

## МОРФОЛОГИЧЕСКИЙ СТАТУС СТУДЕНТОВ С РАЗЛИЧНЫМ УРОВНЕМ ДВИГАТЕЛЬНОЙ АКТИВНОСТИ

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Исследование влияния двигательной активности на состояние здоровья студентов, обобщающее особенности морфологического статуса и физического развития в целом, позволяет выявлять механизмы управления факторами здоровья. **Цель.** Определение особенностей динамики морфологического статуса студентов с различным уровнем двигательной активности за период обучения в ВУЗе. **Материалы и методы.** Проведено проспективное исследование физического здоровья 630 студентов 17-22 лет в течение 2010-2018 гг. У студентов ежегодно в период обучения в ВУЗе (5 лет) проводились измерения длины тела, массы тела, окружности грудной клетки, определение соматотипа и др. показателей. **Результаты.** Установлено, что среди обследованных студентов за период обучения в ВУЗе только у 51,9% юношей продолжались ростовые процессы, которые постепенно завершились в 21-22 года, аналогично – у 36,9% девушек, с завершением в 20-21 год. У большинства студентов зарегистрирован прирост массы тела и окружности грудной клетки, но также выявлены юноши и девушки, у которых за время обучения в ВУЗе эти показатели не изменились, а в некоторых случаях было выявлено их снижение. Продемонстрировано, что прирост массы тела и окружности грудной клетки замедляется с остановкой ростовых процессов, но не прекращается совсем, что ведет к увеличению числа студентов с избыточным весом. Этому способствует также снижение уровня двигательной активности студентов на старших курсах, когда в учебном процессе отсутствуют занятия по физической культуре. Выявлена зависимость протекания ростовых процессов у юношей и девушек на возрастном этапе 17-22 года от уровня двигательной активности, который оказывает влияние на скорость и направленность прироста показателей тотальных размеров тела и изменение типа телосложения. По нашим данным, большинство юношей поддерживают высокий уровень двигательной активности для наращивания мышечной массы и формирования телосложения, а девушки ведут активный образ жизни для снижения веса и поддержания его на оптимальном уровне.

**Ключевые слова:** студенты; двигательная активность; морфологический статус; соматотип; прирост показателей; динамика показателей; период обучения в ВУЗе.

## MORPHOLOGICAL STATUS OF STUDENTS WITH DIFFERENT LEVEL OF MOTOR ACTIVITY

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A study of the effect of motor activity on the health condition of students that generalizes peculiarities of the morphological status and of physical development on the whole, permits to identify



mechanisms controlling health factors. **Aim.** Determination of the peculiarities of the dynamics of morphological status of students with different levels of motor activity in the period of study at an institution of higher education (IHE). **Materials and Methods.** A prospective study of physical health of 630 students of 17-22 years of age in the period from 2010 to 2018. In students, the body length, body mass, chest circumference and other parameters were measured and the somatotype was determined every year in the period of study at an IHE (5 years). **Results.** It was found that in the period of study at an IHE, growth processes continued only in 51.9% of examined boys and gradually terminated at 21-22 years of age, and in 36.9 % of girls with termination at 21-22 years. In most students increment of the body mass and chest circumference was recorded, there were also found boys and girls with these parameters remaining unchanged during period of study at an IHE, and in some cases their decline was found. The increment of the body mass and chest circumference was demonstrated to slow down with termination of growth processes, but did not stop altogether which resulted in increase in the amount of students with excessive weight. This was also facilitated by reduction of the level of motor activity in senior years when physical culture classes are no longer included into the curriculum. The dependence of growth processes in boys and girls at the age of 17-22 years on the level of motor activity was revealed that influenced the speed and direction of increment of the total dimensions of the body and the type of body-build. According to our data, the majority of boys support a high level of motor activity to buildup the body mass, and girls lead an active way of life to decrease the body mass and to keep it on the optimal level.

**Keywords:** *students; motor activity; morphological status; somatotype; increment of parameters; dynamics of parameters; period of study at IHE.*

Student ship period that continues from 17 to 23 years of age, is characterized by termination of the growth processes, stabilization of the morphological status and of hormonal maturation of an organism of boys and girls [1]. Morphological status is one of the generalizing parameters of health with the main components being body length (BL) characterizing growth processes, and body mass (BM) evidencing development of musculo-skeletal apparatus and internal organs. BL being the most stable marker, reflects individual genetic peculiarities. BM to a larger extent describes the activity of an organism on exposure to environmental factors and integrates individual metabolic processes. Russian anthropology assigns a high significance to the ratio of BM to the chest circumference (CC) as a parameter of density, and to the ratio of BL to CC as a parameter of body shape [2,3].

Morphological status largely depends on the level of motor activity (MA) which activates compensatory-adaptive mechanisms, expands functional capacities of an organism,

improves well-being. Physical culture and sports activity are the basic factors of physical perfection and strengthening of health [4].

A study of influence of motor activity on the health condition of students that generalizes peculiarities of body build, specificity of growth processes, morphological status and physical development in general, permits to identify mechanisms of health control including health-saving techniques of physical education, academic process and medico-hygienic control [5].

### Materials and Methods

The study was conducted on the basis of the results of prospective observations of physical health of 630 students (286 boys and 344 girls) of 17-22 years of age within 2010-2018. In the course of study «Health Diary of a Student» was used where measurements of body length (BL), body mass (BM), chest circumference (CC), determination of somatotype and other parameters were recorded every year during study at an IHE (5 years) [6]. The first examination was conducted in 1<sup>st</sup> year of study in students of

17-22 years of age, the second examination – in 2<sup>nd</sup> year in students of 18-19 years of age, the third – in 3<sup>rd</sup> year in students of 19-20 years of age, the fifth – in 5<sup>th</sup> year students of 21-22 years of age.

The level of motor activity of students was determined based on the questionnaire that included the following questions:

- How frequently do you practice sports, fitness, etc.?
- In what sports group do you participate at your IHE?
- How often do you use active kinds of rest?
- Do you do any physical work at home?
- How often do you dance?
- Do you use health-strengthening procedures?
- How often do you walk 3-5 km distance?
- Do you do your morning exercises?
- Do you visit a bath and a steam room?

The answers were: daily (3 points), often (2 points), sometimes (1 point), never (0 point). The level of motor activity was determined by the score: low (0-8 points), medium (9-19 points) and high (20-27 points) [6].

Types of body build were determined by the method of V.G. Shefko and B.A. Ostrovsky (1929) in the presentation of S.S. Darskaya (1975) [7,8]. Body mass index (BMI,  $BM/BL^2$ ) was evaluated in the following way: deficit of body mass ( $BMI < 18.5 \text{ kg/m}^2$ ), norm ( $18.5\text{-}24.9 \text{ kg/m}^2$ ), pre-obesity ( $25.0\text{-}29.9 \text{ kg/m}^2$ ), 1 degree obesity ( $30.0\text{-}34.9 \text{ kg/m}^2$ ), 2 degree obesity ( $35.0\text{-}39.9 \text{ kg/m}^2$ ), 3 degree obesity ( $>40.0 \text{ kg/m}^2$ ) [9].

Measurements were conducted and recorded in a «Health Diary of a Student» annually in the course of study of medical and sports disciplines within the frames of monitoring of physical health of students at an IHE according to Decree of the Govern-

ment of RF №916 of 29.12.2001 «On All-Russian System of Monitoring of Condition of Physical Health of Population, Physical Development of Children, Adolescence and Young People» in compliance with Regulation on health care of students studying in the branches of N.I. Lobachevsky State University of 27.02.2015, and with the plan of initiative research work 'A Study of Influence of Motor Activity on Physiological Regularities of Formation of Physical Health of Students'.

The study was conducted after receiving a positive decision of local Ethic Committee and of the informed consent of the examined individuals, with observance of exact criteria for exclusion: existence of an acute disease or an exacerbation of a chronic disease at the moment of examination, pregnancy or refusal from examination. Measurements were taken with observance of methodical recommendations on conduction of anthropometric screenings [6].

Based on the results of study, a personified data base was created, statistical processing of data was carried out using Excel 8.00 and Version 4.03 Primer of Biostatistics office package. For implementation of the work variation statistics methods were used ((mean arithmetic (M), error of mean arithmetic (m)), methods of assessment of statistical significance of differences between groups (Student's t-test,  $\chi^2$  criterion). The differences were considered statistically significant at  $p < 0.05$ .

### Results and Discussion

Based on the results of questionnaire it was found that a status of motor activity of students considerably changed throughout the period of study at IHE (Table 1). According to our data, in the 4<sup>th</sup> and 5<sup>th</sup> years, when classes on physical culture were no longer resented in the curriculum, the number of students with low MA increased, and that with high MA respectively decreased.

Table 1

*Dynamics of Level of Motor Activity of Students during Period of Study at IHE, %*

| Gender | Level of Motor Activity | 1 <sup>st</sup> year | 2 <sup>nd</sup> year | 3 <sup>rd</sup> year | 4 <sup>th</sup> year | 5 <sup>th</sup> year | Statistical Parameters                    |
|--------|-------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---|
| Boys   | Low                     | 13.3                 | 15.4                 | 13.6                 | 19.6                 | 24.5                 | $\chi^2 = 31.54$ ,<br>Df = 8,<br>p=0.0001 |
|        | Medium                  | 55.6                 | 53.2                 | 58.4                 | 58.4                 | 57.7                 |   |
|        | High                    | 31.1                 | 31.5                 | 28.0                 | 22.0                 | 17.8                 |   |
| Girls  | Low                     | 18.6                 | 16.6                 | 19.5                 | 25.9                 | 27.0                 | $\chi^2 = 20.47$ ,<br>Df = 8,<br>p=0.0087 |
|        | Medium                  | 56.4                 | 57.9                 | 54.9                 | 54.9                 | 54.7                 |   |
|        | High                    | 25.0                 | 25.6                 | 25.6                 | 20.1                 | 18.3                 |   |

In the period of study the level MA changed in 39.8% of students. Further on, the influence of the level of MA on the morphological status was studied in students (60.2%) in whom it remained constant throughout study: high level in 23.4% of boys and in 21.3% of girls, medium level in

61.0% and 57.8%, low level – in 15.6% and 20.9% of boys and girls, respectively ( $\chi^2 = 12.98$ , p=0.0015).

A study of somatotypes showed that their dynamics in the period from the 1<sup>st</sup> to the 5<sup>th</sup> year was determined by the level of MA (Table 2).

Table 2

*Dynamics of Somatotypes in Students with Different Levels of Motor Activity, during Period of Study at IHE %*

| Gender | Somato-types | Prevalence of Somatotypes among Students |                      |                                |                      |                              |                      |                      |                      |
|--------|--------------|--|----------------------|--------------------------------|----------------------|------------------------------|----------------------|----------------------|----------------------|
|        |              | Low level of motor activity              |                      | Medium level of motor activity |                      | High level of motor activity |                      | All students         |                      |
|        |              | 1 <sup>st</sup> year                     | 5 <sup>th</sup> year | 1 <sup>st</sup> year           | 5 <sup>th</sup> year | 1 <sup>st</sup> year         | 5 <sup>th</sup> year | 1 <sup>st</sup> year | 5 <sup>th</sup> year |
| Boys   | Asthenoid    | -  | -                    | 6.7                            | 6.8                  | 5.9                          | 5.9                  | 9.8                  | 4.2                  |
|        | Thoracic     | 33.3                                     | 26.7                 | 42.4                           | 33.9                 | 52.9                         | 41.2                 | 45.5                 | 38.1                 |
|        | Muscular     | 13.3                                     | 6.7                  | 20.3                           | 27.1                 | 35.3                         | 52.9                 | 24.1                 | 35.0                 |
|        | Digestive    | 46.7                                     | 60.0                 | 22.0                           | 23.7                 | -                            | -                    | 14.7                 | 18.5                 |
|        | Indefinite   | 6.7                                      | 6.7                  | 8.5                            | 8.5                  | 5.9                          | -                    | 5.9                  | 4.2                  |
| Girls  | Asthenoid    | 18.2                                     | 15.2                 | 6.7                            | 6.7                  | 4.8                          | 4.8                  | 9.3                  | 4.7                  |
|        | Thoracic     | 39.4                                     | 42.4                 | 72.0                           | 61.3                 | 42.9                         | 47.6                 | 53.2                 | 50.3                 |
|        | Muscular     | 9.1                                      | 9.1                  | 16.0                           | 24.0                 | 33.3                         | 33.3                 | 20.9                 | 27.3                 |
|        | Digestive    | 24.3                                     | 27.3                 | 2.7                            | 2.7                  | -                            | -                    | 9.6                  | 12.2                 |
|        | Indefinite   | 9.1                                      | 6.1                  | 2.7                            | 2.7                  | 19.0                         | 14.3                 | 7.0                  | 5.5                  |

Among students with a high level of MA there were no individuals with digestive build, and among boys with a low MA there were no those with asthenoid somatotype. The highest prevalence of thoracic somatotype in the period of study at IHE was noted among students with a high and medium level of MA, but in the 5<sup>th</sup> year male students with

high MA a muscular somatotype predominated. Among boys with low MA a digestive somatotype predominated with its prevalence in the 5<sup>th</sup> year increasing by 13.3%.

On the whole, among boys there were more individuals with muscular and digestive types of body build than among girls. Indefinite somatotype predominated among

girls with high MA, and on examinations most of them were characterized as having intermediate thoracic-muscular type. During period of study, in 13.9% students (19.7% of boys and 10.1% of girls) the type of body build changed.

A study of dynamics of increment of

BL in students during period of study at IHE showed its dependence on the level of MA (Table 3). Examination of the 3<sup>rd</sup> year boys showed that growth processes stopped in 77.3% of them, but in 22.7% they continued and in 19.2% of such students BL increment was 1 cm, and in 3.5% – 2 cm.

Таблица 3

*Динамика приростов длины тела (ДТ) студентов за период обучения в ВУЗе, %*

| Gender | BL Increment | Annual BL Increments |                      |                      |                      | BL Increment within 5 Years |          |        |      |
|--------|--------------|----------------------|----------------------|----------------------|----------------------|-----------------------------|----------|--------|------|
|        |              | 2 <sup>nd</sup> year | 3 <sup>rd</sup> year | 4 <sup>th</sup> year | 5 <sup>th</sup> year | In all students             | BL level |        |      |
|        |              |                      |                      |                      |                      |                             | low      | medium | high |
| Boys   | 0 cm         | 50.1                 | 77.3                 | 89.2                 | 96.8                 | <b>48.1</b>                 | 79.2     | 57.5   | 25.0 |
|        | 1 cm         | 41.2                 | 19.2                 | 10.1                 | 3.2                  | <b>26.8</b>                 | 12.4     | 24.5   | 25.0 |
|        | 2 cm         | 7.0                  | 3.5                  | 0.7                  |                      | <b>11.4</b>                 | 4.2      | 9.4    | 19.4 |
|        | 3 cm         | 1.8                  |                      |                      |                      | <b>8.0</b>                  | 4.2      | 4.3    | 16.7 |
|        | 4 cm         | -                    | -                    | -                    | -                    | <b>3.9</b>                  | -        | 4.3    | 8.3  |
|        | 5 cm         | -                    | -                    | -                    | -                    | <b>1.8</b>                  | -        | -      | 5.6  |
| Girls  | 0 cm         | 64.0                 | 87.2                 | 97.7                 | 100.0                | <b>63.1</b>                 | 93.6     | 70.8   | 18.6 |
|        | 1 cm         | 31.1                 | 11.6                 | 2.3                  | -                    | <b>22.3</b>                 | 6.4      | 20.8   | 35.4 |
|        | 2 cm         | 4.9                  | 1.2                  | -                    | -                    | <b>9.3</b>                  | -        | 6.9    | 22.9 |
|        | 3 cm         | -                    | -                    | -                    | -                    | <b>4.1</b>                  | -        | 1.5    | 16.7 |
|        | 4 cm         | -                    | -                    | -                    | -                    | <b>1.2</b>                  | -        | -      | 6.4  |

*Notice:* annual increments of body length are shown in comparison with the previous year.

On the whole, during period of study at IHE, BL increment was noted: in 20.8% of boys with low MA – within 1-3 cm, in 42.5% of boys with medium MA – 1-4 cm, in 75.0% of boys with high MA – 1-5 cm. Girls showed a similar dynamics of BL increment depending on the level of MA: in 6.4% – not more than 1 cm, in 29.2% – 1-3 cm, in 81.4% – 1-4 cm. It follows from the obtained results that the higher the level of MA, the wider the range of BL increment both in boys and girls. With increase in the tempo of physical activity, the amount of young people with continuing growth increases.

The most intense increments of BL were noted in boys in the 1<sup>st</sup>-3<sup>d</sup> years (17-21 years of age), and in girls in the 1<sup>st</sup>-2<sup>nd</sup> years (17-20 years), after that growth processes slowed down and stopped by the end of the educational period. In examination of 5<sup>th</sup> year

students, the increment of growth was found in 3.2% of boys with a high level of MA, and in 2.3% of girls (also with a high level of MA). Last increments were recorded in 4<sup>th</sup> year students.

In the course of study, comparative analysis of the mean values of BL ( $M \pm m$ ) obtained on examination of students of the first and fifth years, was conducted. In boys with a low level of MA the parameters of BL during the period of study at IHE increased from  $171.0 \pm 1.51$  cm to  $171.3 \pm 1.48$  cm ( $p > 0.05$ ); in boys with a medium level of MA – from  $175.2 \pm 0.61$  cm to  $175.9 \pm 0.58$  cm ( $p < 0.05$ ); in boys with a high level of MA – from  $174.2 \pm 1.10$  cm to  $176.0 \pm 0.99$  cm ( $p > 0.05$ ). In accordance with the level of MA, increments of the mean values of BL were: 0.3 cm, 0.7 cm and 1.8 cm. Because of a small amount of samples of the extreme variants of groups of



MA (24 boys in the group with low level of MA and 36 – with high level of MA), the obtained results remain at the level of tendency ( $p>0.05$ ), but nevertheless they show that the level of MA stimulates growth processes.

Changes in the mean values of BL in girls within 5 years were insignificant (0.1 cm, 0.4 cm and 1.2 cm according to the level of MA) and were at the level of tendency ( $p>0.05$ ): with low level of MA, BL parameters increased from  $164.8\pm0.91$  cm to  $164.9\pm0.92$  cm; with medium level of MA –

from  $164.3\pm0.52$  cm to  $164.7\pm0.51$  cm; with high level of MA – from  $165.1\pm0.81$  cm to  $166.3\pm0.82$  cm (the number of girls in groups – 47, 130 and 48, according to the level of MA).

In the study it was found that changes in the dynamics of BM increments were associated with MA level, both in boys and in girls. Changes in the parameters of BM within the range from -1 kg to +1 in the period of study at IHE were characterized a sun changed body weight (Table 4).

Table 4

*Dynamics of Increments of Body Mass of Students during Period of Study at IHE, %*

| Gender | Dynamics of BM (kg)    | Annual Dynamics of BM |                     |                      |                      | Dynamics of BM for 5 years |          |      |      |
|--------|------------------------|-----------------------|---------------------|----------------------|----------------------|----------------------------|----------|------|------|
|        |                        | 2 <sup>nd</sup> year  | 3 <sup>d</sup> year | 4 <sup>th</sup> year | 5 <sup>th</sup> year | In all students            | MA level |      |      |
| Boys   | from -6 to -5          | -                     | -                   | 0.4                  | 0.4                  | <b>2.5</b>                 | -        | 2.1  | 5.6  |
|        | from -4 to -2          | 0.8                   | 6.3                 | 5.0                  | 6.3                  | <b>5.0</b>                 | 12.5     | 5.3  | -    |
|        | from -1 to +1          | 62.7                  | 55.8                | 60.8                 | 70.0                 | <b>14.2</b>                | 33.4     | 16.0 | 5.6  |
|        | from + 2 to +4         | 35.1                  | 33.7                | 32.5                 | 23.3                 | <b>29.2</b>                | 16.5     | 32.0 | 13.9 |
|        | from + 5 to +7         | 0.4                   | 4.2                 | 1.3                  | -                    | <b>37.5</b>                | 29.2     | 26.0 | 47.8 |
|        | from +8 to +10         | -                     | -                   | -                    | -                    | <b>8.9</b>                 | 4.2      | 16.4 | 25.1 |
|        | <b>from +11 to +12</b> | -                     | -                   | -                    | -                    | <b>1.3</b>                 | 4.2      | 2.2  | -    |
|        | <b>from +13 to +14</b> | -                     | -                   | -                    | -                    | <b>0.4</b>                 | -        | -    | -    |
| Girls  | from -7 to -5          | -                     | -                   | -                    | -                    | <b>3.8</b>                 | -        | 3.4  | 4.2  |
|        | from -4 to -2          | 4.4                   | 7.5                 | 7.8                  | 7.2                  | <b>13.4</b>                | 10.5     | 10.1 | 14.6 |
|        | from -1 to +1          | 65.0                  | 63.1                | 73.1                 | 75.6                 | <b>23.8</b>                | 34.0     | 23.1 | 35.8 |
|        | from + 2 to +4         | 29.7                  | 27.5                | 18.2                 | 17.2                 | <b>33.1</b>                | 23.5     | 38.0 | 37.2 |
|        | from + 5 to +7         | 0.6                   | 1.9                 | 0.9                  | -                    | <b>19.6</b>                | 25.7     | 21.6 | 8.2  |
|        | from +8 to +10         | 0.3                   | -                   | -                    | -                    | <b>5.0</b>                 | 4.3      | 3.8  | -    |
|        | <b>from +11 to +12</b> | -                     | -                   | -                    | -                    | <b>1.3</b>                 | 2.0      | -    | -    |

*Note:* Annual increments of body mass are shown in comparison with the previous year.

In 54.1% of boys with low level of MA, body mass during period of study increased in the range from 2 to 12 kg, with the mean values increased from  $75.5\pm3.64$  kg in the 1<sup>st</sup> year to  $77.5\pm3.11$  kg in the 5<sup>th</sup> year ( $p>0.05$ ). In 76.6% of boys with medium level of MA, parameters of BM in the period of study increased from  $70.9\pm1.32$  kg to  $74.6\pm1.23$  with min-max increment 2-11 kg ( $p<0.05$ ). In 88.8% of boys with a high level of MA, BM parameters increased from  $67.4\pm1.64$  kg to  $72.5\pm1.43$  kg ( $p<0.05$ ), with the increment

range from 2 to 10 kg. According to MA level, BM increment in boys was: 2.0 kg, 3. kg and 5.1 kg.

There were found 7.5% of boys in whom BM parameters by the end of study at IHE decreased (in the range from -6 to -2 kg) as compared to the 1<sup>st</sup> year: in 12.5% of boys with low MA, in 7.4% with medium level of MA and in 5.6% with high MA.

In 55.5% of girls with low MA, body mass in the period of study increased in the range from 2 kg to 12 kg, and the mean val-

ues of BM increased from  $64.3 \pm 2.35$  kg in the 1<sup>st</sup> year to  $66.5 \pm 2.12$  kg in the 5<sup>th</sup> year ( $p > 0.05$ ). In 63.4% of girls with a medium level of MA, BM parameters in the period of study increased from  $57.1 \pm 0.74$  kg to  $59.3 \pm 0.71$  kg with min-max increment range from 2 kg to 8 kg ( $p < 0.05$ ). In 45.4% of girls with a high level of MA – from  $59.8 \pm 0.82$  kg to  $60.8 \pm 0.78$  kg, with the increment range from 2 kg to 5 kg ( $p > 0.05$ ). According to the levels of MA, increments of the mean values of BM in girls were 2.2 kg, 2.2 kg and 1.0 kg. The obtained results indicate gender differ-

ences: in boys, the BM increments increased with the level of MA, while in girls, vice versa, with increase in the tempo of MA the range of BM increments narrowed.

There were also found 17.2% of girls in whom by the end of study at IHE parameters of BM declined (in the range from -7 to -2 kg) in comparison with those in the 1<sup>st</sup> year: in 10.5% of girls with low MA, in 13.5% with medium MA, and in 18.8% with high MA.

Similarly to BM, CC parameters in students also changed multidirectionally during the period of study (Table 5).

Table 5

*Dynamics of Increments of CC in Students during Period of Study at IHE, %*

| Gender | Dynamics of CC (cm) | Annual Dynamics of CC |                     |                      |                      | Dynamics of CC for 5 Years |          |        |      |
|--------|---------------------|-----------------------|---------------------|----------------------|----------------------|----------------------------|----------|--------|------|
|        |                     | 2 <sup>nd</sup> year  | 3 <sup>d</sup> year | 4 <sup>th</sup> year | 5 <sup>th</sup> year | In all students            | MA level |        |      |
|        |                     |                       |                     |                      |                      |                            | low      | medium | high |
| Boys   | from -5 to -4       |                       |                     |                      |                      | <b>1.2</b>                 | -        | 3.3    | -    |
|        | from -3 to -2       | 0.8                   | 1.7                 | 2.2                  | 3.8                  | <b>4.2</b>                 | 13.3     | 3.3    | 5.4  |
|        | from -1 to +1       | 66.9                  | 56.2                | 71.1                 | 78.3                 | <b>18.8</b>                | 32.4     | 18.1   | 13.9 |
|        | from + 2 to +3      | 27.8                  | 35.3                | 22.4                 | 16.3                 | <b>32.5</b>                | 16.7     | 27.6   | 19.5 |
|        | from + 4 to +5      | 4.5                   | 5.4                 | 0.8                  | 1.7                  | <b>32.5</b>                | 29.2     | 27.6   | 30.6 |
|        | from + 6 to +7      | -                     | 0.6                 | 0.4                  | -                    | <b>9.6</b>                 | 4.2      | 17.0   | 25.0 |
|        | from + 8 to +10     | -                     | -                   | -                    | -                    | <b>1.2</b>                 | 4.2      | 3.1    | 5.6  |
| Girls  | from -6 to -4       | -                     | -                   | -                    | 0.4                  | <b>2.0</b>                 | -        | 3.8    | 2.1  |
|        | from -3 to -2       | 2.7                   | 5.1                 | 5.5                  | 2.6                  | <b>6.7</b>                 | 4.3      | 4.6    | 8.3  |
|        | from -1 to +1       | 72.7                  | 76.3                | 83.8                 | 90.3                 | <b>39.9</b>                | 42.5     | 38.3   | 52.0 |
|        | from + 2 to +3      | 20.8                  | 16.3                | 10.4                 | 6.3                  | <b>32.8</b>                | 31.9     | 26.1   | 27.2 |
|        | from + 4 to +5      | 3.0                   | 2.3                 | 0.3                  | 0.4                  | <b>15.6</b>                | 17.0     | 20.8   | 10.4 |
|        | from + 6 to +8      | 0.8                   | -                   | -                    | -                    | <b>3.0</b>                 | 4.3      | 5.4    | -    |
|        |                     |                       |                     |                      |                      |                            |          |        |      |

*Note:* Annual increments of CC are shown in comparison with the previous year.

In 54.3% of boys with a low level of MA, CC parameters increased from the 1<sup>st</sup> to the 5<sup>th</sup> year from  $95.2 \pm 2.72$  cm to  $97.0 \pm 2.68$  cm with the increment range 2-10 cm ( $p > 0.05$ ); in 75.3% boys with a medium level of MA – from  $92.2 \pm 0.96$  cm to  $95.2 \pm 0.92$  cm with min-max increment 2-9 cm ( $p < 0.05$ ); in 80.7% of boys with a high level of MA – from  $89.0 \pm 1.04$  cm to  $92.9 \pm 0.90$  cm with the increment range 2-8 cm ( $p < 0.05$ ). According to the level of MA, increments of the mean values of CC in boys were: 1.8 cm, 3.0 cm and 3.9 cm.

In 53.2% of girls with low MA, CC increment was in the range from 2 cm to 5 cm, and the mean CC values increased from  $88.4 \pm 1.60$  cm in the 1<sup>st</sup> year to  $90.0 \pm 1.44$  cm in the 5<sup>th</sup> year ( $p > 0.05$ ). In 53.3% of girls with medium MA – from  $82.2 \pm 0.60$  cm to  $83.8 \pm 0.53$  cm with min-max increment 2-5 cm ( $p < 0.05$ ). In 37.6% of girls with high level of MA – from  $84.0 \pm 0.89$  cm to  $84.8 \pm 0.88$  cm with the CC increment range 2-4 cm ( $p > 0.05$ ). According to the level of MA, increments of the mean CC values in girls were:

1.6 cm, 1.6 cm and 0.8 cm. The results of dynamics of increments of CC were similar to those of BM and showed gender differences: in boys CC increment increased with the level of MA, and in girls the range of CC increment narrowed with increase in MA.

As it is shown by the dynamics of BMI, by the last year (as compared to the first one), the share of students with body mass deficit declined, and the amount of students with high parameters of BMI increased (Table 6).

Table 6

*Dynamics of BMI Parameters in Students for Period of Study at IHE, %*

| Gender | BMI Evaluation   | Low Level of Motor Activity |                      | Medium Level of Motor Activity |                      | High Level of Motor Activity |                      | All Students         |                      |
|--------|------------------|-----------------------------|----------------------|--------------------------------|----------------------|------------------------------|----------------------|----------------------|----------------------|
|        |                  | 1 <sup>st</sup> year        | 5 <sup>th</sup> year | 1 <sup>st</sup> year           | 5 <sup>th</sup> year | 1 <sup>st</sup> year         | 5 <sup>th</sup> year | 1 <sup>st</sup> year | 5 <sup>th</sup> year |
| Boys   | BM deficit       | 4.2                         | -                    | 11.7                           | 3.2                  | 8.3                          | 5.6                  | <b>10.5</b>          | <b>3.8</b>           |
|        | Norm             | 45.8                        | 41.7                 | 60.6                           | 60.6                 | 77.8                         | 72.2                 | <b>65.4</b>          | <b>64.7</b>          |
|        | Pre-obesity      | 25.0                        | 25.0                 | 21.3                           | 28.7                 | 13.9                         | 22.2                 | <b>18.5</b>          | <b>23.8</b>          |
|        | 1 degree obesity | 25.0                        | 33.3                 | 6.4                            | 7.5                  | -                            | -                    | <b>5.6</b>           | <b>7.7</b>           |
| Girls  | BM deficit       | 19.2                        | 6.4                  | 14.6                           | 3.9                  | 8.3                          | 4.2                  | <b>15.4</b>          | <b>5.2</b>           |
|        | Norm             | 48.9                        | 59.6                 | 79.2                           | 88.5                 | 91.7                         | 95.2                 | <b>71.2</b>          | <b>80.8</b>          |
|        | Pre-obesity      | 14.9                        | 12.8                 | 4.6                            | 5.4                  | -                            | 4.2                  | <b>9.3</b>           | <b>9.0</b>           |
|        | 1 degree obesity | 12.8                        | 17.0                 | 0.8                            | 1.5                  | -                            | -                    | <b>3.2</b>           | <b>3.8</b>           |
|        | 2 degree obesity | 2.1                         | 2.1                  | 0.8                            | 0.8                  | -                            | -                    | <b>0.6</b>           | <b>0.9</b>           |
|        | 3 degree obesity | 2.1                         | 2.1                  | -                              | -                    | -                            | -                    | <b>0.3</b>           | <b>0.3</b>           |

There were no students with obesity among those with a high level of MA, and among students with a low level of MA their quantity was 3 times that among the students with a medium level of MA. By the end of study at an IHE the amount of boys with BMI parameters corresponding to pre-obesity among boys with a high level of MA increased 8.3%, with the underlying reduction of the amount of boys with parameters corresponding to deficit of BM and to norm.

Proceeding to discussion of the obtained results, first of all it should be said that data on completion of growth processes and formation of somatotypes in young adulthood presented in the literature, may be contradictory. According to V.A. Baronenko and L.A. Rapoport (2003), development of skeleton in men completes by 20-24 years of age and in women – 2-3 years earlier [1]. M.M. Bezrukikh and D.A. Farber (2010) after comparison of the data of previous years note that if at the end of XIX century began to complete at 21 years of age, and at the end of XX century – by 18-19 years (here, in

girls growth of the body in length practically stops at 16-17 years) [10].

M.A. Negasheva and T.A. Mishkova (2005), in examination of boys from 16 to 21 years of age found increase in their body length. They showed changes in length of the body frame, length of legs, diameters of upper arms and chest, circumferences of chest, waist, hips, forearm, upper arm, and fat folds below scapula and on shin, change. In girls only shin circumference changes, and thickness of fat folds increases with age [11].

According to the data of N.G. Ivanova and A.Yu. Leibovsky (2012), no transfigurations of the body build during the period of study were found in girls, and in boys changes in the prevalence of somatotypes were found [12].

In our study dependence of prevalence of somatotypes on the level of MA was found, and also changes of the types of body build during period of study at an IHE in 13.9% of students (19.7% boys and 10.1% of girls).

Modern researchers (E.G. Bulich, I.V. Muravov, 2003; G.V. Uskov, 2004; L.G. Sta-



mov, Yu.M. Sikacheva, 2009; A.V. Kabachkova, V.V. Fomchenko, Yu.S. Frolova, 2015) found the interrelation between impairment of students' health and a low level of MA. Therefore, for rapid recovery of health and for improvement of physical status, they recommend a wide use of sports and physical exercises with the emphasis on the importance of physical activity in the open air throughout the whole year. [13-15].

In our study, the status of MA considerably changed in 39.8% of students throughout the period of study at an IHE. In the 4<sup>th</sup>-5<sup>th</sup> years when the physical training classes are absent in the academic program, the amount of students with low level of MA increased. Throughout the whole period of study, the level of MA kept constant in 60.2% of students: in 23.4% of boys and 21.3% of girls with high MA, in 61.0% and 57.8% of boys and girls a medium level and in 15.6% and 20.9% of boys and girls with a low level.

Many modern researchers note growth of the number of students with excessive weight in the period of study at an IHE [1,11]. In the course of study conducted by us the number of boys with BMI values corresponding to pre-obesity was found to rise by the end of study. It should be noted here that boys who practice the popular now athletics, also fall into this group although they have a high content not of fatty, but of muscular tissue (which is not differentiated by BMI).

Most transfigurations of the morphological status take place in boys in the 1<sup>st</sup>-3<sup>rd</sup> years, and in girls – in the 1<sup>st</sup>-2<sup>nd</sup> years.

Statistically significant changes of BL, BM and CC parameters were determined in boys and girls with the medium level of MA (with the exception of BL increments in girls, where  $p > 0.05$ ), and also in young men with high MA – statistically significant increments of BM and CC.

Because of a small number of samples with the extreme variants of MA groups, the obtained results remain at the level of tendency, but, nevertheless, show that in men the

higher the level of MA, the wider the range of BM and CC increments, and in girls, vice versa, with increase in the tempo of MA, variability of parameters decreases. Increment of BL correlates with MA level both in boys and in girls.

### Conclusion

Thus, in the course of research the following peculiarities of the morphological status of boys and girls were revealed throughout the period of study at an IHE.

1. In 48.1% of boys and 63.1% of girls no increments of body length were revealed in the period of study. In 51.9% of boys growth processes continued and gradually completed at 21-22 years, and in 36.9% of girls – at 20-21 years.

2. In most students an increment of the body mass and of chest circumference was noted, but there were found some boys and girls with no changes in these parameters, and in some cases their reduction was detected.

3. Increase in the body mass and chest circumference slowed down with stoppage of growth processes, but did not stop altogether which led to increase in the number of students with excessive weight and was confirmed by increase in the number of individuals with digestive type of body build and with high values of body mass index to a larger extent among boys.

4. In boys and girls of 17-22 years of age, dependence of growth processes on the level of motor activity was revealed which effects the speed and direction of buildup of parameters of the total dimensions of the body and of body build. In senior years, when physical culture classes are absent in the academic program, the level of motor activity of students declined.

5. Most students maintained a high level of motor activity to increase the muscle mass and body shape, and girls led active way of life to reduce the weight and to keep it at an optimal level.

Thus, a modern successful specialist does not only need to possess a high profes-

sional level, but also health, expressed in parameters of body length, body mass, chest circumference, in their harmonious combination, and type of body build.

The results of numerous studies of physical development of students [16-18], includ-

ing our study, showed that at a high level of motor activity morphological and functional parameters progressively improve throughout the entire studying period. This confirms importance of sports activity, fitness and physical exercises to keep students healthy.

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