ORIGINAL ARTICLE

CONTENTS

Health-promoting effect for students from physical loads of speed and strength orientation

Oleksii V. Tymoshenko[1], Zhanna H. Domina[1], Valentyna H. Bilyk[1], Yurii P. Serhiienko[2], Oleksandr M. Lavrentiev[2], Nataliia A. Dakal[3], Petro S. Horhol [4]

[1]UKRAINIAN STATE DRAGOMANOV UNIVERSITY, KYIV, UKRAINE

[2]STATE TAX UNIVERSITY, IRPIN, UKRAINE

[3]NATIONAL TECHNICAL UNIVERSITY OF UKRAINE "IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE", KYIV, UKRAINE

[4] NATIONAL UNIVERSITY «YURI KONDRATYUK POLTAVA POLYTECHNIC», POLTAVA, UKRAINE

ABSTRACT

Aim: To investigate the impact of speed and strength physical loads on promoting health and reducing the biological age of student youth.

Materials and Methods: The research involved 180 students aged 18-19. The first stage provided for the study of the indicators of the biological age of 120 students, and the second stage covered substantiation of the methodology for martial arts training sessions, based on physical loads of speed and strength orientation. To test its effectiveness, 60 students were involved (30 were in the experimental group (EG), 30 – in the control group (CG)).

Results: The methodology for martial arts training sessions was developed and tested. In the dynamics of the experiment, there is a tendency to a decrease in the difference between the biological and the passport age, but these changes were unreliable in the CG, while a statistically significant decrease in this difference was recorded in the EG. In addition, there were significant changes in the EG in the following indicators: inspiratory breath holding (11.6 %), subjective health assessment (38.5 %), and static balancing (20.0 %).

Conclusions: The use of physical loads of speed and strength orientation in the course of martial arts training has established a health-promoting effect and positive dynamics of the biological age indicators of student youth. The results of the research can be implemented in physical education and the process of sports improvement of students in higher educational institutions.

KEY WORDS: health, biological age, students, martial arts, physical education

Wiad Lek. 2024;77(6):1243-1248. doi: 10.36740/WLek202406120 DOI

INTRODUCTION

The current conditions of production development are constantly depleting human biological and functional reserves. Adaptation processes are disrupted, maladaptation syndrome develops and, as a result, pathology progresses [1]. One of the indicators of human adaptation is biological age, which should be taken into account to predict individual health, as it makes it possible to assess the degree of compliance of the biological development of the body with the calendar age of a person, reflects the rate of biological aging, which determines the level of functioning of the main life support systems and life expectancy. Differences between the calendar and biological ages make it possible to assess the intensity of aging and the level of functional capabilities of an individual [2].

The analysis of the life expectancy and quality of life of Ukrainians shows that over the past decade, there has been a sharp deterioration in the health of the population of all ages, including students. The peculiarities of students' education in recent years are characterized by a decrease in motor activity and an increased level of stress against the background of intensification of the educational process in the context of distance learning due to quarantine restrictions and martial law, which causes premature aging of their bodies [3, 4].

The biological age characterizes the level of wear and tear of the body as a whole by comparing the actual values of individual biomarkers with the norms of these values according to the calendar age [5]. Various studies have shown that the biological age of students ranges from 40 to 46 years on average. The discrepancy between the biological and the passport age ranges from 10 to 40 years, while 15-20 years ago the difference between the calendar and the biological age was 4-5 years [6].

Since the body's aging rate can have a real predictive value for assessing an individual's health, the study of the biological age of students is an important measure for pedagogical control of the effectiveness of physical education in higher education. At the same time, rationally organized motor activity, which arouses interest and has a comprehensive health-promoting effect, has potential opportunities for pedagogical influence on slowing down the age-related aging processes in students' bodies.

Studies show that various types of martial arts are in special demand among male students. Martial arts training helps to increase the overall performance of the body, develop motor skills, and improve the functional capabilities of the body in the conditions of different motor modes of muscle function.

The level of motor fitness of students depends largely on the focus of the educational process, its structure, content, methods, and means of physical education. By choosing a particular sport for training sessions, students try to meet their individual biological and psychological needs for motor activity [7, 8, 9]. In recent years, many researchers have addressed the problem of improving the organization of health-promoting physical education training sessions for students using different types of martial arts [10, 11]. However, it is still important to study the influence of speed and strength exercises on reducing the biological age of students in the process of their physical education.

AIM

The aim is to investigate the impact of speed and strength physical loads on promoting health and reducing the biological age of student youth.

MATERIALS AND METHODS

The research was conducted in 2022-2023. The research involved 180 students of pedagogical specialties of the Ukrainian State Dragomanov University aged 18-19 who had not been involved in sports before entering the higher educational institution. The first stage of the experiment (ascertaining, 2022) provided for the study of the biological age of 120 students, and the second (formative, September 2022 – May 2023) substantiated the methodology for martial arts training sessions based on physical loads of speed and strength orientation. To test its effectiveness, 60 students were involved. The experimental (EG) and the control (CG) groups of 30 people were formed, respectively. The EG students, in addition to compulsory physical education training sessions according to the schedule 2 times a week (4 hours), attended sports club martial arts training sessions 3 times a week (6 hours), which amounted to 10 hours of exercise per week. The CG students were engaged in a traditional physical education program (4 hours of compulsory training sessions) and attended optional or sports club training sessions in other sports of their choice (6 hours). Due to the simplicity of application and relative objectivity of the interpretation of the results, the biological age of students was determined by the method of V. P. Voitenko, using the following formula [2]:

$$BA = 27.0 + 0.22 \times BP_s - 0.15 \times IHB + 0.72 \times SHS - 0.15 \times SB,$$

where BA – biological age, years, BP_s – systolic blood pressure, mm Hg, IHB – inspiratory holding of the breath, s, SHS – self-assessment of health status, points, SB – static balancing, s.

To assess the rate of aging of the students' bodies, it is necessary to compare the individual values of the actual biological age (BA) and the passport age (PA), which characterizes the average population standard of age-related "wear and tear". At the beginning and the end of the academic year, students' BA was diagnosed by the following indicators (biomarkers): systolic blood pressure (BP, mm Hg), inspiratory holding of the breath (IHB, s), index of self-assessment of health status (SHS) according to the special questionnaire (29 questions, points, number of negative answers), time of static balancing (SB, s). At the beginning of the formative stage of the experiment, the homogeneity of all the EG and the CG indicators was determined ($p > 0.05$), and it was found that the distributions of the EG and the CG were normal, which allowed us to assess the reliability of the results using the Student's t-test. All indicators are presented as $M \pm m$, where M is the arithmetic mean, and m is the error of the mean. The process of the research implementation was built following the requirements of scientific ethics. The research was approved by the Academic Ethics Commission of Ukrainian State Dragomanov University. The pedagogical experiment was open, its participants were informed about the aim of the research and voluntarily participated in it.

RESULTS

The average PA of students is 18.2 years (Table 1). The youngest student's BA is 23.5 years, which is 5 years higher than their PA; in all other ca1es, the indicators of students' BA are much worse.

The degree to which the BA exceeds the PA is presented in Table 2.

The rate of body aging was estimated by the difference between the BA and the PA (Table 3).

Table 1. Biological and passport age of 18-19-year-old students under study (n = 120)

Indicators	PA, years	BA, years	Difference, years	Difference, %
M ± m	18.2 ± 1.15	44.8 ± 6.72	26.6 ± 5.57	142.8 ± 45.64

Table 2. The degree to which the biological age of 18-19-year-old students exceeds their passport age (n = 120)

Excess amount, %	Number of students (%)
by 100 % (or twice)	25 (21 %)
from 100 to 150 % (from 2 to 2.5 times)	43 (36 %)
from 151 to 200 % (from 2.5 to 3 times)	34 (28 %)
from 201 to 222 % (more than 3 times)	18 (15 %)

Table 3. Correlation of the biological and the passport age and assessment of aging rates of 18-19-year-old students (n = 120)

Difference, years	The rate of aging	Number of students, (%)
from –15 to – 9	sharply slowed down	0 (%)
from – 8.9 to – 3	slowed down	3 (3 %)
from – 2.9 to +2.9	BA = PA	5 (4 %)
from +3 to +8.9	accelerated	11 (9 %)
from +9 to +15	sharply accelerated	101 (84 %)

Table 4. Correlation between the biological and the passport age of 18-19-year-old students in the conditions of the formative stage of the pedagogical experiment (M ± m, n = 60)

Indicators	Groups	Before the experiment	After the experiment	% increase in the indicators	Reliability
PA	EG	18.1 ± 1.1	19.2 ± 1.1	5.6	**p >** 0.05
	CG	18.2 ± 1.15	19.2 ± 1.15	5.3	**p >** 0.05
BA	EG	44.3 ± 5.72	38.1 ± 2.72	-15.1	p ≤ 0.05
	CG	44.8 ± 6.72	43.8 ± 2.1	-2.6	p > 0.05
Difference between the PA and the BA, years	EG	26.2 ± 4.62	18.9 ± 5.57	-32.4	p ≤ 0.05
	CG	26.6 ± 5.57	24.6 ± 5.57	-7.8	p > 0.05

Table 5. Dynamics of individual biomarkers for assessing the biological age of 18-19-year-old students in the conditions of the formative stage of the pedagogical experiment (M ± m, n = 60)

Indicators	Groups	Before the experiment	After the experiment	% increase in the indicators	Reliability
BP, mm Hg.	EG	116.5 ± 4.5	117.0 ± 3.5	0.4	p > 0.05
	CG	117.5 ± 4.5	117.5 ± 3.5	0	p > 0.05
IHB, s	EG	70.0 ± 2.2	78.6 ± 2.3	11.6	p ≤ 0.05
	CG	71.0 ± 1.8	69.5 ± 2.0	-2.1	p > 0.05
SHS, points	EG	19.5 ± 1.5	13.2 ± 2.3	-38.5	p ≤ 0.05
	CG	18.3 ± 1.5	17.5 ± 1.5	-4.5	p > 0.05
SB, s	EG	10.89 ± 0.53	13.31 ± 0.28	20.0	p ≤ 0.05
	CG	10.77 ± 0.43	11.75 ± 0.43	8.7	p ≤ 0.05

The motor experience of students was taken into account when developing the content of the educational material for martial arts training sessions. The success of competitive activities during martial arts training is influenced by loads of speed and strength orientation, which involve the performance of short-term and long-term work. The experience of the best practice recognizes that the development of the strength of the muscular corset, legs, and arms is the basis of strength training in martial arts. The main methods of developing students' strength abilities are repetitive (or repetitive-serial) and circuit training with the use of non-limited weights. It is expedient to apply game and competitive methods for the development of speed and strength qualities. In this

case, it is worth using games and relays with elements of jumping, climbing, throwing, weight transfer, etc., as well as competitive fights. The method of circuit training in speed and strength preparation of students in martial arts training sessions provides a complex action on different muscle groups with the use of exercises with non-limited weights, which are performed in a circle of 4-6 "stations" (the place of performance of the given exercises) with a certain number of repetitions for a certain unit of time and rest (transition between "stations") at least 2-3 minutes, during which exercises on muscles relaxation are performed. The number of repetitions and approaches is determined depending on the size of the weight (the larger the weight, the fewer repetitions of the exercise and approaches), as well as the individual capabilities of students. During active rest between motor loads, young men performed exercises on stretching, increasing mobility in joints, and relaxation of muscles. In the dynamics of training sessions, it is necessary to periodically change the amount of additional weight, and increase the number of repetitions or approaches in a series of strength exercises.

Since the components of speed abilities are independent of each other, they can be developed both separately and comprehensively. The main methods of speed development are repetitive-serial, game, and competitive. The means are technically simple exercises of maximum intensity lasting 6-10 s, performed in 3-4 approaches with an interval of rest until complete recovery (100 ± 10 beats/min or 1.5-2 minutes). The development of speed and its components is planned under the condition of optimal working capacity of students, that is, at the beginning of training sessions. However, despite the necessity to take into account the specifics of martial arts, the health-promoting orientation is the leading approach in the construction of the content of training sessions with students. The content of realization of health-promoting tasks in the process of martial arts training consists of the prevention of diseases and injuries, the increase of functional capabilities of an organism, and the versatile and harmonious development of motor qualities in students.

Thus, the reduction of 18-19-year-old students' BA in the process of using loads of speed and strength orientation during martial arts training sessions is provided by the realization of health-promoting tasks of physical education aimed at increasing functional capabilities of an organism, development of motor qualities, prevention of disorders in work of organs and systems of an organism and traumatism.

Evaluation of the CG and the EG students' BA at the beginning and the end of the academic year showed a decrease in the difference between the BA and the PA, but these changes were unreliable in the CG students ($p > 0.05$), while a statistically significant decrease in the BA was recorded in the CG students ($p \leq 0.05$) (Table 4). At the same time, the difference between the PA and the BA significantly decreased in the EG students who were engaged in martial arts and amounted to -32.4 % ($p \leq 0.05$). As for the CG students, at the end of the academic year, the changes in the difference between the PA and BA were unreliable ($p > 0.05$).

Regarding the dynamics of indicators (individual biomarkers) characterizing the BA, the EG students showed some positive and significant changes ($p \leq 0.05$) (Table 5).

Thus, significant ($p \leq 0.05$) changes in the EG can be seen in the indicators of inspiratory breath holding (an increase of 11.6 %), subjective health assessment (an increase of -38.5 %), and static balancing (an increase of 20.0 %). As for the CG students who were engaged in the traditional program of physical education and other sports in the conditions of sports club activities, there is no significant improvement of individual biomarkers of organism development characterizing their BA ($p > 0.05$), except for the indicator of static balancing (an increase of 8.7 %, $p \leq 0.05$). Thus, a significant improvement in some indicators of students' BA who were engaged in martial arts with an emphasis on the load of speed and strength orientation in the conditions of sports club activities was established.

DISCUSSION

The actualization of research on the problem of biological age and the rate of aging of the body in recent years is due to the decline in the indicators of the state of health of the population. Several researchers believe that the biological maturity of children and youth has real prognostic value for differentiating motor loads in physical education training sessions. Studies by specialists prove that biological age reflects the ontogenetic maturity of a person, gives an idea of working capacity, functional capabilities, and adaptation reserves, is a prognostic sign of motor talent for selection and orientation in certain sports, and also indirectly characterizes the level of health of an individual [12, 13].

At the same time, practice shows that the biological age of young people is significantly ahead of the passport age, indicating accelerated rates of aging and the dynamics of health deterioration. Given that the physiological, functional, and adaptive capabilities and reserves of the body affect the ratio of biological and passport age and determine the rate of aging of an individual, rationally organized motor activities should be considered the optimal anti-aging means [14].

The results of our research confirm the opinion of scientists [5, 12] that the correlation between biological and passport age describes the degree of loss of general health and vitality

of the body. At the same time, biological age is an indicator of the level of wear and tear of the structure and functions of the body and the organism as a whole, expressed in units of time and characterized by the ratio of the indicators of actual individual biomarkers to their average population values.

Our research is consistent with the results of other authors [2, 6, 8, 9], who argue that the study of students' biological age will help determine the impact of the optimal type and level of motor loads on the body to slow down the rate of age-related changes. Thus, the impact of specific motor loads on individual biomarkers of the body in particular and the rate of age-related changes in students, in general, contributes to a decrease in biological age and slows down the rate of age-related changes.

When using exercises of speed and strength orientation in the process of martial arts training in the conditions of sports club activities, it is necessary to be guided by the fact that the complexity of movements and parameters of loads should be feasible, then they give a health-promoting effect, exercises should be interesting and diverse, then they will cause positive emotions. Otherwise, low motor loads do not cause the desired effect, while excessive loads hurt somatic and mental health indicators, as they cause muscle and functional discomfort and negative emotions. The visible training and health-promoting effect of physical exercises causes a positive emotional effect [10, 15].

As a result of the research, it was confirmed that the use of motor exercises of speed and strength orientation in the process of martial arts training in the conditions of sports club activities positively influences the improvement of results of static balancing, breath holding, and subjective assessment of health [16, 17]. All this testifies to a more pronounced health-promoting effect of physical exercises of speed and strength orientation during martial arts training sessions and the advantages of their use for reducing the intensity of aging of the student youth.

CONCLUSIONS

1. It has been established that, given the steady trend toward the deterioration of public health, the priority task of physical education in higher educational institutions is the improvement of student health. At the same time, one of the ways to improve the effectiveness of physical education of students is the use of speed and strength loads in various forms of organization of loads, which are characteristic of martial arts.
2. The methodology for applying different types of martial arts in the conditions of sports clubs, which includes the content, means, methods, and forms of realization of educational, didactic, and health-promoting tasks, has been substantiated and developed. The methodology is based on the use of loads of speed and strength orientation in the course of martial arts training sessions.
3. The use of physical loads of speed and strength orientation in the course of martial arts training sessions has a health-promoting effect and positively influences the optimization of an organism' biomarkers values and reduction of intensity of "wear and tear" of an organism of student youth. Thus, in the dynamics of the experiment, there is a tendency to a decrease in the difference between the biological and the passport age, but these changes are unreliable in the CG students ($p > 0.05$), while a statistically significant decrease in this difference in the EG students who were engaged in martial arts ($p \leq 0.05$) was recorded. In addition, in the EG, we can talk about significant changes in some individual biomarkers of the body: indicators of inspiratory breath holding (an increase of 11.6 %, at $p \leq 0.05$), indicators of subjective health assessment (an increase of the self-assessment questionnaire scores of -38.5 %, at $p \leq 0.05$), indicators of static balancing (an increase of 20.0 %, at $p \leq 0.05$) in the students who were engaged in martial arts with the use of loads of speed and strength orientation. In the CG students there is a significant improvement only in the indicators of static balancing (an increase of 8.7 %, at $p \leq 0.05$). The results of the research can be implemented in physical education training sessions and the process of sports and pedagogical improvement of students in higher educational institutions.

Prospects for further research will be aimed at studying the impact of training sessions in various types of martial arts on the intensity of aging of the body of female students.

REFERENCES

1. Brady SP, Bolnick DI, Angert AL et al. Causes of maladaptation. Evol Appl. 2019;12(7):1229-1242. doi:10.1111/eva.12844. DOI
2. Mikhaylova SV, Kuzmichev YG, Krasnikova LI, Grinina NM. The interrelation of biological age of the students with the indices of body mass, its components, and the constitutional type. Morfologiia. 2016;149(2):68-72.
3. Griban GP, Dikhtiarenko ZM, Yeromenko EA et al. Influence of positive and negative factors on the university students' health. Wiad Lek. 2020;73(8):1735-1746.
4. Dereń K, Nyankovskyy S, Nyankovska O et al. The prevalence of underweight, overweight and obesity in children and adolescents from Ukraine. Sci Rep. 2018;8(1):3625. doi:10.1038/s41598-018-21773-4. DOI
5. Robinson O, Lau CE, Joo S et al. Associations of four biological age markers with child development: A multi-omic analysis in the European HELIX cohort. Elife. 2023;12:e85104. doi:10.7554/eLife.85104. DOI

6. Prysiazhniuk S, Oleniev D, Tiazhyna A et al. Formation of heath preserving competence of students of higher educational institutions of information technologies specialties. Inter J Appl Exer Physiol. 2019; 8(3.1): 283-292. doi: 10.26655/IJAEP.2019.10.1. DOI
7. Wunsch K, Fiedler J, Bachert P, Woll A. The Tridirectional Relationship among Physical Activity, Stress, and Academic Performance in University Students: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2021;18(2):739. doi:10.3390/ijerph18020739. DOI
8. Griban G, Moskalenko N, Adyrkhaiev S et al. Dependence of students' health on the organization of their motor activity in higher educational institutions. Acta Balneol. 2022;5(171):445-450. doi: 10.36740/ABAL202205112. DOI
9. Bergier B, Tsos A, Bergier J. Factors determining physical activity of Ukrainian students. Ann Agric Environ Med. 2014;21(3):613-616. doi:10.5604/12321966.1120612. DOI
10. Moore B, Woodcock S, Dudley D. Well-being warriors: A randomized controlled trial examining the effects of martial arts training on secondary students' resilience. Br J Educ Psychol. 2021;91(4):1369-1394. doi:10.1111/bjep.12422. DOI
11. Woodward TW. A review of the effects of martial arts practice on health. WMJ. 2009;108(1):40-43.
12. Belsky DW, Moffitt TE, Cohen AA et al. Eleven Telomere, Epigenetic Clock, and Biomarker-Composite Quantifications of Biological Aging: Do They Measure the Same Thing?. Am J Epidemiol. 2018;187(6):1220-1230. doi:10.1093/aje/kwx346. DOI
13. Belsky DW, Caspi A, Arseneault L et al. Quantification of the pace of biological aging in humans through a blood test, the DunedinPoAm DNA methylation algorithm. Elife. 2020;9:e54870. doi:10.7554/eLife.54870. DOI
14. Castillo-Garzón MJ, Ruiz JR, Ortega FB, Gutiérrez A. Anti-aging therapy through fitness enhancement. Clin Interv Aging. 2006;1(3):213-220. doi:10.2147/ciia.2006.1.3.213. DOI
15. Twemlow SW, Lerma BH, Twemlow SW. An analysis of students' reasons for studying martial arts. Percept Mot Skills. 1996;83(1):99-103. doi:10.2466/pms.1996.83.1.99. DOI
16. Marusak HA, Borg B, Morales A et al. Martial arts-based curriculum reduces stress, emotional, and behavioral problems in elementary schoolchildren during the COVID-19 pandemic: A pilot study. Mind Brain Educ. 2022;16(1):5-12. doi:10.1111/mbe.12307. DOI
17. Kotarska K, Nowak L, Szark-Eckardt M, Nowak MA. Intensity of Health Behaviors in People Who Practice Combat Sports and Martial Arts. Int J Environ Res Public Health. 2019;16(14):2463. doi:10.3390/ijerph16142463. DOI

This study was carried according to the research plan of the Faculty of Physical Education, Sports and Health of the Ukrainian State Dragomanov University in 2023-2024 in accordance with the theme "Monitoring, control and evaluation of learning results in physical culture, the basics of healthy lifestyle" (state registration number 0113U009185).

CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Natalia A. Lyakhova
Poltava State Medical University
24 Shevchenko st., 36000 Poltava, Ukraine
e-mail: natanew2017@ukr.net

ORCID AND CONTRIBUTIONSHIP

Oleksii V. Tymoshenko: 0000-0002-5310-4941 A
Zhanna H. Domina: 0000-0002-8315-6590 B D
Valentyna H. Bilyk: 0000-0002-6860-7728 B
Yurii P. Serhiienko: 0000-0003-1019-6513 C
Oleksandr M. Lavrentiev: 0000-0002-6960-0237 D
Nataliia A. Dakal: 0000-0002-7030-5112 E
Petro S. Horhol: 0009-0005-1738-7023 F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 07.02.2024
ACCEPTED: 28.05.2024