

THE DEGREE OF INTERVAL HYPOXIC  
TRAINING EFFECT ON THE RESPIRATORY  
SYSTEM OF BOXERS IN THE MESOCYCLE



<sup>1</sup>Kovalenko Julia, <sup>2,3</sup>Vrublevskiy Eugeni

<sup>1</sup>Vitebsk State Order of Peoples' Friendship Medical University, Belarus

<sup>2</sup>Francisk Skorina Gomel State University, Belarus

<sup>3</sup>University of Zielona Góra, Poland

**Анотація**

Метод гіпоксичного тренування, який передбачає використання гипобарической і (або) нормобарической гіпоксії в інтервальному режимі, останнім часом знаходить все більше застосування в підвищенні реалізації спортсменів в обраному виді спорту.

В статті наведено огляд літератури останніх років щодо впливу адаптації до дії різних типів гіпоксії на організм людини: нормобаричної, гипобаричної, високогірної, гіпоксії навантаженням, що визначає подальший вибір режиму гіпоксичного впливу на спортсмена.

Особливу увагу в статті приділено перевагам інтервального гіпоксичного тренування перед іншими гіпоксичними впливами. Розглянуто основні процеси, що відбуваються в організмі висококваліфікованих спортсменів у передзмагальний період, що спеціалізуються в ациклічних видах спорту (бокс), які тренувалися за авторською методикою застосування інтервального гіпоксичного тренування. Позитивний вплив курсу інтервального гіпоксичного тренування на дихальну систему організму спортсменів, що є економічно вигідним методом тренування для Республіки Білорусь, додержується не тільки у

передзмагальний, змагальний, але і у відновний періоди. Відзначено, що вона не порушує планового тренувального процесу спортсменів і може застосовуватися у поєднанні з основними засобами підготовки або окремо від них, – як додатковий засіб в період відпочинку для стимуляції і завершення відновних процесів в організмі.

Застосування штучно викликаної гіпоксії у поєднанні з різними видами повторних навантажень істотно модифікує тренувальний ефект і прискорює темпи розвитку адаптації до використовуваних фізичних навантажень.

**Ключові слова:** спорт, бокс, інтервальне гіпоксичне тренування, гіпоксія, барокамера, гипобаричне тренування.

**Аннотація**

В данной работе рассмотрены основные процессы, происходящие в организме высококвалифицированных спортсменов в предсоревновательном периоде, специализирующихся в ациклических видах спорта (бокс), которые тренировались по авторской методике применения интервальной гипоксической тренировки. Положительное влияние курса интервальной гипоксической тренировки на дыхательную систему организма спортсменов,

что является экономически выгодным методом тренировки для Республики Беларусь не только в предсоревновательный, соревновательный, но и в восстановительный периоды.

**Ключевые слова:** спорт, бокс, интервальная гипоксическая тренировка, гипоксия, барокамера, гипобарическая тренировка.



### Formulation of the problem.

In the theory and methodology of modern sports more attention is paid to the search of new forms of physical development aimed at the subsequent, effective realization of an athlete's capabilities in the selected sports. In particular, these aspects are revealed in the types of martial arts, where the overall level of health, power and speed and strength components of the physical development of young athletes often restrain the training of basic techniques and the selected sport.

One of the most effective ergogenic means, widely used in sports practice, aiming at potentiating the training effect of exercises and improving the working capacity of athletes is the method of interval hypoxic training (IHT) [3, 4, 8, 9, 10, 15]. Tissue hypoxia and the biochemical and structural changes caused by it can significantly limit the working capacity of the individual, lead to the development of fatigue and sudden deterioration in the body state [1, 2, 3, 12, 18, 19, 20]. But if the effect of hypoxia is short-term and repeated and hypoxic effects alternate with normoxic conditions the reversible effects of tissue hypoxia can have a constructive and creative effect [6, 7, 9, 11, 13, 16, 20].

Among many acyclic sports boxing is one of the most situational ones. A characteristic feature of such sports is working primarily in anaerobic and anaerobic-aerobic zones [4]. Due to the manifestation of special physical qualities at the maximum level an athlete achieves the highest sporting result. To do this it is necessary to form a specific functional state in the body of a boxer that will allow to carry intense loads in the process of preparing for competitions and will enable rapid recovery of the body between rounds. The athlete's body, as a rule, uses the rest to restore the oxygen debt, which is formed as a result of intensive work on the ring and consequently reduces contractile ability

of muscle fibres [3, 5, 7].

Practice shows that the higher the oxygen consumption level of an athlete is, the lower there is the oxygen debt level and respectively the shorter the recovery period is in the rest period between rounds. In this regard regular use of hypoxic procedures in the training process of highly-qualified athletes contributes to the increase and maintenance of high level of their special physical fitness [4, 10, 15, 19].

**Analysis of recent research and publications.** The advantage of IHT over other hypoxic effects is that it does not violate the planned training process of athletes and can be used in combination with basic training means or apart from them as an additional means during the rest period for stimulation and completion of the recovery processes in the body. It has been stated that the use of artificially induced hypoxia in combination with various types of repeated loads modifies the training effect significantly and accelerates the rate of adaptation development to the physical loads used [4, 5, 10, 14].

Short-term exposure to moderate degrees of hypoxia stimulates aerobic metabolism in the majority of organs and tissues, increases the overall nonspecific resistance of the organism, promotes to the development of adaptation to various kinds of adverse effects [1, 6, 10]. An increase in the duration of hypoxia effect or a jump in the strength of this effect, depending on the degree of O<sub>2</sub> pressure reduction in the inspired air, inevitably leads to various kinds of functional disorders and the development of persistent pathology (e.g., altitude sickness and etc. [9]). However, periodically arising hypoxia of one degree or another is common to many forms of labour, military and sport activities [3, 5, 8]. Taking into account this circumstance staying in moderate hypoxia conditions or repeated use of its short-term effects can be used to increase the adaptive reserve

of the body, to treat and prevent a number of diseases as well as special preparation for the conditions of professional activity.

Hypobaric adaptation (HBA) is a non-drug method for stimulating the body's own defenses and physiological reserves. Its essence is breathing with gas mixture with reduced partial pressure of oxygen in the conditions of «mountain air» (low atmospheric pressure), baroreceptors training. Hypoxic training in the pressure chamber is carried out by creating vacuum corresponding to a certain altitude above the sea level with a cyclic repetition of similar «rises». Normobaric hypoxic training supposes the course of breathing with hypoxic gas mixtures at normal atmospheric pressure with the use of various technical means.

When carrying out hypoxic training special importance should be given to the planning of loads - their direction, amount, intensity and alternation with hypoxic stimulus. With a correctly chosen regime, a 15-day course of anti-hypoxic training against the background of sport loads leads to a marked increase of the economical work of the respiratory, circulatory and energy supply systems. Athletes have increased physical and mental working capacity both in the training process and with participation in competitions.

It is necessary to emphasize especially the economic benefit of using normobaric hypoxia in comparison with high altitude training. The main thing is the lack of modern high-mountainous bases in the Republic of Belarus, so now elite training is carried out abroad with high financial relocation and living costs. In addition, there is often no necessary infrastructure for the training in the required sport on the bases used. All this suggests an undeniable advantage of introducing the proposed method into the practice of training athletes in various sports.

Thus, the analysis of literature has shown that studies in the recent decades associated with the use of



interval hypoxic training in the process of training exercises in the pre-contest period are mainly devoted to the effect of IHT on the functional body state of highly qualified athletes.

**The purpose of the study:** to determine the degree of influence of interval hypoxic training by the author's method on the level of physiological indices of the respiratory system of athletes in the pre-contest period.

**Materials and methods of the study.** 30 young men specializing in acyclic sports (boxing) participated in the research. The program of the educational training exercises in the experimental group (EG) and the control group (CG) did not differ in total amount and included 60 hours in the mesocycle.

The experimental group (group 1) consisted of 20 athletes who had been trained according to the author's method according to which training exercises provided the use of the IHT course in the pre-competition period. The athletes had trainings 2 times a day for 1.5 hours 5 times a week during 30 calendar days before the onset of competitions: the first training was in the hall, the second one included a session of interval hypoxic training.

The interval hypoxic training course was carried out in the multiseater medical vacuum unit «Ural-Anteres» on the base of Vitebsk city center of hypobaric therapy and baroclimatic adaptation, which consisted in «stepped climbings» to the height of 2000-4500 m at a speed of 3-7 m/s and «descents» at the speed of 2-3 m / s. The full course of IHT consisted of 20 sessions [5].

The scheme of the IHT course was performed as follows: the 1st session - «2000 m height» (making Stange sample before and after the session, heart contraction rate (HCR) before and after the climbing, BP before and after the session); the 2nd session - «2500 m height» (duration of the session 90 minutes), then climbing to «3000

m height» (duration at «the height» for 60 min); the 3rd session - «3500 m height»; the 4th and 5th session - «3500 m height» (taking HCR heart rate, BP before and after the session).

From the 10th session (taking HCR before and after the session) - climbing to «3500 m height» - 30 min, climbing up to 4500 m («4500 m height» - 5 min), descent up to 3500 m («3500 m height» - 15 min), descent (duration of the session - 90 min). the 15th session (HCR measurement before and after the session); the 20th session (making Stange test before and after the session, HCR and BP before and after climbing to «the height»). [2, 4].

The control group (group 2) consisted of 10 sportsmen also specializing in acyclic sports who trained in the usual regime (2 trainings per day for 1.5 hours in the gym 5 times a week) without using IHT.

The control and experimental groups were comparable by sex, age, weight classes. The mean age was 21,3 years old in the EG and 20,9 years in the CG. The length of sports experience at a high level in the research groups was respectively 3.1 and 3.7 years. Qualification of athletes in both groups was from the 1st rank to Master of Sports. The average body mass indices in the groups did not differ significantly and were 71.6kg and 73.4kg respectively.

During the course of the IHT attention was paid to the dynamics of subjective and objective data. Control studies were conducted in the experimental group before the pre-contest period and after its completion, and in the control group at the very beginning and after 30 calendar days. Spirography and Stange's test were made to all the athletes.

STATGRAPHICS Plus (Version 5.1) was used for statistical manipulation. The significance level was accepted as  $p < 0.05$ .

Results and their discussion. At the initial stage of the mesocycle the initial level of physiological pa-

rameters among the athletes of the experimental and control groups did not differ statistically for sure. During the hypobaric hypoxia pressure chamber session the athletes in the experimental group didn't have any significant differences in the HCR and BP.

According to the level of training Stange test of the athletes in the experimental group was 66.7 s and the representatives of the control group had 59.6 s. By the end of the interval hypoxic training course the indicators of the cardiovascular system condition in the athletes of the experimental group returned to the initial data. The level of blood pressure made 112/64 mm Hg. 13 sportsmen had reduced systolic blood pressure in comparison with the initial by 5%.

During the transition from short-term to long-term adaptation to hypoxia Stange test for each athlete of the experimental group increased by 20% on the average and made 78.7s ( $p = 0.005$ ,  $H = 7.834$ ) - this is the second transitional stage during which the body of each athlete acquires increased resistance to hypoxia.

In the same period of trainings the athletes of the control group didn't have statistically significant differences in the results of Stange test between the indices at the initial stage of the precompetitive period and the indices after 30 calendar days ( $p = 0.238$ ,  $W = 66.0$ ).

When comparing the results of Stange sample between the athletes of the experimental and control groups on completion of the pre-contest period which lasted 30 calendar days of the research we found statistically significant differences ( $p = 0.002$ ,  $H = 9.177$ ). These results are the evidence of an increase in the economization of the respiratory system activity of athletes belonging to the experimental group who trained in the pre-contest period by the author's method including interval hypoxic training into educational training exercises.



Also an increase in the Tiffno index from the initial 86.0% to 96.0% (« $p < 0.001$ »,  $H = 21.86$ ) was revealed in the athletes of the experimental group after the completion of the mesocycle. The vital capacity of the lungs (VCL) made 5.78 l before the course of the IHT and increased to 6.23 l after it ( $p < 0.001$ ,  $H = 4.047$ ). The respiratory volume (RV) increased from 1.17 L to 1.73 l after the course of the IHT ( $p < 0.001$ ,  $H = 5.99$ ).

After 30 calendar days an improvement in the indicators of the Tiffno index from 82.2% to 85.5% ( $p = 0.027$ ,  $W = 79.5$ ) was determined in the control group of athletes who trained in the usual regime without IHT, and the VCL and RV indicators remained at the same level. After 30 days of the research between the experimental and control groups a statistically significant difference in the indices of the lungs ventilating function was revealed: the Tiffno index ( $p < 0.001$ ,  $H = 17.39$ ), VCL ( $p = 0.018$ ,  $H = 5.56$ ), RV ( $p = 0.013$ ,  $H = 6.166$ ).

This is the evidence of the effectiveness of interval hypoxic training course on the respiratory system of an athlete in the process of educational training exercises in the pre-contest period. The latter contributes to the increase of the physical performance level in anaerobic and anaerobic-aerobic zones.

Conclusions of the study. The results of the study give an opportunity to make the following conclusions:

1. The course of interval hypoxic training which includes 20 sessions of 1.5 hours each has a positive effect on the cardiovascular system of the body.

2. The course of IHT leads to the economical functioning of the respiratory system. Stange test for all athletes of the experimental group increased on the average by 20% on completion of the HBA course and made 77.5 s [76.0 s; 90.0 s] ( $p = 0.005$ ,  $H = 7.834$ ).

3. The author's method of edu-

cational training exercises in the pre-contest period including interval hypoxic training proposed by us helps to increase the level of physical working capacity of athletes and promotes to more a qualified performance of combats on the ring.

Prospects of further research. It is planned to develop a hypobaric adaptation (HBA) technique for athletes of various sports that can be considered as an essential part of modern technologies of the training process in the general system of training qualified athletes.

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