

Enhancement of physical health in girls of 17-19 years by adoption of physical loads taking their somatotype into account

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Abstract: This work researches the problem of raising the level of physical health of 17 - 19 year old girls by means of physical culture taking into account their somatic type. The discovered peculiarities of displaying aerobic and anaerobic (lactatic) productivity of organism and qualitative parameters of the mobility allowed appraising the level of functional resources of girls with different somatic types. The analysis of the influence of sanitary physical trainings of different directions to aerobic and anaerobic (lactatic) organism's productivity, qualitative parameters of the mobility and functional state of cardiorespiration system among girls with different somatic types, allowed finding out the effective routines of trainings, which are up to the individual features of organisms. It is established that the representatives of endomorphy end balanced somatic type have greater possibility to improve aerobic productivity and physical health. The improvement of qualitative parameters of the mobility is caused by the direction of sanitary program. Resources for improvement of qualitative parameters of the mobility among the representatives of different somatic types are not equal. Thus, the results of our research prove the need to take into account the somatotype in order to choose the direction of physical education, which corresponds to the individual capabilities of the organism. This will enable to increase the efficiency of physical education classes and increase the level of physical health and qualitative parameters of physical fitness of students

Key words: physical health, physical preparation, somatic type, aerobic productivity, anaerobic (lactic) performance.

Introduction.

Scientific publications of recent years show a lack of a tendency to improve the physical health of the population of Ukraine. The problem of preservation and strengthening of human health is connected with the negative influence of environmental, social and economic factors, and with the low efficiency of the physical education system (Drachuk, 2018, Furman, 2018). Of particular importance is the problem of improving the physical health of student youth, since studying at a higher educational institution is accompanied by stressful situations, mental strain, inefficient organization of study and rest.

Recent advances in theory and methodology of physical education, medical and biological disciplines (physiology, sports medicine, etc.) open up new opportunities in improving the process of physical education. One of the ways to improve the effectiveness of physical education is its modelling based on the somatotype, which reflects the morphological and functional capabilities of the body (Furman, 2006). On the basis of model characteristics, it is possible to develop physical education programs that will fit the individual's personal abilities (Kostykevich, 2018).

Physical health depends on the level of aerobic and, to some extent, anaerobic abilities of the body (Gorshova, 2017); Kropta, 2017); Hruzevych, 2017). There are data indicating the possibility of improving aerobic and anaerobic metabolic processes of the body by means of physical activity of different directions (Bohuslavska, 2017; Sulyma, 2017; Gavrylova, 2017). However, the variation in the degree and character of the effects of such loads, depending on the somatotype, has not been investigated.

In the works of scientists (Furman, 2006) it is convincingly proved that modelling of training of athletes according to somatotypological characteristics allows to increase its efficiency. However, the number of scientific studies devoted to the consideration of somatotypological peculiarities during physical education classes in educational institutions is limited. Most of these works are performed on the example of school and preschool age children. We could not find any information about the consideration of somatotypological features during physical education classes at higher educational establishments in the scientific literature.

Based on the above, creation of new curricula for physical education and study of their effectiveness, taking into account the somatotypological features of students, is an important scientific direction.

The purpose of the research - to reveal the peculiarities of the influence of different physical activities on physical health indicators of girls of 17-19 years of different somatotypes.

Objectives of the study:

1 Using scientific sources, analyze existing approaches to solving the problem of improving the physical health of student youth.

2 To develop programs for the physical education of students of higher educational institutions, the implementation of which will promote the improvement of physical health.

3 Determine the level of physical health and physical fitness 17-19 years girls of different somatotypes.

4 To investigate the effectiveness of author's programs application for physical education for improving physical health and physical fitness of girls of different somatotypes.

Methods and organization of research.

To solve the first and second tasks, methods of theoretical analysis, generalization, and pedagogical observation were used. To solve the third and fourth tasks, methods of pedagogical testing of physical preparedness, physiological methods of research of physical health indicators, anthropometric methods were used.

Physical health was studied by bicycle ergometry. The level of physical health was estimated on a ratio with the "safe level of health".

Physical preparedness was determined by the "Tests and norms of assessment of physical preparedness of students" from the curriculum for higher education institutions of Ukraine of III-VI levels of accreditation (Order of the Ministry of Education and Science of Ukraine No. 757 of November 14, 2003).

The somatotype was determined using the Heath-Carter method.

The effectiveness of author's programs usage was checked in a comparative pedagogical experiment during the school year with the use of instrumental techniques: timekeeping, cardiography, sphygmomanometry, pneumotachometry, spirometry.

Empirical data were processed by methods of mathematical statistics: the probability of difference was determined according to Student t-criterion, correlation analysis was performed at interval level using the Pearson linear correlation coefficient.

The study involved women of the age of 17-19 years old who were studying at the I and II years of higher education institution, were classified in the main medical group and did not go in for sports. The number of individuals studies was 268.

At the first stage, the data of the specialized literature were analyzed and generalized, and we conducted our own monitoring of the dynamics of physical preparedness qualitative parameters of I-II course students, who study at universities. On the basis of the information presented in the scientific literature, as well as the results of our own observations, authors' programs of physical education of different directions were developed. The basis for the development of author's programs was the analysis, synthesis and generalization of data on the peculiarities of the physical activity of different directions on the physical health indicators and the qualitative pairs of measures of physical fitness, as well as scientific information on the peculiarities of the functioning of individual systems of bodies of different somatotypes representatives. The curriculum is designed using modelling and forecasting techniques.

At the second stage, a confirmatory experiment was conducted. The features of physical health indicators and qualitative parameters of physical fitness in girls aged 17-19 years of different somatotypes were studied. For this purpose for all subjects, the somatotype was determined and, the individuals were conditionally divided into the groups according to the somatotypological features.

At the third stage, a formative pedagogical experiment aimed at studying the peculiarities of the influence of physical education classes on the physical health and physical fitness of 17-19 year old girls of different somatotypes was conducted. We studied effectiveness of the current curriculum of physical education for higher educational institutions of Ukraine (program I) and four author programs of physical education: game orientation (program II); track and field athletics, which includes running loads with energy consumption of about 29% of the allowable maximum (Program III); athletic direction, which includes running loads with energy consumption of about 48% of the allowable maximum (program IV); power direction (program V). Frequency of classes in all programs was three times a week. The group, which was engaged in the current curriculum of physical education for universities, was a control one. Individuals who were engaged in each program were conditionally divided into groups according to somatotypological features, which made it possible to study the effect of physical activity on individuals with a separate somatotype and on a group that united representatives of all studied somatotypes. The examinations were carried out in three stages: before the beginning of experimental studies (determined by the baseline), as well as in 14 and 28 weeks.

At the fourth stage, statistical processing, analysis and generalization of the received data was carried out.

Results

The absolute value of the maximum amount of external mechanical work per 1 minute (MAEMW) in the representatives of the endomorphic and endomorphic mesomorphic somatotypes is significantly greater than that of the representatives of ectomorphic and balanced somatotypes. The magnitudes of the relative indicator of MAEMW in representatives of different somatotypes probably do not differ. It is noteworthy that the representatives of endomorphic and endomorphic mesomorphic somatotypes have a significantly greater body mass than those of ectomorphic and balanced somatotypes. Correlation analysis revealed correlation between the values of the relative value Vo_{2max} ($r = -0.621$; $p < 0.001$) and the absolute index of MAEMW ($r = 0.618$; $p < 0.001$) with body weight.

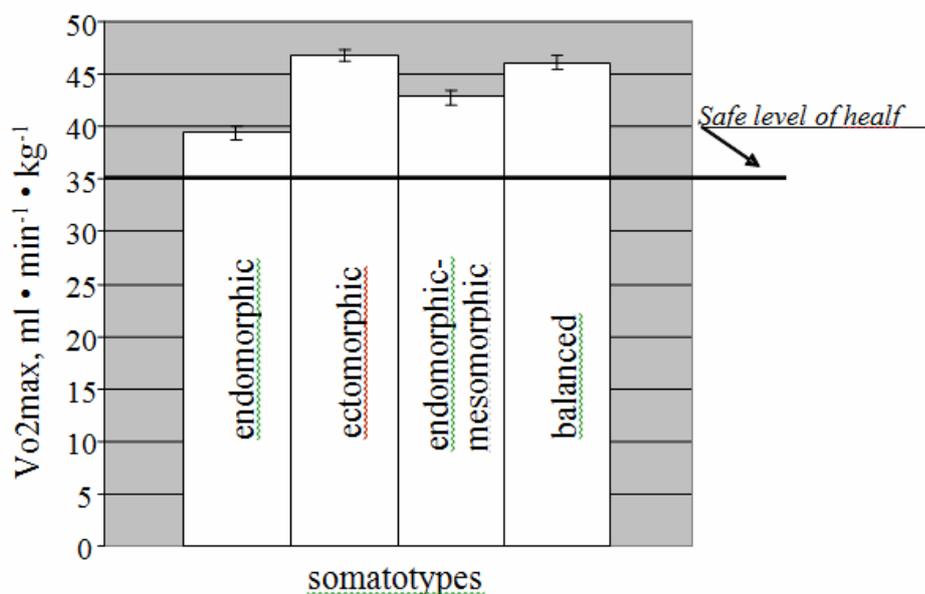


Fig. 1. Relative values of maximum oxygen consumption of girls of different somatotypes.

Anaerobic (lactate) abilities on the absolute index of the maximum amount of external mechanical work for 1 min in representatives of different somatotypes also differ significantly. Representatives of the endomorphic and endomorphic mesomorphic somatotypes have the highest absolute values of the maximum amount of external mechanical work for 1 min (1508.8 and 1450.1 $kgm \cdot min^{-1}$, respectively). In girls of ectomorphic and balanced somatotypes, the lowest absolute values of the maximum amount of external mechanical work for 1 min (1290.2 and 1273.0 $kgm \cdot min^{-1}$, respectively) were found.

Significant differences in the manifestation of qualitative parameters of physical fitness of representatives of different somatotypes were not detected. Only representatives of the endomorphic mesomorphic somatotype have the advantage of manifestation and strength endurance over the representatives of the ectomorphic somatotype.

Changes specifics in the functional capabilities of the body of representatives of different somatotypes under the influence of physical activity of different directions were as follows.

Program II classes in the group with representatives of different somatotypes, improved speed (by 3.5%, $p < 0.001$) and explosive force (by 6.3%, $p < 0.01$). The representatives of the balanced somatotype also improved the rate (by 4.0%, $p < 0.01$) and the explosive force (by 10.0%, $p < 0.05$). The agility improved in the group of different somatotypes (by 2.8%, $p < 0.05$), and for representatives of the ectomorphic somatotype (3.7%, $p < 0.001$). The increase in speed, explosive force and agility under the influence of classes of Program II is due to the significant amount of high-speed and speed-force exercises provided by the program, as well as the improvement of technical actions, interaction with a partner and rival, which in turn increases the level of dexterity.

Program IV classes contributed to an increase in the level of endurance in the group that united representatives of different somatotypes (by 3.6%, $p < 0.01$), and in the endomorphic (5.4%, $p < 0.05$) and balanced (5.9%, $p < 0.05$) somatotypes.

The most significant improvement of the qualitative parameters of physical fitness was detected for Program V lessons, as the explosive force in the group improved by 4.7%, $p < 0.05$, and the endomorphic, 5%, $p < 0.05$ and balanced (by 7.7%, $p < 0.05$) somatotypes; speed-strength endurance - in the group of representatives of different somatotypes (by 26.3%, $p < 0.001$), and in the representatives of balanced (by 16.9%, $p < 0.05$) and ectomorphic (by 60, 7%, $p < 0.001$) somatotypes; Flexibility - in a group of representatives of different

somatotypes (by 12.3%, $p < 0.05$) and representatives of ectomorphic somatotype (by 40.0%, $p < 0.05$); strength endurance - in the group of representatives of different somatotypes (by 42.6%, $p < 0.001$), and among representatives of ectomorphic (by 75.8%, $p < 0.05$) and balanced (by 44.0% , $p < 0.05$) somatotypes. In our opinion, significant positive changes are due to the peculiarities of physical activity exercises, which are aimed at the development of high-speed strength, strength endurance and flexibility.

Among the programs that were used to improve aerobic performance, program IV was the most effective program. At the same time, in the group of different somatotypes and representatives of the balanced somatotype, the probable growth of the aerobic productivity of the organism relative to the initial data took place after 14 weeks of classes and after their completion (after 28 weeks), respectively, reached 6.5 % ($p < 0.01$) and 12.4% ($p < 0.01$). In the representatives of endomorphic somatotype, the probable growth (by 6.4%, $p < 0.01$) of aerobic productivity occurred after 28 weeks of classes. It should be noted that classes of program IV have increased the level of aerobic productivity in the representatives of those somatotypes, which have increased the level of endurance, namely girls of endomorphic and balanced somatotypes. Representatives of ectomorphic and endomorphic mesomorphic somatotypes have shown only a tendency to improve aerobic productivity (Table. 1).

Regardless of the somatotype of the studied anaerobic (lactate) productivity was not probably changed by any of the programs.

Table 1

Dynamics of relative values of maximum oxygen consumption among representatives of different somatotypes in the scope of program IV

Indicator	Average value of $M \pm m$		
	before classes begin	after 14 weeks	after 28 weeks
Representatives of an ectomorphic somatotype, n = 14			
$Vo_{2\max}, \text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$	48.1 ± 1.1	48.2 ± 0.8	48.7 ± 1.0
Representatives of the endomorphic somatotype, n = 13			
$Vo_{2\max}, \text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$	45.2 ± 0.5	44.7 ± 0.6	$48.1 \pm 0.9^{**}$
Representatives of the endomorphic mesomorphic somatotype, n = 13			
$Vo_{2\max}, \text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$	44.0 ± 1.5	45.8 ± 1.4	46.2 ± 1.6
Representatives of a balanced somatotype, n = 16			
$Vo_{2\max}, \text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$	45.0 ± 1.2	$49.4 \pm 1.0^*$	$50.6 \pm 1.3^{**}$
In a group that unites representatives of all somatotypes, n = 65			
$Vo_{2\max}, \text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$	44.9 ± 0.7	$47.0 \pm 0.6^*$	$47.8 \pm 0.8^{**}$

Note: Probability of difference in relation to the initial level:

1) * - $p < 0.05$; 2) ** - $p < 0.01$

The determination of the changes of some functional indicators of circulatory and external respiration systems, which occurred under the influence of physical training by programs of different directions from representatives of different somatotypes, indicated the following.

Positive changes in the bioelectric activity of the heart and the system of external respiration of the subjects in the scope of track-and-field athletics program, which include running loads in aerobic power supply, are detected. Moreover, with the increase in the energy consumption of running from 29.2% of the E_{\max} (Program III) to 48.2% (Program IV), the efficiency of such classes increases. The somatotypological peculiarities of classes on the programs of athletics on the bioelectric activity of the heart and the system of external respiration are detected.

It should be noted that as a result of athletics lessons, the number of cases of increased diastolic pressure as a reaction to metered cyclometric loads decreased. Also, the program of power direction contributes to the increase in the number of persons with increased diastolic pressure during metered cyclometric loads.

Discussion

Analysis and synthesis of literary sources show that physical education classes by the current curriculum for higher education institutions of Ukraine do not adequately improve the physical health and physical fitness of students. One of the effective directions of improving the system of physical education in higher education is the planning of the size and direction of student physical activity, taking into account their somatotypes, since the somatotype is a sign by which one can predict reserves of functional capabilities of the organism and qualitative

parameters of physical fitness. In the scientific and methodical literature, the recommendations concerning the development of the system of physical education of students based on their somatotypes are insufficiently substantiated.

The results of the research show that in girls of 17-19 years the level of physical health, which was estimated by the relative indicator of maximum oxygen consumption, is connected with the somatotype. The highest values of the relative indicator of maximum oxygen consumption were found in the representatives of ectomorphic ($46.8 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$) and balanced ($46.1 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$) somatotypes. The lowest values of the relative indicator of maximum oxygen consumption were recorded in endomorphic ($39.4 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$) and endomorphologically-mesomorphic ($42.8 \text{ ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$) somatotypes.

On the basis of the conducted research and comparison with the data of literary sources, the problem of raising the level of aerobic and anaerobic (lactate) productivity as indicators determining the level of physical health is considered. The factors determining the level of aerobic and anaerobic productivity are determined. It is shown that the somatotype can predict the possibilities of improving the aerobic and anaerobic productivity of the organism and qualitative parameters of physical preparedness by means of physical training. Peculiarities of the influence of physical loads of different directions are analyzed on aerobic and anaerobic productivity and qualitative parameters of physical preparedness.

Received data made it possible for the first time to reveal the peculiarities of the influence of programs of different directions on the physical health indicators of 17-19-year-old girls of different somatotypes.

The revealed features of the indicators of physical health and physical fitness in 17-19-year-old girls of different somatotypes complement some preliminary data (Furman, 2006) about the functional capabilities of persons of different somatotypes. The article describes the impact peculiarities of different direction programs on physical health and physical fitness of students, complementing the data on the effectiveness of health programs of different directions in higher education institutions (Drachuk, 2018). Also, data on changes in the functions of the cardiovascular and respiratory systems of representatives of different somatotypes under the influence of health-improving physical exercises (Furman, 2006) are supplemented.

Other scientific results have provided grounds for confirmation of the opinion of a number of scientists (Gorshova, 2017) on the peculiarities of the impact of exercises on power and athletics programs on the reaction of diastolic pressure on metered bicycle masses.

It should be noted that additional scientific research is necessary to substantiate the detected features of the effect of physical activity on the quality of physical fitness and physical health indicators of different somatotypes.

Thus, the results of our research prove the need to take into account the somatotype in order to choose the direction of physical education, which corresponds to the individual capabilities of the organism. This will enable to increase the efficiency of physical education classes and increase the level of physical health and qualitative parameters of physical fitness of students.

Conclusions

1. Adaptive changes in the system of external respiration in representatives of different somatotypes as a result of the use of a track and field athletic program with running loads, which account for about 29% of the maximum allowable energy, were manifested by an increase in the lung capacity of the representatives of the endomorphic-mesomorphic somatotype (by 11.1% at $p < 0,05$). Classes in athletics with running loads, the energy consumption of which are about 48% of the maximum permissible, also contribute to an increase in the lung capacity of the members of the ectomorphic, endomorphic and endomorphic mesomorphic somatotypes (by 12.9, 15.2 and 14.3% respectively at $p < 0.01$). In addition, among girls of the endomorphic-mesomorphic somatotype, such loads increased the intensity of forced inspiration (by 10.5% at $p < 0.01$).

2. Classes in athletics programs, which include running loads with energy consumption of about 29 and 48% of the maximum allowable, contribute to a decrease (from 8.6 to 5.2% and from 8.6 to 2.8% respectively), the number of persons with an increase diastolic pressure as a response to metered physical activity. At the same time, the power program classes increase the number of people with increased diastolic pressure in response to standard physical activity (from 5.5 to 22.2%). Therefore, when working with women, it is necessary to limit the amount of physical effort of power exercises.

References

- Sulyma A., Bohuslavskaya V., Furman Y., Galan Y., Doroshenko E., Pityn M. (2017) Effectiveness of the application of the endogenous-hypoxic breathing technique in the physical training of the qualified field hockey players. *Journal of Physical Education and Sport* (JPES), 17(4), Art 289, pp. 2553 – 2560. DOI:10.7752/jpes.2017.04289
- Bohuslavskaya V., Furman Y., Pityn M., Galan Y., Nakonechnyi I. (2017) Improvement of the physical preparedness of canoe oarsmen by applying different modes of training loads. *Journal of Physical Education and Sport* (JPES), 17(2), pp.797 -803. DOI:10.7752/jpes.2017.02121

- Furman Yu.M., Miroshnichenko V.M. Characteristics of the physical health of girls of different somatotypes in the postpuber development period. *Physiological journal*, 2006. Vol. 52. No. 2. P. 156-157.
- Furman Yu.M., Miroshnichenko V.M., Brezdeniuk OYu, Furman TYu. An estimation of aerobic and anaerobic productivity of an organism of youth aged 17-19 years old of Podilsk region. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 2018; 22 (3): 136–141. doi:10.15561/18189172.2018.0304
- Gorshova I., Bohuslavska V., Furman Y., Galan Y., Nakonechnyi I., Pityn M. (2017) Improvement of adolescents adaptation to the adverse meteorological situation by means of physical education. *Journal of Physical Education and Sport (JPES)*, 17 (2) pp. 892-898. DOI:10.7752/jpes.2017.02136
- Hruzevych I., Bohuslavska V., Kropta R., Galan Y., Nakonechnyi I., Pityn M. (2017) The effectiveness of the endogenous-hypoxic breathing in the physical training of skilled swimmers. *Journal of Physical Education and Sport (JPES)*, 17 (3), pp. 1009-1016. DOI:10.7752/jpes.2017.s3155
- Gavrylova Nataliia, Bohuslavska Viktoriia, Pityn Maryan, Moseichuk Yuriy, Kyselytsia Oksana (2017) Effectiveness of the application of the endogenous-hypoxic breathing technique in the physical training of 13-16-year-old cyclists. *Journal of Physical Education and Sport* ® (JPES), 17(4), Art 291, pp. 2568 – 2575. DOI:10.7752/jpes.2017.04291
- Kropta Ruslan, Hruzevych Iryna, Bohuslavska Viktoriia, Galan Yaroslav, Nakonechnyi Ihor, Pityn Maryan (2017) Correction of functional preparedness of rowers at the stage of maximal realization of individual capabilities. *Journal of Physical Education and Sport (JPES)*, 17 (3), pp. 1985-1981. DOI:10.7752/jpes.2017.03197
- Drachuk S., Bohuslavska V., Pityn M., Furman Y., Kostiukevych V., Gavrylova N., Salnykova S., Didyk T. (2018) Energy supply capacity when using different exercise modes for young 17–19- year-old men. *Journal of Physical Education and Sport (JPES)*, 18 (1), Art 33, pp. 246-254, 2018, doi:10.7752/jpes.2018.0103
- Kostykevich V., Imas Y., Shynkaruk O., Borysova O., Dutchak M., Kogut I., Voronova V., Shlonska O., Stasiuk I. (2018) Modeling of the athletic training process in team sports during an annual macrocycle. *Journal of Physical Education and Sport (JPES)*, Art 44, pp. 327 - 334, DOI:10.7752/jpes.2018.s144