The Experimental Method of Middle Distance Runners Hypoxic Training

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Abstract: The study is focused on the problem of various hypoxic effects use in the training process of athletes specializing in middle distance running. The purpose - to develop and experimentally justify the method of interval hypoxic training in the annual cycle of middle distance runners training. Hypothesis: the development and application of interval hypoxic training method, which provides the consistent use of hypoxia, adequate structure and volume of different directions training loads in weekly microcycles, will improve the training efficiency and middle distance runners competitive activity effectiveness.The method of hypoxic training includes hypoxic and information tools:Hypoxicator "Peak"(Russia) realizes exogenous type of hypoxia and consists of series connected: mask, the body (filled with absorber of carbon dioxide) and a breathing bag. Diaphragm mask "Elevation training mask"(USA) implements respiratory type of hypoxia. To estimate athletes heart rate monitoring we used the method of obtaining information wireless portable system GPS Garmin Forerunner 310XT (Garmin, USA).The concentration of oxygen in the blood was investigated using pulse oximeter "Oxy-Pulse"(Russia). Hypoxic training technique of athletes specializing in middle distance running is scientifically proved, developed and experimentally checked.

1 INTRODUCTION

Involvement in modern training process of hypoxia methods can allow to increase volume and intensity of training load.

The results of scientific researches show that different variants of artificial and natural hypoxia use were applied in different sports athletes training.

All of the above mentioned actualizes the problem of additional hypoxia use, in particular various types of artificial hypoxia, during the preparatory period of athletes training.

2 ORGANIZATION AND METHODS

For achievement of the purpose and the solution of objectives the following methods of research were used: the analysis and generalization of scientific and methodical literature, pedagogical testing, analysis of sports documentation, express diagnostics of the functional state and reserve opportunities of an organism "D&K Test" method developed by S. A. Dushanin, pedagogical experiment, methods of mathematical statistics.

Subjects. The study involved athletes specializing in middle distance running at the age of 17 - 26 years. One experimental (EG) and one control group (CG) of 15 people with sports categories and ranks (mass categories and CMS, MS) was formed. The study was conducted on the basis of Sport school "Yar Chally", and №12, Naberezhnye Chelny, Russia

2.1 Questionnaire Survey

Coaches, as well as sports professionals (20 persons). For this purpose, two questionnaires were made. The first questionnaire was intended for specialists and trainers in the field of middle distance running, it included 15 questions. The second questionnaire was developed for athletes in middle-distance running and consisted also of 15

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questions. The survey was conducted in order to clarify the means and methods of hypoxia, which are used in the training process of middle distance runners. Questions presupposed a choice of several answers.

2.2 Functional Diagnostics

All laboratory tests were conducted in the research laboratory “Sports and health technologies” of the Naberezhnye Chelny State Pedagogical University.

Functional diagnostics was conducted with the use of hardware and software complex "VALENTA" (Russia). The analysis included the following parameters: cardiac output (IOC), cardiac index (CI), stroke volume (UOK), stroke index (SI), heart rate (HR, bpm).

The load test was set using the software module "Poly-Spectrum-Sport" (Russia). For carrying out the load test, a medical-grade veloergometer with a computerized "e-Bike” control panel was used. The set of equipment used in the experiment, including all accessories in contact with the examined patient during operation, according to the instructions provided in the passport, meets the safety requirements set out in the standards. The speed of pedals rotation amounted to 62 revolutions per/min. The analysis of load tests was carried out automatically. Registration of the Protocol took place individually for each subject.

To find out the level of adaptation to the loads of different capacities of athletes specializing in middle distance running, we used the method of express diagnostics by Dushanin " D & K-TEST»

2.3 Methods

Based on the results of the survey we selected hypoxic training methods. Hypoxicator "Peak"(Russia) realizes exogenous type of hypoxia and consists of series-connected: mask, the body (filled with absorber of carbon dioxide) and a breathing bag. During one breathing cycle (3-5 minutes) the oxygen content in the inhaled gas mixture decreases from 21% vol. up to 12-14% vol. and provides the necessary physiological effect.

Diaphragm mask "Elevation training mask"(USA) implements respiratory type of hypoxia. The mask allows to simulate different Alpine conditions. "Breath resistance" - simulations of different heights, and therefore – the amount of oxygen that can be inhaled at one time. Different altitudes 3,000 ft (Nozzle -1), 6,000 ft (Nozzle -2), 9,000 ft (Nozzle -3), are simulated.

To control the training process, to estimate athletes heart rate monitoring we used the method of obtaining information wireless portable system GPS Garmin Forerunner 310XT (Garmin, USA).

The concentration of oxygen in the blood was investigated using pulse oximeter "Oxy-Pulse"(Russia).

Training Programme

Monday. In the developing microcycle during the first training we used a diaphragm mask in interval mode. The percentage of training exercises in the mask was 10 %. Nozzle-the first. The intensity of the resistance – 25 %. The total number of cycles - 1.

Hypoxicator "Peak" was used 40 minutes after the first training. Breath was conducted through hypoxicator within 5 minutes and breathing atmospheric air within 5 min (1 cycle). The total number of cycles - 4. The total time of hypoxic training was 40 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Diaphragm mask "Elevation Training Mask" was used during the second interval training. The total number of cycles-2 (10% and 10%). The percentage of training exercises in the mask was set to 20 %. Nozzle-the second. The intensity of the resistance was 50 %.

Tuesday. The diaphragm mask was used during the first interval training session. The total number of cycles - 1. (10%). The percentage of training exercises in the mask was set to 10 %. Nozzle-the second. The intensity of the resistance was 50 %.

Hypoxicator "Peak" was used 40 minutes after the first training session. Breath was conducted through hypoxicator within 5 minutes and breathing atmospheric air within 4 minutes (1 cycle). The total number of cycles was 3. The total time of the hypoxic training was 27 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Hypoxicator “Peak” was used 50 minutes before the second training session. Breath was conducted through the hypoxicator within 5 minutes and breathing atmospheric air within -3 minutes (1 cycle). The total number of cycles was 3. The total time of the hypoxic training was 28 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Diaphragm mask was used during the second training in an interval mode. The total number of cycles-2 (10% and 15%). The percentage of training exercises in the mask is 25 %. Nozzle-the third. The intensity of the resistance is 75 %.

Wednesday. Diaphragm mask "Elevation Training Mask" was used during the first training in an interval mode. The total number of cycles-2 (5% and 5%). The percentage of training exercises in the mask was 10 %. When applying the second nozzle resistance intensity was up to 50%.

Hypoxicator "Peak" was used 40 minutes after the first training session. Breath was conducted through hypoxicator within 5 minutes and breathing atmospheric air within 5 minutes (1 cycle). The total number of cycles was 3, The total time of the hypoxic training was 30 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Hypoxicator “Peak” was used 50 minutes before the second training session. Breath was conducted through hypoxicator within 5 minutes and breathing atmospheric air within 3 minutes (1 cycle). The total number of cycles was 4. Total time of hypoxic training was 32 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Diaphragmatic mask was used during the second training in an interval mode. The total number of cycles-2 (15% and 7%). The percentage of training exercises in the mask was` 22 %. When using the third nozzle, the resistance intensity was 75%.

Thursday. Diaphragm mask was used during the first interval training. The total number of cycles – 1 (10%). The percentage of training exercises in the mask was 10 %. The resistance intensity when using the first nozzle was 25%.

Hypoxicator "Peak" was used 40 minutes after the first session. Breath was conducted through hypoxicator within 5 minutes and breathing atmospheric air within 5 minutes (1 cycle). The total number of cycles was 3. The total time of hypoxic training was 30 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Hypoxicator “Peak” was used 50 minutes before the second training session. Breath was conducted through hypoxicator within 5 minutes and the breathing atmospheric air within 10 minutes (1 cycle). The total number of cycles was 2. The total time of hypoxic training was 30 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Diaphragma mask "Elevation Training Mask" was used during the second training in an interval mode. The total number of cycles-2 (7% and 7%). The percentage of training exercises in the mask was 14 %. Nozzle-first. The intensity of the resistance – 25 %.

Friday. Diaphragm mask "Elevation Training Mask" was used during the first training in an interval mode. The total number of cycles-2 (10% and 10%). The percentage of training exercises in the mask was 20 %. The intensity of the resistance when using first Nozzle – 25 %.

Hypoxicator "Peak" was used 40 minutes after the first training session. Breath was conducted through hypoxicator within 5 minutes and breathing atmospheric air within 3 minutes (1 cycle). The total number of cycles was 3. Total time of hypoxic training was 24 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Hypoxicator "Peak" was used 50 minutes before the second training session. Breath was conducted through hypoxicator within 5 minutes and breathing atmospheric air within 5 minutes (1 cycle). The total number of cycles is 3. Total time of hypoxic training was 30 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Diaphragm mask "Elevation Training Mask" was used during the second training in an interval mode. The total number of cycles is 2 (15% and 10%). The percentage of training exercises in the mask was equal to 25 %. The intensity of the resistance when using second Nozzle – 25 %.

Saturday. Diaphragm mask "Elevation Training Mask" was used during the first training in an interval mode. The total number of cycles was 1(10 %). The percentage of training exercises in the mask was 10 %. Nozzle- first. The intensity of the resistance was 25%.

Hypoxicator "Peak" was used 40 minutes after the first training session. Breath was conducted through hypoxicator within 5 minutes and breathing atmospheric air within 5 minutes (1 cycle). The total number of cycles was 4. Total time of hypoxic training was 40 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Hypoxicator "Peak" was used 50 minutes before the second training session. Breath was conducted through hypoxicator within 5 minutes and breathing atmospheric air within 5 minutes (1 cycle). The total number of cycles- 2. Total time of hypoxic training was 20 minutes. Saturation of oxygen in the blood was 85 - 90 %.

Diaphragm mask "Elevation Training Mask" was used during the second training in an interval mode. The total number of cycles was 2(10 % and 10%). The percentage of training exercises in the mask was 25 %. Nozzle-second. The intensity of the resistance was 50%.

Sunday. Recreation. Conducting recovery activities. Seminars were held with the participants of the experiment on the introduction and use of the diaphragm mask "Elevation training" and hypoxicator "Peak", as well as information tools that implement interval exogenous respiratory hypoxic training, pulse oximeter "Oxy-Pulse" and the system "Garmin forerunner 310XT".

2.4 Physical Fitness Testing

On the basis of the scientific and methodical literature analysis for determination of efficiency of experimental technique influence in training process of the athletes specializing in running on average distances, we chose and used the following control exercises: run on 100 m, sec; run on 400m, sec.

2.5 Methods of Mathematical Statistics

All the data obtained were statistically processed using the following criteria:
 check the normality of the distribution, conducted by the Shapiro-Wilk test;
- judgments on the equality of variances - f-Fisher criterion;
- to test the hypothesis of the difference of two mean values, a two-sample Student t-test for independent samples and a pair of two-sample Student t-test were used;
- in case of failure to comply with the normal distribution of samples, the comparison was carried out according to the nonparametric criterion of van der Waerden, Kruskal-Wallis, Kramer-Welch.

The critical level of significance when testing statistical hypotheses in this study was taken equal to 0.05 (a=0.05).

We used the following symbols: X – arithmetic mean; Sx – standard error of arithmetic mean; n – sample size; p is the experimental significance level, obtained by statistical processing of the data; t is the student coefficient; x-the criterion of van der Waerden; T – criterion of the Cramer-Welch.

Statistical processing was carried out on a computer using statistical packages SPSS-17, spreadsheets Microsoft Excel.

3 RESULTS AND DISCUSSIONS

The survey involved coaches and athletes of national teams, heads of federations, coaches of the republics and regions of the Russian Federation, etc.in total, 20 specialists and 50 athletes engaged in running at middle distances completed questionnaire. Experts note that for many years they have been using a rather narrow range of traditional means of hypoxic exposure. Most often (almost 100% of the time) they note their stay in the conditions of the middle mountains (c. Kislovodsk, Russia) It should be noted that the range of hypoxic agents used in individual athletes varies and depends largely on the degree of fitness, material and technical conditions. 85% of respondents noted the need to plan the use of various hypoxic effects in microcycles in the annual training cycle. According to experts, at the preparatory stage such microcycles should be up to 8.

In responses of experts the importance of the correct combination of training load with various hypoxic influences in the preparatory period (81% of respondents) is noted. Among hypoxic events offered to athletes, 87.3% of respondents noted training in the middle mountains conditions; 9.3% of respondents – devices that supply air with a low oxygen content; 3.4% – hypoxic tents. As for hypoxic events offered to athletes personally by coaches, 74.3% of respondents call the middle mountains conditions; 15.3% – the use of various hardware; 10,0% - other means (tents, pressure chambers). When analyzing answers to the question of how hypoxic events affect the success of the athletes' performances the following results were obtained: 73,0% of respondents noted stay in natural hypoxia conditions; 16,7% - stay in artificial hypoxia conditions; 10.3% – pointed to sleep in hypoxia tents.

During the experiment training programs providing the use of hardware hypoxic systems before, during and after training as part of the experimental technique were implemented.

The cross-experiment was carried out at the first base – developing stage of the year cycle preparatory period (November, December) for training middle distance runners.

The control group (CG) included 20 runners, the experimental group (EG) included also 20 runners.

At the first stage (4-week mesocycle) the experimental technique was introduced to the EG group runners. Each runner had access to a set of equipment that he used every day (20 sets of equipment). Athletes of the CG trained according to the standard program for the Sport school.

At the end of the first stage in the EG and CG groups all studied indicators characterizing functional preparedness tended to change significantly.

In the EG athletes' changes are more vivid than in the CG athletes. Thus, the increased VC in the EG score was equal to 4159,07+of 32.03 ml, the improvement was 104,33 ml (2.58 %), while in the CG - 4149,67+19,46 ml, the improvement was 42,27 ml (1,03%).

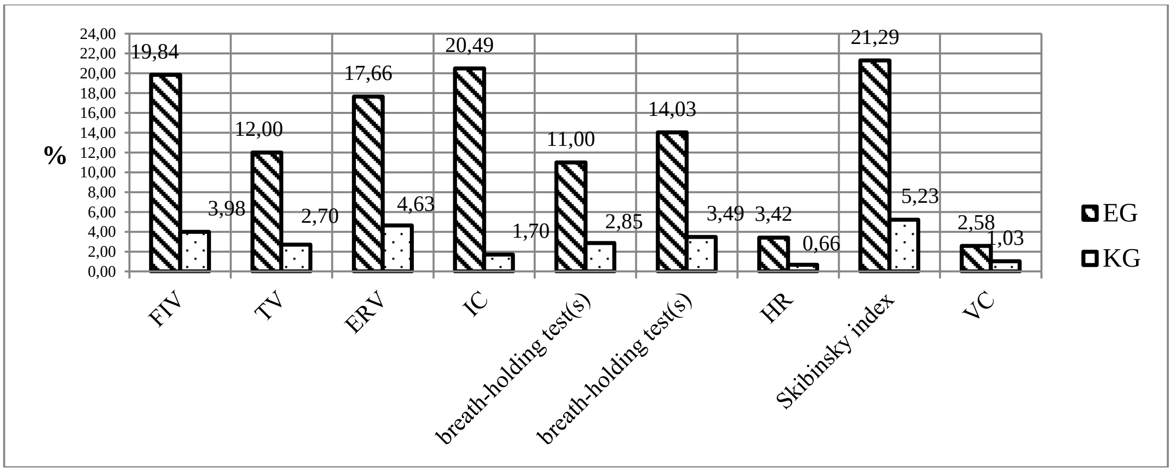

Figure 1: Growth of athletes (EG and CG) respiratory and cardiovascular systems indicators for the period of the first stage.

The results of the FIV and ERV in the EG were equal to 1,74+0.02 liter and 2,11+0,02 liter, the improvement was 0.29 liter (19.84%) and 0,31 liters (20% and 49%) respectively; in the CG - 1,50+0,01 liter and 1.81+0,03 liter, the improvement was 0.29 liter (3.98%) and 0,31 liter (4.63 %);

TV and IC in the EG were equal to 0,75+0,03 liter and 2,79+0,02 liter, the improvement amounted to 0,09 liters (12,00%) and 0.47 liter (20% and 49%) respectively, in the CG - 0.71, +0,03 liter and 2.40+0,03 liter, the improvement was 0.02 liter (2,70%) and 0,04 liter (1,70%).

The results of the breath-holding test(s) in the EG were equal to 97,50+0,41 sec and 57,13+0,43 sec, the improvement was 13 (14,03%) and 6 (11,00%), respectively, in the CG - 87,07+0,55 sec and 52,87 +_ 0.77 sec, the improvement amounted to 3 sec (3.48%) and 1sec (2,85%).

Indicators of heart rate (HR) at rest and Skibinsky index in the EG were equal to 66.93 + 0.67 beats / min and 60.65.13+56.68 stan. units, improvement was 1 beat/min (3.42%) and 11190.47 liter (21.29%), respectively, in the CG - 70.53+0.61 beats / min and 5130.55+70.56 stan. units, improvement was 1 beat / min (0.66%) and 255 stan. units (5.23%).

At the end of the first phase all investigated indices of respiratory and cardiovascular systems of the EG athletes exceeded those of the CG athletes.

In the CG all indicators have positive changes, but they were minimal. But, despite the slight changes, the difference was significant ($p<0.05$).

After the first stage in accordance with the methodology of the cross-experiment the KG became the EG, and the EG became the KG and the experiment continued.

EG group athletes used hypoxia sessions on experimental technique at the second stage of the experiment.

By the end of the second stage results in the EG changed as follows: VC - 4178,07+ 32.03 ml; In the figures FIV and ERV in the experimental group the result was equal to 1.76+0.02 liter and 2,13+0,01 liter; TV and IC were equal to 0, 0,76 +0,01 liter and 2.81 +0.02 liter; breath-holding test(s) - 57,71 +0,37 sec. and - 98,07+0,45 sec.; Indicators of heart rate at rest were - 66,93+0,82 beats/min; and Skibinsky index- 6128,78+62,053 stand. units.

KG athletes results were as follows: lung capacity was equal to 4183,67+19,46 ml, the improvement was 34 ml (0,82%); the reserve volume of inhalation and exhalation is equal to 1.71+0.01 liter, improved by 0.21 liter (14,03%); indicators of respiratory volume and breathing capacity - 2,13+0,01 liter, the improvement was 0.28 liter (15.49%); respiratory volume - 0,78 +0,02 liter, the improvement was 0.07 liter (8.89%); indicator breathing capacity- 2.78 +0.02 liter, the improvement amounted to 0,38 liter (15,80%); indicator Genchi sample - 57,15 +0,78 sec., the improvement was 5.0 sec. (8,11%); indicator Stange sample - 99,07+0,55 sec., the improvement amounted to 12.0 sec. (13,78%); indicator of heart rate - 67,53+0,61 beat/min, the improvement was 3.0 sec. (4,25%); Skibinsky indicator - 6147,28+88,77 stand. units, the improvement amounted to 1016 stand.units (19.82%).

Summarizing the data of the EG and CG athletes second stage research indicators of respiratory and cardiovascular systems, it can be concluded that the use of interval exogenous-respiratory hypoxic training significantly improved performance in the EG and CG (Fig. 2).

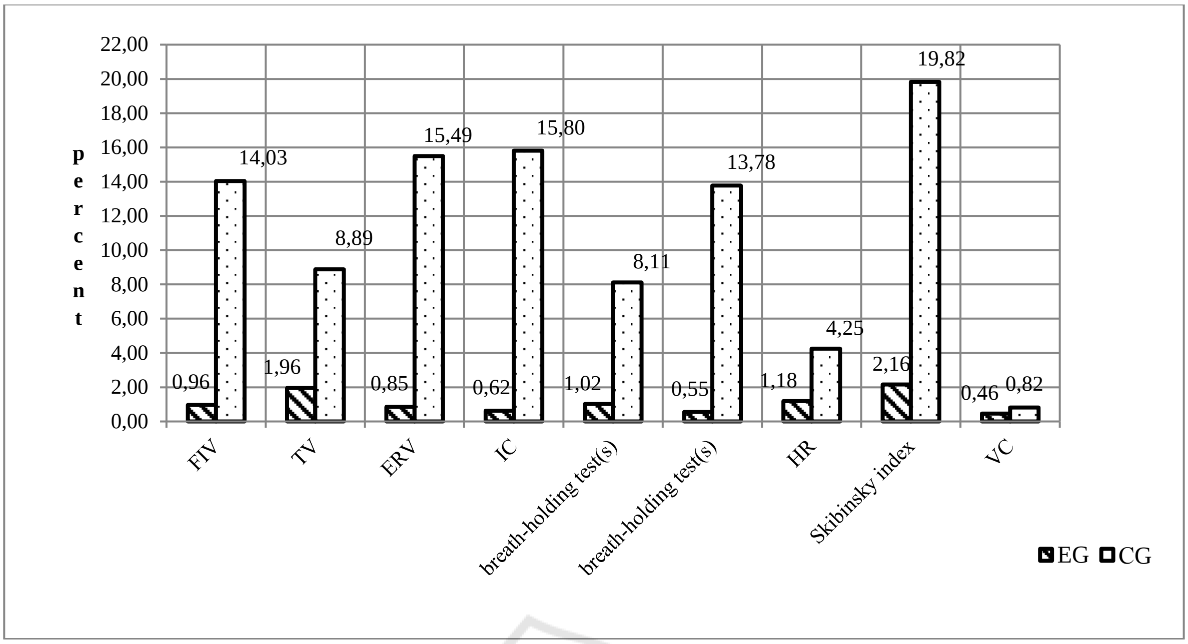

Figure 2: Second stage period growth.

In addition, the residual effect of the technique application in the EG at the first stage of the research was revealed. This indicates that the experimental technique has not only a pronounced immediate effect, but also cumulative deferred one. This confirms the effectiveness of the experimental technique.

4 CONCLUSIONS

Thus, the analysis of scientifically-methodical literature on the problem of interval hypoxic training application in various sports showed that, despite numerous studies of this problem a clear goal, tasks, principles, content, organizational and methodical features of exogenous-respiratory hypoxic training use in the training process of the athletes specializing in middle distance running are not yet defined. Currently, the use of hypoxic activities in the preparatory period is reduced only to the middle mountains conditions, so it is necessary to expand the system of hypoxic means use on the basis of hardware and information tools implementation.

As a result of the carried out research the hypoxic training technique of athletes specializing in middle distance running includes use of hardware and information means, such as hypoxicator "Peak", diaphragm mask "Elevation training mask", system" Garmin Forerunner 310XT", pulse oximeter" Oxy-Pulse "and system of the received information analysis" Connect ". It is scientifically proved, developed and experimentally checked.

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