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The impact of sports and recreational hiking with bicycles on the state of the cardiorespiratory system of Chinese students

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Abstract

Background and Study Aim. In the modern educational space, active forms of recreational and health activities are becoming increasingly important, promoting physical development, health promotion and the formation of a healthy lifestyle among student youth. Cycling tourism is one of the types of active tourism based on travel using a bicycle as the main means of transportation. It combines recreational, educational and sports aspects, promoting the harmonious development of the individual. This type of tourism has a number of specific features that determine its popularity, in particular among student youth. The purpose of the study is to identify the impact of sports and recreational hiking with bicycles on the state of the cardiorespiratory system of Chinese students.

Material and methods. The study involved 12 male students from Boai County Vocational College, China (the average age of the study participants was 18.9±2.83 years). Students took part in a sports and recreational tourism hike with bicycles, which lasted 8 days from October 20 to October 27, 2024. The study involved monitoring the well-being and functional state of the cardiovascular system (in terms of heart rate) and respiratory system (in terms of vital capacity) of students while participating in a sports and recreational cycling trip. During the hike, heart rate and vital capacity of the lungs were measured every morning and evening (after completing the daily stage), and self-monitoring diaries were kept by each of the hike participants.

Results. The analysis of the results of sports and recreational hike with bicycles showed a positive effect of physical activity on the functional state of students. It was found that in the first days of the hike there was a gradual increase in heart rate, which indicates adaptation to physical activity. After a day of rest, heart rate indicators stabilized, and vital capacity of the lungs tended to increase at the end of the hike, which indicates an improvement in the functional reserves of the cardiovascular and respiratory systems of the participants. Thus, cycling tourist hike are an effective means of physical development and health improvement for young people, which confirms the need for their regular implementation in the practice of physical education.

Conclusions. It has been established that the cycling sports and health hike has a positive effect on the functional state of the cardiorespiratory system of students. In the first days of the hike, a gradual increase in heart rate was observed, which indicates the body's adaptation to physical exertion. After a day of rest, the heart rate indicators stabilized, and the vital capacity of the lungs (VC) had a tendency to increase at the end of the hike, which indicates an improvement in the functional reserves of the cardiovascular and respiratory systems of the participants.

Key words: cycling tourism, students, cardiovascular system, adaptation.

Анотація

Вплив велосипедного спортивно-оздоровчого походу на стан кардіореспіраторної

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системи студентів Китаю

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Передумови та мета дослідження. У сучасному освітньому просторі все більшого значення набувають активні форми рекреаційної та оздоровчої діяльності, які сприяють фізичному розвитку, зміцненню здоров'я та формуванню здорового способу життя студентської молоді. Велосипедний туризм є одним із видів активного туризму, що базується на подорожах із використанням велосипеда як основного засобу пересування. Він поєднує рекреаційні, пізнавальні та спортивні аспекти, сприяючи гармонійному розвитку особистості. Даний вид туризму має низку специфічних особливостей, які визначають його популярність, зокрема серед студентської молоді. Мета дослідження – виявити вплив велосипедного спортивно-оздоровчого походу на стан кардіореспіраторної системи студентів Китаю.

Матеріал і методи. У дослідженні взяли участь 12 здобувачів вищої освіти чоловічої статі Професійного коледжу округу Боай (Китай) (середній вік учасників дослідження склав 18,9±2,83 років). Студенти приймали участь у спортивно-оздоровчому поході з велосипедного туризму, що тривав 8 днів з 20 по 27 жовтня 2024 року. Дослідження передбачало спостереження за самопочуттям та функціональним станом серцево-судинної системи (за показником ЧСС) і дихальної системи (за показником ЖЄЛ) студентів під час участі у спортивно-оздоровчому поході з велосипедного туризму. Протягом походу щоденно вранці та ввечері (після подолання щоденного етапу) вимірювалася частота серцевих скорочень та життєва ємність легень, а також здійснювалося ведення щоденників самоконтролю кожним із учасників походу.

Результати. Аналіз результатів велосипедного туристського походу показав позитивний вплив рухової активності на функціональний стан студентів. Встановлено, що у перші дні походу спостерігалося поступове зростання показників частоти серцевих скорочень, що свідчить про адаптацію до фізичних навантажень. Після дня відпочинку показники ЧСС стабілізувалися, а життєва ємність легень мала тенденцію до підвищення наприкінці походу, що вказує на покращення функціональних резервів серцево-судинної та дихальної систем організму учасників. Таким чином, велопоходи є ефективним засобом фізичного розвитку та оздоровлення молоді, що підтверджує необхідність їх регулярного впровадження у практику фізичного виховання.

Висновки. Встановлено, що велосипедний спортивно-оздоровчий похід позитивно впливає на функціональний стан кардіореспіраторної системи студентів. У перші дні походу спостерігалося поступове зростання показників частоти серцевих скорочень (ЧСС), що свідчить про адаптацію організму до фізичних навантажень. Після дня відпочинку показники ЧСС стабілізувалися, а життєва ємність легень (ЖЄЛ) мала тенденцію до підвищення наприкінці походу, що вказує на покращення функціональних резервів серцево-судинної та дихальної систем учасників.

Ключові слова: велосипедний туризм, студенти, серцево-судинна система, адаптація.

Introduction

In the modern educational space, active forms of recreational and health activities are becoming increasingly important, promoting physical development, strengthening health and forming a healthy lifestyle of student youth [1, 2, 3, 4]. The student youth of China from Henan Province deserves special attention, since this region is characterized by a high population density, an urbanized environment and limited opportunities for active leisure in the open air. In the context of the increasing workload on students associated with the intensive educational process, the popularization of sports and health activities, in particular cycling trips, is becoming an important tool for maintaining the physical and mental health of young people.

Sports and health tourism is one of the most popular and accessible for student youth. This is due to the possibility of laying out routes along various roads and terrains, and fully implementing tourist and local history activities [5]. Sports and health tourism combines different types of physical activity with cognitive and educational components, elements of hardening and adaptation to changed environmental conditions. It has an emotional coloring, increases the level of physical activity, maintains performance and has a positive effect on cognitive functions [6, 7, 8].

Cycling tourism is one of the effective forms of physical activity, combining aerobic exercise, recreation and social interaction, allowing students to compensate for the lack of physical activity, expand their physical capabilities and improve their psycho-emotional state. However, conducting cycling hike requires careful planning of the route, physical training of participants and organizational and methodological support, taking into account the peculiarities of the climatic, geo-

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graphical and social conditions of Henan Province. Insufficient physical fitness of students and the lack of a clear methodology for preparing for cycling trips can lead to an increased risk of injury, excessive physical exertion and loss of interest in such measures.

Cycling tourism is one of the types of active tourism based on traveling using a bicycle as the main means of transportation. It combines recreational, educational and sports aspects, promoting the harmonious development of the individual. This type of tourism has a number of specific features that determine its popularity, in particular among student youth [9, 10].

One of the key features of cycling tourism is its mobility and accessibility. A bicycle, as a means of transport, allows you to travel along a variety of routes, in particular in areas inaccessible to automobile or rail transport [3, 7]. In addition, cycling tourism is characterized by relative cost-effectiveness, which is an important factor for students, since it does not require significant financial costs, and the main resources are concentrated on basic equipment.

Physical activity is an integral component of cycling tourism, which helps improve health. During cycling, the work of the cardiovascular and respiratory systems is activated, the musculoskeletal system is strengthened, and overall endurance increases. This is especially important for student youth, who often lead a sedentary lifestyle due to their academic loads.

The importance of cycling tourism for student youth is determined by its impact on various aspects of personal development. First of all, it helps to strengthen physical health, since the combination of physical activity with being outdoors stimulates the immune system, increases the body's tone and is a preventative measure for many diseases. [5, 8, 10].

There are many studies [11, 12, 13, 14] devoted to the impact of different types of sports and fitness activities on the cardiorespiratory system of athletes. Thus, Skaliy et al. assessed the functional state of the cardiovascular system of students during a mountain hiking trip. It was found that after the initial adaptation period, accompanied by a decrease in recovery indicators due to fatigue and lack of accustoming to the loads, an improvement in the work of the cardiovascular system was observed in the second half of the route. In the study by Fesyun et al., the functional state of the cardiovascular system in athletes was assessed and it was found that representatives of cyclic sports have a higher degree of adaptation to physical activity compared to athletes involved in game sports.

Therefore, the *purpose of the study* was to identify the effect of sports and recreational hiking with bicycles on the cardiorespiratory system of Chinese students.

Material and Methods

Participants

The study involved 12 male students from Boai County Vocational College (China) (the average age of the study participants was 18,9±2,83 years). Students took part in a sports and recreational tourism hike with bicycles, which lasted 8 days from October 20 to October 27, 2024. The leader of the tourist group was a college teacher with relevant experience in participating in and leading sports and recreational hikes. The students who took part in the hike had been training in the sports and health tourism section for 2 years and had experience in participating in bicycle tourism hikes with a gradual increase in their duration and length.

The designed bicycle hike with a total length of 361 km assumed the beginning and end of the route in Boai city according to the route thread (Boai – Beimang Town – Zhengzhou – Dengfeng – Luoyang – Jili District – Wulongkouzhen – Boai). The traffic schedule on the first day involved covering a distance of 52 km, the second – 41 km, the third – 65 km, the fifth – 57 km, the sixth – 35 km, the seventh – 64 km, the eighth – 47 km. At each of the daily stages of movement every 45 minutes. The movement was given 15 minutes. for rest, the fourth day of the hike was devoted to rest, recreation and recuperation, during which students had the opportunity to visit the cultural and historical places of the Dengfeng region (Table 1).

Ethics Statements and Participants.

This study was approved by the Bioethics Committee for Clinical Research and conducted according to the Declaration of Helsinki. All participants gave their written consent to research and were informed about the purpose and test procedures and about the possibility of withdrawal of consent at any time for any reason.

Study design.

The study involved monitoring the well-being and functional state of the cardiovascular system (based on the heart rate) and respiratory system (based on the vital capacity) of students participating in a sports and recreational cycling tour. During the hike, heart rate and vital capacity of the lungs were measured every morning and evening (after completing the daily stage), and self-monitoring diaries were kept by each of the hike participants.

Heart rate (HR) is one of the most important physiological indicators characterizing the state of the cardiovascular system when assessing the in-

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Table 1. Description of the route for a seven-day sports and recreational tourism hike with bicycles in Henan Province

Day of the hike	Route	Distance	Description
1	Boai → Beimang Town	52	Road surface: asphalt Terrain: flat, gradual rises Landmarks: Driving along the G234 highway Difficulties: High traffic intensity in certain areas Main attractions: Beimang Old Town, traditional Chinese villages Overnight: camping in Beimang Town
2	Beimang Town → Zhengzhou	41	Road surface: asphalt, city roads. Terrain: flat Landmarks: Driving southeast to the provincial capital of Henan Heavy traffic in Zhengzhou Main attractions: Henan Provincial Museum – history and culture of the region; The Yellow River (Huang He) is the largest river in China Overnight: camping in Zhengzhou District
3	Zhengzhou → Dengfeng	65	Road surface: mixed roads, mountain serpentines Terrain: gradual increase in altitude Reference points: Driving along the G207 highway, transition to the foothills Difficulties: High physical exertion due to climbs Main attractions: Shaolin Temple - the world center of kung fu; Mount Songshan - one of the five sacred mountains of China Overnight: camping in the foothills
4	Rest day (Dengfeng)		Hiking on Songshan Mountain routes. Visit to Shaolin Temple
5	Dengfeng → **Luoyang**	57	Road surface: asphalt, slopes Terrain: mountainous areas alternate with plains References: Driving west along the G207 Difficulties: Steep descents, need to control speed Main attractions: Longmen Grottoes – a complex of rock-cut Buddhist temples; **White Horse Temple** - China's first Buddhist temple Overnight: camping in **Luoyang** District
6	**Luoyang** → Jili District	35	Road surface: city roads Terrain: flat Landmarks: Moving to Jili District (suburb of Luoyang) Main attractions: Xiaolangdi Reservoir – hydroelectric power station and picturesque reservoir; traditional tea houses Overnight: camping in the vicinity of Jili District.
7	Jili District → Wulongkouzhen	64	Terrain: gradual ascent into the mountains Directions: Driving north along the G3511 highway Difficulties: High load due to mountainous terrain Main attractions: **Mount Taihan** - national reserve; Wulongkou Nature Park Overnight: campsite in Wulongkouzhen
8	Wulongkouzhen → Boai	47	Road surface: mostly asphalt Terrain: mountainous descents, exit to the plain Landmarks: Driving southeast along the G55 Difficulties: Steep descents, control your speed Key attractions: traditional Chinese markets and craft workshops; viewpoints of Mount Taihan
	Total:	361 km	

tensity of muscle load. During the hike, HR was recorded by palpation. Numerical indicators were reflected in the number of beats per minute (bpm^{-1}).

Vital capacity of the lungs (VC) was determined using a dry portable spirometer SSP. The subject was asked to put a mouthpiece in his mouth, while putting a clip on his nose. The device was turned on at a speed of 50 mm / sec. A spirogram was recorded during calm breathing. After 30-40 seconds of recording, the subject was asked to take a very deep breath in and out.

When analyzing the test results and identifying the effectiveness of the implemented program, statistical indicators were used, such as:

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arithmetic mean ($\bar{x}$), root mean square and error of the mean (m), the significance of the differences was assessed using the t-test (Student's test), the differences were considered significant using the Shapiro-Wilkie test.

Results

Any hiking trip requires careful planning, organization and preparation. In fact, its implementation begins long before the group directly sets out on the route and continues even after the active part is completed, including analysis of the results and preparation of the relevant documentation.

The developed eight-day route includes key historical, cultural and natural sites of Henan Province, combining physical activity with the opportunity to deeply familiarize yourself with regional features. The use of modern cartographic technologies allows you to optimize the route, ensuring high accuracy and relevance of data, which contributes to the successful organization and safe conduct of the cycling hike.

Thus, cycling tourism is not only an effective form of physical activity, but also a comprehensive means of health improvement, combining physical activity with a cognitive component, careful route planning, taking into account the natural, climatic, historical and cultural features of the region, as well as the use of modern cartographic technologies provide optimal conditions for its implementation.

Considering the importance of physical activity during a long hike with a bicycle, special attention was paid to assessing the state of the cardiorespiratory system of the students who took part in the study. Analysis of the results obtained will determine the effectiveness of this type of activity for strengthening the cardiovascular and respiratory systems of young people.

The first day involved walking the Boai – Beimang Town route (52 km) with rest stops. During the first day of the hike, the heart rate increased by 14,5 bpm^{-1} (Fig. 1), and the vital capacity remained at the pre-hike level (Fig. 2).

On the second day, 41 km were covered (Beimang Town – Zhengzhou). At the end of the second day of the route, the HR increased to 95,1 bpm^{-1} (at the beginning it was 72,6 bpm^{-1}), the VC remained almost at the same level (3112 ml in the morning; 3159 ml in the evening). At the same time, on the morning of the next day, the average group HR had not fully recovered, amounting to 81,5 bpm^{-1}, which affected the increase in indicators at the end of the third hiking day (in the evening, the HR was 98,9 bpm^{-1}). Along with this, the VC data remained at the same level during the third day of the hike (in the morning - 3142 ml, in the evening - 3164 ml).

The use of a rest day on the fourth day of the hike was logical, which is associated with accumulated fatigue, as well as rest in the most picturesque place of the Henan (Dengfeng) region. The rest day was beneficial for the student tourists, in their diaries they saw a desire to continue moving. It was found that the heart rate indicators resumed to 78,2 bpm^{-1}, the vital capacity indicators also decreased during the rest day (in the morning - 3154 ml, in the evening - 3150 ml).

During the next section of the route (Dengfeng – Luoyang), the average group HR increased by 21,2 bpm^{-1}, while VC remained almost the same (3148 ml and 3155 ml).

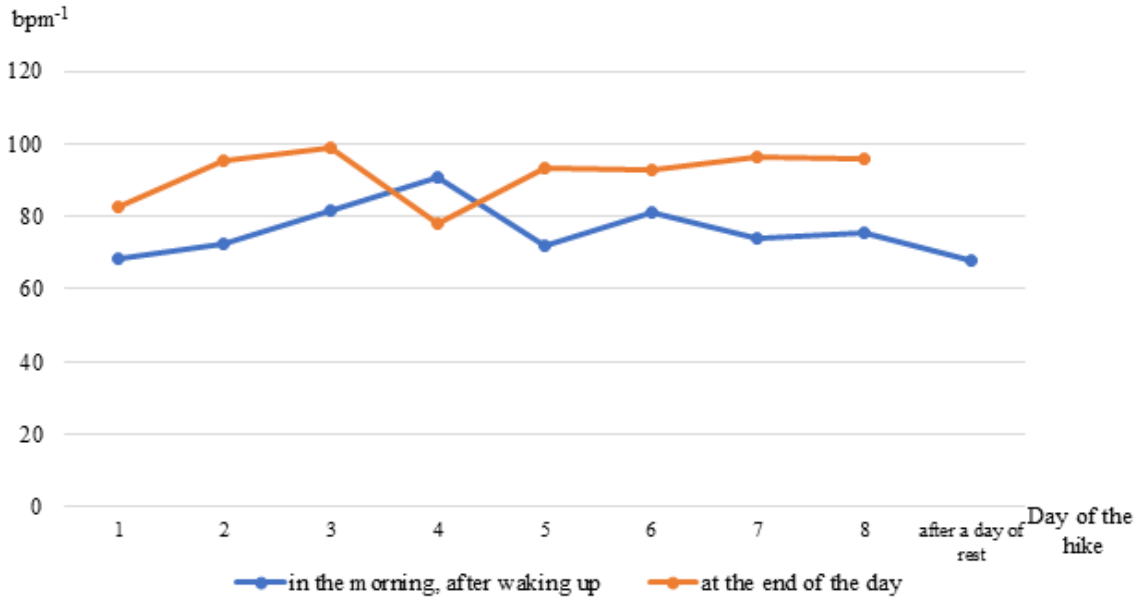

Figure 1. Dynamics of changes in the heart rate of students under the influence of a tourist hike with a bicycle of the 2nd category of complexity.

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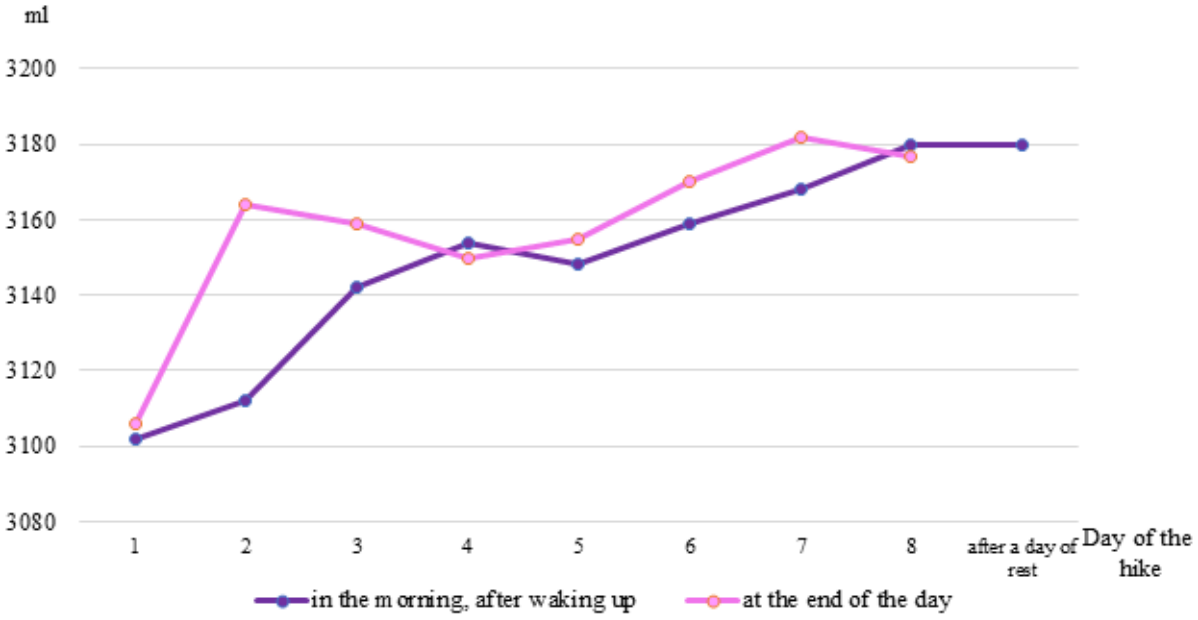

Figure 2. **Dynamics of change in students' vital capacity under the influence of a tourist hike with a bicycle of the 2nd category of difficulty**

On the sixth day of the hike (Luoyang – Jili District), the HR in the morning was (81,2 bpm^{-1}), at the end of the day it was 92.8 bpm-1, and VC did not have a significant difference (in the morning – 3159 ml, in the evening – 3170 ml).

On the penultimate day of covering the route (Jili District – Wulongkouzhen), during a stop for lunch, there was a visit to the Wulongkou Nature Park. During the time spent covering this section of the route (64 km), the average group heart rate increased by 22,5 bpm (from 73,8 bpm in the morning to 96,3 bpm in the evening), and no significant changes were observed in the vital capacity (in the morning – 3128 ml).

The last day of the hike with a bicycle had a stage length of 47 km, which contributed to a gradual decrease in the load. It was found that the average group heart rate during the last stage increased by 20,6 bpm^{-1}, and the vital capacity decreased by 3 ml, which indicates general fatigue during the entire hike. At the same time, after a day of rest, the heart rate indicators returned to the weekend (68,3 bpm^{-1} at the beginning of the hike, 67,9 bpm^{-1} after a day of rest), and the vital capacity tended to increase from 3102 ml at the beginning of the hike to 3180 ml at the end, which indicates the positive influence of the specified hike with a bicycle on the indicators of the functional system of student tourists.

Discussion

The results of this study confirm the position of many scientists on the significant health potential of sports tourism for different groups of the population, especially student youth [15, 16, 17]. The data obtained indicate that sports tourism, in particular cycling, contributes to the formation of positive changes in physical development, the functional state of the cardiovascular system and the psycho-emotional state of students, which corresponds to the results of our study.

It has been established that moderate physical activity, characteristic of hiking, is a factor not only in the physical, but also in the mental adaptation of young people to new environmental conditions. As noted by Dunets et al. [16], the most natural environment of a moderate climate and the picturesque landscapes of foothill and low-mountain areas create the most favorable conditions for recovery and stress reduction. This is confirmed by the results of our study, where students demonstrated a stable improvement in psycho-emotional indicators at all stages of the tourist route.

The studies by Gonzalez-Herrera et al. [17], Butenko et al. [18] and Grynova et al. [5] also emphasize the importance of preliminary physical and psychophysiological preparation for effective adaptation of the body to physical activity, especially in the context of hiking. According to these authors, students' physical activity should not be limited to traditional academic activities, but should be supplemented by various forms of active leisure, among which tourist activities occupy a place. The results of our study confirmed this thesis, showing that after the initial adaptation period, students demonstrated a stable improvement in their physical condition indicators.

At the same time, an important aspect of the study is the assessment of the adaptive potential

of the organism, manifested in the reactivity and lability of functional systems. Similar results were obtained by Podrihalo et al. [19], who noted that systematic physical activity significantly increases the lability of physiological processes and the overall fitness of athletes. Our study also noted an increase in the functional reserves of the body of the participants of the hike, especially in relation to indicators of the cardiovascular system.

The cardiovascular system assessment technique used in our study was based on measuring heart rate using modern heart rate monitors. This technique is consistent with the studies by Bocharin et al. [20] and Eisfeld et al. [21], who emphasize the importance of monitoring heart rate and other cardiac indicators to determine adaptation reserves. The use of modern monitoring tools, such as sports bracelets and heart rate monitors, is also confirmed by other researchers [22, 23, 14]. These authors point out the high accuracy and practicality of using such devices even in hiking conditions, which significantly simplifies the process of collecting and analyzing data.

The results of our study also confirmed the importance of an optimal balance between physical activity and rest, which is a key factor in developing a high level of endurance, according to the findings of Vorobieva et al. [11]. Thus, hiking trips, especially cycling ones, provide a comprehensive development of the body's adaptive mechanisms and contribute to the improvement of students' functional reserves, which was confirmed by the results of comparison with the indicators of athletes involved in cyclic sports [12].

It should be noted that for the effective use of hiking trips as a means of improving the health of student youth, it is necessary to take into account the individual level of training of the participants. Thus, Abramov [9], Ostrowski et al. [10] and Skaliy et al. [13] emphasize the need for special training and differentiation of loads in accordance with the physical capabilities of students, which were taken into account during the organization and conduct of our study.

Thus, our results confirm the scientific position on the high efficiency of sports tourism in the process of physical education and health improvement of students, as well as the need to take into account the individual characteristics of the participants for the maximum realization of the potential of this type of physical activity.

Conclusions

It has been established that a sports and recreational hike with bicycles has a positive effect on the functional state of the cardiorespiratory system of students. In the first days of the hike, a gradual increase in heart rate (HR) was observed, indicating the adaptation of the body to physical activity. After a day of rest, the HR stabilized, and the vital capacity of the lungs (VC) tended to increase at the end of the hike, indicating an improvement in the functional reserves of the cardiovascular and respiratory systems of the participants.

The results of the study confirm the significant health potential of cycling tourism as an effective way to develop the physical qualities of student youth. The optimal combination of physical activity and rest helps to develop endurance, strengthen the cardiovascular system and increase the adaptive capabilities of the body. It was found that during the hike with bicycles, the functional state indicators significantly improved, which confirms the effectiveness of the systematic use of sports and health events in the process of physical education of students.

Correct route planning, consideration of the participants' physical fitness and optimization of physical activity play a significant role in achieving positive results. The study participants demonstrated high adaptability to a gradual increase in activity, which confirms the feasibility of including hikes with bicycles in the system of physical education and recreation for students.

Thus, cycling tourism is an effective form of active recreation, which not only promotes physical development, but also has a positive effect on the psycho-emotional state of student youth. Further research can be aimed at determining the optimal parameters of physical activity during hiking trips, taking into account the individual characteristics of students.

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