

# Formation of Anthropometric, Functional and Psychophysiological Indicators in Students of Medical Colleges under the Influence of Physical Activity

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**Abstract:** *Purpose:* to define the dynamics of physical development indicators among medical college students in 2017 and to compare it with the results of the previous study of 2005.

*Method:* The inclusion criteria were: no health complaints at the time of the examination, no chronic diseases in family medical history, no deviations from the norm in clinical and laboratory tests. The selected young men were examined by medical specialists (neuropathologist, ophthalmologist, otolaryngologist, therapist, surgeon); detailed clinical, laboratory and diagnostic tests were conducted: X-ray; spirometry; electrocardiography; dental examination; ultrasound examination (cardiovascular, thyroid, abdominal, urological); biochemical blood testing. The participants were subdivided into two groups: Group 1 (students (n=140) who studied at Zhytomyr Medical College in 2004-2005) and Group 2 (students (n=150) who studied at Zhytomyr Medical Institute in 2016-2017).

*Results:* According to the results of studying the dynamics of anthropometric, functional and psychophysiological indicators of physical development among Ukrainian medical college students (n=290; 17-21 years old) in 2017, comparing them with the results of the previous study, conducted in 2005, the tendency to gain in body mass in average values from (0.88 ± 0.26) to (2.7 ± 0.67), in body mass index from (0.88 ± 0.26) to (1.38 ± 0.38), in the fat component from (8.70 ± 0.22) to (9.36 ± 0.21) was established.

*Conclusions:* An increase in body mass index, the fat component in medical college students was revealed, which is related to problems in the quality of the students' diet. Though the muscle mass has increased, and the study indicates that there is insufficient physical activity; sustainability and concentration of attention indicators tend to decrease under the influence of intensification of the educational process. The dynamics of the indicators under analysis indicates the stabilization of the growth process in Ukrainian male students.

**Keywords:** Students, physical constitution, anthropometry, sexual dimorphism, physical development, healthy lifestyle, physical training.

## 1. INTRODUCTION

The World Health Organization [1] listed the health problem of young age persons as one of the key concerns to date and called for public health action recognizing the unique health problems of young people and responding to their special need for support. In Ukraine, the National Strategy entitled "Physical activity – a healthy lifestyle – the healthy nation" presents a thorough analysis of the challenges and opportunities of the state health programs. So, one of the National Strategy objectives is "formation of the

value attitude of youth to their health, improvement of physical development and physical preparedness taking into account the requirements of future professional activity" [2].

Currently, the young age is perceived worldwide as a key developmental period, laying the basis for healthy behaviours throughout an individual's life [3]. Several cutting-edge researches addressed the issues of students' physical education [4], lifestyle and health maintenance problems faced by young people in college and university settings [5, 6], as well as programmes and strategies that have been put into effect [1, 2]. Overall, in implementing the European policy "About Health 2020" [7], interventions in the student community at large can be powerful tools. With

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this purpose, many researchers address general theoretical principles of healthy lifestyle's formation, as well as consider directions for promoting health-enhancing physical activity [8, 9].

As shown by Shaparenko (2006), anthropometric and somatotypical characteristics of the individual are conditioned by the influence of environmental factors, primarily by the mode of nutrition and physical training [10]. According to statistics, about 20% of Ukrainian students have varied abnormalities in their health, the number of students assigned to a special medical group has increased by 4 times during the last 5 years, more than a third of students are unaware of the basics of a healthy lifestyle and only 6% are engaged in sports and sports activities on a regular basis [4]. On the other hand, informatization, intensification of activity, analysis, processing and redistribution of large masses of information, the use of information technologies are those requirements that a society currently puts forward to a college graduate, and therefore, it is necessary to study the anthropometric parameters characterizing physical development carefully, the intensity of growth processes, the level of morphofunctional maturity and mental qualities among which such as concentration, attention span and switching, emotional stability, action speed, specific endurance, agility, etc.

The purpose of this study was to define the dynamics of physical development indicators among medical college students in 2017 and to compare it with the results of the previous study of 2005. With this in mind, the functional state of the muscular system, component composition of the body mass, and psychophysiological indicators were examined among college students at the beginning and after a year of training. And the results were compared with a similar study conducted in 2004-2005.

## **2. METHOD**

### **Participants**

The participants were 290 students, subdivided into two groups:

Group 1: Individuals aged 17-21 years old who studied at the Communal Institution of Higher Education "Zhytomyr Medical College" and were examined in 2004-2005, with the total number of 140 persons;

Group 2: Individuals aged 17-21 years old who studied at Zhytomyr Medical Institute of Zhytomyr

Oblast Council and were examined in 2016-2017, with the total number of 150 persons.

The peculiarity of this longitudinal study was that anthropometric measurements were carried out among college students at the beginning and after a year of training, and were compared with the results of a similar study conducted in 2004-2005.

### **Research Design**

Among the students who studied at the Communal Institution of Higher Education "Zhytomyr Medical Institute" of Zhytomyr Oblast Council in 2016-2017, were selected 180 males, urban and rural residents, representatives of the Ukrainian ethnic group, residents of the Polissia region of Ukraine. The inclusion criteria were as follows:

No health complaints at the time of the examination,

No chronic diseases in family medical history,

No deviations from the norm in clinical and laboratory tests.

The selected young men were examined by medical specialists (neuropathologist, ophthalmologist, otolaryngologist, therapist, surgeon). Detailed clinical, laboratory and diagnostic tests were conducted which includes, ultrasound examination of the heart and major vessels, thyroid gland and parenchymal organs of the abdominal cavity, bladder, X-ray of the chest, spirometry, electrocardiography, dental examination, testing the basic biochemical parameters of blood [11].

In the course of these medical tests, 150 healthy young men were identified. The selection protocol corresponded to the methodology and stages of the study [12], which was conducted among 140 students of Zhytomyr Medical College in 2004-2005. Thus, 290 students were surveyed and correspondingly subdivided into two groups. The study included the identification of the following indicators: anthropometric, psychophysiological, functional state of the muscular system, composition of the body mass.

The anthropometric parameters were studied according to the Bunak method [13] in the modification of Harrison [14] - the total body size was determined (the height and the mass of the body, the surface area of the body) and the following were measured: 5 longitudinal dimensions; 10 transverse dimensions, sagittal size of the chest; 15 girth sizes.

To determine the degree of development consistency, the following values were determined:

1. Kettle body mass index (BMI) – ratio of the mass in kilograms to the height, squared, upper limit of the norm – 25.0 kg/m<sup>2</sup>, international obesity standard – BMI > 30.0 kg/m<sup>2</sup>; BMI < 18.5 kg/m<sup>2</sup> – chronic energy deficiency (CED).
2. J. Tanner's Sexual Dimorphism Index (SDI) [14] was used to determine the type of somatic sex. SDI at values < 83.7 corresponds to a gynecomorphic type of the body structure, with values of the index from 83.7 to 93.1 – to a mesomorphic type, more than 93.1 – to an andromorphic.

The index of sexual dimorphism is determined by the following formula:  $SDI = 3 \times \text{shoulder width (cm)} - \text{pelvic width (cm)}$ .

3. Chest index (the ratio of the girth size of the chest to the height of the body). It is used to determine the dolichomorphism of an individual (<51), mesomorphism (51-56) and brachymorphism (>56) [15].
4. The index of shoulder width (the ratio of acromial diameter to body height) also makes it possible to characterize the structure of the individual's body as dolichomorphic (<22), as mesomorphic (22-33), and as brachymorphic (>33) [15].

The functional state of the muscular system was evaluated by determining the maximum strength of the handgrip. Measurements were made by the handgrip dynamometer in accordance with the instructions for the instrument. The ratio of the strength of the handgrip to the absolute mass of muscle tissue was calculated. The index of brush strength for men is, on average, 65-80% of the body mass [16].

To determine the composition of the body mass, the formulas by Matiegka [17] were used. An absolute amount of fat, muscle, and bone components were determined.

The analysis of quantitative parameters was carried out using the STATISTICA program using parametric estimation methods. The evaluation of the following values was conducted: the correctness of the distribution of signs for each of the variation series received, the average values for each attribute being studied and their standard deviations. The determination of differences between the samples that were compared was performed using Student's t-criterion (when the sample has all the signs of normal distribution).

Psychodiagnostic testing "Correctional test" according to Ivanov-Smolensky methodology [18] was used to determine the efficiency, stability of attention and ability to its concentration. The evaluation of attention, its switching and efficiency were carried out in points on a nine-point system. For this purpose:

- a) the total number of checked characters (letters) was counted;
- b) the number of errors (missed, or incorrectly deleted, or incorrectly emphasized letters) was counted. Each such error makes 20 points, each missed line – 60 points;
- c) the number of correctly marked letters was determined (for this purpose, of the total number of revised characters was counting the number of points received for mistakes);
- d) determination of workability and concentration of attention according to Table 1.

### 3. RESULTS

A comparative analysis of anthropometric indicators in college students found out that the average *body mass* during the 2004-2005 study was (69.36 ± 0.88) kg, while the maximum body mass recorded was 86.0 kg, the minimum value of this indicator is 50.0 kg. After one year of studying at a medical college, the average student's weight of (70.23 ± 0.83) kg, a maximum of 88.0 kg, a minimum of 55.0 kg, and consequently, the

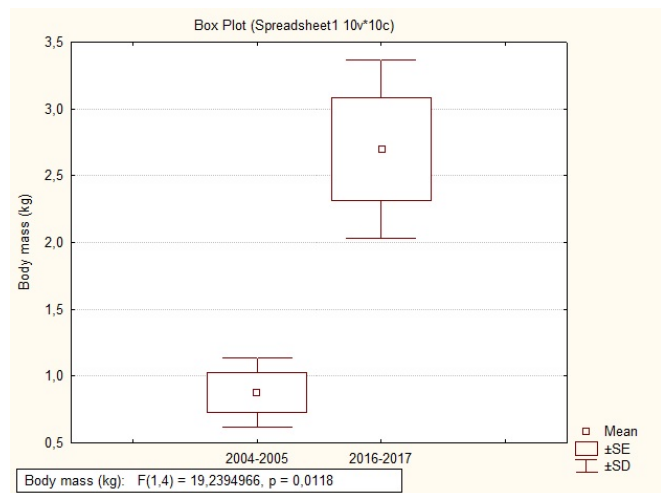
**Table 1: Sustainability and Concentration of Attention**

The level of attention concentration	2004	2005	2016	2017
Low	8,6%	20,7%	20.2 %	48,7%
Satisfactory	91,4%	64,7%	79.8 %	43,0%
High	0 %	14,6%	0 %	8,3%

increase in student body mass was on average ( $0.88 \pm 0.26$ ) with the reliability of the result  $p > 0.05$ . When conducting the study of total sizes in 2016-2017, we found that the first-year students' average body mass was ( $72.44 \pm 0.93$ ) kg, the maximum of 92.0 kg, the minimum of 58.0 kg. Anthropometric measurements conducted in these students after one calendar year revealed an average of ( $75.14 \pm 0.26$ ). The increase in body mass in Group 2 was ( $2.7 \pm 0.67$ ), which should be considered as a reliable value of  $p < 0.01$ .

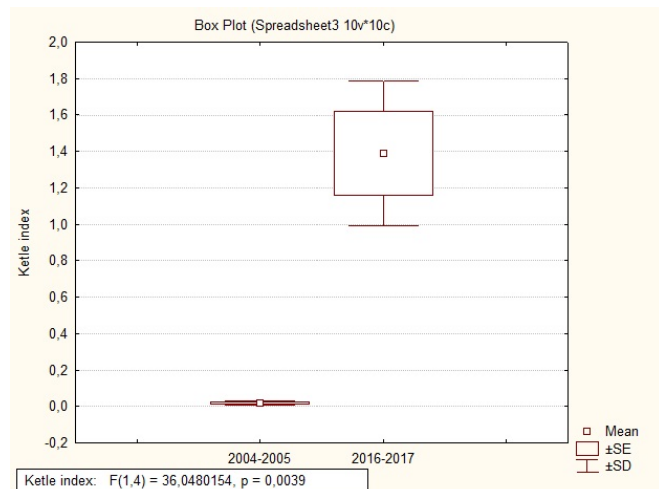
In the study of *body height* measurements in 2004, it was determined that the average value was ( $173.38 \pm 0.88$ ) cm, with a minimum and a maximum height of 151.0 and 194.0 cm, respectively. Measuring the *body height* of the students in one year of training has made it possible to set the following values of indicators: minimum 154.0 cm; average ( $175,14 \pm 0,79$ ) cm; maximum 197.0 cm. The index of *body height* gain was ( $1.26 \pm 0.12$ ) cm per year, with the probability of a result  $> 0.05$ . The studies conducted in 2016-2017 provided an opportunity to determine the average *body height* of the students of the medical college at the beginning of the study ( $171.19 \pm 0.56$ ) cm, in one academic year ( $173.0 \pm 0.72$ ) cm, the mean the increase in body height for the year was (2,010,16) with the reliability of the result  $p < 0.05$  [19].

The analysis of *the body mass index* (Figure 1) in the period of 2004-2005 revealed at that time an increase in the average of this indicator, the presence of persons with chronic energy insufficiency (with an index of  $< 18.5$  kg/m<sup>2</sup>) and the absence of adolescents with a standard of obesity [20]. Studies conducted in 2016 revealed the average value of the Kettle index



**Figure 1:** The Results of the Study of the Students' Body Mass Index.

(Figure 2), which was ( $23.32 \pm 0.17$ ) cm, and the presence of 10% of people with the criterion of the international standard of obesity. After a year of observation, we observed a tendency to increase the body mass index among medical students, the increase for the year is equal to ( $1.38 \pm 0.38$ ) cm, the absence of persons with the criterion of chronic energy failure.



**Figure 2:** The Results of the Study of the Students' Kettle Body Mass Index.

The 2004-2005 study indicated that at the beginning of the college study and after one year, the average values corresponded to the mesomorphic body-type with an annual growth rate ( $1.11 \pm 0.26$ ,  $p > 0.05$ ). Anthropometric measurements in 2016-2017 showed that the somatotype of the medical college students in the average value is mesomorphic, comprising ( $87.25 \pm 0.96$ ) during the first year of the studies and ( $88.5 \pm 0.27$ ) after a year of studies, the annual growth ( $1.25 \pm 0.69$ ,  $p > 0.05$ ).

*The chest index* according to the results of studies conducted in 2004-2005 and 2016-2017, in the mean values is evaluated as mesomorphic with annual growth rates ( $0.02 \pm 0.01$ ) and ( $1.06 \pm 0.32$ ) respectively, the maximum and minimum values of the variational series reflect the dolichomorphic and brachymorphic types of somatotype, the reliability of the indicators is  $p > 0.05$ .

The mean values of the shoulder width obtained during the study were ( $21.83 \pm 0.22$ ) at the beginning of the research ( $21.90 \pm 0.21$ ) after one year of studies. Among the students of 2016-2017 study, we determined the mesomorphism of the body structure in mean values that did not change over time.

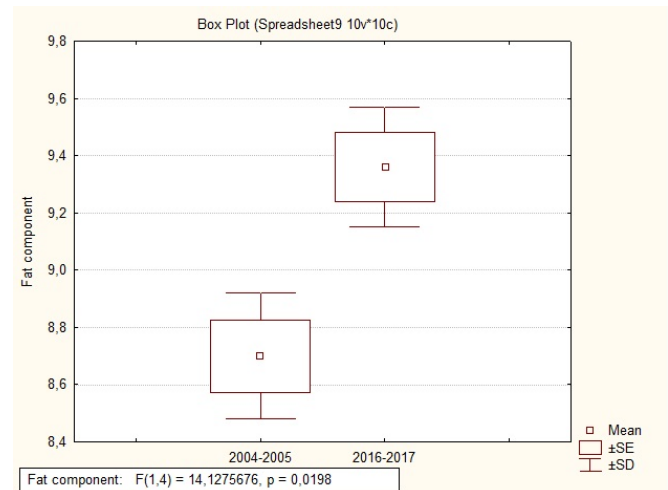
When evaluating the functional state of the muscular system by determining the maximum handgrip strength, we found out that the average *index of the left handgrip strength* in the group of students in 2004 was  $(71.47 \pm 1.0)$ . The minimum index value is 43.22, while the maximum is 97.0. In boys who studied in 2016, the average value of the corresponding index is  $(65.72 \pm 0.33)$ , at the same time, the lowest handgrip strength is 54.42, the highest – 90.11.

The maximum index of *the left handgrip strength* in the students after one year of observation in 2005 is 93.22; this indicator among the students in 2017 is 89.20. The average value of this index among the group of students in 2005 is  $72.07 \pm 0.98$ , and for students studying in 2017, this indicator has the value  $(65.91 \pm 0.24)$ .

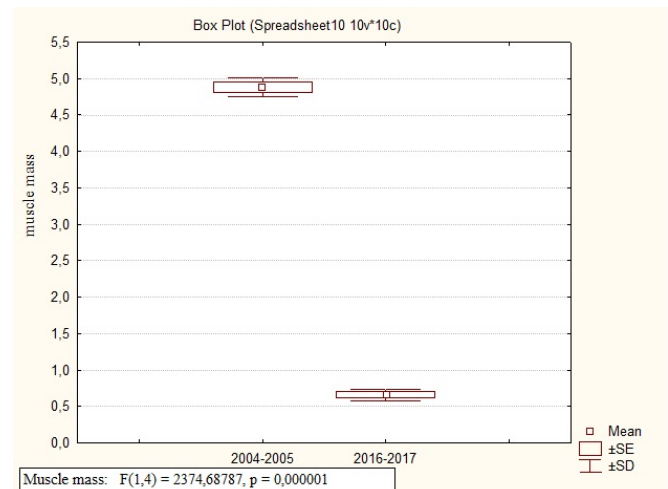
According to the results of measuring the indicator of the right handgrip strength of the students in 2004, it was found out that the highest indicator is 103.45. The average value for the group is  $(76.26 \pm 8.79)$ ; the minimum strength value is 56.76. The maximum index of the right handgrip strength analyzed among the students at Zhytomyr Medical Institute during the 2016 study is 96.52, the smallest value is 55.62, while the average index is  $(70.81 \pm 0.44)$ . Describing the results of the values of the *index of the left hand grip strength* after one year of the study, it was found out that the average value for the groups is as follows: students of 2005  $(77.64 \pm 8.97)$ , students of 2017  $(71.20 \pm 0.65)$ .

In determining the composition of the body mass, it was found out that the amount of *the fat component* in the students at the beginning of the study, which was conducted in 2004, was in its mean value  $8.35 \pm 0.22$ , and was not statistically significantly different from that of the students who studied at the medical college in 2016, the mean value of the indicator in the group is  $9.30 \pm 0.66$  (Figure 3). The values of annual growth in 2017 are  $0.56 \pm 0.45$  with the mean value of the indicator  $(9.86 \pm 0.21)$ .

While analyzing *the muscle mass* of the students in the first year of research conducted in 2004 and 2016, we established the following indicators:  $25.30 \pm 0.55$  and  $25.11 \pm 0.44$ , respectively (Figure 4). The change in muscle component among medical students in 2005 was  $5.03 \pm 0.22$  with an average of  $30.33 \pm 0.62$ . In the course of the study in 2017, it was found out that the annual gain of the muscle mass is  $4.66 \pm 0.08$ , the mean value is  $29.77 \pm 0.36$ .



**Figure 3:** The results of the Study of the Students' Fat Component.



**Figure 4:** The results of the Study of the Students' Muscle Mass.

According to the results of the research, it was found out that *the bone mass* in both samples in the first and second years of the research was not significantly different ( $5.94 \pm 0.14$  and  $5.83 \pm 0.54$ ), and during the entire period of the study did not change significantly ( $6.02 \pm 0.13$  and  $5.96 \pm 0.33$ ). Annual gains were  $0.81 \pm 0.13$  and  $0.13 \pm 0.21$ , respectively.

According to the results of psychophysiological testing conducted among students in 2004, we obtained data that allow us to claim that students of medical college were more successful in their ability to perceive the information. The average value of stability and concentration of attention in them was evaluated as "satisfactory", but 8.6% of the surveyed had a low level of attention and generally no persons with high concentration and attention stability [12] (Table 1).

The results of the tests conducted on the basis of a similar method among the students of the Medical College in 2016 indicate that at the beginning of the first year of study, 20.2% of respondents showed low sustainability of attention, 79.8% focused their attention on the satisfactory level, no persons with a high level of attention were identified.

After conducting a re-examination in one year, we found out that in the study of students in 2005, 14.6% of the surveyed persons focused their attention on a high level, the number of respondents with the satisfactory level of attention decreased to 64.7%, however, the number of students with low activity and attention increased from 8.6% in 2004 to 20.7% in 2005.

The same tendency was also observed in the analysis of the results of the sustainability and concentration of attention among the students of the medical college, which was held in 2017. Thus, 8.3% of the individuals with high activity and attention were identified, and the number of students with a low concentration rate decreased to 43%. However, the number of respondents with low levels of attention increased to 48.7%.

#### **4. DISCUSSION**

Thus, we have a tendency to increase the body mass index, which is the result of the students' unhealthy diet, the excessive consumption of fast food, which contains excessive fats, carbonated beverages, the substitutes of the natural products by the synthetic ones, etc.

The results of the study of the students' body *height* testify that ten years after the determination of the normative criteria of physical development for the boys of the Polissia ethno-territorial population there were no significant changes in the fixed normative indicators. Thus the stabilization of the acceleration process continues.

We associate these results with the increasing body mass of students as a result of non-compliance with a balanced diet.

The 2004-2005 study indicated that at the beginning of the college study and after one year, the average values corresponded to the mesomorphic body-type with an annual growth rate. Anthropometric measurements in 2016-2017 also confirmed that the

somatotype of the medical college students in the average value is mesomorphic. As for the *chest index*, according to the results of studies conducted in 2004-2005 and 2016-2017, in both mean values mesomorphic with annual growth rates are established. The maximum and minimum values reflect the presence of students with dolichomorphic and brachymorphic types of somatotype.

The indicator of the shoulder width index among the boys who studied at the medical college in 2004-2005 we can define as dolichomorphic, since the mean values obtained during the study were ( $21.83 \pm 0.22$ ) at the beginning of the research, ( $21.90 \pm 0.21$ ) after one year of studies. Among the students in whom anthropometric measurements were conducted in 2016-2017 years, we determined the mesomorphism of the body structure in mean values that did not change over time. The fact of the absence of persons with a brachymorphic type of body structure in both groups was established.

As far as the functioning state of the muscle system is concerned, proceeding from the fact that the index of handgrip strength for the surveyed students is on average 65-80% of the body mass, for the majority of representatives of both groups the left hand's grip strength is within the normal range, though in both groups there are individuals with the low level of handgrip.

Thus, the evaluation of the functional state of the muscular system in the left handgrip in each of the groups made it possible to establish that the mean values do not exceed the limits of the norm, although in both samples there are persons with a low level of the handgrip strength.

Based on the study result results of measuring the indicator of the right handgrip strength of the students, it should be noted that the overwhelming number of students in 2004 and 2016 had a normal index of the right handgrip strength. Thus, the indicators of muscle strength on the right handgrip in the groups of young men who studied at the medical college during the years of research correspond to the values of the norm criterion.

In our opinion, an increase in fat component confirms the fact of non-rationality of nutrition among students. The obtained data testify to the insufficient effect of physical activity, which was to be carried out

during the morning physical exercises, physical training classes, training in sports sections, sports competitions, etc.

Thus, the weakening of the stability and concentration of attention, the increase in the test failures, the decrease in activity and attention among students should be associated with the intensification of the educational process, the non-observance of the daily programme, hypodynamia, caused by the lack of physical activity and long hours of computer work, intensity of mental activity, etc.

However, all students who participated in the survey believe that the elective subjects will increase motivation to attend classes, enhance the choice of an active lifestyle, improve instilling their positive attitude and the desire to do physical culture, provide an opportunity to exercise independently and willingly. Students also noted that the most popular types of recreational gymnastics which include various forms of motor activity (aerobics, shaping, rhythmic gymnastics), in their opinion would increase the level of satisfaction, interest, self-expression, change in activities and positive emotions.

## 5. CONCLUSION

According to the results of studying the dynamics of anthropometric, functional and psychophysiological indicators of physical development among Ukrainian medical college students ( $n=290$ ; 17-21 years old) in 2017, comparing them with the results of the previous study, conducted in 2005, was established the tendency to gain in body mass in average values from  $(0.88 \pm 0.26)$  to  $(2.7 \pm 0.67)$ , in body mass index from  $(0.88 \pm 0.26)$  to  $(1.38 \pm 0.38)$ , in the fat component from  $(8.70 \pm 0.22)$  to  $(9.36 \pm 0.21)$ . In our opinion, it is related to the students' non-observance of nutrition quality and regularity. Muscle component indicators increased from  $(4.66 \pm 0.08)$  to  $(5.03 \pm 0.22)$ , but on average, they point to the absence of systematic exercise. The value of attention concentration also tends to decrease by an average of 48.7%, which we attribute to the enhanced academic loads. Regarding the dynamics of the other examined indicators, we determined that ten years after establishing the normative criteria of physical development for the young male individuals of Polissya ethnic territorial population were not observed significant changes, which indicates the stabilization of the process of acceleration.

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