

# CHANGES IN THE SPORTS ACHIEVEMENT FOR 5000 METERS DISTANCE RUNNING FOLLOWING NORMOBARIC HYPOXIA TRAINING

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## ABSTRACT

*The aim of this study is to investigate the changes in the sports achievements for 5,000 meters running as a result of interval normobaric hypoxia training.*

*Ten college sportsmen preparing for national and students long distance track and field championships, were randomly assigned into two groups - Experimental and Control. The Experimental group performed 3 training sessions weekly with interval normobaric hypoxia. The experiment was of 6 weeks duration. Every new week the hypoxic stimulus was increased with 500 m simulated altitude while speed of running remained constant during the whole experiment. The training speed of running was determined individually as 70% from the maximal running speed at  $VO_2$  max from incremental cardio-pulmonary test to exhaustion. The control group was performing standard training at 560 m altitude.*

*The results show statistically significant improvement ( $p < 0.05$ ) in the sports results in the experimental group which improved their personal best records in 5000 m long distance. The results also show small, but significant increase in  $VO_2$  max for the Experimental group, while there is not such a tendency in the Control group.*

**Key words:** normobaric hypoxia training, 5000 m. running, sports achievement,  $VO_2$  max.

## INTRODUCTION

The normobaric hypoxia training as a substitute for the real altitude training has been studied for more than 30 years. The reduction of the oxygen concentration in the gas mixture inhaled from the hypoxicator during physical load is an additional stress for the organism, which imposes the inclusion of adaptation mechanisms with direct effect on the improvement of the sports achievement in the endurance disciplines (Wolski, et al. 1996). The authors, having studied that issue, report various rates of the sports achievement growth or lack of it. The application of various approaches for designing the normobaric training may be one of the factors of that controversy. However, not all researchers have unanimous view in relation to its effect on the sports achievement for the middle and long-

distance runs (Mirzaei, Shadmehr 2016). The justification of some basic methodological formulations is of importance for the development of the training programs (Karabiburov, 2017). The author mentioned defines the interval training with speed of running at  $V_2$  and heart rate of 70-75% of the maximal heart rate as the most effective method for developing athletes' aerobic abilities. That presumes a choice of an optimal combination between the intensity of load, duration and number of the separate series for the optimization of the hypoxic effect. Dasheva D. et al. (2017) investigated athletes training for endurance and showed that training process with loadings around anaerobic threshold in moderate altitude (1720 m) with 16 days sessions improved aerobic abilities.

## HYPOTHESIS

Our study presumes that the individually applied interval normobaric hypoxia training would improve the sports achievement in the long distance 5000 m run.

## PURPOSE

The aim of the study is to improve the sports achievement of the athletes applying normobaric hypoxia interval training and to establish the individual response of athletes to normobaric hypoxia interval training.

## TASKS OF THE STUDY

To follow up the changes in the development of the sports achievement for the 5000 m run in competitors after normobaric hypoxia interval training.

To study if there are changes in the VO<sub>2</sub> max after normobaric hypoxia training.

To apply some methodological recommendations in relation to the optimization of the normobaric hypoxia interval training for middle and long-distance runners.

## METHODOLOGY

The experiment was held in April, May and

June 2017 during the stage of early and basic competition period.

The project was supported as a scientific program in National Sports Academy “Vassil Levski”.

## *Design of the study*

Ten middle and long-distance runners were randomly divided into two groups: Experimental and Control, with equal number of athletes (5 per group). The Experimental group was subject of normobaric hypoxic training with hypoxicator “Higher-Peak” MAG 20, USA, 2015. Original methodology for normobaric hypoxia interval training was developed and applied in the following protocol:

1. Six weeks duration of normobaric hypoxia training.
2. Three training session per week.
3. Speed of running on treadmill was determined individually, as equivalent of 70% of speed of running at VO<sub>2</sub> max.
4. Every new week the hypoxic effect increased with 500 m simulated altitude. During the first week the hypoxic effect was with equivalent of 2100 altitude and during the

**Table 1.** Simulated altitudes, percentage of oxygen in respective hypoxic air gas mixture, and speed of running of Experimental group.

Training week	Simulated altitudes	Oxygen content in the gas mixture, %	Speed of running as percentage of speed of running at VO <sub>2</sub> max.
First week	2100 m.	15,9%	70% VO <sub>2</sub> max
Second week	2600 m.	14,9%	70% VO <sub>2</sub> max
Third week	3100 m.	14%	70% VO <sub>2</sub> max
Fourth week	3700 m.	13,2%	70% VO <sub>2</sub> max
Fifth week	4200 m.	12,3%	70% VO <sub>2</sub> max
Sixth week	4700 m.	11,4%	70% VO <sub>2</sub> max

sixth week the equivalent was 4700 m.

5. The load (speed of running) was constant during the whole experiment - Table 1

6. The training sessions consist of five runs

with duration of five minutes each and rest periods in-between until heart rate falls to 120 per minute. Each person breathes through a mask connected to the hypoxicator (Fig. 1).



**Figure 1.** Hypoxic training with hypoxicator

The Control group was training along an individual scheduled training plan at 560 m altitude.

### ***Participants***

Ten athletes between 18-28 years of age, with body weight range 61-74 kg and height of 167 -183 cm took part in the study. All competitors volunteered and signed an informative consent. Both groups were preparing to participate in summer National and Student's championships in track and field -

middle and long distance.

### ***Incremental cardio-pulmonary test to exhaustion***

Both groups were tested with cardio-pulmonary exercise test (CPET) for determining the functional capacity and  $VO_2$  max two times: prior to the start of the experiment and two days after the end of the experiment. A metabolic cart for gas analysis "breath-by-breath" Oxicon Pro - Jaeger, Germany, and treadmill H/P/Cosmos were used. The system is calibrated prior to the test. The cardio-

pulmonary test protocol is according to prof. I.Iliev's methodology. It starts with initial speed of 6 km/h, the duration of each step is a minute and a half, the speed of running is increased by 1,2 km/h without changing the inclination of 2.5%. The test goes on up to the individual refusal. Each competitor was acquainted individually with the procedure prior to the test. During the test the athletes were informed about the time reached and the basic functional indicators.

**Sport pedagogy test 5000 m running**

The competitors from both groups (control and experimental) were tested twice on 5000 m run. The first test was carried out prior to the start of the experiment and the second test was made 18 days after the end of the experiment. Both tests were made at same track with 400 m length and altitude of 560 m above sea level.

**Statistics**

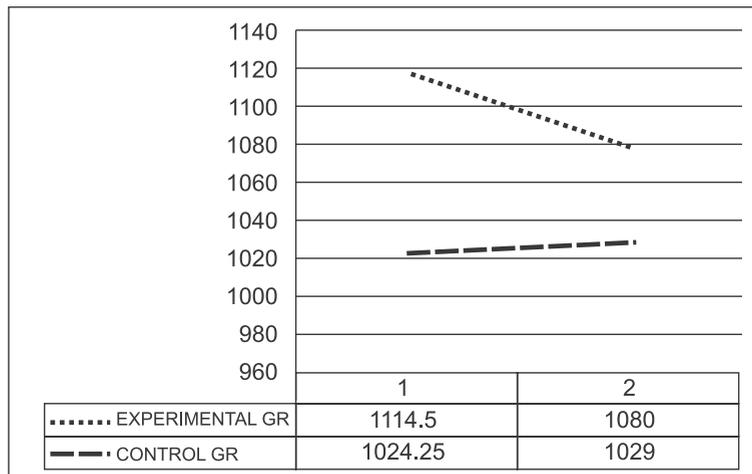
Results are presented as mean values and standard deviation by the Paired-Sample t-test SPSS 17, at a level of significance  $P < 0.05$ .

**RESULTS**

The comparative analysis of the changes in the sports achievement are presented as average values for each group (experimental and control).

**Comparative analysis of the changes between the experimental and control group for the 5000m distance running**

The experimental group showed statistically significant improvement in sports results in seconds. Paired Sample T-test was used, and we accepted significance level of  $P < 0.05$ . The Control group did not show significant change in the sports achievement - Figure 2.



*1st measure - 24.04.2017, 2nd measure - 23.06.2017*

**Figure 2.** Comparative analysis of the changes in 5000 meters distance running

The rate of improvement of the sports achievement in seconds is individual for every athlete from the hypoxic group under study. The improvement is within broad range of 10 to 55 seconds. We consider that

the improvement depends on the level of competitors' mastership - highly qualified athletes improve their results less because they are closer to the limit of their abilities. The lower qualified competitors have more

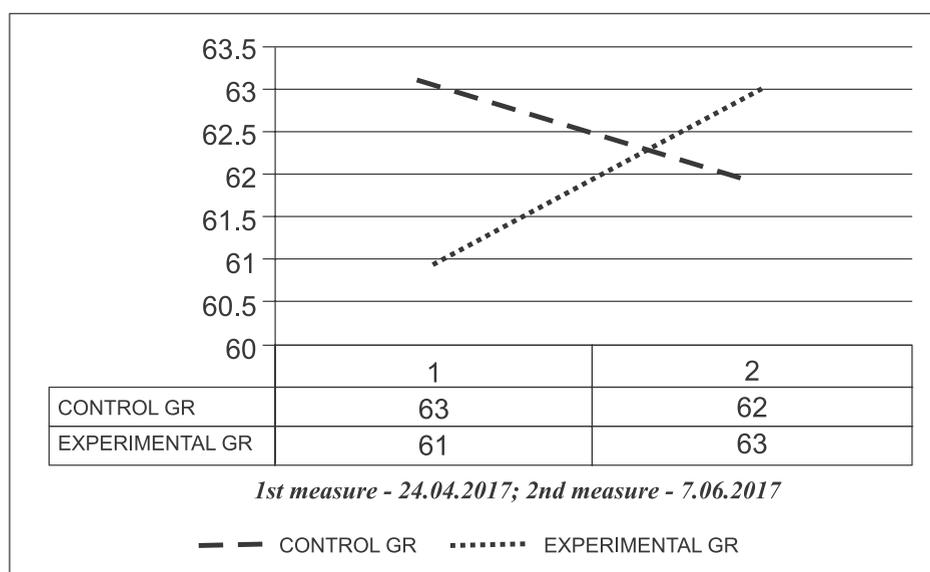
reserves to their limit and improvement is with more seconds.

**Comparative analysis of the changes between experimental and control group in VO<sub>2</sub> uptake**

All competitors from the experimental group showed increased values of VO<sub>2</sub> max after normobaric hypoxia training – the average improvement is 3, 3% at statistically significance of P<0.05.

The tempo of growth here is again indi-

vidual for the various persons under study; it is within the limits of 1-8 ml/kg/min. An interesting fact is that the competitors with higher growth of the sports achievement register higher growth of the VO<sub>2</sub> max in comparison with the lower qualified athletes. We think that could be due to the individual reaction to hypoxic training and physical load. The control group does not show statistical significant changes in VO<sub>2</sub> max, two participants have a tendency of decline - Figure 3.



**Figure 3.** Comparative analysis of the changes in VO<sub>2</sub> max after 6 weeks normobaric hypoxic interval training

**DISCUSSION**

Similar methodology was used by Favier R. at all. (1995) who examined three groups of sedentary high-altitude residents, who trained for 30 minutes a day at constant work rate on a bicycle ergometer during a six-week period. Group 1 trained at a FiO<sub>2</sub> that was equivalent to an altitude of 3340 m pedaling at 70% of VO<sub>2</sub> max determined in hypoxia. The remaining two groups trained under normoxic conditions at the same relative work rate 70% of the normoxic VO<sub>2</sub> max. An incremental test to exhaustion was performed

by all groups in normoxia and hypoxia before and immediately after training in an attempt to ascertain the physiological responses to maximal exercise. They suggested that a lower reduction in base excess and bicarbonate stores were observed in the hypoxia trained group which could only potentially benefit anaerobic metabolism and time to exhaustion.

Zwaard et al. (2018) investigated adaptations in muscle oxidative capacity and oxygen supply capacity in elite hockey players after six repeated sprint sessions in nor-

normobaric hypoxia combined with 14 days of chronic hypoxic exposure at 2800-3000 m altitude. They concluded that the team-sport athletes substantially increased their skeletal muscle oxidative capacity with six repeated sprint training sessions in altitude hypoxia.

In our study, we have compared the results of the experimental group with the results of the control group. Both groups were in the competitive period and were preparing to participate in national championships. All competitors from the experimental group improved their personal achievement for the 5000 m run, the increase is individual – it varies (from 10 sec. to 55 sec) with statistical significance of  $P < 0.05$ . We suppose that this is due to both the stage of the sports specialization and the individual reaction to the hypoxia. No statistical changes in the sports achievement were observed in the control group. The experimental group showed statistical confident increase of 3, 3 % (average) in  $\text{VO}_2$  max, but with individual results of the improvement between 2 to 8 ml/kg/min. In the control group  $\text{VO}_2$  max was insignificantly changed with  $\pm 2$  ml/kg/min.

Other authors (Levine, Stray-Gundersen, 1997) studied the effect of the natural hypoxia on the sports achievement and reported similar results. They found improvement up to 55 seconds for the 5000 m run. Robert F. Chapman et al. (1998) studied the individual adaptation to the natural altitude training. They found individual changes for the  $\text{VO}_2$  max - overall mean improvement of 2.5 ml/kg/min with a similar wide variability after altitude exposure with range -3.2 to + 8, 7 ml/kg/min. The mentioned authors divided the persons under study into two groups: responders and non-responders depending on whether significant increase of the erythro-

poiesis concentration occurred or not after 30 hours exposure at 2500 m altitude.

## CONCLUSIONS

The comparative analysis of the changes in the development of the sports achievement for the 5000 m run following 6 weeks normobaric hypoxic interval training registers improved time for running the competitive distance by the athletes from the Experimental (hypoxic) group, which is statistically reliable. The control group does not show similar change.

Following the end of the hypoxic training program, the experimental group shows statistically reliable increase of the  $\text{VO}_2$  max while the control group registers a drop down.

The hypoxic training program could be optimized by increasing the number of the training sessions within the week micro cycle.

## Limitations of the study

The experiment was performed with 10 competitors only (5 persons in experimental and 5 in control group). For more convincing results, it is necessary to involve more participants in the study which has to be designed as double-blind experiment - the control group has to train with placebo breathing from the hypoxicator. The results provide us with the reason to think that the training methodology we have developed with interval normobaric hypoxic training is suitable for use in other sports where endurance is the leading factor.

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