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Training program in the lowlands for amateur mountaineers for climbing to the peaks

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Abstract

Purpose: We develop and experimentally substantiate the use of a method of training amateur mountaineers in conditions of flat terrain to high altitude and ascent to the top.

Material and methods: The study involved 12 men (age 20-25 years old) who have 1 year experience in mountaineering. The participants were divided into two groups, control and experimental, 6 people each. The study was conducted from March to August 2021. The intervention program lasted 9 weeks. All participants gave their consent to participate in the experiment.

Methods: Physical fitness was measured by the 20 squat test. The resting heart rate was measured while standing. Psychophysiological condition was determined with the "International Reaction Test", the test shows the reaction time to a stimulus. Altitude was chosen as an influence factor on reaction time and HR in different test modes: initial testing (plain), testing at an altitude of 1900 m and at an altitude of 3200 m.

Results: The altitude factor had no significant effect on preload reaction time in both control and experimental groups ($p>0.05$). However, a significant influence of altitude on post-load reaction time was found in both control and experimental groups ($p<0,05$). HR was significantly influenced by altitude in both control and experimental groups. However, the effect is stronger in the control group than in the experimental group.

Conclusions. The method increasing tolerance in hypoxia has a positive effect on the organism recovery after the stress in conditions of natural hypoxia, observed during climbing in the mountains.

Key words: amateur climbers, functional training, hypoxic training, high mountains

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Анотація

Олена Рєпко, Олександр Скалій, Євген Тимко, Сергій Козін, Жаннета Козіна, Андрій Фещенко. Програма підготовки в умовах низини альпіністів-любителів до сходжень на вершини

Мета: розробити та експериментально обґрунтувати використання авторської методики підготовки альпіністів-аматорів в умовах рівнинної місцевості до високогір'я і сходження на вершину

Матеріал і методи: у дослідженні взяли участь 12 чоловіків (вік 20-25 років), які мають досвід занять альпінізмом 1 рік. Учасники були поділені на дві групи: контрольну та експериментальну по 6 осіб. Дослідження проводилося з березня по серпень 2021 року. Програма втручання тривала 9 тижнів. Усі учасники дали свою згоду на участь в експерименті.

Методи: Фізичну підготовленість визначали за допомогою тесту "20 присідань". Вимірюється ЧСС у стані спокою стоячи. Психофізіологічний стан визначали за допомогою тесту "Тест на реакцію міжнародний", тестування показує час реакції на подразник. Як фактор впливу на показники час реакції та ЧСС у різних режимах тестування було обрано висоту над рівнем моря: початкове тестування (рівнина), тестування на висоті 1900 м і на висоті 3200 м.

Результати: було виявлено, що фактор висоти над рівнем моря впливає не достовірно на час реакції до навантаження і в контрольній, і в експериментальній групах (p>0,05). Однак виявлено достовірний вплив висоти над рівнем моря на час реакції і в контрольній, і в експериментальній групах після навантаження (p<0,05). На показники ЧСС висота над рівнем моря впливає достовірно в обох групах, і в контрольній, і в експериментальній. Однак у контрольній групі цей вплив виражений сильніше порівняно з експериментальною групою.

Висновки: методика, що підвищує стійкість у гіпоксії, позитивно впливає на відновлення організму після навантаження в умовах природної гіпоксії, що спостерігається під час підйому в гори.

Ключові слова: альпіністи-аматори, функціональна підготовка, гіпоксичне тренування, високогір'я

Аннотация

Елена Репко, Александр Скалий, Евгений Тимко, Сергей Козин, Жаннета Козина, Андрей Фещенко. Программа подготовки в условиях равнины альпинистов-любителей к восхождениям на вершины

Цель: разработать и экспериментально обосновать использование авторской методики подготовки альпинистов-аматоров в условиях равнинной местности к высокогорью и восхождению на вершину **Материал и методы:** В исследование приняли участие 12 мужчин (возраст 20-25 лет) которые имеют опыт занятий альпинизмом 1 год. Участники были поделены на две группы контрольную и экспериментальную по 6 человек. Исследование проводилось с марта по август 2021 года. Программа вмешательства длилась 9 недель. Все участники дали свое согласие на участие в эксперименте.

Методы: Физическую подготовленность определяли с помощь теста «20 приседаний». Измеряется ЧСС в состоянии покоя стоя. Психофизиологическое состояние определялось с помощью теста «Тест на реакцию международный», тестирование показывает время реакции на раздражитель. В качестве фактора влияния на показатели время реакции и ЧСС в разных режимах тестирования была выбрана высота над уровнем моря: начальное тестирование (равнина), тестирование на высоте 1900 м и на высоте 3200 м.

Результаты: было выявлено, что фактор высоты над уровнем моря влияет не достоверно на время реакции до нагрузки и в контрольной, и в экспериментальной группах (p>0,05). Однако выявлено достоверное влияние высоты над уровнем моря на время реакции и в контрольной, и в экспериментальной группах после нагрузки (p<0,05). На показатели ЧСС высота над уровнем моря влияет достоверно в обеих группах, и в контрольной, и в экспериментальной. Однако в контрольной группе данное влияние выражено сильнее по сравнению с экспериментальной группой.

Выводы. методика, повышающая устойчивость в гипоксии, положительно влияет на восстановление организма после нагрузки в условиях естественной гипоксии, наблюдаемой при подъеме в горы.

Ключевые слова: альпинисты-аматор, функциональная подготовка, гипоксическая тренировка, высокогорье

Introduction

Mountain peaks have attracted people since ancient times. The desire to ascent the top of a mountain, overcoming all difficulties and testing one's strength and capabilities has encouraged people to take up mountaineering. Nowadays mountaineering remains one of the most popular sports although it is not included in the program of the Olympic Games. Athletic training in mountaineering is multifaceted, involving physical, tactical, technical and psychological preparation [1,2]. In addition to excellent physical training, a mountaineer must have technical skills of working with rope and equipment brought to perfection, in conditions of overwork and hypoxia an athlete must be able to make tactical decisions, on which his life and the lives of his comrades depend. Preparing for ascent the climber must study climatic features of the region, because human performance depends on weather conditions both bodily and cognitively [3,4]. Staying in the mountains is accompanied by many risks that are a threat to the life and health of the athletes. The danger of avalanches and rockfalls, being in the mountains, climbers must follow all safety rules, always use a helmet when climbing, correctly organize safety precautions, especially on the ascent, because the most common injuries occur as a result of a fall [5,6,7]. In case of an accident a climber has to organize rescue operations and provide first aid to the injured [8]. These skills are practiced in stages. The skills and knowledge are acquired over many years.

Preparation for ascent begins long before the expedition. Being in the mountains has a special effect on human body. A person gets mountain sickness, which is manifested by symptoms such as drowsiness, intermittent breathing, lethargy, and in severe cases it may be fatal [9,10]. Many climbers live permanently in flat terrain and training requires a special approach with the use of modern techniques and equipment [11,12,13]. After analysing scientific researches, we found that many researches focus on the analysis and implementation of techniques for the training of elite athletes who have a high level of training [14]. Also, techniques using expensive equipment that are available in medical centers, such as barometric chambers, have been proposed [15,16]. Studies have been developed on training in mountains and different altitudes [16] and psychological resilience in high altitude [17]. However, the studied literature does not cover the topic of training amateur mountaineers in flat terrain. There is also a peculiarity of training novice mountaineers, which is based on their individual mode of living and studying. Modern recommendations on preparation for ascents are based on running training in an aerobic regime. But this has disadvantages, which are manifested during the stay at altitude in the mountains. Therefore the necessity of development of program of training of amateur mountaineers in conditions of lowland area with use of available means and methods has come up.

Purpose: The purpose of our study is to develop and experimentally substantiate the use of the author's methodology for preparing for high mountains and climbing to the top of amateur climbers in conditions of low-altitude terrain.

Material and Methods

Participants

The study involved 12 men (age 20-25 years old) who have 1 year of experience in mountaineering and ascent Hoverla Mount (2061 m) (the highest mountain of Ukraine). The participants were divided into two groups, control and experimental, 6 people each. All participants gave their consent to participate in the experiment.

Procedure

The study was conducted between March and August 2021. At the first stage of the study all participants underwent tests of functional fitness and psychophysical state. The testing was conducted in conditions of flat terrain in the city of Kharkiv (202 m) At the second stage the methodology of alpinists' training for high altitude in conditions of flat terrain was developed and applied. At the end of the second stage the functional and psychophysiological condition of the participants of the experiment was tested again, the testing was conducted in the city of Kharkiv (202 m). At the third stage, the participants of the experiment made an ascent to the Kazbek peak (5033m), the Caucasus Mountain range. At this stage two tests were conducted, the first test was conducted at an altitude of 1900 m above sea level at the first base camp and the second test was conducted at the second base camp at an altitude of

3200 m above sea level. The test was conducted in the morning after an overnight stay at base camp. The test displayed the body's response to altitude and acclimation.

Physical measurements

Physical fitness was determined with the 20 squat test. The heart rate is measured while standing at rest. The subject performs 20 deep squats for 30 seconds and the heart rate is recorded at the end of the exercise. The HR was measured after 1 minute of rest and after 5 minutes of rest while standing.

Psychophysiological condition was determined using the "International Reaction Test", the test shows the reaction time to a stimulus. The test subject has to remove their finger from the screen when the colour of the image changes to red. The test was conducted using the mobile application for ANDROID.

Training Intervention

The author's methodology was applied in the second stage of the study for 3 months and was divided into stages. The first stage lasted for 3 weeks - a retraction mesocycle. This stage involved 3 training sessions per week and included a 1.5-kilometre run around the stadium ring. The second stage was the basic microcycle, which lasted 9 weeks and consisted of 9 microcycles. During the 9 weeks the volume of training loads was gradually increased. Each microcycle included 5 training days: 2 general physical training sessions of 60 minutes duration and 3 sessions including different types of running training. General physical training sessions included a set of exercises to develop back, abdominal and leg muscle strength. Running training was divided into 3 types: running on the steps of 120 steps, height of elevation 34 m; running on the stadium ring; cross-country running (distance "figure eight" of 2400 meters includes two climbs with an elevation gain of 40 meters).

The training load was gradually increased from week 1 to week 4. In step running, the number of climbs increased from 3 to 6 times. Distance in stadium ring running increased from 1.5 to 3 km. The length of distance in cross-country running evenly increased from 6 to 10 km, which included 6 to 10 climbs.

In week 5, recovery was offered and the volume and intensity were reduced.

Subsequently, from weeks 6 to 9, the load was gradually increased. In step running, the number of climbs increased from 7 to 10 times. The distance in the stadium ring run increased from 3.5 to 5 km. The cross-country distance has retained its length of 12 km, which includes 12 climbs.

Training days were adapted to the work week. Monday - running on the steps, Tuesday - physical training, Wednesday - running in the stadium circle, Thursday - rest, Friday - physical training, Saturday - cross-country run in the woods, Sunday - rest.

Then followed an adaptation period in the mountains at an altitude of 1900 m for one week, where athletes were hiking with a backpack for 7-10 km.

The control group trained according to a program which had 3 stages of training: retraction, basic and adaptation. The volume of training loads was identical to the experimental group, but the control group was running on the stadium ring and working on a bicycle and a treadmill. The program also included a set of exercises for general physical training.

Statistical analysis

The obtained during the tests was processed using Microsoft Excel and SPSS, 20.0. For each indicator, the arithmetic mean value x, the standard deviation S, the representativeness error m, the assessment of the probability of discrepancies between the parameters of the initial and final results according to the Student's t-criterion with the corresponding level of probability (p) were determined. The sample was tested for normality of distribution using the one-sample Kolmogorov-Smirnov's test.

Single factor analysis of variance (ANOVA) was applied to determine the effect of altitude on reaction time and HR in different test modes (before standard load, after standard load, after 1 minute of recovery, after 5 minutes of recovery). Altitude was chosen as an influence factor on reaction time and HR in the different test modes: initial testing (plain), testing at 1900 m and at 3200 m altitude.

Results

Before the experiment began, the control and experimental groups were tested for normality of the distribution, using the Kolmogorov-Smirnov test. The test showed that all samples conformed to the normal distribution ($p>0.05$).

Before the experiment, the control and experimental groups did not differ significantly from each other on all test indicators (Table 1).

Table 1

Results of testing of athletes of the experimental (n = 6) and control (n = 6) groups before the experiment

Testing time	Name of metrics	Group	Statistical Indicators				
			$\bar{x}$	S	m	t	p
Before standard load	Response time, s	K	0.2985	0.02802	0.01144	1.368	0.201
		E	0.2779	0.02397	0.00979		
	HR, bpm	K	66.0000	7.29383	2.97769	0.000	1.000
		E	66.0000	5.21536	2.12916		
After standard load	Response time, s	K	0.3452	0.05584	0.02280	0.036	0.972
		E	0.3442	0.03930	0.01605		
	HR, bpm	K	128.1667	10.59088	4.32371	-0.981	0.350
		E	133.8333	9.38971	3.83333		
After 1 min of recovery	Response time, s	K	0.3491	0.06300	0.02572	1.287	0.227
		E	0.3150	0.01589	0.00649		
	HR, bpm	K	98.6667	19.45936	7.94425	-2.391	0.038
		E	120.8333	11.70328	4.77784		
After 5 min of recovery	Response time, s	K	0.2966	0.01735	0.00708	1.056	0.316
		E	0.2852	0.01996	0.00815		
	HR, bpm	K	71.6667	8.21381	3.35327	1.729	0.125
		E	65.1667	4.16733	1.70131		

After completing the training program in flat terrain conditions, the participants were retested. According to the results of testing in the control group after the experiment, the results of the "International Test", which displays the reaction time, significantly improved. Significant differences ($p<0.05$) were found in the test, which displays the reaction time before load, after load, 1 minute after recovery and 5 minutes after recovery (Table 2).

After completion of the training program, the participants in the experimental group were tested. The test results showed a significant improvement ($p<0.05$) in resting HR and a significant improvement ($p<0.05$) in the "Test International" after 5 minutes after recovery (Table 3).

When comparing the test results of the control and experimental groups after completing the training program in flat terrain conditions, no significant differences were observed (Table 4).

At the third stage of the experiment, climbers in the control and experimental groups climbed Mount Kazbek (5033m) of the Caucasus mountain range. At an altitude of 1900 m above sea level at Base Camp 1, after an overnight stay at this altitude, the functional and psychophysiological state of the climbers was tested. Significant differences were observed in the test indicators, reflecting the reaction time in the state ($p<0.05$) (Table 5).

Participants were tested after an overnight stay at Base Camp 2 at an altitude of 3200 m. The experimental group performed significantly better in tests showing HR and reaction time before load and 5 minutes post-load recovery ($p<0.05$) (Table 6).

The altitude factor was found to have no significant effect on the pre-exercise reaction time in both the control and experimental groups ($p>0.05$) (Table 7, 8). However, there was a significant effect of altitude on post-exercise reaction time in both control and experimental groups ($p<0.05$) (Table 7, 8). HR was significantly influenced by altitude in both control and experimental groups. However, in the control group this influence is stronger in comparison with the experimental group. Thus, the effect of altitude on pre-load HRR was significant at F=42.552 ($p<0.001$) in the control group whilst the effect of altitude on HRR was significant at F=16.786 ($p<0.001$) in the experimental group (Table 7, 8). The effect of altitude on post-load HR in the control group is significant at F=12.543 ($p<0.001$), while in the experimental group the effect is significant at a lower level of significance: F=7.061 ($p<0.01$) (Tables 7, 8). The most significant differences in the effect of altitude on HR between the control and experimental groups were found for HR after 1 minute and after 5 minutes of recovery. Thus, in the control group, the effect of altitude on HR measured after 1 minute of recovery was significant at F=12.158 ($p<0.001$) and in the experimental group at F=3.871 ($p<0.05$) (Tables 7, 8). The effect of altitude on HR measured after 5 min of recovery in the control group is significant at F=24.109 ($p<0.001$), while in the experimental group this effect is significantly less pronounced and significant at a lower level than the control group at F=6.581 ($p<0.01$) (Tab. 7, 8).

Table 2

Test results of control group climbers (n = 6) before and after the experiment

Testing time	Name of metrics	Group	Statistical Indicators				
			$\bar{x}$	S	m	t	p
Before standard load	Response time, s	K_1	0.044	0.966	0.01144	2.624	0.025
		K_2	0.2671	0.00860	0.00351		
	HR, bpm	K_1	66.0000	7.29383	2.97769	1.222	0.250
		K_2	61.3333	5.85377	2.38979		
After standard load	Response time, s	K_1	0.3452	0.05584	0.02280	2.663	0.024
		K_2	0.2817	0.01704	0.00696		
	HR, bpm	K_1	128.1667	10.59088	4.32371	1.617	0.137
		K_2	116.0000	15.08642	6.15900		
After 1 min of recovery	Response time, s	K_1	0.3491	0.06300	0.02572	2.876	0.017
		K_2	0.2738	0.01198	0.00489		
	HR, bpm	K_1	98.6667	19.45936	7.94425	-0.268	0.794
		K_2	101.6667	19.31493	7.88529		
After 5 min of recovery	Response time, s	K_1	0.2966	0.01735	0.00708	2.933	0.015
		K_2	0.2596	0.02553	0.01042		
	HR, bpm	K_1	71.6667	8.21381	3.35327	0.021	0.983
		K_2	71.5000	17.24819	7.04154		

Table 3

Test results of the climbers in the experimental group (n = 6) before and after the experiment

Testing time	Name of metrics	Group	Statistical Indicators				
			$\bar{x}$	S	m	t	p
Before standard load	Response time, s	E_1	0.2779	0.02397	0.00979	1.038	0.324
		E_2	0.2612	0.03126	0.01276		
	HR, bpm	E_1	66.0000	5.21536	2.12916	2.781	0.019
		E_2	57.6667	5.16398	2.10819		
After standard load	Response time, s	E_1	0.3442	0.03930	0.01605	1.734	0.114
		E_2	0.3036	0.04163	0.01700		
	HR, bpm	E_1	133.8333	9.38971	3.83333	0.044	0.966
		E_2	133.5000	15.93424	6.50513		
After 1 min of recovery	Response time, s	E_1	0.3150	0.01589	0.00649	0.848	0.416
		E_2	0.3015	0.03572	0.01458		
	HR, bpm	E_1	120.8333	11.70328	4.77784	0.061	0.953
		E_2	120.1667	24.11984	9.84688		
After 5 min of recovery	Response time, s	E_1	0.2852	0.01996	0.00815	3.659	0.004
		E_2	0.2495	0.01314	0.00536		
	HR, bpm	E_1	65.1667	4.16733	1.70131	-0.152	0.882
		E_2	65.8333	9.86745	4.02837		

Table 4

Test results of climbers in the control group (n = 6) and the experimental group (n = 6) after the experiment

Testing time	Name of metrics	Group	Statistical Indicators				
			$\overline{x}$	S	m	t	p
Before standard load	Response time, s	K	0.2671	0.00860	0.00351	0.446	0.665
		E	0.2612	0.03126	0.01276		
	HR, bpm	K	61.3333	5.85377	2.38979	1.151	0.277
		E	57.6667	5.16398	2.10819		
After standard load	Response time, s	K	0.2817	0.01704	0.00696	-1.195	0.260
		E	0.3036	0.04163	0.01700		
	HR, bpm	K	116.0000	15.08642	6.15900	-1.954	0.079
		E	133.5000	15.93424	6.50513		
After 1 min of recovery	Response time, s	K	0.2738	0.01198	0.00489	-1.796	0.103
		E	0.3015	0.03572	0.01458		
	HR, bpm	K	101.6667	19.31493	7.88529	-1.467	0.173
		E	120.1667	24.11984	9.84688		
After 5 min of recovery	Response time, s	K	0.2596	0.02553	0.01042	0.863	0.408
		E	0.2495	0.01314	0.00536		
	HR, bpm	K	71.5000	17.24819	7.04154	0.699	0.501
		E	65.8333	9.86745	4.02837		

Table 5

Test results of climbers in the control group (n = 6) and the experimental group (n = 6) at 1900 m

Testing time	Name of metrics	Group	Statistical Indicators				
			$\overline{x}$	S	m	t	p
Before standard load	Response time, s	K	0.2886	0.02433	0.00993	3.686	0.004
		E	0.2497	0.00867	0.00354		
	HR, bpm	K	74.6667	5.95539	2.43128	0.437	0.671
		E	73.3333	4.50185	1.83787		
After standard load	Response time, s	K	0.3374	0.04138	0.01689	0.517	0.616
		E	0.3255	0.03831	0.01564		
	HR, bpm	K	139.6667	7.60701	3.10555	-0.793	0.446
		E	143.6667	9.72968	3.97213		
After 1 min of recovery	Response time, s	K	0.3264	0.03533	0.01442	2.282	0.069
		E	0.2931	0.00542	0.00221		
	HR, bpm	K	127.1667	16.47321	6.72516	-0.875	0.402
		E	134.6667	13.03329	5.32082		
After 5 min of recovery	Response time, s	K	0.2916	0.01758	0.00718	1.816	0.099
		E	0.2629	0.03446	0.01407		
	HR, bpm	K	88.6667	7.36659	3.00740	1.217	0.252
		E	79.6667	16.54892	6.75607		

Table 6

Test results of climbers in the control group (n = 6) and the experimental group (n = 6) at 3200 m

Testing time	Name of metrics	Group	Statistical Indicators				
			$\overline{x}$	S	m	t	p
Before standard load	Response time, s	K	0.3352	0.05357	0.02187	2.665	0.024
		E	0.2705	0.02571	0.01050		
	HR, bpm	K	98.1667	10.49603	4.28499	3.227	0.009
		E	80.3333	8.54790	3.48967		
After standard load	Response time, s	K	0.3955	0.01569	0.00640	-0.843	0.419
		E	0.4061	0.02641	0.01078		
	HR, bpm	K	147.6667	7.28469	2.97396	-1.021	0.332
		E	152.5000	9.02774	3.68556		
After 1 min of recovery	Response time, s	K	0.3653	0.03012	0.01230	-0.291	0.777
		E	0.3732	0.05966	0.02435		
	HR, bpm	K	135.8333	8.63520	3.52531	-0.270	0.793
		E	137.5000	12.40564	5.06458		
After 5 min of recovery	Response time, s	K	0.3317	0.03840	0.01568	3.163	0.010
		E	0.2587	0.04150	0.01694		
	HR, bpm	K	109.6667	6.15359	2.51219	5.745	0.000
		E	78.8333	11.61752	4.74283		

Table 7

Effect of altitude on reaction time and HR in climbers in a control group (n = 6)

ANOVA

Name of metrics	Statistical Indicators	Statistical Indicators				
		$\overline{x}$	DF	S	F	p
Response time before standard load, s	Between the groups	0.027	2	0.013	3.175	0.061
	Inside the group	0.093	22	0.004		
	Total	0.120	24			
HR before standard load, bpm	Between the groups	4762.786	2	2381.393	42.552	0.000
	Inside the group	1231.214	22	55.964		
	Total	5994.000	24			
Response time after standard load, s	Between the groups	0.027	2	0.014	7.628	0.003
	Inside the group	0.039	22	0.002		
	Total	0.066	24			
HR after standard load, bpm	Between the groups	3103.796	2	1551.898	12.543	0.000
	Inside the group	2721.964	22	123.726		
	Total	5825.760	24			
Response time after 1 min of recovery, s	Between the groups	0.012	2	0.006	2.646	0.003
	Inside the group	0.050	22	0.002		
	Total	0.061	24			
HR after 1 min of recovery, bpm	Between the groups	6033.286	2	3016.643	12.158	0.000
	Inside the group	5458.714	22	248.123		
	Total	11492.000	24			
HR after 5 min of recovery, bpm	Between the groups	5811.761	2	2905.881	24.109	0.000
	Inside the group	2651.679	22	120.531		
	Total	8463.440	24			

Table 8

Effect of altitude on reaction time and HR in climbers in the experimental group (n = 6)

Name of metrics	Statistical Indicators	Statistical Indicators				
		Sum of squares	DF	S	F	p
Response time before standard load, s	Between the groups	0.005	2	0.002	2.387	0.115
	Inside the group	0.022	22	0.001		
	Total	0.026	24			
HR before standard load, bpm	Between the groups	2871.873	2	1435.937	16.786	0.000
	Inside the group	1881.967	22	85.544		
	Total	4753.84	24			
Response time after standard load, s	Between the groups	0.036	2	0.018	11.661	0.000
	Inside the group	0.034	22	0.002		
	Total	0.07	24			
HR after standard load, bpm	Between the groups	1678.793	2	839.397	7.061	0.004
	Inside the group	2615.367	22	118.88		
	Total	4294.16	24			
Response time after 1 min of recovery, s	Between the groups	0.025	2	0.013	9.667	0.001
	Inside the group	0.029	22	0.001		
	Total	0.054	24			
HR after 1 min of recovery, bpm	Between the groups	1780.165	2	890.083	3.871	0.036
	Inside the group	5058.875	22	229.949		
	Total	6839.04	24			
HR after 5 min of recovery, bpm	Between the groups	2583.765	2	1291.883	6.581	0.006
	Inside the group	4318.875	22	196.313		
	Total	6902.64	24			

Discussion

Thus, the author's flatland methodology for improving functional ability had an effect on both reaction time and HR measured at different altitudes. However, the effect of altitude on HR was more pronounced in the control group. This is especially true for HR measured after 1 minute and after 5 minutes of recovery. From the results obtained, one can conclude that the author's method influences the adaptive capacity to altitude from the nervous and cardiovascular systems. This effect is particularly pronounced for the cardiovascular system's performance during recovery after physical exertion. We can explain this fact by the fact that the hypoxic training, which was the basis for the author's method of adaptation of mountaineers to altitude, used in the plain before the ascent, is the main component influencing the work of the cardiovascular system during the ascent to the mountain. Recovery from physical exertion is of great importance to climbers. The hypoxia that occurs with increasing altitude is due to a lack of oxygen in the air. It is known that the body's recovery from exercise is achieved by activating aerobic energy-supplying mechanisms. This requires a sufficient amount of oxygen in the inhaled air, combined with the development of the body's ability to consume the oxygen that comes with the inhaled air. We cannot influence the amount of oxygen inhaled with the air. We can, however, influence the consumption of oxygen by the body's tissues. In this respect, our technique of increasing resistance in hypoxia has a positive effect on the body's recovery from the stress of natural hypoxia, as seen when climbing mountains.

Early studies show changes in performance at high altitude in amateur athletes and the need to adapt training loads [19]. The authors also state that aerobic training should be included in high altitude training as athletes need to tolerate fatigue and strenuous and prolonged exertion under conditions of severe hypoxia at high altitude and cope with an unstable and hazardous environment [20,21]. Interval training and aerobic exercise improves maximum oxygen uptake [22]. In order to train high-altitude mountaineers it is necessary to use special programs with high-tech equipment and prolonged training in mountainous terrain with a more pronounced gradient

So, the method has been developed for amateur athletes, it has simplified to the maximum the means in preparation for high altitude, which the authors in earlier studies displayed preparation in conditions of flat terrain with application of hypoxic training for skilled sportsmen. Our study recommends cross-country, gradient training. As we have proven that aerobic training without the use of altitude and running steps is less effective. The authors recommend training on exercise bikes in different modes. However, this kind of training is not enough, because it does not involve all the muscles that are involved in walking with a backpack. We have included in the training exercises for strengthening the back muscles in the block of general physical preparation. This opinion is shared by Kyyko in his works [11,12].

Conclusions

The present study has shown that the author's methodology influences the adaptive capacity to altitude on the nervous and cardiovascular systems. The effect is particularly pronounced on the cardiovascular system performance during recovery from physical exertion. Our method of increasing resistance to hypoxia has a positive effect on the body's recovery after exercise in conditions of natural hypoxia, observed when climbing mountains. We recommend the use of this technique to prepare for high altitude mountaineering in flat terrain conditions for amateur climbers.

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Conflict of interest

The authors declare that there is no conflict of interest.

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