

ORIGINAL ARTICLE

Health-promoting technologies for enhancing students' motor activity during online learning

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ABSTRACT

Aim: To investigate the impact of health-promoting technologies designed to increase students' motor activity during online learning on their level of physical fitness and health status.

Materials and Methods: The research, conducted in 2025–2026, involved 70 students aged 17–19 (first-year students). Two groups were formed: an experimental group (EG, $n = 33$) and a control group (CG, $n = 37$). During online learning, the EG students followed a newly developed health-promoting program designed to increase their motor activity; the CG students participated only in remote physical education training sessions (twice a week).

Results: The effectiveness of the developed health-promoting program in maintaining and improving students' physical fitness and preserving their health has been demonstrated. After completing the online learning, the EG students showed significantly ($p < 0.05$) better results than those in the CG in the following tests: push-ups in 1 minute – by 3.8 reps, sit-ups in 1 minute – by 3.6 reps, in the sit-and-reach test – by 1.2 cm, and in plank holding – by 13.1 sec. HR indicators, which characterize students' health status, were also better than those in the CG after online learning.

Conclusions: The results indicate that the systematic implementation of a health-promoting technology program into the educational process at HEIs contributes to maintaining and even increasing students' levels of motor activity and physical fitness, as well as improving their health indicators in an online learning environment, compared to the traditional organization of physical education in an online format.

KEY WORDS: health, health-promoting technologies, physical fitness, motor activity, students, online learning, martial law

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INTRODUCTION

The current transformation of Ukraine's higher education system is taking place amid profound socio-political changes, martial law, and the rapid digitization of the educational process [1, 2]. The transition of higher education institutions (HEIs) to online learning is driven by security challenges, primarily air raid alerts, limited access to educational infrastructure, the need to reallocate instructional time, an increase in the proportion of independent student work, as well as the need to ensure the continuity of the educational process in war-time [3, 4]. Under such conditions, the risk of reduced motor activity among students increases significantly, which negatively affects their physical fitness, functional status, and health [5].

In online learning, the volume and intensity of motor activity necessary to preserve students' health and maintain their psychological well-being are not always provided [6]. Students are forced to spend long periods in

front of digital screens, which leads to physical inactivity, poor posture, reduced tolerance for physical exertion, increased fatigue and anxiety, and decreased motivation for physical exercise and self-improvement [7].

The issue of motor activity among young people and its impact on physical and mental health is reflected in numerous studies. However, according to many researchers [8, 9], implementing a set of health-promoting technologies is particularly significant under martial law, as these technologies enable targeted maintenance of students' motor activity levels during the online format of the educational process at HEIs.

AIM

The aim is to investigate the impact of health-promoting technologies designed to increase students' motor activity during online learning on their level of physical fitness and health status.

MATERIALS AND METHODS

PARTICIPANTS

The research, conducted in 2025-2026 at the Department of Rehabilitation Technology and Sports of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Kyiv, Ukraine), involved 70 students aged 17-19 (first-year students in the faculties of "Management and Marketing" and "Software Systems and Applied Mathematics"). Two groups were formed: an experimental group (EG, $n = 33$) and a control group (CG, $n = 37$). During online learning, the EG students followed a newly developed health-promoting program designed to increase their motor activity. In contrast, the CG students participated only in remote physical education training sessions (twice a week for 2 hours each).

In the context of this research, health-promoting technologies are understood as a specially organized set of pedagogical, physical education, health-related, motivational, and digital tools aimed at preserving, maintaining, and strengthening students' health by increasing their daily motor activity. Unlike traditional online physical education training sessions, health-promoting technologies were systematic and focused not only on completing a specific set of motor tasks but also on changing students' attitudes toward motor activity and on developing skills in self-control, self-organization, self-regulation, and a responsible attitude toward their own physical condition.

Inclusion criteria: all students involved in the research belonged to the general health group (had no health issues or contraindications for motor activity); before on-line learning, all students were informed about their participation in the study for research purposes (those who did not wish to participate had the right to decline). Additionally, all students were instructed on the importance of motor activity for maintaining health during on-line learning under martial law. There was no special selection of students for the EG and the CG: all first-year students of the Management and Marketing Faculty were included in the EG and were asked to follow the developed health-promoting program during online learning; all first-year students of the Software Systems and Applied Mathematics Faculty were included in the CG. The exclusion criterion was a female student's voluntary desire to withdraw from the research at any time. The research was conducted in two phases (Phase 1 (beginning) – before on-line learning, Phase 2 (end) – after the completion of on-line learning). The research lasted 3 months (December 2025 – February 2026). Research limitations: students who regularly attended sports clubs for various sports and held sports ranks and titles did not participate in the research.

RESEARCH METHODS

bibilosemantic, testing, biomedical, statistical. The bibilosemantic method was aimed at studying the state of the problem, identifying the main trends and systematizing the accumulated knowledge on the topic of research (18 sources from MedLine, Scopus, Web of Science databases were analyzed).

Testing was used to assess students' physical fitness levels. Tests that can be performed without special equipment, in a relatively confined space while adhering to safety requirements, were used: push-ups in 1 minute (to assess the speed-strength endurance of the shoulder girdle muscles); sit-ups in 1 minute (to determine the strength endurance of the abdominal muscles); sit-and-reach test (to determine flexibility); the prone plank test (to assess the static endurance of the trunk muscles).

Biomedical methods were used to assess students' functional status and health using indicators that students could measure independently: resting heart rate (HR) in the morning, a 20-squat test with HR measured before and after exercise, and HR recovery rate.

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 Academic Council of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Protocol No. 5 dated 04.12.2025). Informed consent was received from all students who took part in this research.

AI STATEMENT

The author states that no AI tools were used in writing this article.

FRAMEWORK

This research was carried out according to the research work of National Technical University of Ukraine "Igor

Sikorsky Kyiv Polytechnic Institute" for 2024-2027 on the theme of "Information technologies for assessing and correcting the state of health of students in higher educational institutions" (state registration number 0117U006954).

RESULTS

Based on the findings of numerous scholars and our own research, we have developed and implemented a set of health-promoting technologies to optimize motor activity, improve physical fitness, maintain health, and enhance students' well-being during online learning under martial law. The formative approach combined physical education with health-promoting, organizational, methodological, motivational, and digital support tools, which together were intended to ensure more effective engagement of the EG students in systematic motor activity. As part of the research, the EG students were provided with individualized exercise programs, the content and scope of which were selected based on their baseline levels of physical fitness, functional capabilities, daily routines, and the availability of conditions for independent training sessions. Such individualization was particularly important in the context of online learning, where students were in different living situations, had varying access to sports equipment, and had different opportunities for organizing motor activity. The exercise programs included morning calisthenics routines; exercises to develop strength, endurance, flexibility, and coordination; elements of functional training; and compensatory exercises to reduce the negative effects of prolonged sitting at a computer.

An important component of the experimental program was the use of digital tools to monitor students' physical activity. This made it possible to systematically track students' motor activity levels, the frequency and duration of exercise, and the dynamics of individual workload, as well as to foster a more conscious attitude toward their own motor activity regimen. The use of digital tools not only facilitated the recording of results but also enhanced students' self-control, discipline, and responsibility for maintaining an appropriate level of physical fitness within the online learning format.

In addition to direct physical exercise, regular online support was provided to students throughout the online learning process. This support was provided through consultations, thematic webinars, online discussions, individual recommendations, and ongoing feedback between instructors and students. Its goal was not only to adjust the physical work-

load but also to support student motivation, help overcome difficulties with self-organization, foster a consistent commitment to regular motor activity, and raise awareness of its role in maintaining health. Motivational and informational support also played a significant role, including explaining the importance of motor activity for physical and mental well-being, preventing overfatigue, and maintaining work capacity and functional readiness under increased academic workload.

The implementation of health-promoting technologies into the educational process during online learning was carried out with key conditions in mind. First, all exercises were designed to be performed independently without special sports equipment or with minimal use of it. Second, exercises and workloads were selected with consideration for the limited space available to students. Third, special emphasis was placed on the safety of performing physical exercises, the clarity of instructions, and the ability to self-monitor workload intensity. Fourth, the entire system of formative influence was designed not to overload students with an excessive number of tasks, but rather to integrate motor activity into their daily routine as a natural, regular component of a healthy lifestyle. The structure of the health-promoting technology program to increase students' motor activity in an online learning environment is presented in Table 1.

The results of the comparative analysis of the physical fitness indicators for the EG and the CG students before and after online learning are presented in Table 2.

The analysis of the physical fitness of the EG and CG students before online learning revealed no significant differences between the groups on any measured indicator ($p > 0.05$). After online learning, certain changes occurred in the indicators: in the EG, there was a significant improvement across all tests, while in the CG, the results remained virtually unchanged (with non-significant improvements or declines). Thus, in the push-up test, results in the EG improved significantly by 4.4 repetitions ($p < 0.01$), while in the CG, they deteriorated insignificantly by 0.2 repetitions ($p > 0.05$). At the end of the research, the EG showed significantly better results in this test than the CG, by 3.8 repetitions ($p < 0.05$). A similar trend was observed in the 1-minute sit-ups test: in the EG, performance improved by 3.5 repetitions during the online training period ($p < 0.05$), whereas in the CG, it improved by 0.5 repetitions ($p > 0.05$). After completing the online learning, the EG's indicators on this test were significantly better than those of the CG by 3.6 repetitions ($p < 0.05$). In the sit-and-reach test, flexibility improved in both groups during the

Table 1. The structure of the health-promoting technology program to increase students' motor activity in an online learning environment

Program module	Goal	Content	Frequency of execution	Duration
1. Morning motor activity	Waking up after sleep, boosting overall energy levels, and getting ready for the academic day	March in place for 1-2 minutes; rotate your head, shoulders, and wrists; swing your arms; bend forward and to the sides; rotate your hips; do 10-15 squats; do 8-10 lunges on each leg; run in place for 30-60 seconds.	Daily	10-15 minutes
2. Active breaks during study sessions	Reducing the negative effects of prolonged sitting, preventing fatigue, and static strain	Stand up every 45-60 minutes; walk around the room; rotate your shoulders in circles; do 10 squats; do 10-12 push-ups against a table or wall; rise onto your toes 15-20 times; do eye exercises; do breathing exercises.	2-3 times a day	3-5 minutes
3. Strength module	Developing speed-strength endurance and strength in major muscle groups	Push-ups; squats; lunges; sit-ups; bicycle crunches; forearm plank; side plank; "superman" (lying on your stomach).	3 times a week	20-25 minutes
4. General endurance training module	Improving aerobic capacity and cardiovascular function	Brisk walking; jogging; running in place; stepping onto a platform or step; interval training: 30 seconds of active exercise / 30 seconds of walking; cardio exercise routines.	2-3 times a week	20-30 minutes
5. Flexibility and mobility module	Improving joint mobility, preventing muscle stiffness, and addressing posture problems	Forward bends from a standing and sitting position; calf and quadriceps stretches while standing; trunk twists while sitting; shoulder girdle stretches.	Daily or after your main workout	10-15 minutes
6. Static endurance and core stabilization module	Strengthening the core muscles, improving postural stability	Prone plank test; side plank; holding the "chair against the wall" position; holding the "boat" position; balancing on one leg.	Twice a week	10-15 minutes
7. Functional rehabilitation module	Restoring normal functional status after exercise, reducing stress	A leisurely walk, relaxing the neck and shoulder muscles, gentle bends and stretches, breathing exercises, and monitoring your heart rate before and after exercise.	After every workout	2-3 minutes
8. Self-monitoring and digital support	Developing self-awareness skills, improving discipline, and motivation	Keeping a motor activity log, recording the number of workouts per week, tracking steps, measuring resting heart rate, and conducting a brief self-assessment of well-being.	Daily / weekly	3-5 minutes
9. Motivational and educational module	Developing a conscious approach to health and motor activity	Online consultations; lectures on the importance of motor activity; recommendations for a daily routine; personalized messages; discussions of interim results.	Once a week	10-15 minutes

Source: compiled by the authors of this study

research period: in the EG by 1.8 cm ($p < 0.01$), and in the CG by 0.2 cm ($p > 0.05$). However, at the end of the research, the results in the EG were significantly better than in the CG by 1.2 cm ($p < 0.05$). In the prone plank test, both groups showed an improvement in the duration of maintaining a horizontal static trunk position: in the EG by 19.4 s ($p < 0.01$), and in the CG by 4.4 s ($p > 0.05$). At the same time, after the completion of online learning, the results for holding the plank in the EG were significantly better than in the CG by 13.1 s ($p < 0.05$). The results indicate that the proposed health-promoting technology program is superior to the traditional physical education program in HEIs in improving students' physical fitness during online learning.

The results of the comparative analysis of health indicators for the EG and the CG students before and after online learning are presented in Table 3.

Before online learning, none of the health indicators differed significantly between the EG and the CG students ($p > 0.05$). After the research, the resting HR in the EG improved by 0.7 bpm ($p > 0.05$), while in the CG it worsened by 0.3 bpm ($p > 0.05$). At the end of the research, the resting HR in the EG was 0.8 bpm better than in the CG; however, no significant difference was found ($p > 0.05$). Assessment of HR before exercise (20 squats in 30 seconds) shows a trend similar to that of resting HR: an improvement in HR in the EG by 1.0 bpm ($p > 0.05$), a decrease of 0.5 bpm in the CG ($p > 0.05$), and a 1.4 bpm advantage of the EG over

Table 2. The results of the comparative analysis of the physical fitness indicators for the EG (n=33) and the CG (n=37) students before and after on-line learning (M±m)

Research stages	Groups of students		Significance of the difference	
	EG (n=33)	CG (n=37)	Difference	t; p
Push-ups in 1 minute, reps				
Beginning	27.3±1.07	28.1±0.99	0.8	0.55; >0.05
End	31.7±0.98	27.9±0.97	3.8	2.76; <0.05
t; p	3.03; <0.01	0.14; >0.05		
Sit-ups in 1 minute, reps				
Beginning	35.9±1.14	35.3±1.06	0.6	0.39; >0.05
End	39.4±1.11	35.8±1.05	3.6	2.36; <0.05
t; p	2.20; <0.05	0.33; >0.05		
Sit-and-reach test, cm				
Beginning	7.8±0.39	8.2±0.32	0.4	0.79; >0.05
End	9.6±0.41	8.4±0.34	1.2	2.25; <0.05
t; p	3.18; <0.01	0.45; >0.05		
Prone plank test, sec				
Beginning	107.5±3.71	109.4±3.52	1.9	0.37; >0.05
End	126.9±3.84	113.8±3.61	13.1	2.49; <0.05
t; p	3.63; <0.01	0.87; >0.05		

Notes: M – arithmetic mean; m – error of arithmetic mean; n – number of students; t – Student's test value; p – reliability value

Source: compiled by the authors of this study

Table 3. The results of the comparative analysis of health indicators for the EG (n=33) and the CG (n=37) students before and after online learning (M±m)

Research stages	Groups of students		Significance of the difference	
	EG (n=33)	CG (n=37)	Difference	t; p
Resting HR, bpm				
Beginning	71.5±1.28	71.3±1.21	0.2	0.11; >0.05
End	70.8±1.30	71.6±1.24	0.8	0.45; >0.05
t; p	0.38; >0.05	0.17; >0.05		
HR before exercise, bpm				
Beginning	71.9±1.31	71.8±1.22	0.1	0.66; >0.05
End	70.9±1.32	72.3±1.25	1.4	0.77; >0.05
t; p	0.54; >0.05	0.29; >0.05		
HR after exercise, bpm				
Beginning	99.5±1.42	101.3±1.28	3.6	1.86; >0.05
End	97.3±1.37	103.1±1.32	5.8	3.05; <0.01
t; p	1.10; >0.05	0.98; >0.05		
HR 1 minute after recovery, bpm				
Beginning	78.1±1.35	80.5±1.27	2.4	1.29; >0.05
End	76.6±1.34	81.2±1.29	4.6	2.47; <0.05
t; p	0.79; >0.05	0.28; >0.05		

Notes: M – arithmetic mean; m – error of arithmetic mean; n – number of students; t – Student's test value; p – reliability value

Source: compiled by the authors of this study

the CG after online learning ($p > 0.05$). The analysis of HR immediately after exercise indicates that in the EG, the indicators were significantly better than in the CG by 5.8 bpm ($p < 0.01$). At the same time, in the EG, the

studied indicators tend to improve over the course of the study, whereas in the CG, they tend to worsen. The analysis of HR 1 minute after recovery shows that, at the end of the research, the HR recovery rate in the

EG was significantly higher than in the CG by 4.6 bpm ($p < 0.05$). Furthermore, during the online learning period, the duration of recovery processes in the EG decreased, whereas in the CG it increased. All of this also confirms the effectiveness of the health-promoting technology program in preserving and strengthening students' health during online learning under martial law.

DISCUSSION

The development of Ukraine's higher education system under martial law is accompanied by large-scale digitization of the educational process in HEIs and the introduction of distance and blended learning formats. While in the early stages of the COVID-19 pandemic, online learning was viewed primarily as a necessary, temporary measure, it is now being gradually integrated into HEIs' curricula as a tool for ensuring the continuity of professional training for future specialists [6, 10]. At the same time, the transition to distance learning formats significantly alters the structure of students' academic days, their motor activity patterns, and the conditions for organizing physical education.

Studies [11] examining the lifestyles of university students during the COVID-19 pandemic and prolonged remote learning document a systematic decline in motor activity, an increase in sedentary behavior duration, and a related deterioration in students' subjective health indicators. Analyzing the characteristics of students' lifestyles under online learning conditions, researchers [12] note that the transition to online formats was accompanied by increased time spent at the computer, decreased physical activity, and a blurring of structured daily routines. Similar results have been obtained in other studies [13], which show that among students who studied remotely, the proportion of individuals with insufficient motor activity is increasing, while the proportion of those who regularly engage in physical exercise is decreasing. Analyzing the educational process during wartime, researchers [14] emphasize that remote learning formats, amid air raid alerts, movement restrictions, and unstable energy supplies, further exacerbate the trend toward a sedentary lifestyle among students. In studies on students' motor activity during the war in Ukraine [15], it was found that the combination of pandemic and war-related factors creates a "double challenge" for young people's health: on the one hand, access to infrastructure (gyms, stadiums, parks) is limited, and on the other, psycho-emotional stress intensifies, which also reduces motivation for regular motor ac-

tivity. Summarizing the results of surveys of students across various fields of study, researchers [16] note that distance learning fosters a specific "screen-centered" lifestyle, in which a significant portion of time is spent using devices, and physical activity is often limited to brief daily movements. Researchers [17] emphasize that online learning has altered the content, location, and structure of physical education for students. Most exercises are performed at home, and a significant portion of physical education training sessions consists of video tutorials, online classes, and self-monitoring via mobile apps. Under these conditions, the demands on students' self-discipline, intrinsic motivation, and ability to plan their own motor activity increase significantly. In the absence of external supervision, a clearly defined sports infrastructure, and group dynamics (competitions, joint training sessions), there is a high risk of a reduction in the actual volume of physical activity, even if the curricula are formally "fulfilled." At the same time, researchers [18] emphasize that negative trends are not fatally inevitable. With purposeful organization of the educational process and the implementation of health-promoting technologies, the distance learning format can be combined with sufficient daily motor activity among students.

Our research found that implementing a set of health-promoting technologies within the educational processes of HEIs during online learning increased students' motor activity and, in turn, helped maintain and improve their physical fitness and health. The results obtained confirm the conclusions of many researchers and expand upon them.

CONCLUSIONS

A program (set) of health-promoting technologies has been developed and implemented in the educational process to optimize motor activity, improve physical fitness, and maintain students' health during online learning under martial law. The program combined physical education with health-promoting, organizational, methodological, motivational, and digital support tools, which together were intended to ensure more effective student engagement in systematic motor activity.

The effectiveness of the developed health-promoting program in maintaining and improving students' physical fitness and preserving their health has been demonstrated. After completing the online learning, the EG students showed significantly ($p < 0.05$) better results than those in the CG in the following tests: push-ups in 1 minute – by 3.8 repetitions, sit-ups in 1 minute – by 3.6 repetitions, in the sit-and-reach test – by 1.2 cm, and in plank holding – by 13.1 seconds. HR indicators, which

characterize students' health status, were also better than those in the CG after online learning: resting HR – by 0.8 bpm ($p > 0.05$), HR before and after exercise – by 1.4 bpm ($p > 0.05$) and 5.8 bpm ($p < 0.01$), respectively, and HR recovery time – by 4.6 bpm ($p < 0.05$).

The results indicate that the systematic implementation of a health-promoting technology program into the educational process at HEIs – which includes rationally planned individualized exercise programs, the use of digital tools for monitoring motor activity, online guidance, and motivational and informational support,

contributes to maintaining and even increasing students' levels of motor activity and physical fitness, as well as improving their health indicators in an online learning environment, compared to the traditional organization of physical education in an online format.

PROSPECTS FOR FURTHER RESEARCH

It is planned to investigate the impact of a set of health-promoting technologies on students' mental health during online learning.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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