ORIGINAL ARTICLE

CONTENTS

The influence of physical activity training sessions in the natural environment on high schoolers' physical health

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ABSTRACT

Aim: To experimentally test the influence of orienteering training sessions on high schoolers' physical health.

Materials and Methods: The research involved 177 high schoolers aged 16-17 (grades 10-11), including 84 boys and 93 girls. The experimental (EG) and the control (CG) groups were formed, which included 89 persons (42 boys and 47 girls) and 88 persons (42 boys and 46 girls), respectively. The EG high schoolers were engaged in orienteering in the natural environment, while the CG high schoolers were involved in physical exercises in the gym during their physical education. Physical health was studied by the body mass, strength, vital, Robinson and Rufier indices.

Results: It was found that in the process of orienteering training sessions, both boys and girls of the EG showed significant ($p \leq 0.05$-0.001) improvement of their vital index, Robinson index, and Rufier index. The changes were not significant ($p > 0.05$) in the CG. Both groups had no statistically significant changes in body mass index and strength index. Also, the vital, Robinson, and Rufier index indicators were significantly ($p \leq 0.05$–0.01) better in the EG than in the CG at the end of the research, which proves the expediency of using orienteering training sessions in the physical education of senior high schoolers for their health improvement.

Conclusions: After orienteering training sessions, the EG high schoolers showed a significant improvement in physical health indicators, which confirms the enhanced health-improving effect of this type of motor activity in the natural environment.

KEY WORDS: high schoolers, physical health, motor activity, orienteering, natural environment

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INTRODUCTION

At the current stage of development of national school education in Ukraine, an important strategic task of reforming its content is preserving the physical and mental health of high schoolers, taking into account the needs of personality-oriented education and fostering high schoolers, and establishing the priorities of a healthy lifestyle [1, 2].

It is essential to state that a new quality of education and preserving the health of high schoolers can be achieved only if various means of physical education are used to ensure that high schoolers adhere to the principles of a healthy lifestyle. This requires a profound restructuring of the educational process at school, the search for new forms and methods of physical education for high schoolers, effective health-improving and developmental technologies that will contribute to the training of a fully developed and creative personality who is able and willing to defend their country [3, 4].

According to many scientists [5, 6], orienteering, which is carried out mainly in the natural environment, opens up vast opportunities for teachers and high schoolers, especially those of senior school age. Accessibility and efficiency of orienteering in organization and conducting physical culture classes with senior high schoolers allows solving problematic issues typical for modern school [7]. Orienteering is a modern sport in which competitors independently cover distances to control points on the terrain, using only a map and compass and applying many technical and tactical techniques while running on rough terrain. That is why the results in orienteering depend equally on the physical and mental abilities of the participant [8]. Orienteering training sessions help improve physical development,

functional state, and health, fostering volitional and moral qualities, improving mental cognitive processes, and intellectual working capacity of those engaged [9, 10]. At the same time, the issue of studying the health-improving effect of orienteering in physical education lessons is not sufficiently covered in modern educational and methodical literature. This explains the relevance of the research topic, which is associated with the need to solve a scientific problem of significant theoretical and practical importance for improving the high schoolers' physical education system.

AIM

The aim is to experimentally test the influence of orienteering training sessions on high schoolers' physical health.

MATERIALS AND METHODS

PARTICIPANTS

The research involved 177 high schoolers aged 16-17 (grades 10-11) from Lesia Ukrainka Gymnasium No. 117 (Kyiv, Ukraine), including 84 boys and 93 girls. The experimental (EG) and the control (CG) groups were formed from the total contingent of high schoolers, which included 89 (42 boys and 47 girls) and 88 high schoolers (42 boys and 46 girls), respectively. The EG high schoolers were engaged in orienteering in the natural environment. In contrast, the CG high schoolers were involved in physical exercises mainly in the gym according to the curriculum during their physical education. There was no special selection for the groups; two 10^{th} and two 11^{th} grades of the gymnasium were included in the EG and the CG. The mandatory criterion for involving high schoolers in the experiment was that they had no contraindications for physical exercise and were assigned to the main medical group for health reasons. Also, each EG and CG high schooler provided written consent to participate in the experiment. The number of hours spent on physical education for the EG and the CG high schoolers was the same. Extracurricular motor activity of the EG and the CG high schoolers was not considered. Classes in the EG were conducted by orienteering coaches, in the CG – by gymnasium physical education teachers.

Research methods include the analysis and generalization of literary sources, as well as medical and biological methods, and statistical methods. The analysis and generalization of literary sources were employed to substantiate the theoretical problem (24 sources from scientometric databases MedLine, Scopus, Web of Science were analyzed). The medical and biological methods allowed us to assess the physical health indicators of high schoolers.

The physical health of high schoolers was assessed by body mass index, which is the ratio of body weight to body length; strength index, which reflects the development of muscle strength relative to body weight; vital index, which allows to assess the reserve capacity of the respiratory system; Robinson index and Rufier index, which characterize the functional capacity of the cardiovascular system of the high schooler's body.

Body mass index (BMI) was determined by the formula: BMI = body weight (kg) / body length (m^2); strength index (SI): SI = hand dynamometry (kg) / body weight (kg); vital index (VI): VI = vital capacity of the lungs (ml) / body weight (kg); Robinson index (RI): RI = systolic blood pressure (mm Hg) x resting HR (bpm) / 100; Rufier index (RfI): RfI = (4 x (HR1 + HR2 + HR3) – 200) / 100, where HR1 is the resting HR for 15 s, HR2 and HR3 are the HRs of the first and last 15 s of the first minute of recovery after 30 squats for 45 s.

The study of high schoolers' physical health indicators was conducted at the beginning (September) and end (May) of the academic year 2024-2025.

STATISTICAL METHODS

At the beginning of the pedagogical experiment, the homogeneity of all indicators of the EG and the CG high schoolers was determined, i.e., the absence of a significant difference in the studied indicators ($p>0.05$), and it was found that the distributions of the EG and the CG are normal, which allowed us to assess the reliability of the results using Student's t-test. The reliability of the difference was set at $p \leq 0.05$. All statistical analyses were performed using SPSS software. The results were presented as $X \pm m$, where X is the arithmetic mean and m is the standard error of the arithmetic mean.

ETHICAL STANDARDS

The process of research implementation is built following the requirements of scientific ethics. The Academic Ethics Commission of the Ukrainian State Dragomanov University approved the research. The pedagogical experiment was open, and its participants were informed about the aim and tasks of the research, and they voluntarily participated in it.

RESULTS

At the beginning of the research, we conducted the comparative analysis of physical health indicators of

Table 1. Characteristics of physical health indicators of senior male high schoolers at the beginning of the experiment

Physical health indicators	16-year-old boys	Level following the age norm	17-year-old boys	Level following the age norm	Reliability of the difference, t; p
BMI, kg/m^2	20.3 ± 0.28	average	21.1 ± 0.31	average	1.92; > 0.05
SI, %	50.1 ± 0.74	below normal	51.9 ± 0.69	average	1.78; > 0.05
VI, ml/kg	48.4 ± 0.81	below normal	48.5 ± 0.76	below normal	0.09; > 0.05
RI, c. u.	84.5 ± 0.58	average	83.9 ± 0.62	average	0.71; > 0.05
RfI, c. u.	9.8 ± 0.11	average	9.7 ± 0.12	average	0.61; > 0.05

Legend: t – Student's t-test value, p – statistical significance indicator
Source: compiled by the authors of this study

Table 2. Characteristics of physical health indicators of senior female high schoolers at the beginning of the experiment

Physical health indicators	16-year-old girls	Level following the age norm	17-year-old girls	Level following the age norm	Reliability of the difference, t; p
BMI, kg/m^2	19.6 ± 0.25	average	20.1 ± 0.26	average	1.39; > 0.05
SI, %	44.6 ± 0.77	below normal	45.3 ± 0.79	below normal	0.63; > 0.05
VI, ml/kg	47.4 ± 0.73	below normal	48.0 ± 0.76	below normal	0.57; > 0.05
RI, c. u.	82.0 ± 0.64	average	81.9 ± 0.68	average	0.11; > 0.05
RfI, c. u.	8.9 ± 0.09	average	9.0 ± 0.10	average	0.74; > 0.05

Legend: t – Student's t-test value, p – statistical significance indicator
Source: compiled by the authors of this study

high schoolers in grades 10 and 11 (16 and 17 years old). We assessed the compliance of the studied indicators with age norms. The results are presented in Table 1 (boys) and Table 2 (girls).

It was found that the indicators of the vital and strength indices in boys aged 16 and the indicators of the vital index in boys aged 17 do not correspond to the age norm; they are below normal. Statistical evaluation of the differences between the studied groups of the boys aged 16 and 17 showed no significant difference between their physical health indicators ($p > 0.05$).

It was found that the vital and strength indicators in the girls aged 16 and 17 do not correspond to the age norm and are below normal. Statistical evaluation of the differences between the studied groups of the girls aged 16 and 17 showed no significant difference between their physical health indicators ($p > 0.05$). The results also indicate insufficient physical health among high schoolers and the need to find effective ways to maintain and strengthen it with modern and effective means of physical education.

During the academic year, in the EG, high school physical education classes used orienteering, which involved teaching boys and girls to navigate the terrain with a map and compass and to find the fastest possible control points in the natural environment. The organic combination of physical and mental activity in the school playground, park, urban forest, and forest has a positive effect not only on the physical but also on the emotional state of high schoolers.

Orienteering, unlike many other sports, has several significant advantages that can be successfully used in the school environment. The availability of different types of orienteering, accessibility of use in rural and urban areas open up vast opportunities for the development of physical (speed, agility, endurance, strength, flexibility as well as speed and strength qualities), mental (memory, attention, thinking) and emotional and volitional (initiative, confidence, balance, perseverance, determination and other) qualities. To improve the learning process and increase the class's motor density, the experimental classes' theoretical material was organically combined with the content of practical activities. In particular, the study and consolidation of knowledge about the conventional signs of sports maps was mixed with various relay races and outdoor activities.

Exercises and motor actions used in orienteering are pretty diverse. For example, the main ones are alternating running and jumping. However, orienteering is not just a cross-country run in a particular area (park, forest). The high schooler must perform technical actions related to reading a map and using a compass, marking at a control point (CP), etc. The time spent performing these actions determines the level of technical and tactical preparedness of high schoolers and significantly affects the final result when overcoming the distance. The following motor tasks were used in orienteering classes: exercises aimed at forming and improving the ability to read a map; exercises aimed

Table 3. Dynamics of physical health indicators of high schoolers in the conditions of the pedagogical experiment

Physical health indicators	Groups	Stages of the research		The difference	Reliability of the difference, t; p
		Beginning	End		
Boys (EG: n = 42; CG: n = 42)					
BMI, kg/m^2	CG	21.8±0.32	22.1±0.33	0.3	0.65; >0.05
	EG	21.7±0.29	21.8±0.28	0.1	0.25; >0.05
SI, %	CG	51.2±0.63	52.8±0.67	1.6	1.74; >0.05
	EG	51.0±0.71	52.7±0.69	1.7	7.72; >0.05
VI, ml/kg	CG	48.5±0.68	49.3±0.72	0.8	0.81; >0.05
	EG	48.4±0.70	52.9±0.74**	4.5	4.42; ≤0.001
RI, c. u.	CG	84.4±0.52	83.9±0.54	0.5	0.65; >0.05
	EG	84.5±0.59	81.6±0.63*	2.9	3.36; ≤0.01
RfI, c. u.	CG	9.8±0.10	9.6±0.11	0.2	1.35; >0.05
	EG	9.7±0.11	9.1±0.09**	0.6	4.22; ≤0.001
Girls (EG: n = 47, CG: n = 46)					
BMI, kg/m^2	CG	19.7±0.29	20.2±0.30	0.5	1.20; >0.05
	EG	19.8±0.27	20.0±0.29	0.2	0.50; >0.05
SI, %	CG	44.7±0.71	45.9±0.73	1.2	1.18; >0.05
	EG	44.5±0.75	45.4±0.76	0.9	0.84; >0.05
VI, ml/kg	CG	47.9±0.59	49.1±0.61	1.2	1.41; >0.05
	EG	47.8±0.57	51.5±0.58*	3.7	4.55; ≤0.001
RI, c. u.	CG	83.8±0.54	82.7±0.51	1.1	1.48; >0.05
	EG	84.0±0.52	81.5±0.49*	2.5	3.50; ≤0.01
RfI, c. u.	CG	9.1±0.11	9.0±0.11	0.1	0.64; >0.05
	EG	9.0±0.10	8.6±0.09*	0.4	2.97; ≤0.05

Legend: t – Student's t-test value, p – statistical significance indicator; *, ** – reliability of the difference between the EG and the CG at the end of the research at the level of $p \leq 0.05$, $p \leq 0.01$

Source: compiled by the authors of this study

at correct map orientation; exercises aimed at rational choice of objects (landmarks) that allow to find the CP without mistakes; exercises aimed at determining the distance between objects; types of distances and the sequence of their use in classes; exercises aimed at mastering the work with a compass; exercises aimed at choosing the right movement options; exercises aimed at forming the ability to select rational reference points (anchors); exercises aimed at developing memory; exercises aimed at developing attention; quests (adventure tasks); special running and jumping exercises; exercises for developing flexibility; exercises aimed at developing general and special endurance; exercises for developing agility; exercises for developing speed; exercises aimed at strengthening the muscle corset.

The CG high schoolers were engaged in other types of physical exercises in the gym. In particular, they used general developmental exercises, gymnastic exercises, and sports games.

To study the influence of orienteering classes on the physical health indicators of senior high schoolers, we evaluated the dynamics of the body mass, vital, strength, Robinson and Rufier indices (Table 3).

The obtained results show that at the end of the academic year there is a positive dynamics of physical health indicators of boys and girls of both groups, but statistically significant are changes in the indicators of vital index, Robinson index and Rufier index in high schoolers of both sexes only in the EG ($p \leq 0.05$-0.001). The body mass and strength indices in the EG have no significant difference between the initial and final data of the experiment ($p > 0.05$). There were no substantial changes in the CG, both boys and girls ($p > 0.05$). The comparative analysis of the EG and the CG indicators at the beginning of the experiment showed no significant difference between the studied indices. Still, at the end of the research significantly better indicators were found in the EG compared to the CG by the following indices: vital index – by 3.6 ml in boys ($p \leq 0.01$) and by 2.4 ml in girls ($p \leq 0.05$); Robinson index – by 2.3 c. u. in boys ($p \leq 0.05$) and by 1.2 c. u. in girls ($p \leq 0.05$); Rufier index – by 0.5 c. u. in boys ($p \leq 0.01$) and by 0.4 c. u. in

girls ($p \leq 0.05$). The obtained data confirm the expediency of using orienteering in the practice of physical education of senior high schoolers with the purpose of their health improvement.

DISCUSSION

Scientists [11, 12] note that realizing educational tasks in physical education lessons is impossible without solving health problems. Health-promoting tasks include applying health-improving and preventive measures during physical culture lessons, improving physical condition indicators, and developing high schoolers' motor skills. In orienteering classes, we paid special attention to improving the health and functional capabilities of the main body systems of high schoolers, due to the nature of motor activity, which includes mainly aerobic exercises in the natural environment. The organization of orienteering classes in the open air helps to harden the bodies of high schoolers and increase their immunity. Similar conclusions have been drawn in studies by other scientists [13].

Experts [1, 14, 15] argue that even though the healing forces of nature (hardening by air, sunlight, water) and hygienic factors (daily routine, rational nutrition, hygiene of places of study, personal hygiene, etc.) are auxiliary means of physical education, their role is no less critical in organizing motor activity of high schoolers than the use of physical exercises. Given that most orienteering classes in the EG took place in natural conditions, the impact of nature's healing powers on high schoolers' bodies has also increased.

The functional state of high schoolers' cardiovascular and respiratory systems is one of the most essential characteristics of physical health. They play an important role in the body's adaptation to motor activity and are one of the leading indicators of its viability [16]. Diagnostics of an organism's functional state during physical exercises are essential for assessing the degree of influence of motor loads on an organism and its correspondence to gender, age, and individual capabilities of high schoolers [17].

It should be noted that the specificity of functional diagnostics of practically healthy people involves assessing not so much the nature and degree of disorder of a particular system or organ but the current level of their functioning or functional reserve [18]. In our research, the following functional parameters of high schoolers were determined to characterize the state of the cardiovascular and respiratory systems by the Robinson, Rufier, and vital indices: resting heart rate, blood pressure (systolic and diastolic), and vital capacity of the lungs. As a result of assessing the functional state of the cardiovascular and respiratory systems of senior high schoolers before the experiment, we found that the average group values of these indices are at low (below normal) and average levels. This may indicate an insufficient level of general endurance development and the need to improve high schoolers' respiratory function. It should be taken into account that heart rate and blood pressure, even in practically healthy people, can change under different circumstances, including emotional ones caused by current living conditions during the war in Ukraine [19].

Orienteering combines orienteering skills, physical endurance, and the ability to make quick decisions. Through specialized motor activities of a predominantly aerobic nature, it contributes to improving the functional state of the cardiorespiratory system and strengthening one's health [7, 9].

Thus, our research is consistent with the results of other studies on the health effects of orienteering on the body of those involved [8, 10, 20] and is an effective means of combined development of high schoolers' motor skills and cognitive abilities [21]. Running on rough terrain with simultaneous orienteering using a map compares favorably with ordinary running in the absence of monotony, which, from a psychological point of view, is an essential factor that increases the working capacity of those engaged. The constant change of external conditions, positive emotions, and the possibility of alternating running attract young people to such activities [22].

The content of motor loads in orienteering classes is characterized by the influence on the functioning of the musculoskeletal system and muscles, which contributes to an increase in the content of endorphins in the blood, which causes positive emotions in a person, while increasing strength, mobility, and balance of nervous processes [23, 24]. Therefore, it can be argued that orienteering can affect not only the physical and mental health of high schoolers, which is essential during the war. Health-promoting orienteering and its applied nature determine their introduction into the physical education system of high schoolers.

CONCLUSIONS

1. Orienteering, unlike many other sports and motor activities, has several significant advantages that can be successfully used in the school environment. Orienteering is distinguished by its accessibility in rural and urban areas, the possibilities of combined development of motor skills and cognitive abilities of high schoolers, and the unique health-improving effect of combining physical exercises of a predom-

inantly aerobic nature and the healing powers of nature.

2. The effectiveness of the implementation of orienteering classes in school physical culture lessons was based on the assessment of the physical health indicators and the dynamics of senior high schoolers. At the end of the research, statistically significant increases of indicators of the vital index, Robinson and Rufier indices in the boys and girls of the EG were fixed ($p \leq 0.05$-0.001). The body mass index and strength index in the EG do not show a significant difference between the initial and final data of the experiment ($p > 0.05$). In the CG, both in boys and girls, there were no significant positive changes in the studied indicators ($p > 0.05$). The comparative analysis of the EG and the CG indicators at the end of the research showed significantly better indicators in the EG compared to the CG: vital index – by 3.6 ml in boys ($p \leq 0.01$) and by 2.4 ml in girls ($p \leq 0.05$); Robinson index – by 2.3 c. u. in boys ($p \leq 0.05$) and by 1.2 c. u. in girls ($p \leq 0.05$); Rufier index – by 0.5 c. u. in boys ($p \leq 0.01$) and by 0.4 c. u. in girls ($p \leq 0.05$). The obtained data confirm the expediency of using orienteering in the practice of physical education of high schoolers with the purpose of their health improvement.

PROSPECTS FOR FURTHER RESEARCH

Prospects for further research will be aimed at studying the impact of orienteering on improving the emotional state and increasing the stress resilience of high schoolers.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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