

POSSIBILITY OF APPLICATION OF  
INTERVAL HYPOXIC HYPOBARIC TRAINING  
COURSE FOR INCREASING COGNITIVE  
RESERVE OF ATHLETES-BOXERS



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**Анотація**

В умовах штучного гіпоксичного гіпобаричного тренування моделюються кліматичні умови гірської місцевості, де головним дійовим чинником є зниження парціального тиску кисню у вдихуваному повітрі, що запускає реакції адаптації, в яких беруть участь всі органи і системи.

В результаті запропонованого курсу гіпобаричної адаптації у 30 спортсменів-боксерів збільшилися показники ресурсів когнітивних функцій в лобових частках, переважно довірливої уваги (амплітуда хвилі P300). Також отримані дані були підтверджені за допомогою тесту «цифрової послідовності».

**Ключові слова:** когнітивний резерв, інтервальна гіпоксичного тренування, барокамера, гіпоксія, гіпобаричне тренування, спортсмени, боксери.

**Аннотация**

В условиях искусственной гипоксической гипобарической тренировки моделируются климатические условия горной местности, где главным действующим фактором является снижение парциального давления кислорода во вдыхаемом воздухе, что запускает реакции адаптации, в которых участвуют все органы и системы.

В результате предложенного курса гипобарической адаптации у 30 спортсменов-боксеров увеличились показатели ресурсов когнитивных функций в лобных долях, преимущественно произвольного внимания (амплитуда волны P300). Также полученные данные были подтверждены с помощью теста «цифровой последовательности».

**Ключевые слова:** когнитивный резерв, интервальная гипоксическая тренировка, барокамера, гипоксия, гипобарическая тренировка, спортсмены, боксеры.

**Problem statement.**

Hypoxia is one of the most powerful factors modifying metabolic processes in the body. Methods of increasing nonspecific resistance of the body are known at present as well as prevention of various diseases by means of hypoxic training in the mountains, in a pressure chamber under low pressure, equivalent to the conditions of rising to different altitudes (hypobaric therapy) or breathing with hypoxic mixtures (with low oxygen content) under ground-based conditions (normobaric therapy) [3]. Factors affecting athletes in the environment of intensive training and competitive process can be attributed to extreme ones for a person.

Sport competitions require significant physical and emotional costs and accompanying environmental conditions refer to a serious exposure of external factors on the body of athletes. Such effects start a whole series of response reactions in human organs and tissues as a result of which, changes in the body may have important pathogenetic significance for the formation of health disorders.

This creates premises for the growth of somatic morbidity in athletes. According to M.M. Bulatova and V.N. Platonov [3], A.Z. Kolchinskaya [9], and also other au-



thors [4, 5, 6, 11] such a condition is indicated as a syndrome of chronic adaptive overstrain based on endocrine and metabolic changes in the body.

One of the methods is the use of interval hypobaric hypoxic training based on the concept of cross-adaptation in which emergence of resistance to one external factor increases the body's resistance to the whole complex of different effects.

Climatic conditions of mountainous terrain are artificially modeled in the pressure chamber where the main functioning factor is the decrease of partial pressure of oxygen in inhaled air (i.e. artificially established hypoxia). Under conditions of moderate hypoxia minute volumes of respiration and blood circulation raise and then intracellular protective adaptive adjustment reactions, in which all organs and systems participate, start.

The use of available and effective interval hypobaric hypoxia instead of costly stay in conditions of continuous hypoxia during training in the mountains is a perspective and economically grounded method [1, 9, 10]. With daily comparatively short sessions of hypoxia (1, 5 hours) each session is replaced by normal entry of oxygen into the body which creates optimal conditions for rehabilitation. During the course of interval hypoxia the body does not withdraw from staying in conditions of normal atmospheric pressure.

In connection there are no effects of deadadaptation which may cause disturbance of working capacity after descent to the plain of people having been in the mountains for a long time. Duration of adaptive effect retention after finishing the effect of interval and continuous hypoxia is almost identical. However, the body's resistance to hypoxia after interval adaptation is more significant than after a continuous one.

The method of interval hypobaric hypoxic training due to its efficiency, simplicity of use and econ-

omy has found wide application in the process of training athletes in a number of leading countries in the world [4, 5, 9, 12, 13].

Oxygen deficiency and intense muscular activity activate similar physiological processes. The effect of cross adaptation allows to rely on the possibility of using hypoxia with the purpose of improving athletes working capacity.

Performance level of highly qualified athletes is determined by many components: coordination of the body systems in the process of muscular activity, capabilities of the cardiorespiratory system, activity of tissue enzymes. In overtraining there is, first of all, violation of coordination processes [2, 4, 5, 7].

**Analysis of recent research and publications.** The search for ways of optimizing organization of training athletes at present is increasingly aimed at the subject of activity and more precisely to the search for such training programs that allow to take into account individual characteristics of athletes and due to this purposefully effect the athlete's body developing its powerful and compensating weak spots.

In this review of the literature data we want to pay attention to the effect of hypoxic exercise in the training of athletes.

In the recent decades the method of experimental hypoxic training which involves the use of hypobaric and (or) normobaric hypoxia in intermittent (interval) mode has received a widespread use in sports. There are numerous data on high efficiency of interval hypoxic training in improving physical working capacity and sports results in various sports [2, 4, 5, 6, 8, 10, 13]. At the same time there are data that a 2-week course of interval hypoxic training on efficiency corresponds to a monthly stay of athletes in the middle altitude [9]. It should be noted that despite numerous studies on the effect of various types of hypoxia on athletes body in various sports the changes in sport re-

sults and physical working capacity are mainly considered. At the same time the mechanisms of hypoxia action on the body often remain out of researchers' side.

The recent literature data unequivocally testify to the positive effect of adaptation to the action of regulated hypoxia on the human body [1, 4, 6, 7, 8, 11]. At the same time a great variety of hypoxic effects types - normobaric, hypobaric, high-altitude; regimens as well as the time of exposure (from 30-minutes hypoxic mixture inhalation to a month stay in the mountains) often sets a difficult task in choosing a mode of hypoxic action for a coach and doctor in sports medicine.

We should not forget about so-called hypoxia load arising regularly during training and especially competitive loads. A well-proven combined method of interval hypoxic training on the basis of traditional sport training [10, 12] does not give an answer to the question of adaptation contribution to the action of regulated hypoxia into overall effect of the training process and about the role of psychoemotional factor undoubtedly making its own adjustments into the formation of a systemic structural adaptation trace, since staying of a person in the pressure chamber, in the mountains and the use of «hypoxicators» has certain psychological and emotional load.

According to duration and frequency of hypoxic exposure methods of adaptation to hypoxia may be conventionally divided into two main groups: stationary (staying in the mountains, in the pressure chamber, continuous breathing with hypoxic mixtures on the ground) and interval or pulse ones (short-term repeated hypoxic effects alternating with approximately equal time periods of reoxygenation - normo- or hyperoxic exposures). Interval hypoxic training (IHT) is carried out in the hyperbaric chamber by repeated risings to the altitude and descents to the ground. For carry-



ing out interval breathing sessions with «mountain air» on the ground «hypoxicators» creating required hypoxic gas mixtures have been developed.

Methods of hypoxic training depending on conducted conditions of the latter include: normobaric (on the ground breathing with hypoxic gas mixtures) and hypobaric (staying in the mountains and rising in the pressure chamber), when the main adaptation factor – hypoxia is combined with hypobaria - low barometric pressure [1, 4, 9, 12].

The main mechanism of adaptive effect of all hypoxic training types is due to the activation of stress-limiting urgent adaptation systems and formation of structural trace of long-term adaptation aimed at compensation of oxygen deficiency in inhaled air. The central nervous system, cardiorespiratory and hormone system, erythropoiesis and antioxidant enzymes are stimulated at the same time, RNA formation and tissue capillarization of vital organs increase, anaerobic and aerobic processes of energy formation in mitochondria are activated and become more effective, the body's defense against the effect of free radicals and peroxide products enhances [1, 3, 4, 9].

Adaptation to physical loads making the basis of training is accompanied by morphofunctional changes in somatic and visceral organs determining tolerance to the muscular activity [6, 9, 13]. A number of structural changes providing high system performance responsible for oxygen delivery take place in the body during long-term cyclic sports since just they play a determining role in providing hypermetabolism caused by muscular activity. High level of development of functional capacities of the respiratory and circulatory systems and blood determines, as a rule, high overall and special performance of athletes' bodies.

One of effective ways of hypoxic effect is staying and training in

middle altitude and moderate highland (up to 2,500-2,700 m above sea level) which have shown high efficiency in improving overall physical performance and improving sports performance of athletes [3, 9, 12]. At the same time there are difficulties in organizing and planning training sessions in the mountainous terrain connected with the duration of crossings, time zones change, diet, financial costs and etc.

In addition, it is noted that in the first days of staying in a mountain climate, athletes have a decrease in general and special working capacity which creates difficulties for planning and dosing muscular activity because in conditions of hypoxia athletes lose ability to perform usual amount and physical loads [1, 9]. Decrease in working capacity is accompanied by inadequate intensification of the cardiovascular and respiratory systems in the first days of staying at altitude and requires long term acclimatization in the middle and highland. It has been established that after return to the plain athletes have a variability in the level of working capacity which sets an urgent problem of optimal re-adaptation scheduling during which athletes are able to show high sporting result.

According to experts establishment of adequate conditions for recovery and adaptation processes can be carried out in two directions: optimizing the planning of educative - training process and targeted use of the means for recovery and improving working capacity [9, 12, 13].

The proven effect – during two or three weeks of pre-competitive training one can achieve maximum results. Such an effect cannot be achieved in other conditions even with optimal training program. Within three weeks of pre-competitive training with the use of pressure chamber the results are increased by 12-15%.

Today there isn't more effective recovery method than barotherapy. Oxygen helps the body to break

down lactic acid more actively, accelerate recovery after exercise and increase physical endurance. The use of oxygen pressure chamber leads to rapid healing of wounds and stimulates recovery after injuries.

Effectiveness in numerous sports associated with the manifestation of endurance is determined, first of all, by the condition arising from insufficient supply of oxygen to the body tissues and adaptation to this condition [1, 3, 4]. Representatives of cyclical sports encounter with the problem of hypoxia at average, long and extralong distances. There are about half in winter and one third in summer of such types of sports in the Olympic program. Oxygen insufficiency «strikes» on representatives of other sports such as figure skating, calisthenics and etc.

In sport games especially at the end of halves, periods or matches there are too frequent incomprehensible mistakes that can also be explained by acidification of working muscles and depression of the central nervous system. Therefore the main direction of training athletes in many sports is training aimed at improving of the structures providing oxygen delivery to working muscles.

The problems of using hypoxia as a means of improving working capacity of athletes have been seriously studied since the Olympics of 1968 (Mexico, Mexico). This city is located at an altitude of 2200 meters above sea level. Earlier it has been noted that athletes living in the mountains usually have a significant advantage over those who live and train in conditions of normal atmospheric pressure in those sports associated with the manifestation of endurance. It has determined the direction of scientific research related to the effect of hypoxia on working capacity.

**Objective (statement of the problem):** to assess possibility of applying the proposed course of interval hypoxic hypobaric training and to identify the possibility of us-



ing the latter to raise cognitive reserve of athletes boxers.

#### **Materials and methods:**

Pressure chamber training for periodic hypoxia increases the working capacity of athletes without increasing the muscular work, improves coordination of organs and systems and has immune-protective effect.

It allows to prevent overtraining during training and reduce the likelihood of catarrhal diseases both in the training process and in the competitive period.

30 boxers have been examined, the average age was 20.7. The hypoxic interval 90 minutes and duration of the course effect 20 sessions is justified for athletes specializing in endurance sports. At a given hypoxic interval significant increase of their working capacity can be obtained [1]. A busy schedule of training and competitions often does not allow to use fully course pressure chamber adaptation in annual training athletes.

#### **Research results and discussion.**

We have been proposes the method for alternating training in the hall with interval hypobaric training in conditions of «Ural-Antares» multi-seater medical vacuum installation.

The course of adaptation to hypoxia has began from «stage «hoistings to a height of 3-7 m / sec, «descent» - at a speed of 2-3 m / sec. And the course of adaptation to hypobaric adaptation was arranged according to the following scheme:

1<sup>st</sup> session - «height 2000 m» (Stange test before and after the session, heart rate before and after rising);

2<sup>nd</sup> Session - «height 2500 m» (duration of the session 90 min), then rising to «altitude 3000 m», (duration at the «height» 60 min);

3<sup>rd</sup> session – «height 3500 m»;

4-5<sup>th</sup> session– « height 3500 m» (heart rate before and after the session).

From the 10<sup>th</sup> session (heart rate before and after the session) –rising to “altitude 3500 m” - 30 min, ris-

ing to 4500 m («altitude 4500 m» - 5 min), descent - to 3500 m («height 3500 m» - 15 min), descent (duration of the session - 90 min).

15<sup>th</sup> session (heart rate before and after the session);

20<sup>th</sup> session (Stange test before and after the session, heart rate before and after rising to «height»).

«Ural - Antares» for boxers with a comprehensive assessment of complete blood cell test, biochemical blood test, cortisol biochemical blood test, thyroid hormone level, anxiety and depression conditions, electroencephalogram cognitive potentials of P300 wave, «digital sequence» test.

As a result of hypobaric adaptation course qualification indicators of cognitive functions resources in frontal lobes have statistically significantly increased in athletes boxers of various qualification mainly of voluntary attention (amplitude wave P300). Also obtained data have been confirmed by a «digital sequence» test.

Thus, it is shown that an adequate training effect can be achieved in athletes-boxers by increasing the interval of stationary hypoxia. Combination of hypoxia and hypobaria factors allows to withdraw negative effect of high altitudes and reduce hypoxic interval [1]. This training course can be also used in competitive period if it is necessary to improve urgently the athlete's functional condition.

Only a small part of athletes in case of climatic zone change may immediately join a competitive schedule. For the majority it takes time to restore competition form which leads to worsening of the results.

Preliminary pressure chamber adaptation to hypoxia before a trip to the midland and highland, in transmeridian flights allows to minimize the evidence of an emergency adaptation stage to hypoxia. Thus upon arrival at the competition site athletes are ready to start the pre-game training immediately without worsening athletic results achieved

on the plain [1, 7].

It is known that foothills and moderate altitudes - 1500-2500 m above sea level, which are attributed to midlands, exert the most favorable effect on humans [1, 3, 12]. It is at this altitude where the majority of well-known mountain resorts is located. Moderate hypoxia of these heights is not training for high-class athletes. At the same time it can be significant for maintaining a sport form, withdrawal of competitive period stressful situation, normalizing the function of the endocrine, immune and antioxidant systems [2, 4, 8, 10, 13].

**Conclusions:** Alternation of hyperbaric adaptation to hypoxia and training in the gym makes it possible to improve the indices of cognitive functions of athletes boxers which is physiologically justified, economically advantageous method for adapting athletes during the training process, competitive and recovery periods.

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