THE IMPACT OF PHYSICAL EXERCISES AND STRENGTH SPORTS ON THE LEVEL OF PHYSICAL HEALTH OF STUDENTS

ВПЛИВ ФІЗИЧНИХ ВПРАВ АТЛЕТИЧНИХ ВИДІВ СПОРТУ НА РІВЕНЬ ФІЗИЧНОГО ЗДОРОВ'Я СТУДЕНТІВ

Mahlovanyy A.[1,2], Grygus I.[2], Kunynets O.[1]
[1]Danylo Halytsky Lviv National Medical University, Lviv, Ukraine
[2]National University of Water and Environmental Engineering, Institute of Healthcare, Rivne, Ukraine
[1]ORCID: 0000-0002-1792-597X
[2]ORCID: 0000-0002-1270-4123
[3]ORCID: 0000-0003-2856-8514

DOI https://doi.org/10.32782/2522-1795.2025.19.2.15

Abstracts

Students' education occurs in an environment characterized by a constant influx of educational information, which leads to hypodynamia and a decline in physical health. One way to address this decline in physical health is by incorporating exercises from athletic sports. **The purpose of this study** is to examine the impact of physical exercises in athletic sports (using kettlebell sports as an example) on the level and trends of students' physical health indicators. **Research methods.** Analysis of literary sources, testing, pedagogical experiment, methodology for assessing the level of physical health, methods of mathematical statistics. The level of physical health of students was studied according to the dynamics of indicators of a qualitative express assessment of somatic health. **Results.** Male students of the 1st–2nd years, all faculties of the medical university, aged 18–20 years (n=54) participated in the study. An experimental (EG, n=26) and control (CG, n=28) groups were formed. Thus, the obtained data allowed us to establish that according to the Quetelet index, the indicators of both groups were at the average level of completeness for men. The dynamics of the vital index, strength index, Robinson index of the experimental group students significantly ($p<0.01$) exceeded the similar indicators of the control group students and were assessed as higher than average. In EG students, during two years of study, there was an improvement in the recovery time of the heart rate, which indicated the strengthening of the cardiovascular system of students engaged in physical exercises with kettlebells. The indicator of the level of physical health of EG students was 13.97 conventional units at the end of stage 4, which was also assessed as higher than average and reached the "safe zone", and it significantly ($p<0.001$) increased from stage 1 to stage 4 and amounted to 7.38 conditional units, which indicated the positive impact of physical exercises with kettlebells on improving the physical health indicators of students.

Conclusions. It was established that the use of physical exercises with kettlebells forms the basis for the development of basic physical qualities, has a positive effect on improving the reserve of external respiratory functions, the functional state of the cardiovascular system, restoring heart rate, contributes to the development of the muscular system and improving the level of physical health of students.

It is proven that students who were engaged in physical exercises with kettlebells reached the "safe zone" of the level of physical health, which contributed to improving their well-being, increasing the effectiveness of learning and readiness to perform the tasks of future professional activity.

Key words: students, physical health, rapid assessment of somatic health, physical exercises with kettlebells.

Навчання студентів відбувається в умовах, пов'язаних із постійним зростанням обсягу навчальної інформації, що призводить до гіподинамії та зниження рівня фізичного здоров'я. Одним із напрямів вирішення проблеми зниження рівня фізичного здоров'я є використання вправ атлетичних видів спорту. **Мета дослідження** – вивчити вплив застосування фізичних вправ атлетичних видів спорту (на прикладі гирьового спорту) на рівень та динаміку показників фізичного здоров'я студентів. **Методи дослідження:** аналіз літературних джерел, тестування, педагогічний експеримент, методика оцінки рівня фізичного здоров'я, методи математичної статистики. Рівень фізично-

го здоров'я студентів досліджувався за динамікою показників якісної експрес-оцінки соматичного здоров'я. **Результати.** У дослідженні брали участь студенти-чоловіки I–II курсів усіх факультетів медичного університету віком 18–20 років (n=54). Було сформовано експериментальну (ЕГ, n=26) і контрольну (КГ, n=28) групи. Таким чином, отримані дані дозволили встановити, що за індексом Кетле показники обидвох груп перебували на середньому рівні повноти для чоловіків. Динаміка показників життєвого індексу, силового індексу, індексу Робінсона студентів експериментальної групи достовірно ($p<0,01$) переважала аналогічні показники студентів контрольної групи та оцінювалася як вища за середній. У студентів ЕГ протягом двох років навчання відбувалося покращення часу відновлення частоти серцевих скорочень, що вказувало на зміцнення серцево-судинної системи студентів, які займаються фізичними вправами з гирями. Показник рівня фізичного здоров'я студентів ЕГ становив 13,97 ум. од. наприкінці 4-го етапу, що оцінювався також як вищий за середній і досягнув «безпечної зони», причому він достовірно ($p<0,001$) зростав від 1-го до 4-го етапу і становив 7,38 ум.од., що свідчило про позитивний вплив занять фізичними вправами з гирями на покращення показників фізичного здоров'я студентів.

Висновки. Встановлено, що застосування фізичних вправ з гирями формує базу для розвитку основних фізичних якостей, позитивно впливає на покращення резерву функцій зовнішнього дихання, функціонального стану серцево-судинної системи, відновлення частоти серцевих скорочень, сприяє розвитку м'язової системи та покращенню рівня фізичного здоров'я студентів.

Доведено, що студенти, які займалися фізичними вправами з гирями, досягли «безпечної зони» рівня фізичного здоров'я, що сприяло покращенню їхнього самопочуття, підвищенню ефективності навчання та готовності до виконання завдань майбутньої професійної діяльності.

Ключові слова: студенти, фізичне здоров'я, експрес-оцінка соматичного здоров'я, фізичні вправи з гирями.

Introduction. Students' education in a modern higher education institution (HEI) takes place in specific conditions associated with a constant increase in the volume of educational information, a high level of responsibility for learning outcomes, and intellectual overload, which leads to a decrease in motor activity and physical health [2; 9]. In addition, the low level of physical fitness of school graduates does not allow for a sufficient level of development of students' general physical fitness, which leads to a decrease in functional and physical health indicators to a level that does not ensure sufficient effectiveness of learning and readiness to perform tasks of future professional activity [4: 6; 7].

According to G.L. Apanasenko [2; 3] Ukraine ranks 2nd in the world in terms of depopulation rates, 1st–2nd in Europe in terms of mortality from cardiovascular diseases, among students aged 20–24, the "biological" age exceeds the passport age by 10–15 years. One of the directions for solving the problem of reduced physical activity is to improve physical health using physical sports [3; 7; 8; 10; 12]. Among the strength sports that can help solve the existing problem, kettlebell exercises can be used, which have a number of advantages: health-improving orientation, low level of injuries, accessibility, simplicity, economic efficiency, ease of material support [1; 4; 8]. According to the World Health Organization, health is defined as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity [3; 9]. According to the definition [3; 9], a person can be considered healthy if he or she is in harmonious physical and mental development and is well adapted to the surrounding physical and social environment. In our previous scientific works [2; 3; 9] two concepts of health were presented, with the first definition being predominantly structural and based on objects that characterize health (body, thinking, behavior), and therefore – human health is a state characterized by normal intrasystemic functioning of the organism and the brain as a potential basis of the individual and adequate systemic and environmental manifestation of the personality, and the second is functional and based on systemic functions of health statuses – human health is a state that ensures static-dynamic material and energy homeostasis of the organism (physical health), intrasystemic homeostasis of the brain (mental health) and systemic and environmental homeostasis of behavior (social health) [2; 9].

Based on the fact that our work is aimed at studying the level and dynamics of physical

health of students who additionally engaged in physical exercises in the university's training groups, we have also provided a definition of the concept of physical health, which was proposed by us [2; 3; 9], where the physiological norm is understood as the range of indicators of the organism's vital activity, in which the lability, mobility and adaptability of the organism to environmental loads are manifested throughout life, and therefore the author claims that physical health is a state of the organism in which the integral indicators of the main physiological systems are within the physiological norm and adequately change during the interaction of a person with the environment. Thus, the systemic function of physical health, according to the second definition of human health given above, is static-dynamic, material-energy homeostasis of the human organism. Static homeostasis is the homeostasis of the parameters of the organism's vital activity, it is the intrasystemic, inherent in the organism itself, the basis of its stable existence. Dynamic homeostasis is the homeostasis of functions performed by all physiological systems of the organism, and ensures the shift of the parameters of the organism's vital activity in accordance with changes in the external and internal environment. Therefore, based on the above, it can be stated that it is a healthy person who is able to fully realize his physical and mental abilities and fulfill his social purpose [2; 9].

In the studies of G.L. Apanasenko [2; 3] it was determined that there is a safe level, or "safe zone" of physical health (on the border of the third and fourth levels – according to the express method – it is 12 points), above which there are practically no endogenous risk factors for the development of chronic somatic diseases, neither the diseases themselves, nor mortality from them [2]. Scientists note that over the past 20 years in Ukraine the share of the population in the "safe zone" of health has decreased from 8 to 1%. For comparison, in the USA up to 80% of Americans aged 20–59 are in the "safe zone" [2; 9; 13; 17].

In the scientific works of a number of scientists it is noted that the main reasons for the decline in health in Ukraine are not only the socio-economic crisis and the deterioration of the functioning of the health care system, but also the insufficient level of information provision of people about the state of health and its main components, in particular physical [9; 11; 14]. The education of an individual in the field of problems of preserving and strengthening health plays, ultimately, a more important role than the level of medical and diagnostic measures in the region [2; 8; 11; 12; 14].

Scientists have established that physical health and professional longevity are effectively formed through systematic physical exercise and sports [5; 7; 10; 12; 16]. A significant number of works have been devoted to the scientific substantiation and introduction of the most effective means of physical education into the educational process of students in order to improve their physical health [1; 4; 8; 10]. At the same time, one of the least studied issues is the influence of physical exercises of kettlebell sports on the development of the functional capabilities of the body and the physical health of students, which determined the choice of the research topic.

The purpose of the study is to study the impact of the use of physical exercises in strength sports (using the example of kettlebell sports) on the level and dynamics of physical health indicators of students.

Material and methods. Analysis of literary sources, testing, pedagogical experiment, method of express assessment of physical health, methods of mathematical statistics.

To study the level and dynamics of physical health indicators of students during exercises with kettlebells, we organized and conducted a pedagogical experiment on the basis of the Department of Physical Education and Sports Medicine of the Danylo Halytsky Lviv National Medical University. The studies were conducted in compliance with the requirements of the Declaration of Helsinki of the World Medical Association "Ethical Principles of Medical Research Involving Human Subjects". The studies, which lasted for 2 years of study, 4 stages, were attended by male first-year students of all faculties, aged 18–20 years (n=54), the sample of which was representative. An experimental (EG, n=26) and control (CG, n=28) groups were formed. The EG

included students who chose to study in training groups in kettlebell sports at the beginning of the first year of study, and the CG included students who were engaged in physical education according to the approved working curriculum of the department in accordance with the requirements of the educational and professional program.

The study of physical health indicators of students was conducted over a two-year period in four stages, namely: stage 1 – the beginning of the first year, stage 2 – the end of the first year, stage 3 – the beginning and stage 4 – the end of the second year of study, according to the following indicators of express assessment of somatic health [2; 3; 15]. The indicators of the Quetelet index, vital and strength indices, Robinson index ("double product" at rest), heart rate recovery time (HR) after 20 sit-ups in 30 seconds and the level of physical health were studied (Table 1).

Results of the study. Analysis of the data obtained by us on the weight-height Quetelet index, which characterizes the features of a person's physique, during the 4 stages of the study allowed us to conclude that from the beginning of the 1st year and at the end of the 2nd year, no significant difference was established between the average indicators of the EG and CG ($p>0.05$) (Table 1). The indicators of the Quetelet index in the EG and CG students were at the average level of the "fullness" indicator for males.

The study of the dynamics of vital index indicators, which reflects the ratio of the vital capacity of the lungs to body weight and is an important criterion of the reserve of external respiratory functions in the process of student education, allowed us to state that the indicators of EG and CG students at the 1st and 2nd stages, 1st year do not have a significant difference ($p>0.05$) (Table 1), and at the 4th stage, at the end of the 2nd year of study, a significant difference was established ($p<0.001$). In EG students, there was an increase in vital index indicators over two years of study: at the 4th stage it was significantly higher than at the 1st stage by 5.25 ml/kg ($p<0.05$). At the same time, the value of the vital index indicator at the 1st year was assessed as average, at the end of the 2nd year – as above average (Table 1).

In KG students in the 2nd year, there is a decrease in the vital index, which indicates a weakening of the functional capabilities of the respiratory system. It should be noted that in KG students in the 1st and 2nd years, the value of the vital index was estimated as average.

Analysis of the strength index indicators (the ratio of the dynamometry of the stronger arm to body weight) allowed us to determine that its values in EG and CG students did not differ significantly at stages 1 and 2 of the 1st year of study ($p>0.05$), and already in the 2nd year the difference was significant, both at stages 3 ($p<0.05$) and 4 ($p<0.001$) (Table 1). Analyzing the strength index indicators of EG students, it can be noted that performing physical exercises with kettlebells positively affects the development of the muscular system: its values in 1st year students were at an average level, and at the end of the 2nd year, at the 4th stage – at a level above average. In CG students, the strength index indicators in the 2nd year did not change significantly compared to the indicators that were registered in the 1st year of study ($p>0.05$). The level of reserves of the muscular system functions in EG students throughout the entire period of study was assessed as average.

By the value of the Robinson index ("double product" at rest), we characterized the criteria for the reserve and economization of the functions of the cardiovascular system. A decrease in the index meant an improvement in the state of the cardiovascular system. Studying the value of the Robinson index in EG and CG students during two years of study allowed us to determine that there was no significant difference in the indicators in EG and CG students in the 1st year, in the 1st and 2nd stages ($p>0.05$). At the 4th stage, at the end of the 2nd year of study, the Robinson index in EG students significantly exceeded ($p<0.01$) the similar one in CG by 3.96 conventional units (Table 1).

The study of the dynamics of the "double product" indicators proved that due to the students of the experimental group doing physical exercises in kettlebell sports, the cardiovascular system improved over two years of study – the value of the indicator significantly improved ($p<0.05$). In CG students, the Robinson index indicators remained stable, without significant

Table 1

Dynamics of students' physical health indicators

Course	Stage	Physical health indicators				p
		EG (n=26)		CG (n=28)		
		X	m	X	m	
Quetelet index (g/cm)						
I	1	389.5	13.47	390.0	8.13	>0.05
	2	386.9	11.61	397.5	5.73	>0.05
II	3	386.1	13.68	398.1	6.08	>0.05
	4	387.3	13.35	400.4	4.51	>0.05
Vital index (ml/kg)						
I	1	57.34	2.05	56.12	1.27	>0.05
	2	61.17	3.21	56.13	0.98	>0.05
II	3	62.29	2.14	56.90	1.04	<0.01
	4	62.59	1.13	55.44	0.96	<0.001
Power index (%)						
I	1	71.52	2.36	69.13	1.83	>0.05
	2	72.31	3.22	69.25	1.14	>0.05
II	3	75.80	2.02	71.65	1.07	<0.05
	4	78.59	1.11	71.44	0.96	<0.001
Robinson Index (conventional units)						
I	1	84.09	1.83	83.64	1.89	>0.05
	2	82.60	0.79	83.27	0.83	>0.05
II	3	80.42	1.21	83.20	1.12	>0.05
	4	79.14	0.86	83.09	0.79	<0.01
Heart rate recovery time after 20 sit-ups in 30 seconds (s) Heart rate recovery time after 20 sit-ups in 30 seconds (s)						
I	1	131.6	2.93	138.1	2.81	>0.05
	2	110.9	2.54	123.3	2.24	<0.001
II	3	91.3	3.08	106.3	2.41	<0.001
	4	81.5	2.22	109.7	2.13	<0.001
Level of physical health (conventional units)						
I	1	6.59	1.02	6.18	0.71	>0.05
	2	8.89	1.18	6.21	0.92	>0.05
II	3	11.17	0.67	9.16	0.46	>0.05
	4	13.97	0.37	10.01	0.48	<0.001

changes ($p>0.05$). The indicators of the functional capabilities of the cardiovascular system of EG students were at a level above average.

The study of the dynamics of the time of recovery of the heart rate to the initial level after 20 squats in 30 seconds showed a significant difference ($p < 0.001$) between the EG and CG indicators during the 4 stages of the I-II courses of study (Table 1). In EG students, the heart rate recovery index improved during the two years of study, which indicated the strengthening of the cardiovascular system of students who were engaged in physical exercises with kettlebells. Thus, if at the beginning of the I course, I stage, the average time of recovery of the heart rate of EG students to the initial level was 131.6 s, which corresponds to the level of functional capabilities of the cardiovascular system "below average", then at the end of the II course, 4 stage, it was 81.5 s, which was assessed as a level above average ($p < 0.001$). In CG students in the first year, the level of functional capabilities of the cardiovascular system was assessed as below average, and at the end of the second year, stage 4, as average.

The study of the indicators of the level of physical health of EG and CG students allowed us to establish that the value of this indicator in CG and EG students in the 1st year during the 1st and 2nd stages does not differ significantly ($p>0.05$). In the 2nd year, stage 4, the difference is – 3.14 conventional units and is significant ($p<0.001$) (Table 1). In EG students, the indicator of the level of physical health significantly increases in the process of study: the difference between the beginning of study in the 1st year, stage 1, and the completion of study in the 2nd year, stage 4, is 6.58 conventional units ($p<0.001$), which indicated a positive effect of physical exercises with kettlebells on improving the indicators of physical health of students in the experimental group. The level of physical health of EG students at the end of the 2nd year, 4th stage, was 13.18 conventional units, which was assessed as higher than average, while this allowed reaching the "safe zone" of the level of physical health. The level of physical health of CG students increases slightly from the beginning of the 1st year, 1st stage, to the end of the 2nd year, 4th stage, the difference in indicators is not significant ($p>0.05$), while in CG students it was noted that at the beginning of the 1st year of study, the indicators of the level of physical health were assessed as low, and at the end of the 2nd year, 4th stage – as average, it is also significantly ($p<0.001$) lower than in students of the experimental group.

Thus, the obtained data allowed us to establish that according to the Quetelet index, the indicators of both groups were at the average level of completeness for men. The dynamics of the vital index, strength index, Robinson index of the experimental group students significantly ($p<0.01$) exceeded the similar indicators of the control group students and were assessed as higher than average. In EG students, during two years of study, there was an improvement in the recovery time of the heart rate, which indicated the strengthening of the cardiovascular system of students engaged in physical exercises with kettlebells. The indicator of the level of physical health of EG students was 13.97 conventional units at the end of stage 4, which was also assessed as higher than average and reached the "safe zone", and it significantly ($p<0.001$) increased from stage 1 to stage 4 and amounted to 7.38 conditional units, which indicated the positive impact of physical exercises with kettlebells on improving the physical health indicators of students.

Therefore, our study allows us to note that performing strength exercises with kettlebells leads to an improvement in the level of development of strength qualities, strength endurance, indicators of physical development and functional state of the body, and the level of physical health of students involved in kettlebell sports.

Conclusions. It has been established that the use of physical exercises with kettlebells forms the basis for the development of basic physical qualities, has a positive effect on improving the reserve of external respiratory functions, the functional state of the cardiovascular system, restoring heart rate, contributes to the development of the muscular system and improving the level of physical health of students.

It has been proven that students who engaged in physical exercises with kettlebells reached a "safe zone" of physical health, which contributed to improving their well-being, increasing their learning efficiency, and readiness to perform the tasks of their future professional activities.

Prospects for further research. In the future it is planned to investigate the level and dynamics of physical health of people with disabilities and war veterans who engage in archery and powerlifting exercises.

Conflict of interest. The authors declare no conflict of interest.

Bibliography

1. Андрейчук В.Я. Методичні основи гирьового спорту : навчальний посібник. Львів : Тріада плюс. 2007. 500 с.

2. Апанасенко Г.Л., Попова Л.О., Магльований А.В. Санологія. Медичні аспекти валеології : підручник для лікарів, слухачів. Львів : Кварт, 2011. 302 с.

3. Апанасенко Г.Л., Попова Л.О., Магльований А.В. Санологія. Основи управління здоров'ям : монографія. Lambert Academy Publisher, 2012. 405 с.

4. Гирьовий спорт у ВНЗ : навчально-методичний посібник / Г.П. Грибан, К.В. Прон-

тенко, В.В. Пронтенко та ін. ; за ред. Г.П. Грибана. Житомир : Вид-во «Рута». 2014. 400 с.

5. Гузій О.В., Магльований А.В., Романчук О.П., Трач В.М. Відношення висококваліфікованих спортсменів до засобів відновлення організму в умовах навчально-тренувального процесу. *Фізична реабілітація та рекреаційно-оздоровчі технології.* 2020. № 5(3). С. 12–20. https://doi.org/10.15391/prrht.2020-5(3).02.

6. Джим В.Ю., Мулик В.В. Вплив занять гирьовим спортом на прояв спеціальної фізичної підготовленості школярів 9–11 класів. *Науковий часопис Національного педагогічного університету імені М.П. Драгоманова. Серія 15 «Науково-педагогічні проблеми фізичної культури (фізична культура і спорт)».* 2023. № 1 (159). С. 76–79.

7. Кашуба В.О., Григус І.М., Самойлюк О.В. Особливості рухової функції осіб зрілого віку у процесі занять фізичними вправами. *Rehabilitation and Recreation*, 2024. 18(3), 179–188. https://doi.org/10.32782/2522-1795.2024.18.3.16.

8. Магльований А.В., Шимечко І.М., Боярчук О.М., Мороз Є.І. Динаміка показників фізичного здоров'я студентів, які займаються силовими вправами. *Педагогіка, психологія та медико-біологічні проблеми фізичного виховання та спорту*. 2011. № 1. С. 80–83.

9. Організм і особистість. Діагностика та керування. / Магльований А., Белов В., Котова А. Львів; Медична газета України, 1998. 250 с.

10. Пронтенко К.В., Пронтенко В.В. Методика підготовки курсантів до виконання вправ із гирями : методичні рекомендації. Житомир. 2018. 68 с.

11. Grygus I., Gamma T., Godlevskyi P., Zhuk M. and Zukow W. Methodological aspects of developing motor skills in children of different ages during football club activities. *Journal of Education, Health and Sport*. Online. 2 September 2024. Vol. 64, p. 55525. [Accessed 23 May 2025]. doi: 10.12775/JEHS.2024.64.55525.

12. Guzii O., Mahlovanyi A., & Romanchuk O. Multifunctional changes in the athletes' body during the formation of autonomic regulations' overstrain under the influence of training load. *Physical Rehabilitation and Recreational Health Technologies,* 2023. 8(2), 91–104. https://doi.org/10.15391.

13. Chenoweth D.H. Worksite health promotion. 2nd ed. Champaigh : Human Kinetics. 2010. 180 p.

14. Mahlovanyy A., Kunynets O., Grygus I., Ivanochko O. The influence of dosed physical exercise on indicators of the cardiovascular system of persons who have lost limbs. *Rehabilitation & Recreation.* 2023. 14. 63–70. https://doi.org/10.32782/2522-1795.2023.14.7.

15. Hotra Z., Mahlovanyy A., Mykytyuk Z., Barylo H., Vistak M., Kremer I., Politanskyi R. Schematic Realization of Flexible Algorithm in Treatment Diagnostic Devices. 2019 IEEE XV International Conference on the Perspective Technologies and Methods in MEMS Design (MEMSTECH). doi: 10.1109/MEMSTECH.2019.8817378.

16. Romanchuk, O., Guzii, O., Mahlovanyi A., Sereda, S., & Ostrovskyy, M. Comparative features of the morphometric correlates of blood pressure response to physical load of qualified athletes in some sports. *Physical Rehabilitation and Recreational Health Technologies*, 2023. 8(1), 3–12. https://doi.org/10.15391/prrht.2023-8(1).01

17. The handbook of physical education / ed. D. Kirk, D. Macdonald, M. O'Sullivan. London; Thousand Oaks; New Delhi : Sage Publications. 2012. 838 p.

References

1. Andreichuk, V.Ya. (2007). Metodychni osnovy hyrovoho sportu: navchalniy posibnyk. Lviv: Triada plius. 500 s.

2. Apanasenko, H.L., Popova, L.O., Mahlovanyi, A.V. (2011). Sanolohiia. Medychni aspekty valeolohii: pidruchnyk dlia likariv, slukhachiv. Lviv: Kvart, 302 s.

3. Apanasenko, H.L., Popova, L.O., Mahlovanyi, A.V. (2012). Sanolohiia. Osnovy upravlinnia zdoroviam: monohrafiia. Lambert Academy Publisher, 405 s.

4. Hyrovyi sport u VNZ: navchalno-metodychniy posibnyk / H.P. Hryban, K.V. Prontenko, V.V. Prontenko ta in.; za red. H.P. Hrybana. Zhytomyr: Vyd-vo «Ruta». 2014. 400 s.

5. Huzii, O.V., Mahlovanyi, A.V., Romanchuk, O.P., Trach, V.M. (2020). Vidnoshennia vysokokvalifikovanykh sportsmeniv do zasobiv vidnovlennia orhanizmu v umovakh navchalno-trenuvalnoho protsesu. *Fizychna reabilitatsiia ta rekreatsiino-ozdorovchi tekhnolohii*. № 5(3). S. 12–20. https://doi.org/10.15391/prrht.2020-5(3).02.

6. Dzhym, V.Iu., Mulyk, V.V. (2023). Vplyv zaniat hyrovym sportom na proiav spetsialnoi

fizychnoi pidhotovlenosti shkoliariv 9–11 klasiv. *Naukovyi chasopys Natsionalnoho pedahohichnoho universytetu imeni M.P. Drahomanova. Seriia 15 «Naukovo-pedahohichni problemy fizychnoi kultury (fizychna kultura i sport)».* 2023. № 1 (159). S. 76–79.

7. Kashuba, V.O., Hryhus, I.M., & Samoiliuk, O.V. (2024). Osoblyvosti rukhovoi funktsii osib zriloho viku u protsesi zaniat fizychnymy vpravamy. *Rehabilitation and Recreation,* 18(3), 179–188. https://doi.org/10.32782/2522-1795.2024.18.3.16

8. Mahlovanyi, A.V., Shymechko, I.M., Boiarchuk, O.M., Moroz, Ye.I. (2011). Dynamika pokaznykiv fizychnoho zdorovia studentiv, yaki zaimaiutsia sylovymy vpravamy. *Pedahohika, psykholohiia ta medyko-biolohichni problemy fizychnoho vykhovannia ta sportu.* 2011. № 1. S. 80–83.

9. Orhanizm i osobystist. Diahnostyka ta keruvannia. / Mahlovanyi A., Belov V., Kotova A. Lviv; Medychna hazeta Ukrainy, 1998. 250 s.

10. Prontenko, K.V., Prontenko, V.V. (2018). Metodyka pidhotovky kursantiv do vykonannia vprav iz hyriamy: metod. rekomendatsii. Zhytomyr. 68 s.

11. Grygus, I., Gamma, T., Godlevskyi, P., Zhuk, M. and Zukow, W. (2024). Methodological aspects of developing motor skills in children of different ages during football club activities. *Journal of Education, Health and Sport*. Online. 2 September 2024. Vol. 64, p. 55525. [Accessed 23 May 2025]. doi: 10.12775/JEHS.2024.64.55525.

12. Guzii, O., Mahlovanyi, A., & Romanchuk, O. (2023). Multifunctional changes in the athletes' body during the formation of autonomic regulations' overstrain under the influence of training load. *Physical Rehabilitation and Recreational Health Technologies,* 8(2), 91–104. https://doi.org/10.15391

13. Chenoweth, D.H. (2010). Worksite health promotion. 2nd ed. Champaigh: Human Kinetics. 180 p.

14. Mahlovanyy, A., Kunynets, O., Grygus, I., Ivanochko, O. (2023). The influence of dosed physical exercise on indicators of the cardiovascular system of persons who have lost limbs. *Rehabilitation & Recreation.* 14. 63–70. https://doi.org/10.32782/2522-1795.2023.14.7

15. Hotra, Z., Mahlovanyy, A., Mykytyuk, Z., Barylo, H., Vistak, M., Kremer, I., Politanskyi, R. Schematic Realization of Flexible Algorithm in Treatment Diagnostic Devices. 2019 IEEE XV International Conference on the Perspective Technologies and Methods in MEMS Design (MEMSTECH). doi: 10.1109/MEMSTECH.2019.8817378.

16. Romanchuk, O., Guzii, O., Mahlovanyi A., Sereda, S., & Ostrovskyy, M. (2023). Comparative features of the morphometric correlates of blood pressure response to physical load of qualified athletes in some sports. *Physical Rehabilitation and Recreational Health Technologies*, 8(1), 3–12. https://doi.org/10.15391/prrht.2023-8(1).01

17. The handbook of physical education / ed. D. Kirk, D. Macdonald, M. O'Sullivan. London; Thousand Oaks; New Delhi: Sage Publications. 2012. 838 p.

Прийнято до публікації: 17.06.2025
Опубліковано: 30.07.2025
Accepted for publication on: 17.06.2025
Published on: 30.07.2025