МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ

ВИЩИЙ ДЕРЖАВНИЙ НАВЧАЛЬНИЙ ЗАКЛАД УКРАЇНИ

«БУКОВИНСЬКИЙ ДЕРЖАВНИЙ МЕДИЧНИЙ УНІВЕРСИТЕТ»

HIGHER STATE EDUCATIONAL ESTABLISHMENT OF UKRAINE

"BUKOVINIAN STATE MEDICAL UNIVERSITY"

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KLINICHNA TA EKSPERIMENTAL'NA PATOLOGIYA

CLINICAL & EXPERIMENTAL PATHOLOGY

На всі статті, опубліковані в журналі «Клінічна та експериментальна патологія», встановлюються цифрові ідентифікатори DOI

Т. XIX, №2 (72), 2020

Щоквартальний український науково-медичний журнал. Заснований у квітні 2002 року

Свідоцтво про державну реєстрацію Серія КВ №6032 від 05.04.2002 р.

Засновник і видавець: Буковинський державний медичний університет, м. Чернівці

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Електронні копії опублікованих статей передаються до **Національної бібліотеки ім. В.І. Вернадського** для вільного доступу в режимі on-line
Реферати статей публікуються в **"Українському реферативному журналі"**, серія "Медицина"

Наказом Міністерства освіти і науки України від 11.07.2019 р., № 975 журнал "Клінічна та експериментальна патологія" включено до переліку наукових фахових видань України, категорія Б

Рекомендовано до друку та поширення через Інтернет рішенням Вченої ради вищого державного навчального закладу України «Буковинський державний медичний університет (протокол № 7 від 04.06.2020 р.)

Матеріали друкуються українською, російською та англійською мовами

Рукописи рецензуються. Редколегія залишає за собою право редагування

Передрук можливий за письмової згоди редколегії

Комп'ютерний набір і верстка – В.Г. Майданюка
Наукове редагування – редакції

Редагування англійського тексту – Г.М. Лапи

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Група технічно-інформаційного забезпечення:
І.Б. Горбатюк
Л.І. Сидорчук
В.Д. Сорохан

ISSN 1727-4338
DOI 10.24061/1727-4338. XIX.2.72.2020

Founded in 2002
Publishing four issues a year

THE EFFECT OF SHORT-TERM INHALATIONS WITH CONCENTRATED OXYGEN ON TOLERANCE DURING VARIOUS TYPES OF PHYSICAL ACTIVITY IN YOUNG HEALTHY PEOPLE

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Key words: *short-term inhalations with concentrated oxygen, tolerance, physical activity, young healthy people.*

Clinical and experimental pathology. Vol.19, №2 (72). P. 78-84.

DOI:10.24061/1727-4338. XIX.2.72.2020.11

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Abstract. *The article presents the results of a study concerning the effect of short-term inhalations with concentrated oxygen on tolerance during various types of physical activity in young healthy people.*

Material and methods. *The study involved 30 healthy volunteers mean age 23.6±3.78 years. The complex of general clinical investigations included functional tests of Ruffier, Stange, Genche was used.*

Results of investigation. *It was found that running speed per 100 m after inhalation of highly concentrated oxygen increased 14.6%, which is significantly better than in control group 1 ($p<0.05$). The 500 m running speed increased 10.6% ($p<0.05$) after the course of oxygen inhalation, as well as an increase in anaerobic reserve and maximum aerobic capacity ($p_1<0.05$). The result of the parameter of limitation of the number of flexions and extensions of the hands in supine support in-group 1 was lower (18.6%) than the result of group 2 ($p<0.05$). As a whole, after the short-term inhalation of highly concentrated oxygen, the indicator under study increased 38.5% over the initial data.*

Conclusions. *Short-term inhalations with concentrated oxygen increase tolerance at different types of physical activity in young healthy people.*

Ключові слова: *короткочасні інгаляції з концентрованим киснем, толерантність, фізичні навантаження, молоді здорові люди.*

Клінічна та експериментальна патологія 2020. Т.19, №2(72). С.78-84.

ВПЛИВ КОРОТКОЧАСНИХ ІНГАЛЯЦІЙ ІЗ КОНЦЕНТРОВАНИМ КИСНЕМ НА ТОЛЕРАНТНІСТЬ ДО ФІЗИЧНОГО НАВАНТАЖЕННЯ ПРИ РІЗНИХ ТИПАХ ФІЗИЧНОЇ АКТИВНОСТІ У МОЛОДИХ ЗДОРОВИХ ЛЮДЕЙ

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Мета роботи *– дослідити вплив короткочасних інгаляцій із концентрованим киснем на толерантність до фізичного навантаження при різних типах фізичної активності у молодих здорових людей.*

Матеріал і методи. *У дослідження включено 30 здорових добровольців, середній вік (23,6±3,78) років. Комплекс загальних клінічних досліджень включав функціональні тести Руф'є, Штанге, Генче.*

Результати. *Встановлено, що швидкість бігу на 100 м після вдихання висококонцентрованого кисню зросла на 14,6%, що значно вище, ніж у контрольній групі ($p<0,05$). Швидкість бігу на 500 м зросла на 10,6% ($p<0,05$) після курсу інгаляцій, також виявлено збільшення анаеробного резерву та максимальної аеробної здатності ($p_1<0,05$). Обмеження кількості згинань і розгинань рук у положенні лежачи на спині в групі 1 було нижчим (на 18,6%), ніж у групі 2 ($p<0,05$). Загалом, після короткочасного вдихання висококонцентрованого кисню досліджуваний показник збільшився на 38,5% порівняно з вихідними даними.*

Висновки. *Короткочасні інгаляції концентрованого кисню підвищують толерантність до різних видів фізичного навантаження у молодих здорових людей.*

Ключевые слова: *кратковременные ингаляции с концентрированным кислородом, переносимость, физическая активность, молодые здоровые люди.*

Клиническая и экспериментальная патология Т.19, №2 (72). С.78-84.

ВЛИЯНИЕ КРАТКОВРЕМЕННЫХ ИНГАЛЯЦИЙ С КОНЦЕНТРИРОВАННЫМ КИСЛОРОДОМ НА ТОЛЕРАНТНОСТЬ К ФИЗИЧЕСКОЙ НАГРУЗКЕ ПРИ РАЗЛИЧНЫХ ТИПАХ ФИЗИЧЕСКОЙ АКТИВНОСТИ У МОЛОДЫХ ЗДОРОВЫХ ЛЮДЕЙ

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Цель работы *– исследовать влияние кратковременных ингаляций с концентрированным кислородом на толерантность к физической нагрузке при различных видах физической активности у молодых здоровых людей.*

Материал и методы. *В исследовании приняли участие 30 здоровых добровольцев, средний возраст (23,6±3,78) года. Комплекс общеклинических исследований включал функциональные пробы Ruffier, Stange, Genche.*

Результаты. *Установлено, что скорость бега на 100 м после вдыхания высококонцентрированного кислорода увеличилась на 14,6%, что значительно*

выше, чем в контрольной группе 1 ($p<0,05$). Скорость бега на 500 м увеличилась на 10,6% ($p<0,05$), отмечены прирост анаэробного резерва и максимальной аэробной емкости ($p_1<0,05$). Ограничение количества сгибаний и разгибаний рук в положении лежа на спине в 1-ой группе было ниже (на 18,6%), чем в группе 2 ($p<0,05$). В целом, после кратковременного вдыхания высококонцентрированного кислорода исследуемый показатель увеличился на 38,5% по сравнению с исходными данными.

Выводы. *Кратковременные ингаляции концентрированного кислорода повышают толерантность к разным видам физических нагрузок у молодых здоровых людей.*

Actuality

For nearly a hundred years, oxygen is used in a gaseous state in steel tanks. Application of oxygen is also used for respiratory and circulatory problems, but this method is not only limited to therapy, and its potential to influence ability to work and performance has also been studied [3, 5].

The positive effect of using concentrated oxygen in sport was set in the numerous researches [2, 4, 6, 8]. However, some studies have not confirmed any benefits for such usage, especially for medium to long periods of exertion, as well as for short periods of submaximal or maximal exertion [9]. The one-off or repeated short-term application of oxygen or hyperoxic mixes has a temporary effect: the increase in oxygen concentration in the tissue is temporary, but it can be used to speed up recovery during exertion of an intermittent character [7].

In other works the influence of hyperoxia on the tolerance for physical activity, oxygen consumption during performance, oxidative metabolism, lactate response during and after exertion and the partial pressure of oxygen were demonstrated [1]. Substantially less work has been published examining the influence of hyperoxia on recovery following physical exertion [11].

Motor activity is one of the important conditions for harmonious development. Lack of mobility entails a malfunction of many body systems. The result of physical inactivity is a decrease in the body's resistance to infectious and respiratory diseases, favorable conditions created for the formation of a weak untrained heart, which in the future can lead to the development of cardiovascular failure [10].

Information concerning the effect of aerobic performance on the functional state of healthy people is very fragmented and, as a rule, refers to individual indicators. Therefore, despite the available data, the possibilities of increasing exercise tolerance remain open [4].

The purpose of the study is to identify the characteristics of the reaction of the functional systems of the body and the dynamics of tolerance to physical activity in healthy people with high and low levels of aerobic power development after regular short-term inhalations of highly concentrated oxygen.

Material and methods of investigation

The study involved 30 healthy volunteers (20 men and 10 women) aged 20–28 years (mean age - 23.6±3.78 years), assigned for health reasons to the main medical group. All participants in the experiment underwent a medical examination and received admission to participate in the study, and gave written informed consent to conduct the experiment in accordance with the requirements of the Helsinki Declaration. No subjects during the two weeks prior to the study were ill, did not smoke or drink strong drinks.

The following research methods are used in the study: general clinical and special examination. The complex of general clinical studies included: data of an objective investigation and examination, measurement of blood pressure, functional tests (Ruffier, Stange, Genche), electrocardiographic examination (ECG).

Systolic (SBP) and diastolic (DBP) blood pressure was measured in accordance with WHO recommendations. The ECG performed by SILER and MAC-1200 ST equipment.

As indicators of fitness training, the results of strength exercises were used (flexion and extension of the body from a supine position; flexion and extension of the arms while lying down), while running at a distance of 100, 500, 2000 m, as well as in long jumps from a stand. Based on the listed indicators, the running speed was calculated. Assessment of speed-power qualities was carried out based on long jumps from a place. Strength endurance was assessed by the results of the limiting number of flexion and extension of the body from the supine position with the legs fixed and the limiting number of flexion and extension of the arms while lying down.

Another study, the Ruffier test, was aimed at assessing the performance of the heart and the training of the body as a whole. In a test person in a resting position, for 5 minutes measures the pulse for 15 s. (R1), then he needs after 45 seconds to complete 30 squats. After that, the number of beats per minute (bpm) in the first 15 s was counted at rest (R2) and the last 15 s. (R3), i.e., from the first minute of the recovery period. In order to obtain the Ruffier index, according to which the fitness training of the heart is evaluated, the formula IR = (4 (R1 + R2 + R3) - 200) / / 10 is used.

The next step was to carry out a functional test of Stange, which made it possible to determine the level of the state of the respiratory and cardiovascular systems, to assess the test's resistance to hypoxemia with a prolonged holding of breath after inhalation. Within 5 minutes the people were in a sitting position, then after a warm-up, which consisted of two or three full breaths and exhalations, they performed close to the deepest possible breath.

Next, the people were carried out a Genche's test, which consisted of determining the maximum arbitrary breath holding on exhalation, which makes it possible to assess the test's resistance to a decrease in the oxygen content in the blood, i.e., hypoxemia. Evaluation of the

results was carried out in accordance with the accepted indicators: unsatisfactory indicator - less than 39 s., satisfactory - 40-49, good - over 50 s.

People were divided into two groups: In group 1 (control) inhalations with high concentrated oxygen were not used (n=16), in group 2 conducted inhalations of high concentrated oxygen (Tesla's Secret by Eco Medical Europe Ltd Oxygen Breathing Mixture, Natural, group 2, n=14). In the group 2 inhalations were conducted with 3 breathing per minute three times (totally 3 minutes) twice per day for the 1 month duration. The results of each study were set into database.

For statistical analysis of the obtained results, we used Statistica for Windows Version 10.0 (Stat Soft inc., USA). Parameters presented in M±m, where M is the mean, m - is standard deviation. At the case of $p<0.05$, differences were statistically significant.

Research results and discussion

Assessment of the dynamics of speed abilities, carried out according to the results of running 100 m, indicates a positive dynamics of this index. It was found that in comparison with the initial data, the running speed increases 14.6% (the time to overcome the distance of 100 m decreases) after a course of short-term inhalations of highly concentrated oxygen ($p<0.05$), which was significantly better than in group 1 ($p_1<0.05$), table 1.

Table 1

Parameters, characterized aerobic type of physical activity in the groups of observation

Parameters	Group 1		Group 1	
	Initial	*At the end of observation*	*Initial*	*At the end of observation*
Running 100 m, sec	17.5±1.56	16.8±1.86	17.3±1.12	15.1±1.17*
Running 500 m, sec	125.6±5.71	119.7±6.45*	124.8±4.81	112.5±5.12*
Running 2000 m, sec	673.4±24.5	660.1±25.8	668.4±25.1	659.1±26.2

Note: **-reliability of the difference in comparison with the initial data, $p<0.05$.*

The calculation of the running speed at 500 m, which showed mainly the reflection of state of the lactic acid system, improved 10.6% ($p<0.05$). All this indicates an increase in overall endurance in the subjects, as well as an increase in the anaerobic reserve and maximum aerobic capacity compared with the control group ($p_1<0.05$), tab. 1.

The 2000 m run result, used to assess the aerobic capacity of the body, showed a slight increase in run speed by 2000 m ($p>0.05$) when using short-term inhalations of highly concentrated oxygen, which did not differ from the control group ($p_1>0.05$). The obtained results correlate with the literature data and reflect the improvement of the aerobic capacity of the body [9], tab. 1.

An analysis of the results of long jumps from a place (broad jump) reflecting the dynamics of speed-power qualities (Tab. 2) showed that the obtained result in

Table 2

Parameters, characterized anaerobic type of physical activity in the groups of observation

Parameters	Group 1		Group 1	
	Initial	*At the end of observation*	*Initial*	*At the end of observation*
Push-up exercises, max	14.5±1.12	16.7±1.45*	14.3±1.29	19.8±1.31*
Press-up exercises, max	40.6±4.12	41.8±4.81	41.6±3.89	48.4±4.48*
Broad jump, sm	165.1±12.2	165.6±14.7	164.2±13.9	166.7±14.2

Note:**-reliability of the difference in comparison with the initial data, $p<0.05$.*

group 2 was slightly higher than the similar one in group 1, while the difference was unreliable (p, $p_1>0.05$). The data obtained allow us to conclude that the length of a jump from a place is a relatively stable indicator that does not respond to short-term effects, including the effect of inhalation of highly concentrated oxygen. It is possible that speed-power qualities are more stable compared to aerobic types of physical activity.

Strength endurance was evaluated based on the limiting number of flexion and extension of the arms while lying down (push-up exercises). The result obtained in the dynamics of observation in group 1 (Tab. 2) was lower (18.6%) of the similar result of group 2 ($p<0.05$). In general, the studied indicator after a course of short-term inhalations of highly concentrated oxygen increased 38.5% compared with the initial indicator.

This indicates a positive effect of aerobic conditions on the degree of maximum muscle strength and muscle endurance. Improving muscle strength is probably associated with a more effective mechanism for extra-muscular and intramuscular coordination under aerobic conditions.

In addition, an increase in muscle endurance under conditions of inhalation of highly concentrated oxygen is apparently associated with an increase in aerobic and anaerobic capabilities. It is possible that another reason is the increase in the power of the phosphorgenic system, which revealed by analyzing the running speed by 100 m.

An analysis of the maximum number of flexion and extension of the body from the supine position, reflecting the maximum strength and endurance of the abdominal muscles revealed (Tab. 2) that there is an increase in this indicator in group 2 (16.3%) versus group 1 (3.0%; p, p_1<0.05). The reasons for improving this indicator are the same as those described above. We note that the dynamics of these two results are similar, but more pronounced for the muscles involved in flexion and extension of the arms in the supine position (including the biceps and triceps muscles of the shoulder, pectoral muscles, and deltoid muscles) compared with the abdominal muscles.

Analyzing the Ruffier test, we can conclude that the performance in young people after a course of inhalation of highly concentrated oxygen was significantly higher than in group 1. In group 2, 8 people had good heart function. (Ruffier test is up to 3 points), the average result was in 6 people (3-6 points). The control group examined showed an average (8 people) and a satisfactory result (9 people - 7-9 points). The degree of improvement in physical performance was 2.8% in the main group (from 7.1±0.89 to 6.9±0.67 points), 63.6% (from 7.2±0.91 to 4.4±0.12 points) - in the control, Fig. 1; p, p_1<0.05.

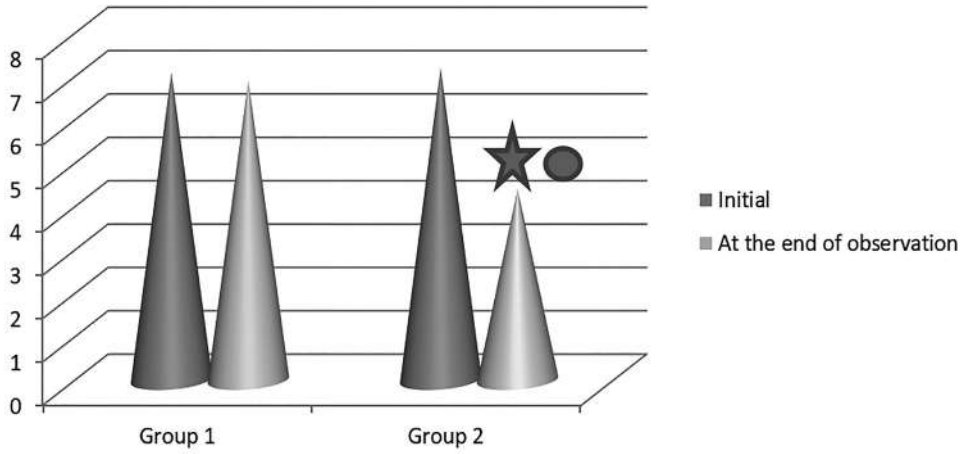

Fig. 1. The dynamics of Ruffier test in observational groups.

★ - *reliability of the difference in comparison with the initial data, p<0.05;*

● - *significance of the difference compared with the data after period of observation, p_1<0.05.*

According to the results of the Stange and Genche tests, it is evident that after the course of inhalation of highly concentrated oxygen, people undergoing the research had increased reserve capabilities of the respiratory system, Fig. 2 and 3.

After the course of training and highly concentrated inhalations, the Stange test index in group 2 increased 20.0% (from 45±4.12 to 54±3.26 sec.) against group 1 (6.7%, from 45±3.81 to 48±2.56 sec.); p, p_1<0.05.

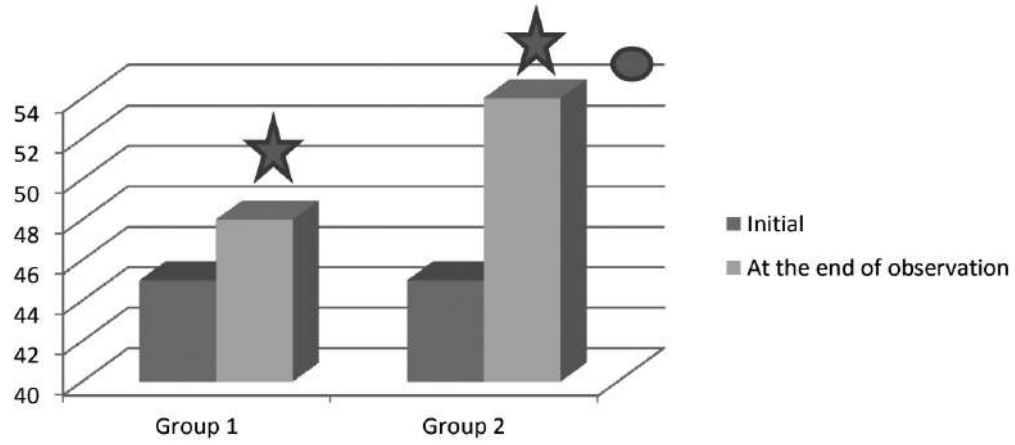

Fig. 2. The dynamics of Stange test in observational groups.

★ - *reliability of the difference in comparison with the initial data, p<0.05;*

● - *significance of the difference compared with the data after period of observation, p_1<0.05.*

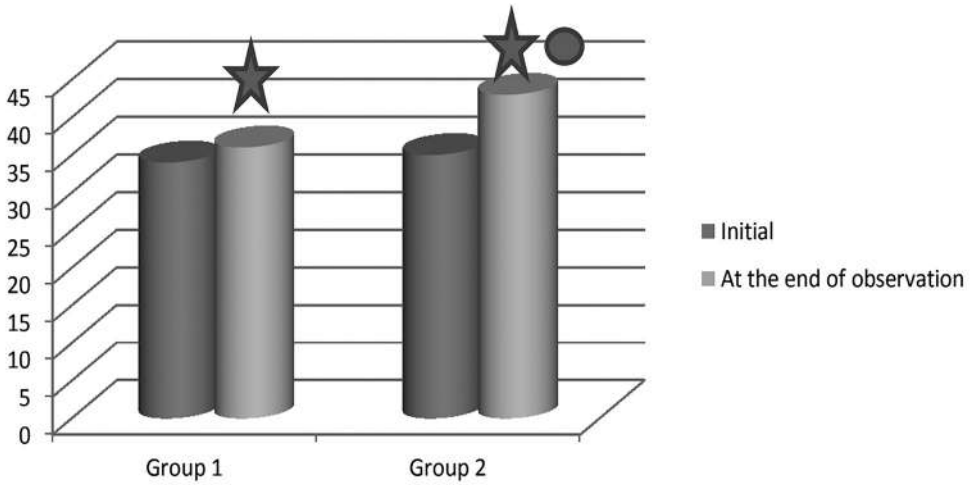

Fig. 3. The dynamics of Genche test in observational groups.

★ *- reliability of the difference in comparison with the initial data, p<0.05;*

● *- significance of the difference compared with the data after period of observation, p_1<0.05.*

The dynamics of the Genche test changes are presented in Fig. 3 and amounted to 22.9% in the main group (from 35±3.45 to 43±4.76 sec.) and to 5.9% in the control group (from 34±3.12 to 36±3.1 sec.), p, p_1<0.05.

Based on the foregoing, we can conclude that inhalation of highly concentrated oxygen really helps to increase the level of tolerance to physical activity of a different nature, the functional state of the body, as well as the reserve capabilities of the respiratory system.

Conclusions

1. It was found that in comparison with the initial data, the running speed per 100 m after inhalation of highly concentrated oxygen increases 14.6%, which is significantly better than in group 1 (p_1<0.05).

2. A running speed of 500 m, reflecting the state of the lactic acid system, increases 10.6% (p<0.05) after a course of oxygen inhalation, which indicates an increase in overall endurance in people, as well as an increase in anaerobic reserve and maximum aerobic capacity compared to the group control (p_1<0.05).

3. The result of running 2000 m showed a slight increase in speed (p>0.05) using short-term inhalations of highly concentrated oxygen, which did not differ from the control group (p_1>0.05). An analysis of the results of long jumps from a place reflecting the dynamics of speed-power qualities showed that the obtained result in group 2 was slightly higher than the similar one in group 1, while the difference was unreliable (p, p_1>0.05).

4. The result obtained in the dynamics of observation for the parameter of the limiting number of flexion and extension of the arms in supine position in group 1 was lower (18.6%) of the similar result in group 2 (p<0.05). In general, the studied indicator after a course of short-term inhalations of highly concentrated oxygen increased 38.5% compared with the initial one.

5. Analysis of the limiting number of flexion and extension of the body from the supine position, reflecting the maximum strength and endurance of the abdominal muscles, revealed that there is an increase in this index in group 2 (16.3%) against group 1 (3.0%, p, p_1<0.05).

6. Analyzing the results of the Ruffier test, we can conclude that the performance in young people after a course of inhalation of highly concentrated oxygen was significantly higher than in group 1 - 2.8% in the main group (from 7.1±0.89 to 6.9±0, 67 points), 63.6% (from 7.2±0.91 to 4.4±0.12 points) - in the control group.

7. After the course of training and highly concentrated inhalations, the Stange test index in group 2 increased 20.0% (from 45±4.12 to 54±3.26 sec.) against group 1 (6.7%, from 45±3.81 to 48±2.56 sec.); p, p_1<0.05. The dynamics of the Genche test was 22.9% in the main group (from 35±3.45 to 43±4.76 sec.), 5.9% in the control group (from 34±3.12 to 36±3.1 sec.), p, p_1<0.05.

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Стаття надійшла до редакції 6.05.2020
Рецензент – проф. Ткачук С.С.