ORIGINAL ARTICLE

Improvement of morphofunctional status of students by modern means of motor activity

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ABSTRACT

Aim: To study the dynamics of students' morphofunctional status indicators during their high-intensity interval training (HIIT).

Materials and Methods: The research involved 132 male students divided into three groups: students in Group No. 1 ($n = 27$) did HIIT; Group No. 2 ($n = 69$) – various sports (sports games, martial arts, strength sports, athletics, swimming, cycling); Group No. 3 ($n = 36$) – general physical training. The morphofunctional status was assessed using indicators of height, body weight, lung vital capacity, hand dynamometry, heart rate, and blood pressure. The generalized indicator of students' morphofunctional status was assessed using the methodology developed by Ye. A. Pyrohova.

Results: It has been proven that HIIT effectively improves students' morphofunctional status during their studies. Most of the morphological and functional indicators of students who practiced HIIT were significantly ($p \leq 0.05$-0.001) better in the 3rd and 4th instructional years than those of students who practiced general physical training. The most significant effect of HIIT was an improvement in indicators of body weight and in the functioning of students' cardiovascular and respiratory systems. Compared to Group No. 2, the indicators of Group No. 1 do not have significant differences ($p > 0.05$).

Conclusions: The results obtained allow us to assert the effectiveness of HIIT, as well as any kind of sport, during their studies at higher educational institutions under martial law, to increase students' motor activity, improve their morphofunctional status, physical and mental performance, strengthen their somatic and mental health, and promote harmonious personal development.

KEY WORDS: motor activity, HIIT, morphological and functional indicators, health, students

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INTRODUCTION

It is well known that one of the most critical factors in a healthy lifestyle for modern people is motor activity. Motor activity plays a key role in maintaining human somatic health, improving physical condition (strengthening muscles, the musculoskeletal system, cardiovascular and other body systems), mental well-being (reducing stress and anxiety), and overall performance [1]. Regular physical activity is an effective way to prevent many diseases, including cardiovascular disease and obesity, and also improves quality of life [2]. At the same time, technological advances and the information revolution have significantly reduced motor activity in modern humans. In the last 20-30 years alone, the proportion of physical labor in daily life has decreased tenfold, leading to a sedentary lifestyle [3]. Decreased physical activity is the cause of many diseases, slows down development in childhood and adolescence, accelerates aging, and reduces life expectancy [4]. Students of higher educational institutions are no exception, as their motor activity is limited by several factors: distance learning (due to martial law in Ukraine, frequent air raid sirens, the COVID pandemic, etc.), the digitization of education, large amounts of educational information, psychological difficulties (constant stress, poor health, etc.), lack of family traditions, insufficient awareness of the benefits of motor activity, etc. [5]. In addition, scientists [6] emphasize significant barriers to students' participation in regular physical activity, including a lack of time, motivation, and resources. Researchers [7] also link low levels of motor activity among students to stress, poor daily routines and nutrition, the lack of a systematic approach to promoting motor activity in higher educational institutions, and limited integration of innovative technologies and modern types of motor activity into students' physical education.

One modern type of motor activity that can help solve the problem outlined above is high-intensity interval training (HIIT), which involves performing intense exercises with weights or your own body weight, with short rest periods between sets [8]. HIIT includes modern physical exercises combined into complexes lasting 10 to 30 minutes, depending on students' physical fitness [9]. HIIT does not require special conditions for training sessions (exercises can be performed in a gym, outdoors, or at home), expensive equipment, and can be done in a short period of time (does not take much time), making it popular among today's youth [10], which is appropriate for their use in the physical education of students during their studies in conditions of martial law to increase the volume of students' motor activity, improve their morphofunctional status, and strengthen their health.

AIM

To study the dynamics of students' morphofunctional status indicators during their high-intensity interval training (HIIT). Objectives: 1) to study the dynamics of morphological and functional indicators of students' bodies under the influence of HIIT during their studies at the university; 2) to conduct a comparative analysis of the studied indicators of students who practiced HIIT and students who practiced other types of motor activity.

MATERIALS AND METHODS

PARTICIPANTS

The research, conducted in 2022-2025, involved 132 male students of Khmelnytskyi National University (KhNU, Khmelnytskyi, Ukraine, specialties: A7 – Physical Culture and Sports, J3 – Tourism and Recreation), who chose a type of motor activity to engage in during their studies at the university while martial law was in effect in Ukraine: Group No. 1 (n = 27), whose students engaged in HIIT during their physical education training sessions; Group No. 2 (n = 69), whose students practiced various sports during their physical education training sessions (sports games, martial arts, strength sports, athletics, swimming, cycling); Group No. 3 (n = 36), whose students practiced traditional methods (general physical training) during their physical education training sessions. Coaches trained the students in Group No. 1 and Group No. 2 in specific sports as part of the university's sports program (sports clubs). In contrast, Group No. 3 was trained by a physical education instructor. The total number of hours of motor activity at the university per week was the same across all groups: 6 hours (3 training sessions of 2 hours each). Limitations of the research: we did not take into account the types of activities and the amount of motor activity of students outside of academic hours (outside the university). Inclusion criteria: all students were male, students belonged to the main medical group (had no health deviations or contraindications for the selected types of motor activity), students participated in sports clubs at their own choice, which are available at KhNU (there was no special selection for the groups; analysis of the initial indicators of the morphofunctional status of students in all three groups showed that they were reliably the same ($p > 0.05$)). The exclusion criterion was the student's voluntary desire to withdraw from the research at any time.

RESEARCH METHODS

Theoretical analysis and generalization of literature sources, biomedical methods, statistical methods. The method of theoretical analysis and generalization of literary sources was used to conduct an analytical review of scientific sources on the outlined range of issues (20 sources from MedLine, Scopus, Web of Science databases were analyzed).

Biomedical methods were used to determine the morphofunctional status of students. The morphofunctional status was studied according to the following indicators: morphological – height (H), body weight (BW), vital capacity of the lungs (VC), hand dynamometry (HD); functional – resting heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP). The generalized indicator of the morphofunctional status of students was assessed using the methodology of Ye. A. Pirohova, which involves determining the morphofunctional status index (MSI) [11]. The MSI was calculated using the formula that takes into account the age, body weight, height, heart rate, and blood pressure of students at rest, and was assessed in c. u.:

$$MSI = (700 - 3\times HR - 2.5\times BP\ aver. - 2.7\times A + 0.28\times BW) / (350 - 2.6\times A + 0.21\times H),$$

BW – body weight, kg; H – height, cm; A – age, number of full years; BP aver. – average blood pressure (mm Hg), determined by the formula:

$$BP\ aver. = ((SBP - DBP) / 3) + DBP.$$

The level of morphofunctional status of students is considered low if the MSI is 0.375 c. u. and less; below average – 0.376-0.525 c. u.; average – 0.526-0.675 c. u; above average – 0.676-0.825 c. u; high – 0.826 c. u and above.

STATISTICAL METHODS

Statistical analysis was applied to correctly process the data and identify the difference between the indicators under study. The significance of the difference in the results of the students was determined based on the Student's t-test. The significance for all statistical tests was set at $p \leq 0.05$. All statistical analyses were performed with the SPSS software, version 11.0.

ETHICS

This research followed the regulations of the World Medical Association Declaration of Helsinki and ethical principles for medical research involving human subjects and was approved by the Academic Council of Khmelnytskyi National University (Protocol No. 7 dated 10.05.2022). Informed consent was received from all students who took part in this research.

FRAMEWORK

The study was conducted according to the research plan of the Khmelnytskyi National University for 2024-2027 within the topic "Formation of Personality as a Subject of Self-Creation" (state registration number 0119U103663).

RESULTS

A study of students' height indicators shows no significant difference among the three groups across all instructional years ($p > 0.05$). The dynamics of students' height indicators during their studies show that the average values increased across all groups. Still, the results for students in the 1st and 4th instructional years do not differ significantly (Table 1).

By studying students' body weight, we found that the average values during the 1st and 2nd instructional years did not differ significantly ($p > 0.05$). In the 3rd instructional year, the body weight indicators of students in Group No. 1 were significantly ($p \leq 0.05$) lower than those in Group No. 3, by 4.4 kg, and in the 4th instructional year, by 5.3 kg. No significant difference ($p > 0.05$) was found between Group No. 1 and Group No. 2 (Table I). During their studies, the students who practiced HIIT showed a non-significant increase in body weight of 2.4 kg ($p > 0.05$), while those who practiced other sports gained 2.8 kg ($p > 0.05$). The students who practiced general physical training gained 5.7 kg ($p \leq 0.01$), which may hurt their health. The analysis of body weight indicates that the physical loads students receive during HIIT and other sports help stabilize their body weight.

The analysis of VC indicators showed that in the 1st and 2nd instructional years, no significant differences were found among the indicators of students in Group No. 1, Group No. 2, and Group No. 3 ($p > 0.05$). No significant difference between VC indicators was found in the 3rd and 4th instructional years; however, in the 4th instructional year, the difference between the indicators of Group No. 1 and Group No. 3 is significant and amounts to 252.3 ml, and between Group No. 1 and Group No. 2 – 185.9 ml. During the studies, the VC indicators improved in all student groups. Still, in Group No. 1 and Group No. 2 in the 4th instructional year, the VC indicators were significantly better than in the 1st instructional year by 338.4 ml ($p \leq 0.05$) and 191.8 ml ($p \leq 0.05$), respectively. At the same time, in Group No. 3, the difference between the VC indicators of the 4th and 1st instructional years is 177.4 ml and is insignificant ($p > 0.05$).

The muscular system of students was assessed using hand dynamometry indicators. In the 1st instructional year, the indicators across all groups did not differ significantly ($p > 0.05$). In the 2nd-4th instructional years, the dynamometry indicators of students in Group No. 1 are better compared to the indicators of Group No. 2 and Group No. 3. Thus, in the 4th instructional year, the difference between the indicators of students in Group No. 1 and Group No. 2 is 2.8 kg, and between Group No. 1 and Group No. 3 – 4 kg. However, the difference is not significant ($p > 0.05$) (Table I), which indicates the greater effectiveness of HIIT training sessions on the strength indicators of students. During the research period, the strength indicators of students in Group No. 1 and Group No. 2 improved significantly ($p \leq 0.05$), whereas those of students in Group No. 3 did not ($p > 0.05$).

The study of HR dynamics at rest shows that in the 1st and 2nd instructional years, the average indicators of Group No. 1, Group No. 2, and Group No. 3 did not differ significantly ($p > 0.05$). In the 3rd instructional year, the difference between the HR indicators of students in Group No. 1 and Group No. 3 was 3.6 beats/min, and in the 4th instructional year, it was 4.9 beats/min, which is significant ($p \leq 0.05$-0.001). In the 4th instructional year, the HR indicators of students in Group No. 2 were also significantly better than those in Group No. 3. At the same time, no significant difference between the indicators of Group No. 1 and Group No. 2 was found in all instructional years ($p > 0.05$), which indicates the effectiveness of both HIIT and other sports in improving the functional capabilities of the cardiovascular system of students during their studies in conditions of martial law. This is confirmed by a significant difference between the indicators of the 4th and 1st instructional years in Group No. 1 and Group No. 2 ($p \leq 0.001$) and the absence of a difference in Group No. 3 ($p > 0.05$) (Table 2).

The study of students' systolic and diastolic blood pressure enabled us to observe positive dynamics and improvements in the average indicators of students across all studied groups during their studies. However, the

Table 1. Dynamics of morphological indicators of students in the process of different types of motor activity during their studies (n = 132)

Year of study	Group No.1 (n=25)	Group No. 2 (n=108)	Group No.3 (n=25)	Significance of the difference		
	X±m	X±m	X±m	t_{1-2} (p)	t_{1-3} (p)	t_{2-3} (p)
Students' height, cm						
1st	176.3±2.11	175.8±1.45	176.1±1.96	0.20 (p>0.05)	0.07 (p>0.05)	0.12 (p>0.05)
2nd	176.5±2.03	175.9±1.39	176.4±1.92	0.24 (p>0.05)	0.04 (p>0.05)	0.24 (p>0.05)
3rd	176.8±1.99	176.2±1.40	176.7±1.91	0.25 (p>0.05)	0.04 (p>0.05)	0.21 (p>0.05)
4th	177.0±1.98	176.6±1.39	176.9±1.87	0.17 (p>0.05)	0.04 (p>0.05)	0.13 (p>0.05)
t_{1-4} (p)	0.24 (p>0.05)	0.40 (p>0.05)	0.30 (p>0.05)			
Body weight, kg						
1st	68.4±1.21	70.2±0.94	70.4±1.16	1.17 (p>0.05)	1.19 (p>0.05)	0.13 (p>0.05)
2nd	69.3±1.28	71.6±0.95	72.5±1.21	1.44 (p>0.05)	1.82 (p>0.05)	0.59 (p>0.05)
3rd	70.3±1.31	72.3±1.07	74.7±1.34	1.18 (p>0.05)	2.35 (p≤0.05)	1.40 (p>0.05)
4th	70.8±1.34	73.0±1.05	76.1±1.38	1.29 (p>0.05)	2.76 (p≤0.05)	1.79 (p>0.05)
t_{1-4} (p)	1.33 (p>0.05)	1.98 (p>0.05)	3.16 (p≤0.01)			
Vital capacity, ml						
1st	4205.4± 112.35	4166.1± 72.49	4114.1± 123.22	0.29 (p>0.05)	0.55 (p>0.05)	0.36 (p>0.05)
2nd	4376.1± 111.47	4234.5± 70.28	4192.9± 119.65	1.07 (p>0.05)	1.12 (p>0.05)	0.30 (p>0.05)
3rd	4452.2± 107.16	4292.6± 64.12	4250.7± 116.37	1.28 (p>0.05)	1.27 (p>0.05)	0.31 (p>0.05)
4th	4543.8± 105.28	4357.9± 58.48	4291.5± 114.84	1.54 (p>0.05)	1.62 (p>0.05)	0.52 (p>0.05)
t_{1-4} (p)	2.20 (p≤0.05)	2.06 (p≤0.05)	1.05 (p>0.05)			
Hand dynamometry, kg						
1st	40.1±2.13	41.3±1.11	40.6±2.44	0.50 (p>0.05)	0.15 (p>0.05)	0.26 (p>0.05)
2nd	42.4±2.04	42.3±0.96	41.8±2.31	0.04 (p>0.05)	0.19 (p>0.05)	0.20 (p>0.05)
3rd	45.4±1.92	44.2±0.83	42.9±2.25	0.57 (p>0.05)	0.85 (p>0.05)	0.54 (p>0.05)
4th	47.9±1.85	45.1±0.78	43.9±2.12	1.39 (p>0.05)	1.42 (p>0.05)	0.53 (p>0.05)
t_{1-4} (p)	2.76 (p≤0.01)	2.80 (p≤0.01)	1.02 (p>0.05)			

Notes: X – arithmetic mean; m – error of arithmetic mean; t – Student's test value; p – reliability value
Source: compiled by the authors of this study

indicators of SBP and DBP in Group No. 1, Group No. 2, and Group No. 3 in all instructional years did not differ significantly from each other (p > 0.05) (Table 2).

The analysis of the students' morphofunctional status index showed that in the 1st and 2nd instructional years, there was no significant difference between the indicators of the studied groups (p > 0.05). In the 3rd and 4th instructional years, students in Group No. 1 showed significantly better MSI indicators than in Group No. 2 and Group No. 3 by 0.047 and 0.077 c. u (p ≤ 0.05-0.01) in the 3rd instructional year and by 0.070 and 0.122 c. u (p ≤ 0.001) in the 4th instructional year, respectively (Table II). The data obtained indicate that HIIT has a positive impact on the functioning of the central life-support systems of students' bodies during their studies at higher educational institutions under martial law.

Table 2. Dynamics of functional indicators of students in the process of different types of motor activity during their studies (n = 132)

Year of study	Group No.1 (n=25)	Group No. 2 (n=108)	Group No.3 (n=25)	Significance of the difference		
	X±m	X±m	X±m	t_{1-2} (p)	t_{1-3} (p)	t_{2-3} (p)
Resting heart rate, cm						
1st	71.0±1.35	70.7±0.55	71.2±1.21	0.21 (p>0.05)	0.11 (p>0.05)	0.38 (p>0.05)
2nd	68.2±1.28	69.5±0.52	70.6±1.16	0.94 (p>0.05)	1.39 (p>0.05)	0.87 (p>0.05)
3rd	66.5±1.24	68.2±0.47	70.1±1.12	1.28 (p>0.05)	2.15 (p≤0.05)	1.56 (p>0.05)
4th	64.8±1.17	66.7±0.44	69.7±1.06	1.52 (p>0.05)	3.10 (p≤0.001)	2.61 (p≤0.01)
t_{1-4} (p)	3.47 (p≤0.001)	5.68 (p≤0.001)	0.93 (p>0.05)			
Systolic blood pressure, mmHg						
1st	123.5±2.08	122.9±0.91	123.7±2.14	0.26 (p>0.05)	0.07 (p>0.05)	0.34 (p>0.05)
2nd	122.5±1.99	122.1±0.82	122.9±2.03	0.19 (p>0.05)	0.14 (p>0.05)	0.37 (p>0.05)
3rd	121.4±1.92	121.5±0.74	122.2±1.93	0.05 (p>0.05)	0.29 (p>0.05)	0.26 (p>0.05)
4th	120.2±1.85	121.0±0.68	121.3±1.86	0.39 (p>0.05)	0.42 (p>0.05)	0.15 (p>0.05)
t_{1-4} (p)	1.19 (p>0.05)	1.67 (p>0.05)	0.85 (p>0.05)			
Diastolic blood pressure, mmHg						
1st	70.2±1.12	70.5±0.54	70.4±1.08	0.24 (p>0.05)	0.13 (p>0.05)	0.08 (p>0.05)
2nd	70.0±1.07	70.4±0.51	70.1±0.97	0.34 (p>0.05)	0.07 (p>0.05)	0.27 (p>0.05)
3rd	69.7±0.98	70.3±0.46	69.9±0.92	0.55 (p>0.05)	0.15 (p>0.05)	0.39 (p>0.05)
4th	69.5±0.96	70.2±0.42	70.1±0.88	0.67 (p>0.05)	0.48 (p>0.05)	0.10 (p>0.05)
t_{1-4} (p)	0.47 (p>0.05)	0.43 (p>0.05)	0.22 (p>0.05)			
Morphofunctional status index, c.u.						
1st	0.675±0.020	0.678±0.013	0.680±0.022	0.13 (p>0.05)	0.17 (p>0.05)	0.08 (p>0.05)
2nd	0.719±0.019	0.694±0.011	0.683±0.020	1.14 (p>0.05)	1.30 (p>0.05)	0.48 (p>0.05)
3rd	0.764±0.018	0.717±0.010	0.687±0.019	2.28 (p≤0.05)	2.94 (p≤0.01)	1.40 (p>0.05)
4th	0.813±0.016	0.743±0.009	0.691±0.018	3.81 (p≤0.001)	5.07 (p≤0.001)	2.58 (p≤0.05)
t_{1-4} (p)	5.39 (p≤0.001)	4.11 (p≤0.001)	0.39 (p>0.05)			

Notes: X – arithmetic mean; m – error of arithmetic mean; t – Student's test value; p – reliability value

Source: compiled by the authors of this study

DISCUSSION

Scientists [12] argue that the problem of low motor activity among students is becoming increasingly relevant in the modern educational environment, especially during the legal regime of martial law in Ukraine. Hypodynamia caused by a sedentary lifestyle, excessive use of digital technologies, and academic workload negatively affects the physical and psycho-emotional health of young people [13].

Scientists [14] identify the main problems in students' motor activity as a lack of motivation for regular physical activity, insufficient awareness of the impact of motor activity on health and quality of life, and limited or ineffective physical education and health services provided by higher educational institutions. Digitalization also significantly affects student involvement in motor activity, promoting a passive lifestyle through prolonged gadget use.

Experts [15] see prospects for improving the situation in improving the quality of physical education and health services, justifying, developing, and implementing modern programs focused on the needs of students, using innovative technologies and recreational approaches; increasing motivation by organizing events aimed at promoting a healthy lifestyle, active recreation, and regular motor activity; using an individual approach that will facilitate the implementation of personalized recommendations for motor activity based on an assessment of students' health status; and forming a culture of health through educational and awareness-raising activities on the importance of motor activity for disease prevention and health promotion.

Considering the capabilities of the higher educational institution and the availability of appropriate trainers in various types of motor activity (sports) within the Department of Physical Education, we suggested that students independently choose the type of motor activity for their training sessions during their studies. Among the proposed types of motor activity, students were most interested in HIIT as a modern form of motor activity and an innovative approach to physical culture and health technology. In the literature [16], we find that HIIT refers to a type of physical training whose main characteristic is the alternation of short periods of intense anaerobic exercise with shorter periods of rest. Experts [17] consider the "Tabata" method to be the most popular and effective type of HIIT in the world. Back in 1996, Japanese professor Izumi Tabata developed a technique to improve athletes' aerobic capacity, which he used to train the Japanese Olympic speedskating team. The method was based on athletes performing 20-second ultra-intense exercises (pedaling) on an exercise bike, bringing their maximum oxygen consumption to 170 %, followed by a 10-second rest. The professor chose 8 work-rest cycles. Each set lasts only 4 minutes. The number of sets and the rest time between sets depend on the athletes' level of physical fitness [18]. Today, interval training using the "Tabata" technique is widely used among students. The technique allows you to use a series of exercises (100 or more) from modern sports, which can be performed independently or in a group, indoors or outdoors, with additional sports equipment or your own body weight, in pairs, over a short period of time. The advantages of HIIT using the "Tabata" technique also include: a significant increase in students' aerobic capacity, increased oxygen consumption, effective fat burning, compensation for a sedentary lifestyle, and time savings in training [19]. As a result of introducing HIIT into university training sessions, we found that systematic HIIT training, on a par with other sports (sports games, martial arts, strength sports, athletics, swimming, cycling), is an effective means of increasing students' MA, improving their morphofunctional status, strengthening their health, and improving their psycho-emotional state. Our results confirm, complement, and expand on the conclusions of many scientists [8, 9, 18, 20], who have studied students' motor activity and the effectiveness of HIIT and other modern methods for strengthening young students' health.

CONCLUSIONS

The research shows that HIIT effectively improves students' morphofunctional status during their studies. Most morphological and physiological indicators of students who practiced HIIT were significantly ($p \leq 0.05$-0.001) better in the 3rd and 4th instructional years than those of students who practiced general physical training during their physical education training sessions. The most significant effect of HIIT was an improvement in body weight indicators and in the functioning of the cardiovascular and respiratory systems of students. Compared to Group No. 2, the indicators of Group No. 1 do not have significant differences ($p > 0.05$), which also allows us to assert the effectiveness of sports activities during studies in higher educational institutions under martial law to increase the volume of students' motor activity, improve their morphofunctional status, physical and, accordingly, mental performance, and strengthening their somatic and mental health.

PROSPECTS FOR FURTHER RESEARCH

It is planned to investigate the dynamics of students' somatic health indicators during HIIT training sessions.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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