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Original Article

Monitoring of the physical fitness of 17-19 year old young men during physical education

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Abstract
According to the purpose of the study, in the process of physical education, indicators of physical development, functional state, level of physical working capacity, basic motor qualities, morbidity by the main classes of diseases were investigated and analysed. Analysis of the average statistical indicators of physical development, in particular length and body weight, girth dimensions meet the age standards. We found that 25.0 % (n = 39) of young men have a body mass deficit, in 17.3 % (n = 27) of young men the body mass index is within 25.1-30 that corresponds to the level of "overweight", and the remaining 7.7 % (n = 12) of young men have an excess body weight and corresponds to the level of "obesity". Analysis of the functional state of the cardiovascular system showed that 41.0 % (n = 64) of young men have a high heart rate at rest (80 to 96 beats min^{-1}), signs of bradycardia are observed in 5.1 % (n = 8) of young men. Symptoms of hypotension are characteristic of 2.6 % (n = 4), and signs of hypertension are found in 7.7 % (n = 12) of young men. An analysis of the individual results of the vital capacity of the lungs indicated that 23.1 % (n = 36) of young men had low results.
Keywords: monitoring, physical fitness, young men, physical education.

Introduction

The issue of monitoring of the physical fitness of student youth in the process of physical education is one of the topical problems of the theory and methodology of physical education. According to a number of researchers (Seghers et al., 2009; Azhippo, 2016; Bolotin et al, 2016; Masliak et al., 2016; Galan et al., 2016; Tomenko et al., 2017; Yarmak et al., 2017; Yarmak et al, 2018), modern learning conditions at a university do not contribute to improving health. The physical fitness of student youth is negatively affected by a number of factors. Objective factors associated with the organization of living conditions, the duration of the school day, the amount of information load, nutrition, sleep and the organization of motor activity. Subjective factors mostly characterize personal characteristics, in particular, organization and discipline, motivation for a healthy lifestyle, the presence of harmful habits.

For a long time there has been a negative dynamics of the level of physical fitness of student youth in Ukraine (Chertanovskyi, 2010; Chychkan et al., 2012; Blagii et al., 2015; Bolotin et al., 2017; Kashuba et al., 2017). This fact demonstrates the need for pedagogical monitoring with a view to continuous observation, evaluation and analysis of the obtained results. When implementing pedagogical monitoring, the principles of purposefulness, continuity, integrity, consistency are generally accepted.

Most authors use five criteria to monitor the physical fitness of schoolchildren (Rogers, 2010; Gontarev et al., 2016; Kvesić et al., 2017; Džibrić et al., 2017) and student youth: the level of physical development, the degree of its harmony, the correspondence of biological age to calendar; level of functioning of the main body systems; level of physical readiness; the degree of the organism's resistance to unfavourable environmental conditions; the presence or absence of chronic diseases (Havrylov, 2006; Yarmak, 2009; Yarmak et al., 2017)

Materials and methods

To determine the indicators of physical development of student youth, there were carried out anthropometric measurements that reflect the level of morphological features. To characterize the general physical preparedness, motor tests were used.

The results were processed using the mathematical statistics methods. The research work was carried out on the basis of the Bila Tserkva National Agrarian University of the city of Bila Tserkva with young men aged 17-19 years. A sample of 156 young men took part in the research.

Results

In accordance with the goal of the work, we carried out research of the components of the physical state of young men aged 17-19 years, in particular: physical development, functional condition, physical performance

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and the development of basic motor qualities.

Physical development reflects the formation of structural and functional features of the organism in ontogenesis. Phenotypic signs of the body are formed under the influence of the hereditary nature of man and the environment. In a broad sense, development is the process of qualitative and quantitative changes that occur in the human body and cause an increase in the complexity of the organization and interaction of all its systems. Development includes three main factors: growth, differentiation of organs and tissues, and form-building. They are closely related and interact.

According to the scientific and methodological literature the processes of formation of the organism are completing in the young men of 17-19 years. In this period, the structural and functional maturity of all body systems takes place.

In the course of the study of the physical development of young men, the following parameters were determined: body length (BL) and body mass (BM), body mass index (BMI), chest girth, shoulder girth, waist girth, pelvis girth, thigh girth. In addition, the somatoscopy indicators were determined: the thickness of the five skin-fat folds and their sum. The average statistical results are presented (Table 1).

Table 1: Indicators of physical development of boys aged 17-19 years (n = 156)

Indicators	$\overline{x}$	**S**	**Me**	**25%**	**75%**	**Min.**	**Max.**
Age, years	17.7	0.89	17.0	17.0	19.0	17.0	19.0
BL, cm	177.9	6.01	178.0	175.0	182.5	152.0	187.0
BW, kg	69.7	10.97	68.6	64.5	74.0	43.1	111.0
BMI, kg/м^2	21.1	2.98	20.6	19.2	22.6	15.1	33.1
Chest girth, cm	92.0	7.29	93.0	89.0	95.0	71.0	120.0
Shoulder girth, cm	29.3	3.49	29.0	27.0	31.0	23.0	42.0
Waist girth, cm	76.5	8.60	76.0	73.0	78.0	59.0	118.0
Pelvis girth, cm	93.4	9.21	94.0	91.0	98.0	52.0	121.0
Thigh girth, cm	50.5	5.98	49.5	46.5	54.0	35.0	74.0
Sum of the skin-fat folds, mm	48.1	24.91	39.6	33.0	61.2	17.0	150.0

Comparing the average statistical results of anthropometric data with the age standards, it was found out that BL in young men is below the norm, while BW and Chest girth are on the contrary above the age standards. Analysis of the individual body mass index (BMI) results indicates that 25.0 % (n = 39) of young men have a body mass deficit, 50.0 % (n = 78) of young men are within the norm, 17.3 % (n = 27) of young men, BMI is in the range 25,1-30 that corresponds to the level of "overweight", and the remaining 7.7 % (n = 12) of young men have excess body weight and corresponds to the level of "obesity".

In the course of the study of the functional state of the cardiovascular, respiratory and cognitive functions, the following parameters were determined: heart rate at rest (HR_{rest}), systolic blood pressure (SBP) and diastolic (DBP), systolic blood volume (Stroke Volume) (SV) and minute blood volume (Cardiac Output) (CO), the vital lung capacity (VC); the sharpened Romberg's test The average statistical results are presented (Table 2). The functional state of the cardiovascular and respiratory systems of student youth is one of the significant characteristics of health. It plays an important role in the adaptation of the body to physical workload and is one of the indicators of the functional capabilities of the body.

Table 2: Indicators of the functional state and physical performance of boys 17-19 years (n = 156)

Indicators	$\overline{x}$	**S**	**Me**	**25%**	**75%**	**Min.**	**Max.**
$HR_{rest,}$ beats /min^{-1}	79.1	7.57	79.0	74.0	84.0	56.0	96.0
SBP, mmHg.	115.6	6.86	120.0	110.0	120.0	90.0	140.0
DBP, mmHg	75.4	5.36	80.0	70.0	80.0	60.0	90.0
SV, ml	71.1	5.57	72.7	68.1	74.2	59.3	83.0
CO, l·min^{-1}	4.4	1.33	4.8	3.4	5.5	1.8	6.8
VC, l	3.8	0.87	3.7	3.1	4.3	2.1	6.5
Robinson index, nominal units	92.1	9.73	91.2	85.8	97.2	66.0	115.2
Ruffier index, nominal units	10.7	2.28	10.2	9.1	12.4	4.2	18.4
Sharpened Romberg test, sec	9.4	4.97	8.6	6.0	13.7	1.1	21.8

According to the results of the study of the functional state, we established that the average statistical values of the heart rate at rest (HR_{rest}), systolic blood pressure (SBP) and diastolic (DBP), systolic blood volume(Stroke Volume) (SV) and minute blood volume (Cardiac Output) (CO), the vital lung capacity (VC) are within the age limits. 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 for identifying a risk group, we have 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 41.0 % (n = 64) of young men had a high heart rate at rest (from 80 to 96 beats per minute), signs of bradycardia were observed at 5.1 % (n = 8) of young men, in the rest of the patients, the HR_{rest} was within the normal range (from 64 to 80 beats min^{-1}). Signs of hypotension are peculiar to 2.6 % (n = 4) of the young men when the parameters of the systolic and diastolic blood pressure are less than 110/70, the signs of hypertension are characteristic of 7.7 % (n = 12) the studied young men.

The total amount of reserve volume of inspiration, respiratory volume and reserve expiration volume is the vital capacity of the lungs. This value is one of the most important indicators of the respiratory system. The analysis of individual indicators of VC showed that 23.1 % (n = 36) of young men have low results, which are within the limits of 2.1-2.9 l. As it is known, the magnitude of the 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 young male organism.

In the practice of monitoring studies, the value of the Robinson index is used to study the respiratory system, which in its turn is an important criterion of the reserve and economization of the function of the cardio-respiratory system and indicates the aerobic capacity of the organism.

Analysing the individual results of the values of the Robinson index, we found that in young men aged 17-19 years they were at a level below the average and average.

Physical working capacity is manifested in various forms of muscular activity. In a broad sense, physical working capacity reflects the functional capabilities of the human body and depends on age, gender, physique, anthropometric data, capability, capacity and efficiency of energy production by aerobic and anaerobic routes. The strength and endurance of muscles, neuromuscular coordination, the state of the musculoskeletal system and the neuroendocrine system also play an important role in overall physical performance.

Functional tests characterize the activity of the body as a whole, but they can also be used to assess the response of an individual body system to physical activity.

Based on the results of the Ruffier test, we found that the average result corresponds to a satisfactory level. Analysis of the individual results of Ruffier test allowed us to state that there is no high level of physical performance at all, 5.8 % (n = 9) of young men have a higher than average level, 52.6 % (n = 82) of boys have an average level, 25 6 % (n = 40) have a satisfactory level and 16.0% (n = 25) of the participants have a low level of physical performance have.

In our study, to determine the static coordination, we used a sharpened Romberg test. An analysis of the average statistical result indicates a satisfactory level of coordination abilities of young men. The individual results of the boys were distributed as follows: 21.8 % (n = 34) of young men with a range of values within limits from 1.1 s to 5.0 s had an unsatisfactory level; 53.2 % (n = 83) of young men had a satisfactory level, the range of values was within limits from 6.0 s to 13.5 s; 25.0 % (n = 39) of the young men had a high level, their range of values was distributed from 13.5 to 21.8 seconds. As Platonov (2004) notes, physical preparedness is defined as the level of functional capabilities of various human body systems (cardiovascular, respiratory, muscular) and the motor qualities development (strength, speed, coordination, endurance and flexibility in the joints). He distinguishes the current, operational and staging monitoring of physical preparedness. Assessment of the level of the motor qualities development is carried out according to the results shown during the performance of special control exercises.

So, the pedagogical control of physical preparedness of students should be performed with the purpose of objective quantitative estimation of development of motor qualities (power, high-speed, coordination, endurance and flexibility in joints).

For the purpose of monitoring of the basic motor qualities, tests were used that are part of the curriculum for the discipline "physical education" for university students and are the basis of regulatory requirements. The average statistical results are presented (Tables 3).

Table 3: Indicators of physical preparedness of young men aged 17-19 (n = 156)

Indicators	$\overline{x}$	**S**	**Me**	**25%**	**75%**	**Min.**	**Max.**
Running 100 m race, sec	14.7	4.51	14.1	13.8	14.5	12.9	21.3
Shuttle running 4 × 9 m, sec	9.8	0.44	9.8	9.4	10.1	8.8	11.1
Standing long jump, cm	217.9	23.64	214.0	202.0	236.0	165.0	280.0
Flexion and extension of arms in front lying support, times	31.9	11.99	31.0	20.0	44.0	10.0	52.0
Sit-up from the back-lying position, times /1min	36.6	10.18	38.0	32.0	43.0	13.0	54.0
Bending forward from the sitting position, cm	3.1	3.74	2.0	0.0	4.5	0.0	19.0
Running 3,000m race, min. sec	15.54	1.35	16.25	15.02	17.07	13.21	18.32

The biological development of motor qualities is the result of a complex interconnection of many genetic and external factors. The influence of the genetic factor on the natural process of the formation of motor functions is associated with the stage of morpho-functional structures of the organism in the process of ontogenesis. The age category of young men of 17-19 years, investigated by us, is characterized by the slowed down rate of the biological development of the organism. The formation of the musculoskeletal system is coming to an end, the bones thicken, the muscle fibres are close to the muscles of an adult person. In terms of heart rate, HR_{rest}, SV, CO and VC, young men of 17-19 years practically do not concede to adult men. The formation of these morpho-functional structures increases the adaptive capacity to moderate and large-intensity physical loads.

Analysis of the average statistical results in the running 100m race, shuttle running 4x9m, standing long jump, sit-up from the back-lying position, flexion and extension of arms in front lying support correspond to a satisfactory score. The average statistical results in bending forward from the sitting position and running 3,000 m race correspond to an unsatisfactory score. During the monitoring of the development of the motor qualities, we found young men whose individual results had unsatisfactory scores: in running 100 m race (19.9 % (n = 31) of the young men), in the shuttle race 4x9 m (22,4 % (n = 35) of subjects), in standing long jump (26,9 % (n = 42) of the young men), in flexion and extension of arms in front lying support (21,8 % (n = 34 of the young men), in sit-up from the back-lying position for 1 min (7.7 % (n = 12) of the young men), in bending forward from the sitting position (90.4 % (n = 141) of participants), and running 3,000 m race – 48.1 % (n = 75) of the young men.

In the course of our study, the data of medical cards of 156 young men aged 17-19 years were analysed and it was established that the health status of young men is characterized by a high incidence rate and a tendency to increase in the main classes of diseases.

Diseases of the respiratory system are the most common, a significant role in the formation of the incidence rate of this class is played by chronic diseases of adenoids 17.9 % (n = 28) and bronchitis 29.5 % (n = 46).

The second position is held by the diseases of the digestive system, the greatest attention is drawn to gastritis and duodenitis 19.9 % (n = 31), and cholecystitis 7.1 % (n = 11). Acute respiratory diseases were seasonal, 21.1 % (n = 33) of the young men were ill more than 2 times a year; 13.5 % (n = 21) of young men were ill more than 3 times a year. One of the significant causes of acute respiratory diseases is overheating or hypothermia. The organism of young men, due to the lack of functional readiness of physiological systems that are responsible for maintaining the state of thermal comfort, is determined by the optimal level of the thermoregulatory function, and the cardiovascular, respiratory and a number of other functions closely related to it, is more prone to pathological reactions even with relatively low actions of environmental meteorological factors.

Analysing the nosology of diseases of the musculoskeletal system, it is especially important to note such as the curvature of the spine in the sagittal and frontal plane, this disease is registered in 96.8 % (n = 151) of boys aged 17-19 years.

Discussion

Monitoring in this context is considered as a component of pedagogical activity, has its purpose, objectives, principles, structure and tools, and is aimed at correcting the content component of the educational process in a higher educational establishment.

It is topical to create information databases in higher educational establishments that provide an opportunity to systematize information on the physical fitness of student youth. Such databases allow to analyze, on the principle of feedback, the results of pedagogical influence, and to correct them in the process of physical education.

To monitor the physical fitness of student youth, simple informative indicators are needed, accessible to each user: a doctor, a nurse, a physical education teacher and a coach. They should not be based on complex diagnostic equipment, time consuming and preliminary preparation. It will give an opportunity to perform the operative and objective control of the physical fitness, the analysis of the dynamics of an individual level and of the group as a whole, and the timely correction of the training process (Yarmak et al., 2017; Roy, 2017; Galan et al., 2018).

So pedagogical monitoring in the process of physical education is a system of collection, processing, pedagogical interpretation and storage of information during training, which provides continuous monitoring of the dynamics of the physical fitness of young men, gives opportunity for timely correction and predict the level of physical fitness in the future. The results of monitoring studies will allow to observe the dynamics of indicators of physical development, functional status, physical work capacity and preparedness of student youth, and thus it can be used as an effective means for implementing an individual approach to physical education, finding ways to optimize the learning process and preserve the individual health of each student.

The results of our studies confirm the data about the low level of the basic motor qualities in young men aged 17-19 (Dukh, 2012; Shephard et al., 2013; Korol, 2014; Sergoyenko, 2014, Zekrin et al., 2017; Kashuba et al., 2017; Kekeeva et al., 2016; Paliichuk et al., 2018).

The results of our studies supplement the data about the age-related dynamics of physical development indicators, functional parameters of the cardiovascular and respiratory systems (Blagii et al., 2015), the incidence of student youth by main classes of diseases (Tserkovna et al., 2017).

Conclusion

In the course of monitoring of the physical fitness of young men aged 17-19 years, we conducted research of 25 indicators characterizing physical development, the functional state of the cardiovascular and respiratory system, the level of physical performance, the basic motor qualities. There was a high variability in BW parameters and the sum of skin-fat folds V = 15.7 % and V = 51.8 %, which indicates the heterogeneity of the sample. In determining the harmony of the physique in young men aged 17-19 years according to girth dimensions it was found out that individual indices are lower than the average standard of harmonious athletic development. Individual results of the values of the Robinson index in young men aged 17-19 years were estimated as a level below the average and average. Individual results of Ruffier test in young men were distributed as follows: high level was absent, above average – 5.8 % (n = 9) of young men, 52.6 % (n = 82) of participants had an average level, 25.6 % (n = 40) had a satisfactory level, 16.0 % of young men (n = 25) had a low level of physical performance. Analysis of the results in individual motor tests indicates a low level of development of most physical qualities, in particular: endurance, flexibility and strength. It should be noted the high variability of flexibility (V = 120.6 %).

Thus, according to the results of our own research, we can draw the following conclusions:

- monitoring is the most productive tool for observing, analysing and control of the physical fitness of young men;
- monitoring allows to minimize the negative consequences of educational and professional activities, as well as to improve the effectiveness of the means and methods used in the process of physical education.

Conflicts of interest – If the authors have any conflicts of interest to declare.

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