistical results are presented in table 1.

Comparing the average statistical results of anthropometric data with age norms, we found that BL in young men is below the physiological norm, while BW and GDC, on the contrary, are within the range above the age norm. Information about the relationship between function and size is very important for scientific research. It makes it possible to interpret the difference between the studied contingent, as well as compare individual results with age norms, or assess changes that occur under the influence of external and internal factors. The intensity of metabolic processes, the activity of physiological functions, including heart rate, respiration rate depends on the size of the body. During the determining of the harmony of body structure in young men 17-19 years old according to the girth of

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different parts of the body we came to the conclusion that when comparing the average results with the standards, we obtained data that were in the range below the average standard of harmonious athletic development. The obtained results may indicate the incomplete formation of the musculoskeletal system, and the girth of the waist and hips, which exceeded physiological norms, and may indicate the excess fat mass.

Table 1

### Indicators of physical development of young men 17-19 years old (n=277)

Indicators	$\bar{x}$	S	Min.	Max.	V, %
Age, years	18.0	0.92	17.0	19.0	5.1
BL, cm	177.4	6.42	152.0	187.0	3.6
BW, kg	69.3	8.37	43.1	105.0	12.1
GDC, cm	90.6	6.39	71.0	101.0	7.1
Shoulder girth, cm	29.2	2.85	23.0	36.0	9.8
Waist circumference, cm	74.5	6.15	59.0	93.0	8.2
Girth of the pelvis, cm	92.3	8.87	52.0	103.0	9.6
Thigh girth, cm	50.7	5.87	35.0	74.0	11.6
Triceps fold, mm	5.8	5.33	1.0	25.0	91.9
Bicep fold, mm	12.4	6.61	3.0	33.0	53.5
Crease under the shoulder blade, mm	12.2	9.37	4.0	44.0	77.0
Subiliac crease, mm	11.6	8.12	4.0	27.0	69.9
Internal calf fold, mm	10.0	6.79	3.0	25.0	68.1
The amount of skin and fat folds, mm	51.9	32.85	17.0	150.0	63.3
Dynamometry of the right hand, kg	43.8	8.78	20.5	67.5	20.1
Dynamometry of the left hand, kg	37.6	8.36	19.0	62.0	22.2

The content of adipose tissue was determined by the caliperometry method by the thickness of five skin and fat folds, as well as their sum. It is generally known that adipose tissue is necessary for the body, since it provides an energy supply of vitamins and fatty acids, which in turn contribute to the maintenance of vital processes. Also, fat cells perform a protective and insulating function, accumulate and synthesize some hormones. But it should be noted that excess body fat can cause many diseases including hormonal disorders, problems with the musculoskeletal

system, cardiovascular and respiratory systems. The results of studies of five skin and fat folds and their sum in young men 17-19 years old indicate the significant variability, the coefficients of variation are in the range from 53.5% to 91.9%, which indicates the sample heterogeneity. The highest content of fat mass was found in the folds of the biceps and under the shoulder blade, and the lowest content was observed in the folds of the triceps of pre-conscript young men. Thus, the nature of activities and nutrition of young men is reflected in changes in body composition, which in turn is one of the characteristics of physical development. Thus, the nature of activity and nutrition of young men is reflected in changes of the body composition, which in turn is one of the characteristics of physical development.

To characterize the strength abilities of pre-conscript young men, we performed wrist dynamometry. Dynamometry is one of the important components of anthropometry, which has found its application in physiology, sports medicine and sports hygiene. It is known that one of the indicators of physical development of the body is muscle strength, which is directly dependent on the number of muscle fibres, that is, on muscle thickness. The greatest increase in carpal strength is observed in young men from 15 to 18 years. Young men at the age of 18, muscle strength approaches the lower limit of adult male strength. It is possible to draw conclusions about the physiological state of skeletal muscles based on the absolute results of the performed dynamometric measurements only in the dynamics, when the previous results were recorded in a special diary. The factors such as age, length and body weight affect the results of measurements performed using a dynamometer.

The obtained results of wrist dynamometry in pre-conscript young men indicate a significant asymmetry. Thus, the difference between the strength of the right wrist and the left one is 6.2 kg. There is also a significant variability in the dynamometry of the wrist, which indicates the muscular system formation of the young men. The range of results of the strength of the right wrist (hand) is from 20.5 kg to 67.5 kg, that is, the difference between the maximum and minimum value is 47 kg. A similar situation is observed with the results of the left wrist strength, the maximum value is 62.0 kg and the minimum is 19.0 kg, and the difference is 42.0 kg. We found that the lowest individual indicators of dynamometry of the right and left wrist had young men with underweight.

**3. Analysis of the body composition of the young men 17-19 years old**

The next stage of our scientific work was the analysis of the body composition of pre-conscript young men, which is based on the presence of objective and sustainable patterns that link the measured values of impedance with the parameters of body composition. These patterns have an impact on the physical models of the body and its segments, and on the statistical relationships between anthropometric, physical and other variables that characterize the human body. It should be noted that changes in the human body composition occur throughout the whole life. Deviations from the physiological norm usually fall into the field of scientific interest, as they may be associated with functional disorders and the development or presence of any disease. The results of the study of the body composition of young men aged 17-19 are presented in table 2.

The average fat mass group index (FM,%) of the studied young men corresponds to the age norm. As fat mass is the most variable component of the human body, individual results of young men aged 17-19 ranged from a minimum of 8.6% to a maximum of 29.1%. That is, among the studied young men of pre-prescription age there was both a deficit of fat mass (10.1%) and exceeding the age norms (12.6%). It is known that the indicators of visceral fat in the norm are in the range from 1.0% to 4.0%, the interval from 5.0% to 8.0% and are considered as an acceptable level, 9.0% and above indicates the presence of obesity. The average group indicators of visceral fat of young men aged 17-19 are within the age norm.

Table 2

**Average results of the body composition  
of young men aged 17-19 are presented (n=277)**

<b>Researched data</b>	$\bar{x}$	S	Min.	Max.	V,%
Fat mass, %	16.9	5.03	8.6	29.1	29.7
Basal metabolism, cal	1831.8	271.65	1210.0	2517.0	14.8
Water, %	62.4	5.40	51.0	72.0	8.7
Visceral fat, %	2.4	1.96	1.0	10.0	81.9
Bone mass, %	3.0	0.41	2.0	4.0	13.5
Muscle mass, %	58.2	8.44	36.2	78.7	14.5
Biological age, years	16.9	6.90	12.0	33.0	40.8

It is known that the total water content is the most massive composite of the body at the molecular level. For young men and women the norm of the total water content is within 60.0% of the total body weight. As can be seen in the chart 2, the average group water content for young men aged 17-19 corresponds to the age norm.

Individual age changes without fat mass (bone and muscle component) are more stable than the body fat component, and are directly dependent on genetic factors. During puberty, boys gain muscle and bone mass rapidly. The physiological norm of without fat component for young men and men aged 16-39 is more than 70.0%. The individual figure without fat mass of 80.0% and above is usually typical for young men and women who regularly exercise. The results of the study without fat mass indicate that the average group indicators of muscle and bone components of the studied young men of pre-prescription age are below the physiological norm. Analysis of individual results indicates a significant range of muscle component values from a minimum of 36.2% to a maximum of 78.7%. The results of scientific research indicate that the biological formation of young men organism continues. The average group indicators of biological age in young men aged 17-19 are at the level of 16.9 years. Analysing the individual results of biological age, we found the following pattern, biological age of young men who were overweight was in the range from a minimum of 32 years to a maximum of 33 years, and conversely biological age of young men who were underweight was in the range of minimum 12 years to a maximum of 16 years.

Based not only on anthropometric data, but also on the composition of the body, bioimpedance analysis allows you to choose the most informative ways to normalize the overall metabolism. Determining the rate of basal metabolism makes it possible to adjust the diet and physical activity. It is known from the literature that the value of the rate of basal metabolism directly depends on gender, age, length and weight, body temperature and other factors. The physiological norm for young men aged 17-19 is in the range of 1800-2100 kcal per day. The average group result for young men of pre-prescription age is within the physiological norm. It should also be noted that the amount of basal metabolism depends on the level of development of skeletal muscle tissue. At the same weight and length of a body individual values of the basic exchange size for young men with an

athletic body structure are higher 10-15%, than for young men with excess fat weight. One of the reasons for the low basal metabolism rate can usually be disorders of the endocrine system, the drugs impact, transients that are associated with physical and emotional stress.

### **4. Analysis of the functional state of the cardio-respiratory system of young men aged 17-19**

Determining the functional status of young men involved the study of indicators of the cardio-respiratory system. The functional state of the cardiovascular and respiratory systems was studied by indicators: heart rate at rest (HRrest), systolic blood pressure (BP<sub>syst</sub>) and diastolic blood pressure (BP<sub>diast</sub>), vital lung capacity (VLC), respiratory rate per 1 minute, Genchi breath-hold tests. The parameters obtained during the objective examination of the cardiovascular system were used by us to determine the relationship between blood pressure and heart rate, in particular: pulse pressure (PP); endurance coefficient (EC); shock index (SI); systolic blood volume (SBV), and minute blood volume (MBV). The hypoxia index (HI) was calculated based on indices of Genchi breath-hold test and heart rate.

The functional state of the cardiovascular and respiratory systems of pre-prescription youth is one of the important characteristics of health. It plays an important role in the adaptation of the body to physical activity and is one of the indicators of the body's functional capacities. The response of the organism to changes in environmental conditions in individuals can be qualitatively different and can range from physiologically optimal to pathological. Therefore, when assessing the adaptive capacity of the body of pre-prescription youth, special importance is given to determining the functional state of the cardiovascular system, which is a marker of adaptive processes and the first one to signal the presence of tension and pathology. It should be noted that the mechanisms of autonomic regulation play a leading role in the adaptive responses of the body and the preservation of homeostasis in changing environmental conditions. The heart rate should be considered an integral indicator of the level of functioning of the circulatory system, which is maintained in the range of normal values due to the activity of many compensatory mechanisms. The physiological norm of heart rate in the state of relative rest of young men aged 17-19 is in the range of 72-85 beats per minute<sup>1</sup>. In cases where the heart rate is less

than 60 beats per minute<sup>1</sup> in non-athletes, it may indicate the presence of bradycardia and be a sign of impaired atrioventricular or internal precordial conduction, as well as weakness of the sinus node. Systolic blood pressure is one of the most informative functional parameters and subtly reflects the changes associated with the state of its regulatory components: peripheral vascular resistance, activity of the sympathetic division of the autonomic nervous system, vasomotor centre tone, heart rate, and the minute volume of the blood circulation. Diastolic blood pressure, in its turn, depends on the tone of small and medium vessels and is associated with the activity of parasympathetic innervation and the condition of the vascular wall. The value of blood pressure is considered a homeostatic indicator, in connection with which its deviation in one direction or another may indicate certain changes in the general functional state of the body. If we consider the physiological norms for young men aged 17-19, the WHO refutes the theory of the normality of blood pressure with age and suggests that the optimal values are 130-110/70-80 mmHg.

The average results of the functional state of young men of pre-conscription age obtained as a result of this study are presented in Table 3.

Table 3

**Indicators of functional status and physical performance  
of young men aged 17-19 (n=277)**

<b>Indicators</b>	$\bar{x}$	S	Min.	Max.	V, %
Heart rate beats per min <sup>1</sup>	80.2	8.21	60.0	111.0	10.2
BP <sub>syst</sub> , mmHg	113.5	5.82	90.0	145.0	5.1
BP <sub>diast</sub> , mmHg	73.9	5.08	60.0	90.0	6.9
SBV, ml	70.9	6.28	51.3	82.95	8.8
MBV, l per min <sup>1</sup>	5.7	0.78	4.0	7.8	13.7
Pulse pressure, mmHg	39.6	3.62	30.0	60.0	9.1
Endurance coefficient, u.o.	20.4	2.96	13.3	29.0	14.5
VLC, l	4.1	0.72	2.6	6.7	17.6
Respiration rate	16.8	1.26	14.0	22.0	7.5
Hypoxia index u.o.	0.341	0.09	0.174	0.575	27.1
Rufier index. u.o.	10.2	2.96	4.2	18.4	29.0

According to the results of the functional state study, we found that the average indices of heart rate at relative rest, systolic blood pressure, diastolic blood pressure, systolic blood volume, minute blood volume, and vital capacity of lungs are within age-related norms.

To draw conclusions about the functional state only on the basis of average values is insufficiently justified and expedient. For more objective information, as well as to identify the risk group, we completely studied the individual indicators of young men.

Analysing the individual indicators of the cardiovascular system of young men aged 17-19 years, we found that a high heart rate at rest (from 88 to 111 beats  $\cdot$  min.<sup>-1</sup>) have 26.3% (n = 73) of young men, signs of bradycardia are observed in 7.6% (n = 21) of young men, the rest of the heart rate at rest was within normal limits (from 64 to 85 beats per minute<sup>-1</sup>). It should be pointed out that we did not find any correlation between the increase in the value of heart rate at relative rest and body weight. Young men with weight deficiency also had individual results that exceeded the physiological norms. We can explain this peculiarity by the presence of certain stress factors, which in turn negatively affect the cardiovascular system.

When analysing blood pressure results, we found that signs of hypotension characterized 4.7% (n = 13) when systolic and diastolic blood pressure readings were less than 110/70; signs of hypertension characterized 18.4% (n = 51). The category of young men whose individual scores fell within the range of hypertension was characterized as overweight. Conversely, young men who were underweight had individual blood pressure results indicating the presence of hypotension.

It is worth noting that blood pressure indexes change significantly in diseases of the cardiovascular and endocrine systems. Thus, an increase in blood pressure index is the main symptom of the disease in hypertension, acute diffuse nephritis. Significant decrease in blood pressure index is a sign of decline in cardiac activity and tonus of peripheral arteries. Such low indexes occur in acute infectious diseases, blood loss, acute vascular insufficiency of any etymology. During morphofunctional screening we did not find any persons who had such serious abnormalities in cardiovascular system activity.

For a more in-depth analysis of the cardiovascular system of pre-conscription youth we applied calculated indices, which reflect the state of

autonomic regulation and economical functioning of cardiac activity. Also, calculated methods allow us to obtain the necessary information about the state of leading hemodynamics and their dynamics, in particular, during physical training and sports.

The systolic volume value we studied reflects the volume of blood ejected by each of the ventricles of the heart during a single contraction. In the upright body position at physiological rest in 17-19-year-old males the systolic blood volume is in the range of 60-80 ml, with an average of 70 ml. There are several important factors that influence systolic blood volume: heart size, physical and mental condition of the individual, sex, strength and duration of contraction, before exercise, and post-exercise.

The individual results of systolic blood volume in young men mainly corresponded to the age physiological norm, only in 4.7% of young men this value was lower than the norm.

The next value studied was the minute blood volume, which depends on age, body weight, body position, ambient air temperature and degree of physical exertion. Physiological factors contributing to increased cardiac minute volume were physical work, nervous excitement, excessive fluid intake, and high ambient air temperature. Under the condition of relative rest, the minute blood volume, depending on body size, varies in 17- to 19-year-old males between 4.0 and 6.0 L – min<sup>-1</sup>. Analysis of individual results of blood minute volume in young men of pre-prescription age did not reveal persons with significant disorders, although in 12.3% (n = 34) this index was greater than the age norm.

The average group indicator of pulse pressure in young men of pre-prescription age was normal. An analysis of individual results revealed 7.6% (n = 21) of individuals whose PO indicator exceeded the permissible threshold, as a rule, they are overweight persons.

When analyzing the individual results of the endurance coefficient, a significant number of young men, 70.7% (n = 196), were found with indicators that were in the range of 17-29 su, which indicates a weakened activity of the cardiovascular system. The average group indicator in young men also exceeds the physiological norm, which is in the range of 12-16 conventional units. We did not find individuals with increased activity among the studied contingent.

It should also be pointed out that not only body weight can negatively affect the indicators of the cardiovascular system; among the factors are the deficit of motor activity and high emotional and intellectual stress.

The next stage of screening was the study of the external respiration system, which is one of the basic components of the study of the functional state of the body as a whole. In the conditions of motor activity, high requirements are imposed on the external respiration apparatus, the implementation of which ensures the effective operation of the entire cardio-respiratory system. The sum of the inspiratory reserve volume, tidal volume and expiratory reserve volume is the vital capacity of the lungs. This value is one of the most important indicators of the respiratory system. It depends on the biomechanical properties of the lungs and chest, as well as on gender, age and lifestyle. Thanks to the indicator of the vital capacity of the lungs, it is possible to indirectly estimate the size of the area of the respiratory surface of the lungs, on which gas exchange occurs between the alveolar air and the blood of the pulmonary capillaries. The larger the VC value, the larger the respiratory surface, the depth of breathing and, as a result, the easier it is to increase the ventilation volume. From literary sources it is known that the value of VC in athletes can fluctuate within 5.0-8.0 l, in young men 17-19 years old, not involved in sports, this value is normally 3.5 -5.0 l.

Analysis of individual VC indicators showed that 8.3% (n = 23) young men have low results, which are in the range of 2.6-2.9 litres. As you know, the value of VC is in a certain dependence on the size of the body and age, and also most significantly on the functional state and physical fitness of the body of young men.

The respiratory rate, which reflects the number of breaths taken by a person in 1 min, was determined in a state of relative rest, in a standing position. When measuring this indicator, you need to pay attention to the fact that the respiratory rate changes for a number of reasons: in a calm state, breathing is less frequent, and when exercising movements, physical exercises – more often. Breathing increases with rising of ambient temperature, body temperature, during and after eating, during excitement. With any stress, especially physical, the value of the respiratory rate increases several times. Also, the breathing rate changes depending on the initial position of the body: slower breathing occurs in the prone position,

and rapid breathing in the standing position. The norm of the respiration rate for 1 minute in a state of relative rest for young men 17-19 years old is considered 16-17 times. Analysis of individual results of the respiratory rate revealed 10.1% (n = 28) of young men, in whom this indicator significantly exceeded the age norm and was in the ranges 19-22.

In order to determine the degree of resistance of the organism to oxygen deficiency, the hypoxia index (HI) was determined. In functional diagnostics, the hypoxia index becomes important when examining young men of pre-prescription age, performing physical activities with oxygen debt while overcoming sprint distances, etc. Normally, in healthy untrained individuals, the IG value is 0.409-0.586 c.u.

The obtained results of the study of IG in young men 17-19 years old indicate a low level of resistance of the organism to oxygen, since the average group result is below the physiological norm. There is a significant variability in this indicator, which indicates the heterogeneity of the sample. As a rule, young men with obvious underweight had low individual indicators of IG. Only 19.1% (n = 53) boys had individual IH results that corresponded to the age norm.

To study the functional readiness, which reflects the state and response of vital body systems to exercise, we used a functional test. A functional test is a dosed physical activity that is given to the subject to determine the functional state and capabilities of any organ, system or organism as a whole. Often the term «functional test with exercise» is replaced by the term «testing». The reaction of the organism to a given physical work is an indicator of the functional state of the organism under study. Screening studies use various functional tests – with a change in body position in space, respiratory arrest on inhalation and exhalation, etc. Functional tests characterize the body as a whole, but they can also be used to assess the response of a particular body system to exercise. The results of the cardiovascular response to dynamic load (Ruffier's test) made it possible to assess the level of physical performance of young men aged 17-19.

Physical performance is manifested in various forms of muscular activity. In a broad sense, physical performance reflects the functional capabilities of the human body and depends on age, sex, body structure, anthropometric data, power, capacity and efficiency of energy production by aerobic and anaerobic means. Muscle strength and endurance, neuromuscular

coordination, musculoskeletal status, and the neuroendocrine system also play an important role in overall physical performance.

According to the results of the Rufier's test study, we found that the average result corresponds to a satisfactory level. The analysis of individual results of Rufier's test allowed to state that the high level of physical working capacity at young men of pre-prescription age is absent at all, 7.9% (n = 22) have above average level, average level of 37.2% (n = 103) of young men, satisfactory level of 42.3% (n = 117), 12.6% have a low level of physical fitness (n = 35). According to the test results, it can be concluded that the vast majority of young men of pre-prescription age have a satisfactory level of physical fitness. Unfortunately, among the studied sample there were young men in whom the reaction of the cardiovascular system to dynamic physical activity was negative, and their individual results of the Rufus index exceeded the value of 15 su.

### **5. Analysis of young men aged 17-19 physical working capacity**

At the stage of preliminary control, an important component is the rational use of in-depth methods of physical working capacity and cardiovascular system functional status diagnostics. Therefore a separate study concerned the assessment of the young men of pre-prescription age physical performance level. Such studies involve the use of laboratory methods in the conditions of bicycle ergometric and stepperometric studies to establish the level of health on the verge of normal and pathology. Among the physiological tests that determine human aerobic potential, the greatest attention is paid to measuring the maximum oxygen consumption (MOC), which is an integral indicator of the vegetative systems degree of perfection in the body and clearly reflects the level of working capacity (PWC<sub>170</sub>). The obtained results are usually used to normalize the physical activity intensity.

To determine the level of physical working capacity and the maximum oxygen consumption requires exercise in submaximal and maximum modes with the participation of special medical personnel and the duration of testing on average from 20 to 40 minutes, such tests for mass research are not entirely acceptable. Therefore, experts in the field of physical culture and sports have proposed a large arsenal of informative motor tests that do not require the use of complex diagnostic equipment. To do this, the natural physical exercises (swimming, running, etc.) tests are used on treadmills or

step-test. In the absence of appropriate conditions, the value of maximum oxygen consumption can be predicted by the results of a running endurance test used to assess physical fitness. According to R. Astrand, the average values of maximum oxygen consumption when running 3,000 meters in young men aged 17-19 years are  $46 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$ . It should be noted that the MOC is an extremely variable indicator, it depends on lifestyle, occupation, climate, geographical and environmental conditions. To determine the MOC in young men 17-19 years the motor test performed during running 3000 m proposed by L. Serhiienko [12, p. 254]. The obtained result was compared with the proposed scale of gradations to determine the predicted value of MOC. Table 4 presents an analysis of the aerobic capacity level of young men of pre-prescription age.

Table 4

**The level of aerobic capacity according to the predicted value of MOC in young men 17-19 years in%, (n = 277)**

High level of aerobic capacity	0.0
Average level of aerobic capacity	0.0
Satisfactory level of aerobic capacity	11.5
Unsatisfactory level of aerobic capacity	88.5

Analysis of individual results in the 3000 m run in young men aged 17-19 years indicates a significant range of values from 15.31 min.s to 20.36 min.s, and the predicted values of MOC ranged from a minimum of  $38 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$  to a maximum of  $47 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$ .

The value of the maximum oxygen consumption that we received as a result of testing served as a criterion for determining the initial level of aerobic capacity. The average group value of the predicted MOC value was  $43.2 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$ , which indicates an unsatisfactory level of aerobic capacity of the young men organisms. We also found that it was difficult for the young men to complete the test task in the 3000 m run and during the distance they mostly switched to walking. We can conclude that the general level of the endurance in young men of pre-prescription age is low.

The analysis of the results presented in Table 4 indicates that young men do not have a high and medium level of aerobic capacity and only 11.5% of people have a satisfactory level. It is well known that the reduction of

aerobic capacity of the body adversely affects the overall level of physical working capacity.

The obtained results of the predicted value of young men MOC may indicate a low level of special motor activity, and the lack of regular aerobic exercise of a cyclical nature.

### 6. Conclusions

1. During the morphofunctional screening of young men aged 17-19, we found that the studied indicators of physical development continue to form with the general biological patterns characteristic of this age group. Analysis of individual indicators of body weight indicates the presence of a significant number of people with excess body weight. Analysis of the fat component by studying the skin and fat folds and their sum indicates significant variability and large sample size. According to the comprehensive sizes of different parts of the body, the harmony of body structure development was determined in young men aged 17-19 years and it was established that the average group data were in the range below the average standard of harmonious athletic development. The results of dynamometry of the right and left hands indicate asymmetric muscle development.

2. Using the bioimpedance method, a detailed analysis of the composition of the body of young men of pre-prescription age was performed, and it was found that the average group indicators of muscle and bone components are below the physiological norm. The analysis of individual results of JM, % of young men of pre-prescription age made it possible to detect a deficit of fat mass in 10.1% of people, and on the contrary, the excess of age norms is observed in 12.6% of young men. Within the physiological norm are the average group indicators of visceral fat, aqueous component and indicators of basal metabolism.

3. Screening of the functional state of the cardiovascular and respiratory systems in pre-prescription young men made it possible to obtain detailed information about the functional capabilities of the body. Individual results of resting heart rate exceeded the age norm (from 88 to 111 beats per minute) in 26.3% (n = 73) of pre-prescription youth, signs of bradycardia were found in 7.6% (n = 21) of young men. Signs that characterized the presence of hypotension were found in 4.7% (n = 13) of adolescents and signs of hypertension were found in 18.4% (n = 51). The analysis of individual

results of pulse pressure revealed 7.6% ( $n = 21$ ) of young men in whom the indicator exceeded the permissible age norms.

Thus, as the results of our research show, screening of the pre-conscription age young men morphofunctional state in the modern educational process is one of the important elements of the pedagogical process management. The adaptive activity of the body of some of the studied young men aged 17-19 is in such a disorder that even minor physical loading can lead to negative consequences. In practice, the results of screening studies will allow specialists in the field of physical culture and sports to monitor the dynamics of physical development, functional status, physical performance, adjust the intensity of physical activity in accordance with the individual capabilities of the body.

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