

Comparative analysis of indicators of the morpho-functional condition of the young men aged 15-16 years during the process of physical education

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Abstract The article presents the results of the assessment of the morphological status and functional condition of the body of the young men aged 15-16 years. Altogether 140 young men aged 15-16 who study and live in the city of Chernivtsi took part in the pedagogical experiment. The data obtained as a result of the research, complement the knowledge in the field of age morphology and physiology regarding the growth and development of the juvenile population of this region. It has been established that the young men aged 15 years have a predominantly disharmonious body structure. In the boys aged 16 years, the chest girth, thigh girth and dynamometry of the right and left hands are significantly higher ($p < 0.05$). We have established that the functional condition of the cardiovascular system and respiratory system in young men is developed heterochronously. The worst indicators of the level of the Ruffier index are observed in the boys aged 16 years. 16.6 % of boys showed unsatisfactory level of recovery after dynamic load. The practical significance of our research is detection of a discernible decrease of the adaptive capacity of the body of the young men of 15 and 16 years. And also this will enable us to use the obtained results in the prognostic plan, since the obtained data can be used as the starting point for comparison of the further similar studies results.

Key words: morpho-functional condition, young men, physical education.

Key Words: power; adolescent; youth; combined training; stretch-shortening cycle; vertical jump.

Introduction

In recent years, introduction of the differentiated approach during the process of physical education has been a matter of great concern in the modern Ukrainian school (Azhippo, 2015). Today, this issue attracts the attention of specialists in the field of physical culture and sports, teachers and medical scientists (Yarmak, 2009; Bolotin, 2015; Blagii, 2016; Bolotin, 2016; Galan, 2017; Ivashchenko, 2017; Kozhokar, 2018). It is known that taking into account the individual characteristics of schoolchildren during the process of physical education in the future has a positive impact on the harmonious physical development, increase of the performance efficiency and strengthening of the functional capabilities of the body (Druz, 2013; Bolotin, 2017). The main objective of the differentiated approach in the educational process is to ensure the maximum productive activities of each student, providing the optimal motor mode (Glazyrin, 2003; Meleshko, 2009). According to many scientists, the most significant criterion of differentiation is the morpho-functional features of an individual (Ermolova, 2003).

In-depth and comprehensive study of schoolchildren is the main condition for an objective assessment of the pedagogical process (Arefiev, 2013). Therefore, it is essential to accumulate scientific data on the changes occurring in the physical development of schoolchildren, in the functional state of the cardiovascular and respiratory systems, in physical performance and physical fitness.

Today, many scientists, educators and specialists in the field of physical culture and sports pay great attention to the solution of topical issues on the introduction of modern health technologies (Ermolova, 2003). But without a global study of age and individual morpho-functional features of schoolchildren, it is inappropriate to use outdated techniques (Yarmak, 2012). According to many scientists, for a teacher of physical culture it is advisable to apply the morphological method of differentiation. It is necessary to take into account the level of physical development of students, which is determined by the ratio of the main body sizes: body length, body weight and the chest girth. It is common knowledge that the physical development of schoolchildren is one of the main indicators of the physical health of child and adolescent population. Permanent screening of physical development enables determining the characteristics of growth and development of schoolchildren, which are formed under the influence of lifestyle, climate - geographical features of residence and socio-economic conditions of life (Blagii, 2015; Yarmak, 2017).

The abovementioned facts allow us to make a conclusion about the relevance of the chosen topic of the research work.

Materials and Methods

To solve the tasks set in the research work, the methods used in the theory and practice of physical education and sport and pedagogy were used. In the work we used the following research methods: analysis and synthesis of special scientific and methodological literature; anthropometric research methods; physiological research methods; methods of mathematical statistics. The data obtained as a result of the theoretical analysis helped us during interpreting and discussing the results of the research. In the process of generalization of the data of the scientific and methodological literature, particular attention was paid to the study of: published researches on the control of the morpho-functional condition of 15-16-year-old boys during physical education; methodological developments, documents and statistical materials for determining the level of physical development, the functional state of the cardiovascular and respiratory systems; researches on the use of mathematical statistics in physical education and sport.

The research work was conducted on the basis of general educational institutions No. 6, 27, 30, 33 of the city of Chernivtsi with the young men aged 15-16 years, from September 2017 to November 2017. Altogether 68 young men of 15 years and 72 young men of 16 years took part in the research. In total, 140 young men took part in the research, for health reasons all of them are referred to the main medical group.

Results

As it is known from literature, the age of 15-16 years in young men is characterized by the completion of the processes of formation of all organs and systems of the body and the approximation in their functional characteristics to the level of an adult. The juvenile age of 15-16 years is primarily associated with a rapid increase in body length, while the largest increase in body weight is observed at the age after 16 years. Intensive development of the muscular system is observed after 15 years and up to the age of 17 years it reaches 40-44 % of body weight. In boys at the age after 16 years, the indicators of muscular strength are close to those of an adult, and the development of general endurance is 85 % of the corresponding level of an adult. The processes of formation of the musculoskeletal system continue, the full growth of the pelvic bones and the formation of the bones of the feet continue until the age of 18 years. With an increase in the size and organs of the body, their physiological functions also change.

Information about the relationship between the function and size is very important for scientific researches. It enables interpreting the difference between the studied contingent, as well as to compare individual results with age norms, or to assess changes occurring under the influence of external and internal factors.

The results of our research show that the young men ages 15-16 years have a high variability in terms of body mass, the sum of five skin-fat folds, dynamometry of the right (15-year-old boys only) and the left hand. The coefficients of variation exceed 14.6%, this feature indicates the heterogeneity of the sample. The research results are presented in the Table 1.

Table 1. Comparative analysis of indicators of physical development of the young men aged 15-16 years (n = 140)

Indicators under study	15-year-old boys (n=68)		16-year-old boys (n=72)		±Δ, %	p
	\bar{x}	S	\bar{x}	S		
Body length, cm	175.9	5.44	177.3	4.52	0.8	>0.05
Body weight, kg	64.9	10.03	68.1	12.28	4.7	>0.05
Chest girth, cm	86.7	6.68	89.6*	7.98	3.2	<0.05
Shoulder girth, cm	28.9	3.22	29.5	3.25	2.0	>0.05
Waist girth, cm	75.1	5.64	76.1	7.98	1.3	>0.05
Pelvis girth	93.1	6.46	94.1	6.71	1.1	>0.05
Thigh girth, cm	47.5	2.92	49.0*	4.97	3.1	<0.05
Sum of five skin-fat folds, mm	49.0	23.93	48.8	29.68	0.4	>0.05
Dynamometry right, kg	35.2	8.33	38.5*	5.58	8.6	<0.05
Dynamometry left, kg	33.4	9.38	35.4*	8.4	5.6	<0.05

Note: ± Δ, % - the difference between the young men aged 15 and 16 years.

Note: * the difference between the young men aged 15 and 16 years is statistically significant at the level of p <0.05.

There is a statistically significant difference between the young men of 15 and 16 years of age at p <0.05 in the indicators of chest girth, thigh girth, and right and left hand dynamometry. The results obtained by us indicate that natural processes of development are taking place in young men. Body length increases only by 0.8 % (p>0.05), whereas body weight increases by 4.7 % (p>0.05), chest girth - by 3.2 % (p <0.05), and thigh girth - by 3.1 % (p <0.05). The 16-year-old boys have a decrease in the amount of five skin-fat folds by 0.4% (p> 0.05). This fact testifies to the process of formation of the muscular system in the young men. In the young men aged 16 years the muscle strength of the right and left hand increases by 8.6 % and 5.6 % (p <0.05).

The proportionality of the constitution of young men according to the girth measurements of various parts of the body, was determined by the ratio of individual data with middle-aged standards. Assessment of the results was performed by comparing the individual girth dimensions of particular body parts with the average standard for a given person. The obtained results of the chest girth measurements indicate that the largest percentage - 61.8 % (n = 42) of 15-year-old boys have a level below average; the insufficient development of skeletal muscles of the chest is one of the factors that can explain this fact. In most of the young men aged 16 years, the overwhelming majority - 52.8 % (n = 38) have an average level, that is, with age there is positive dynamics in the formation of skeletal muscles.

The determination of the functional status of the young men included research of indicators of the cardio-respiratory system (Table 2.) The obtained average results of the heart rate at rest between the age groups did not have a statistical difference ($p > 0.05$). In the young men aged 15 and 16, the average result corresponds to the age norm. In the 16-year-old boys, the heart rate at rest is 2.5 % lower than that of 15-year-old boys, this feature indicates natural biological changes because up to the age of 18 years, the formation process is completed. Analysis of individual results revealed 19.2 % (n = 13) of the 15-year-old boys, whose heart rate was in the range from 89 beats·min⁻¹ to 105 beats·min⁻¹. In the boys of 16 years, we also found 12.5 % (n = 13), in which the heart rate was higher than the age norms. This fact is disturbing and testifies to the presence of abnormalities in the work of the cardiovascular system of the young men.

A study of the average blood pressure in the young men aged 15 and 16 years indicates a statistically significant difference ($p < 0.05$) between them. Among the young men of 16 years, the SBP indicators are by 3.4% ($p < 0.05$) higher than that of the young men of 15 years, and the DBP indicators – by 2.0 % ($p < 0.05$), respectively. Such dynamics indicates the processes of formation of the cardiovascular system and the approximation of parameters to the indicators of an adult person.

When analysing the indicators characterizing the respiratory system of the 15-year-old boys, it was found out a significant variability of VC (V = 18.5 %), Genchi test (V = 28.3 %), Shtange test (V = 23.0 %), Skibinskyi index (V = 34.3%), of the vital index (LI) (V = 19.2 %). Such high coefficients of variation indicate heterogeneity of the sample. The young men of 16 years also have a significant variation in these indicators, the coefficients of variation are in the range from V = 15.3 % to V = 30.7 %. When analysing the indices of the respiratory system, we found no statistically significant difference ($p > 0.05$) between the 15-year-old and 16-year-old boys (Table 2).

Table 2. Comparative analysis of the indicators of the cardio-respiratory system of the young men aged 15-16 years (n = 140)

Indicators under study	15-year-old boys (n=68)		16-year-old boys (n=72)		±Δ, %	p
	\bar{x}	S	\bar{x}	S		
HRrest, beats /min ⁻¹	81.4	5.80	79.4	6.55	2.5	>0.05
SBP, mmHg	116.3	7.71	120.4*	7.84	3.4	<0.05
DBP, mmHg	74.4	6.55	75.9*	5.26	2.0	<0.05
VC, l	2907.4	539.02	2923.0	446.15	0.5	>0.05
Genchi test, sec	23.5	6.65	24.4	7.49	3.7	>0.05
Shtange test, sec	48.4	12.58	46.1	11.80	5.0	>0.05
Ruffier index, nominal units	11.8	1.52	11.4	1.82	3.5	>0.05
Robinson index, nominal units	95.1	9.16	97.0	10.57	2.0	>0.05
Skibinskyi index, nominal units	844.5	289.72	876.8	262.24	3.7	>0.05
Life index (LI), ml/kg	44.5	8.33	43.5	6.57	2.3	>0.05

Note: ± Δ, % - the difference between the young men of 15 and 16 years

Note: * the difference between the young men of 15 and 16 years is statistically significant at the level of $p < 0.05$.

To study the state of aerobic capacity, we used Robinson index. The obtained average results indicate a negative trend, so for the 16-year-old men this indicator is by 2.0 % lower. The average results in the boys of 15 and 16 years correspond to a level below the average. Also, some negative dynamics is observed when comparing the indicator of LM, which is 15% higher in the boys of 15 years than in the boys of 16 years.

In the course of our research, we found out that in the young men aged 15-16 years with a high level of physical development, individual indicators of the Ruffier index and Robinson index corresponded to the average and above average levels.

Discussion

Physical development in adolescence reflects the morphological and physiological changes of organs and systems. This is a natural process that can be affected by: the genetic heredity, the constitutional features of the body, the congenital or hereditary pathology of growth and development, the ecological situation, the quality of nutrition and the intensity of physical activity. The physical development of the youth contingent is

characterized by the proportionality of the body build, that is, its geometric dimensions, which in their turn affect the functioning of all organs and body systems without exception. The intensity of metabolic processes, the activity of physiological functions, in particular, heart rate, respiration rate, depend on the size of the body.

A large number of authors engaged in the study of the physical development of children of different age groups, while developing complex techniques. The anthropometric indicators take a significant place in physical education because of their informativeness for diagnosing physical fitness, the system of indices of physical fitness of the author (Krutsevych, 2006; Kashuba, 2017; Yarmak, 2018; Galan, 2018), physical health, the express system of somatic health assessment (Apanasenko, 2000), physical condition (Borysova, 2009). The simplicity of the measurement of these indicators and the availability of the use of these research methods by practitioners in the field of physical culture further more enhance their value.

The scientists share a view that at the final stages of puberty, before the beginning of the adolescence, the main physiological systems are already formed. However, the data we obtained as a result of the anthropometric measurements suggest the opposite. The results of the study of the morphological characteristics of the young men aged 15-16 years have minor intragroup deviations, this fact is confirmed by literature data on the age peculiarities of the development of young men at the stage of completion of puberty and postpuberty periods.

We have confirmed the data (Serhiienko, 2005) on the gradual growth in the age aspect of body length and body weight, as well as the strength of the muscles of the right and left hand of the 15-16 years old boys.

We confirmed data (Bogdanovska, 2014), that the most unfavourable period of decline in the functional condition and adaptive capacity of young men is the age period of 15-16 years.

Conclusions

The results of the study of physical development testify to the overwhelming majority of persons with a disharmonious body structure, especially in 61.8 % of 15-year-old boys. The matter of concern is the presence of overweight persons in both age categories, there are 27.9 % of 15-year-old and 23.6 % of 16-year-old young men. In persons with overweight, the indicators of heart rate at rest, SBP and DBP are significantly higher than the age norms ($p < 0.05$). Changes in the VC in the age aspect retain the pattern of gradual increase with age. The range of variation of VC indicators in the age groups from the minimum to the maximum values was as follows: in the 15-year-old young men - from 1650 to 4000 ml, in the 16-year-old young men - from 1750 to 4100 ml. The study of the morpho-functional condition of the young men aged 15-16 years provides the necessary information about the functional capabilities of the body of each individual and of the age group as a whole. Identification of deviations in boys at the stage of preliminary control allows teachers to make the necessary adjustments in the educational process in order to correct physical exertion.

Competing Interests

The authors declare that they have no competing interests.

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