Effect from respiratory depression on organism functionality in pre-season training period in cycling in triathlon

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Summary

The purpose of this study was to investigate the effects of the lack of oxygen on an organism's functionality in the low season preparation term within the cycling stage of triathlon. This study might be applied to many different sports. “Oxygen intake”, “Hypoxia”, “Respiratory muscles training” are very well known terms in sports. Methods: nine healthy active triathletes (males n = 9), age (20 ± 7 years). All subjects were competitive at national and international level. All were trained in the equal conditions using Spinning bikes in the same room (22 °C ± 2.4 °C and 82 ± 4% RH), at the same time, at the same cadence (100 revolutions ± 5 rev.) and performing the same exercises. All participants had 4 monocycles pre-experimental preparation (PP), followed by 12 monocycles (hypoxia training – HT) as a part of a monthly microcycle. During a 60 min session one group was using Ultrabreathe, another group was using the Elevation Mask 2.0 and the last group didn’t use any device performing as a control group, then another 4 monocycles for recovery (R). Data was collected at the end of each phase-PP (4 monocycles in one week), in the middle and at the end of phase-HT (8-monocycles using Elevation Mask 2.0 and Ultrabreathe devices) and the end of phase-R (4-monocycles with no respiration effort). Maximal oxygen consumption (VO₂max), Lactate (LA), cadence power (W) and heart rate (HR) was recorded and collected as part of the research. All were measured in laboratory conditions using KORR CardioCoach gas analyzing system for VO₂max, cadence power was measured by the Monark LC4R ergometer bike, whereas blood samples were collected for lactate using the COBAS Accutrend Plus device, heart rate data was measured by the POLAR H7 heart rate belts and POLAR Power Flow system. The performances expressed changes in all four parameters on all stages of the experiment. Maximal oxygen consumption showed an increase in two groups who were using the respiratory depression devices after 8 monocycles – by 4.35 and 3.01% respectively, and by the end of the experiment the total difference was – 3.74 and 0.82% respectively. Improvements were also defined in the level of increase in lactate and maximum cadence power. There was a power increase in the two groups who were using the respiratory depression devices after 8 monocycles – 3.92 and 1.57% respectively, and by the end of experiment the total difference was – 3.57 and 0.87% respectively. All this data shows us the positive effects of hypoxial training, what might prove a useful tool for increasing endurance and, meanwhile, it might positively affect the final competition results. HT might be used for pulmonary function increase, increase of the respiratory muscles strength and body adaptation against stress created by hypoxial conditions during a race.

Keywords: Breathing depression, hypoxia, indoor cycling, maximum oxygen consumption, triathlon.

Introduction

Triathlon is one of the newest, hardest and most popular sports in the Olympic program. Today, for the sake of achieving outstanding results, the maximum mental and physical strength investment is needed for many years. Proper and effective breathing is one of the key components that affects the final result and keeps the result for longer period of time, as well as the functionality of the organism and the recovery processes. The number of studies on theoretical and methodological support for athletic training using artificial hypoxic approaches and methods is sufficiently large, but this problem is still insufficiently investigated using this unusual ergogenic approach in several sports (Faiss et al., 2013). Same time, energy-generating processes depend on respiratory efficiency and energy levels in the body (Чижов, Стрелков, 2001; Romer et al, 2002). By improving different breathing phases, you can get an extra energy reserve that will also be used to get better results. Breathing equipment and methods are widely used in the world for various reasons, for example, in sports, they are used for natural sport result enhancement. It has been shown in studies of the University of Nottingham in 2013, in research on bathing performance improvement of the elite class swimmers and their specific muscle warm-up. Another study was focused on the fatigue of respiration muscles and its negative effects on fatigue in their respiration muscles training cycling. The study
was conducted at Birmingham University in 2002. Respiratory muscle training significantly affects the circulation of the blood: both – the respiratory organs and muscles (Фролов, 1998; Dominelli et al., 2017). By using breathing muscle training (IMT), aerobic and anaerobic thresholds can be improved by 15% (Moreira, 2016; Cross, Winters, 2014). To achieve high level competitive proficiency and to improve performance, athletes need an effective interaction between physical and psychological stimuli (Kayser, 2003). Experiences of competitive athletes indicate that the ability to withstand high levels of effort, pain and fatigue are important requirements to excel in top-level competitions. Additionally, it could be assumed that as athletic performance becomes more strenuous and professional, a harder stimulus is needed to become accustomed to pain and fatigue (Scott, Gijsbers, 1982). The International Association of the Study of Pain defines pain as unpleasant sensory and emotional experience, associated with actual or potential tissue damage. Furthermore, fatigue can be defined as any exercise-induced reduction in the ability to exert muscle force or power, regardless of whether or not the task can be sustained (Gandevia, 2001). It is generally assumed that hypoxia exacerbates the reduced capacity for oxygen uptake and transport (1% to 2% decrease in VO$_2$max for each 1% decrement in oxygen saturation below 95%) leading to diminished aerobic performance. In this regard, J. Calbet et al. (2003) reported a 7% to 16% reduction in aerobic power output during maximal exercises in hypoxia.

**Aim of research:** an assessment of the effects of the use of the UltraBreathe and ElevationMask 2.0 Respiration depression devices on the physical characteristics, respiratory system and the functionality of the organism.

The pedagogical experiment was conducted to determine the effectiveness of the use of Ulbrabreathe and ElevationMask 2.0 during the inter-season preparation process. During the experiment (12 monocycles), we focused on four vital parameters of the preparation in endurance sports: lactate, VO$_2$max, power, heart rate.

**Material and methods**

For the experiment triathletes were divided into following training groups, which were based on the level of their preparation. Criteria included: 6 times a week and at least 13 hours per week. 1st experimental group included triathletes who had been training for 3 years and had already completed the triathlon middle distance (1900 m swimming + 90 km cycling + 21.1 running), 2nd group – triathletes who had 2 years of experience and preparing for the middle distance (1900 m swimming + 90 km cycling + 21.1 running) and in the 3rd group – triathletes who were called also „the control group”, which had experience of doing triathlon for 3 years and training for Standard distance (1500 m swimming + 40 km cycling + 10 km running). The following tests were performed to determine the initial results and to determine the effectiveness of the training: VO$_2$max – maximum oxygen consumption test, PWC170 – physical ability test, lactate assay. All participants had good physical condition. 9 triathletes participated in the test. The experiment took place in 2016/2017 during inter-season preparation period in the cycling segment preparation. The main difference between the groups was that 1st group used respiratory „altitude” masks, 2nd group used respiratory depression devices with a mouthpiece. Finally, the control group (3rd) was given an equivalent training program and load, and wasn’t using any respiratory depressing devices. For all experiments was applied arithmetic mean (X), standard deviation (S), standard error (Sx), and “Student t-test for independent groups with similar dispersion” was calculated. The MS EXCEL software was used for the “Mathematical Statistics” and appropriate programs were loaded => “descriptive statistics”.

**Results and discussion**

All research testings were done in the laboratory of sanatorium “Jantarnij Bereg” in 2016 December/2017 January after 60 min overall strength and conditioning training. For all athletes during this training average heart rate (AVP) wasn’t overreaching 140 bpm., what was recorded with POLAR FLOW platform and devices for group training POLAR H7 heart rate belts. Humidity in gym – 42%, Air temperature – 20 °C, Air mobility – 0.2 m/s. In the first stage of the study, the results of the initial test were obtained in special tests using a veloergometer, also using a gas analyzer. The obtained results were used to analyze initial data of the experiment. Organizing pedagogical
experiments subjects were divided into three equal groups. During the pedagogical experiment, based on the analysis of the special literature and scientific research, training criteria and restrictions were introduced. At the end of the 1st stage (four training mono cycles), the test on gas analyzer was made. In the second phase of the study, four training mono cycles were repeated, followed by testing on a gas analyzer on more time. In the third stage of the study, four training mono cycles were repeated again, in which no breathing difficulty was applied in all three groups. After this stage, the results of the athletes were also taken for evaluation of the dynamics. At each stage of the study, each participant had to individually undergo a warm-up on a veloerogometer, followed by a step test: every 2 minutes the intensity (power) was increased to 15 W until the peak heart rate was reached. At the each stage of the study, the participants identified four mean group results (LA, VO\textsubscript{max}, Pulse, Power – Watt), which one more time were compared to the average of the other two groups.

![Fig. 1. 1M Participant initial testing results](image1)

![Fig. 2. 2M Participant initial testing results](image2)

![Fig. 3. 3M Participant initial testing results](image3)

On this chart it is graphically shown that the participant from the M group, who used ElevationMask 2.0, and had peaked his initial experiment results up to 371 W at 183 bpm, with a maximum oxygen consumption of 62.6 ml/kg/min. The chart also shows the individual graphical representation of athlete’s lactate, which at his pulse 183 bpm reached its critical level of 10.7 Mol/L. The starting parameter for the Athlete 1M was as follows: Power – 88 W, Lactate – 0.5 Mol/L, HR – 82 bpm, VO\textsubscript{2} – 19.1 ml/kg/min. Threshold limit for the Athlete 1M was achieved at HR of 168 bpm, when lactate reached the limit of the aerobic threshold of 4.0, at a power of 330 W, all parameters after this point were showing faster growth.

On this chart it is graphically shown that the participant from the M group, who used ElevationMask 2.0, and had peaked his initial experiment results up to 377 W at 185 bpm, with VO\textsubscript{max} of 65.3 ml/kg/min. The chart also shows the individual graphical representation of athlete’s lactate, which at his pulse 185 bpm reached its critical level of 10.9 Mol/L. The starting parameter for the Athlete 2M was as follows: Power – 86 W, Lactate – 0.5 Mol/L, HR – 74 bpm, VO\textsubscript{2} – 18.6 ml/kg/min. Threshold limit for the Athlete 2M was achieved at HR of 165 bpm, when lactate reached the limit of the aerobic threshold of 4.0, at a power of 303 W, all parameters after this point were showing faster growth.

On this chart it is graphically shown that the participant from the M group, who used ElevationMask 2.0, and had peaked his initial experiment results up to 395 W at 182 bpm, with a maximum oxygen consumption of 65.8 ml/kg/min. The chart also shows the individual graphical representation of athlete’s lactate, which at his pulse 182 bpm reached its critical level of 10.4 Mol/L. The starting parameter for the Athlete 3M was as follows: Power – 103 W, Lactate – 0.4 Mol/L, HR – 79 bpm, VO\textsubscript{2} – 20.1 ml/kg/min. Threshold limit for the Athlete 3M was achieved at HR of 170 bpm, when lactate reached the limit of the aerobic threshold of
4.0, at a power of 331 W, all parameters after this point were showing faster growth. The M-group members have reported peak performance ratio averaging over 370 W, which is defined as a good level of preparation by comparing their result with the average results of athletes who train more than 13 hours/week and involved only in cycling sport (Моногаров, 1986; Мищенко, 1990; Поляцук, 1996). Also, for all three athletes, VO₂max exceeded the average level of preparedness (Поляцук, 1996).

On this chart it is graphically shown that the participant from the T group, who used “Ultrabreathe” respiration depression device, and had peaked his initial experiment results up to 388 W at 185 bpm, with a maximum oxygen consumption of 62.9 ml/kg/min. The chart also shows the individual graphical representation of athlete’s lactate, which at his pulse 185 bpm reached its critical level of 10.8 Mol/L. The starting parameter for the Athlete 1T was as follows: Power – 88 W, Lactate – 0.5 Mol/L, HR – 82 bpm, VO₂ – 19.1 ml/kg/min. Threshold limit for the Athlete 1T was achieved at HR of 168 bpm, when lactate reached the limit of the aerobic threshold of 4.0, at a power of 330 W, all parameters after this point were showing faster growth.

On this chart it is graphically shown that the participant from the T group, who used “Ultrabreathe” respiration depression device, and had peaked his initial experiment results up to 377 W at 185 bpm, with a maximum oxygen consumption of 58.6 ml/kg/min. The chart also shows the individual graphical representation of athlete’s lactate, which at his pulse 185 bpm reached its critical level of 11.0 Mol/L. The starting parameter for the Athlete 2T was as follows: Power – 77 W, Lactate – 0.5 Mol/L, HR – 82 bpm, VO₂ – 19.3 ml/kg/min. Threshold limit for the Athlete 2T was achieved at HR of 165 bpm, when lactate reached the limit of the aerobic threshold of 4.0, at a power of 304 W, all parameters after this point were showing faster growth.

On this chart it is graphically shown that the participant from the T group, who used “Ultrabreathe” respiration depression device, and had peaked his initial experiment results up to 374 W at 183 bpm, with a maximum oxygen consumption of 62.0 ml/kg/min. The chart also shows the individual graphical representation of athlete’s lactate, which at his pulse 183 bpm reached its critical level of 10.5 Mol/L. The starting parameter for the Athlete 3T was as follows: Power – 77 W, Lactate – 0.4 Mol/L, HR – 78 bpm, VO₂ – 18.1 ml/kg/min. Threshold limit for the Athlete 3T was achieved at HR of 171 bpm, when lactate reached the limit of the aerobic threshold of 4.0, at a power of 304 W, all parameters after this point were showing faster growth. The T-group members have reported peak performance ratio averaging over 370 W, which is defined as a good level of preparation by comparing their result with the average results of athletes who train more than 13 hours/week and involved only in cycling sport (Моногаров, 1986; Мищенко, 1990; Поляцук, 1996; Edwards, Cooke, 2004). Also, for all three athletes, VO₂max exceeded the average level of preparedness (Поляцук, 1996).
On this chart it is graphically shown that the participant from the Eks-group, who wasn’t using any respiration depression devices, and had peaked his initial experiment results up to 371 W at 185 bpm, with a maximum oxygen consumption of 59.0 ml/kg/min. The chart also shows the individual graphical representation of athlete’s lactate, which at his pulse 185 bpm reached its critical level of 11.2 Mol/L. The starting parameter for the Athlete 1Eks was as follows: Power – 82 W, Lactate – 0.6 Mol/L, HR – 90 bpm, VO\textsubscript{2} – 17.7 ml/kg/min. Threshold limit for the Athlete 1Eks was achieved at HR of 173 bpm, when lactate reached the upper-limit of the aerobic threshold of 4.5, at a power of 277 W, all parameters after this point were showing faster growth. From this chart we can also conclude, that athlete’s reaction on given training stimulus was constant and growing with linear progression.

On this chart it is graphically shown that the participant from the Eks-group, who wasn’t using any respiration depression devices, and had peaked his initial experiment results up to 369 W at 180 bpm, with a maximum oxygen consumption of 61.2 ml/kg/min. The chart also shows the individual graphical representation of athlete’s lactate, which at his pulse 180 bpm reached its critical level of 10.5 Mol/L. The starting parameter for the Athlete 3Eks was as follows: Power – 82 W, Lactate – 0.5 Mol/L, HR – 79 bpm, VO\textsubscript{2} – 18.5 ml/kg/min. Threshold limit for the Athlete 3Eks was achieved at HR of 158 bpm, when lactate reached the limit of the aerobic threshold of 4.0, at a power of 307 W, all parameters after this point were showing faster growth. From this chart we can also conclude, that athlete’s reaction on given training stimulus was not even, as upon high intensity stimulus hear rate of the athlete significantly fast increased, and only after some time returned to natural (linear) growth. The T-group members have reported peak performance ratio averaging over 370 W, which is defined as a good level of preparation by comparing their result with the average results of athletes who train more than 13 hours/week and involved only in cycling sport (Могогаров, 1986; Мищенко; 1990; Полищук, 1996). After analyzing the results of all three groups of athletes, it can be concluded that the average level of preparedness above medium level considering organism response to the added load stimulus. For majority of participants, the heart rate response to
the added increase of pedaling power was increase of it’s activity in linear progression. Lactate level for all athletes showed a steep increase form 4.0 ± Mol/L. Following the use of breathe depression devices during 8 monocycles, the maximum results for all athletes were grouped for detailed analysis.

Analyzing the results after phase III and comparing them with the results that were presented after the use of ElevationMask 2.0 are related to the most convenient use and the ability to more accurately select the load using a variety of values. The design of the UltraBreathe device also provides a different level of load selection, but with less precision than Elevation-mask. However, T-group members noted that the use of the UltraBreathe device is difficult in a dynamic environment due to facial muscle overload when using it.

On average, all group performance was improved, which is reflected in Fig. 11. The results that were presented after the use of ElevationMask 2.0 are related to the most convenient use and the ability to more accurately select the load using a variety of values. The design of the UltraBreathe device also provides a different level of load selection, but with less precision than Elevation-mask. However, T-group members noted that the use of the UltraBreathe device is difficult in a dynamic environment due to facial muscle overload when using it.

The results of the control group were less developed from of all groups, as well as the results of some athletes have been dropped in various parameters. All the participants who used the „UltraBreathe” respiratory depressing devices noted that at the time of use, there was a greater discomfort for breathing during normal aerobic work (around the pulse frequency ≥150 bpm/min). For some athletes, the maximum heart rate hasn’t improved and even “dropped” what was associated with atypical bike loads during this training period.

### Table 1

<table>
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<th>Test results of Triathletes after II and III phase</th>
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<th>LA</th>
<th>VO₂max</th>
<th>BPM</th>
<th>Watt</th>
<th>LA</th>
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<td>3t</td>
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<td>VO₂max</td>
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M – group, who used “Elevation Mask 2.0” respiratory depressing mask
T – group, who used “UltraBreathe” respiratory depressing device
Eks – experimental group, who haven’t used any respiratory depressing devices

[Fig. 10. Result increase/decrease for each participant comparing II and III phase]

[Fig. 11. Result increase/decrease for each group comparing II and III phase]

[Fig. 12. Result increase/decrease for each group comparing III phase with initial results]
The average drop of lactate for all groups was 4.3%, which also showed a very good increase. For the M-group participants, the pedaling power increased for 3.9%, and the VO\(_2\)\text{max} for all experimental groups increased by an average of 3.5%.

![Fig. 13. Result increase/decrease for each participant comparing initial results with III phase results](image)

For each participant, the comparison of the results between phases I and IV is as follows: for the 1-M participant, an improvement is defined in all 4 parameters: the power level has improved to 2.96%, or from 371 W to 382 W. The lactate level after added workload stimulus has improved to 6.54%, other words, from 10.7 Mol/L to 10.0 Mol/L. Maximum oxygen consumption, or VO\(_2\)\text{max}, has improved by 2.08%, or from 62.6 to 63.9 ml/kg/min. The maximal heart rate allowed within the test protocol has improved to 2.19%, or from 183 to 179 bits/min. For the 2-M participant, an improvement is defined in all 4 parameters: the power level has improved to 3.45%, or from 377 W to 390 W. The lactate level after added workload stimulus has improved to 3.67%, other words, from 10.0 Mol/L to 10.5 Mol/L. Maximum oxygen consumption, or VO\(_2\)\text{max}, has improved by 4.59%, or from 65.3 to 68.3 ml/kg/min. The maximal heart rate allowed within the test protocol has improved to 1.08%, or from 185 to 183 bits/min. For the 3-M participant, an improvement is defined only in 2 parameters: the power level has improved to 4.30%, or from 395 W to 412 W. The lactate level after added workload stimulus hasn’t changed. Maximum oxygen consumption, or VO\(_2\)\text{max}, has improved by 4.56%, or from 65.8 to 68.8 ml/kg/min. The maximal heart rate allowed within the test protocol has shown negative improved to –1.65%, or from 182 to 185 bits/min. For the 1-T participant, an improvement is defined in all 4 parameters: the power level has improved to 1.08%, or from 388 W to 392 W. The lactate level after added workload stimulus has improved to 0.93%, other words, from 10.8 Mol/L to 10.7 Mol/L. Maximum oxygen consumption, or VO\(_2\)\text{max}, has improved by 0.91%, or from 62.9 to 63.5 ml/kg/min. The maximal heart rate allowed within the test protocol has improved to 1.51%, or from 185 to 182 bits/min. For the 2-T participant, an improvement is defined in all 4 parameters: the power level has improved to 0.87%, or from 377 W to 380 W. The lactate level after added workload stimulus has improved to 2.73%, other words, from 11.0 Mol/L to 10.7 Mol/L. Maximum oxygen consumption, or VO\(_2\)\text{max}, has improved by 0.91%, or from 58.6 to 59.1 ml/kg/min. The maximal heart rate allowed within the test protocol has improved to 1.72%, or from 185 to 182 bits/min. For the 3-T participant, an improvement is defined in all 4 parameters:
power level has improved to 0.67%, or from 374 W to 377 W. The lactate level after added workload stimulus has improved to 6.66%, other words, from 10.5 Mol/L to 9.8 Mol/L. Maximum oxygen consumption, or VO\textsubscript{max}, has improved by 0.65%, or from 62.0 to 62.4 ml/kg/min. The maximal heart rate allowed within the test protocol has improved to 0.65%, or from 183 to 182 bits/min. For the 1-Eks participant, an improvement is defined in 2 parameters, as well in one parameter changes hasn’t been defined, and in another one negative changes took place: the power level has negative improved to −2.88%, or from 382 W to 371 W. The lactate level after added workload stimulus has improved to 4.46%, other words, from 11.2 Mol/L to 10.7 Mol/L. Maximum oxygen consumption, or VO\textsubscript{max}, hasn’t shown any improved. The maximal heart rate allowed within the test protocol has improved to 1.62%, or from 185 to 182 bits/min. For the 2-Eks participant, an improvement is defined in 3 parameters: the power level has improved to 0.54%, or from 370 W to 372 W. The lactate level after added workload stimulus has improved to 0.93%, other words, from 10.7 Mol/L to 10.6 Mol/L. Maximum oxygen consumption, or VO\textsubscript{max}, has improved by 0.16%, or from 60.9 to 61.0 ml/kg/min. The maximal heart rate allowed within the test protocol has shown negative improved to −1.65%, or from 182 to 185 bits/min. For the 3Eks participant, an improvement is defined in 3 parameters: the power level hasn’t showed any improvements. The lactate level after added workload stimulus has improved to 2.78%, other words, from 10.8 Mol/L to 10.5 Mol/L. Maximum oxygen consumption, or VO\textsubscript{max}, has improved by 0.10%, or from 61.1 to 61.2 ml/kg/min. The maximal heart rate allowed within the test protocol has improved to 1.10%, or from 182 to 180 bits/min. According to all obtained results, we see that the power pedaling for the M-group members, the power and VO\textsubscript{max} parameters have improved after 12 monocycles, of which 8 were using breathing depression devices. Only in 1 out of 3 M-group participants shown lactate levels with no difference comparing with the 1\textsuperscript{st} to the 4\textsuperscript{th} phase, and the same participant also worsened the maximum heart rate, which tends to be related to total fatigue and to another non-experiment related factor. All T-group members have the power and maximum oxygen consumption parameters equally improved. By analyzing the differences between the 8\textsuperscript{th} and 12\textsuperscript{th} monocycles, we can conclude that the results slightly decreased from the moment participants were training with and without respiration depression. These results are graphically shown in Fig. 16. and in Fig. 17.

Eks-group members showed a slight improvement in VO\textsubscript{max} – 0.09%, what indicates a natural increase in the chosen training method. The other 3 parameters did not improve, and also dropped below the starting level, indicating the worst recovery and less efficient energy consumption.
Comparing the results of the individual participants, it can be seen that lactate level continues to improve, which is associated with increased fitness level. The improvement of the lactate levels is process noticeable for almost all tested athletes. In all cases, the capacity ratio dropped by 0.33%, and the VO₂ max ratio decreased in all cases.

As from results of the control group during the experiment showed a difference of α > 0.05 compared to the dynamics reported by experimental groups α < 0.05. Comparing the results for the M-group and the T-group, we can conclude that more Effective use is “Elevation Mask 2.0”, which is associated with ergonomic factors, practical application factors and accuracy. As well we can’t overlook the fact that the convenience of the UltraBreathe device is more likely to appear in workouts out of the gym.

Conclusions

1. Initial parameters of the respiratory system were determined before the start of the experiment: Maximum Oxygen Consumption (MOC or VO₂ max) – Mean M-group result 64.6 ml/kg/min; Maximum power of the test movement: Power (W) – Average M-group result is 381 W; Blood lactate level (LA) – mean result/level 10.8 Mol/L; Pulse Frequency – The average group result is 184 bits/min. Initial parameters of the respiratory system were determined before the start of the experiment: Maximum Oxygen Consumption (MOC or VO₂ max) – Mean T-group result 61.2 ml/kg/min; Maximum power of the test movement: Power (W) – Average T-group result is 380 W; Blood lactate level (LA) – mean result/level 10.9 Mol/L; Pulse Frequency – The average group result is 183 bits/min.

2. Respiratory depression devices were used in the first 8 monocycles, out of 12 monocycles during the experiment. The duration of the training was 60 minutes. The results obtained in all the investigated parameters improved after the fourth monocycle, and even bigger improvement of results was after the 8th monocycle, where the increase of the results was even higher. A slight drop of the results was from 9 to 12 monocycles, as the participants did not use any respiratory depression devices, although, in comparison with the first results (initial), the improvement in all parameters was determined.

3. Comparing the M-group end-results after the experiment, we can define that the statistically significant differences were: in the test pedaling power: W, maximum oxygen consumption – VO₂ max ml/kg/min, blood Lactate-LA Mol/L, Pulse Frequency Ratio/min, indicating that the members of this group who were using Elevation Mask 2.0 during 8 monocycles managed to improve the above-mentioned parameters more effectively during interseason. The total score of T-group for all results (Power W, maximum oxygen consumption VO₂ max, Lactate LA, Pulse) were α < .05, which indicates a positive result increase and effectiveness of the frequency and duration of training for the group with the UltraBreathe respiration depression device. The group also noted a lowered ergonomic level during the use of this device, which was one of the stress factors during experimental period. Total score of the ex-group is α > 0.05, what indicates that the result is constant and that it also sometimes worsens. Such frequency and duration, as well as interval and stimulus addition, are more recommended for use with breathing devices.
obtained results confirm the hypothesis that use of the UltraBreathe and ElevationMask 2.0 respiratory depressing devices (12 monocycles) in preparation for triathlon in cycling segment gives additional benefit for physical skills to be developed more effectively: overall endurance parameters and movement power.

REFERENCES

KVĖPAVIMO SULĖTĖJIMO POVEIKIS ORGANIZMŲ FUNKCIONALUMUI PRIEŠSEZONINIŲ TRENIRUOČIŲ PERIODO TRIATLONO VAŽIAVIMO DVIRAČIŪ RU GUN TYGE

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SANTRAUKA

Tyrimo tikslas – nustatyti deguonies stigias poveikį organizmo funkcionavimui priešsezoninių treinėriuocių perio du triatlono važiavimo dūriaus ru gundyje. Šis tyrimas gali būti pritaikomas daugeliui skirtingų sporto šakų. „Deguonies įsisavinimas“, „hipoksija“, „kvėpavimo raumenų stiprinimas“ – labai gerai šiandienos sportui žinomi terminai. Tyrime dalyvavo devyni sveiki triatlono sportininkai (vyrai, n = 9), kurių amžius 20 ± 7 metų. Visi tyrėjai dalyvavo 4 monociklų priešeksperimentiniame pasiren- gime (PP), po kurio sekė 12 monociklų (hipoksijos treniravimą – HT) kaip mėnesinio mikrociklo dalis. Per 60 s sesiją viena grupė naudojo UltraBreathe, kita grupė – Elevation Mask 2.0, o trečia, kontrolinė, grupė nenaudojo jokio prietaiso. Duomenys buvo renkami po keturių atsigavimo (A) monociklų, kiekvieno PP etapo pabaigoje (4 monociklai per vieną savaitę), HT ciklo viduryje ir pabaigoje (8 monociklai naudojant Elevation Mask 2.0 ir UltraBreathe įrangą) ir A ciklo pabaigoje (4 monociklai netelkiant kvėpavimo pastangų). Tyrimui buvo pasitelkta šie duomenys: maksimalusis deguonies suvartojimas (VO2max), laktatas (La), ritmiškumas (W) ir širdies ritmas (ŠR). VO2max duomenys buvo paimti laboratorijos sąlygomis naudojant KORR Cardio Coach dujų analizi- vimo sistemą, ritmiškumas buvo matuojamas Monark LC4R ergometru, kraujo mėginiai laktatu be paimtų
naudojant COBAS Accutrend Plus įrenginį, o širdies ritmas matuotas su POLAR H7 diržais naudojant POLAR Power Flow sistemą. Atliekant testus pademonstruoti visais keturiais parametriais pokyčiai visose eksperimento stadijose. Maksimaliojo deguonies suvartojimo rodikliai atskleidė padidėjimą po 8 monociklų dviejose grupėse, kurios naudojo kvėpavimo sulėtėjimo įrenginius – atitinkamai 4,35 ir 3,01 %, o eksperimento pabaigoje absoliutus skirtumus buvo atitinkamai 3,74 ir 0,82 %. Užfiksuotas ir laktato padidėjimas bei maksimalaus ritmingumo pagerėjimas. Po 8 monociklų buvo užfiksuotas ir jėgos padidėjimas – atitinkamai 3,92 ir 1,57 % – tose dviejose grupėse, kurios naudojo kvėpavimo sulėtėjimo aparatus, o eksperimento pabaigoje – atitinkamai 3,57 ir 0,87 %. Visi gauti duomenys demonstruoja teigiamą hipoksijos treniravimo poveikį, kuris gali tapti naudinga priemone didinant ištvermę ir kartu gali daryti teigiamą įtaką varžybiniam rezultatams. HT gali būti taikomas treniruojant plaučius, didinant kvėpavimo raumenų jėgą ir kūno adaptaciją prieš varžybų metu hipoksijos sukuriamą stresą.

Raktiniai žodžiai: kvėpavimo sulėtėjimas, hipoksija, važiavimas dviračiu uždarose patalpose, maksimalus deguonies suvartojimas, triatlonas.

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