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THE PARTICULARITIES OF THE USE OF BREATHING SIMULATORS ON THE YOUNG SWIMMERS' PHYSICAL TRAINING

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Abstract: *This study explores breathing simulators in young swimmers' training, assessing their role in performance, endurance, and oxygen use. It reviews existing knowledge, analyzing physiological and psychological effects while addressing risks. Findings indicate these devices improve fitness and adaptation but require monitoring for safety. The paper highlights benefits and challenges, including psychological preparation, injury prevention, and developmental impacts.*

Key words: *breathing simulators, young swimmers, physical training.*

1. Introduction

The use of breathing simulators in the training of young swimmers has become increasingly popular in recent years. These devices are designed to create hypoxic conditions, mimicking high-altitude training, which forces the body to adapt by improving oxygen utilization efficiency. This adaptation is particularly beneficial for swimmers, who rely heavily on cardiovascular and respiratory efficiency for best performance. The primary purpose of this study is to explore the particularities of using breathing simulators in the physical training of young swimmers, focusing on their physiological and psychological effects.

Breathing simulators are not only effective in enhancing physical fitness but also play a crucial role in preventing overuse injuries by distributing the physical load more evenly across the body. However, the implementation of these devices in training programs raises several questions, including the optimal duration and intensity of their use, the specific physiological adaptations they promote, and the long-term effects on young athletes' development. This study aims to address these questions by synthesizing existing research and providing a comprehensive overview of the potential benefits and drawbacks of breathing simulators in swimming training.

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Of great importance for the development of the functional and physical qualities of an athlete are the correctly selected means and methods of training, the correct ratio of loads of different directions, applied in the annual cycle and at individual stages of preparation [6]. The literature on the use of breathing machines in sports training, particularly swimming, highlights several key benefits and aspects to consider. First, external devices are effective in increasing lung capacity and endurance in athletes. Research shows that controlled hypoxia induced by human devices stimulates erythropoiesis, thereby increasing the oxygen load of the blood. Secondly, the use of breathing machines can lead to significant increases in maximal oxygen consumption (VO2 max), a key indicator of aerobic performance. Various studies have shown that young swimmers who included these devices in their training showed significant improvements in endurance and recovery time compared to those who did not [2], [4], [10[, [11]. According to Solomatin V.R., Voitenko Yu.L., Egorov A.V. (2017), the use of swimming exercises with a capnicator in the preparatory period allows to significantly increase the indicators of both aerobic and anaerobic abilities of young swimmers and achieve higher sports results at medium and long distances [10].

However, not all results are unambiguously positive, as incorrect use or overuse of breathing apparatus can lead to fatigue of the respiratory muscles, thus highlighting the need for carefully controlled training programs tailored to the individual needs of each swimmer. While breathing training devices can improve certain aspects of performance, such as lung function and VO2 max, they may not significantly influence swimming technique or skill development. These findings suggest that while breathing simulators offer physiological benefits, their integration into training programs should balance with other training modalities to ensure comprehensive skill development. Additionally, the psychological impact of breathing machines on young swimmers cannot ignored, showing that while some athletes reported increased confidence and motivation, others expressed feelings of anxiety and pressure related to performance. These psychological factors may influence training commitment and performance outcomes, highlighting the importance of considering athletes' mental well-being when implementing breathing exercises into training.

An important aspect that requires attention is the development of training protocols using breathing simulators. Now, the training of swimmers in the annual macrocycle based on the competition calendar is built on three large training cycles, each of which includes: - a preparatory period; - a basic period; - a pre-competition period; - a competition period. Based on this, specific tasks are set for each training period, the effective solution of which decided by the professionalism and creativity of the trainer. The use of breathing simulators in the preparation of swimmers in each training period figured out by its objectives, which, in turn, confirmed by the results of research over a long period of time [11].

2. Materials and methods

2.1. The purpose of the research:

To examine the use of breathing simulators in the physical training of young swimmers, synthesizing the results of various studies to provide a comprehensive understanding of the benefits and potential risks associated with the use of breathing simulators.

2.2. Research goals

1. Theoretical and methodological aspects of the use of breathing simulators in the physical training of young swimmers.
2. Analysis of the impact of breathing training technologies and identification of the importance of an integrated approach to the training process.
3. Identification of aspects of the influence of breathing simulators on the physical training of young swimmers

2.3. Methods

The methods includ a theoretical basis for the study, a synthesis of the basic concepts regarding breathing simulators, and an induction and deduction regarding their use in the training process of young swimmers.

3. Results and Discussion

As technology continues to advance, there's potential for the development of more sophisticated breathing simulators tailored to the specific needs of swimmers. Research now shows that personalized training approaches using advanced sensor technologies and real-time feedback mechanisms can improve the effectiveness and safety of breathing trainer use.

These innovations could enable trainers to adjust parameters such as hypoxic intensity and breathing patterns in real-time, based on individual physiological responses and performance goals. Additionally, incorporating virtual reality simulations or gamification elements into breathing simulator-training sessions may enhance engagement and adherence among young swimmers, thereby promoting long-term benefits. For example, some modern breathing simulators are equipped with biofeedback systems that check heart rate, oxygen saturation, and respiratory rate. This data can be used to customize training sessions, ensuring that each swimmer is training at the optimal intensity for their current fitness level.

The authors Li, X., Fan, D., Feng, J., Lei, Y., Cheng, C., Li, X. (2025) of it claim that in the modern era of sports training, the synergy between motion capture and Virtual Reality (VR) offers an innovative approach to enhancing training precision. This systematic review delves into the application of motion capture within VR for sports training, highlighting its transformative potential [8]. Furthermore, the integration of virtual reality (VR) into breathing simulators can create immersive training environments, such as simulating high-altitude conditions or competitive race scenarios. This not only makes training more engaging but also helps swimmers develop mental resilience by

practicing under realistic, high-pressure conditions.

Another technological advancement is the use of artificial intelligence (AI) to analyze training data and provide personalized recommendations. AI algorithms can track an athlete's progress over time, find areas for improvement, and suggest adjustments to the training regimen. This level of personalization can help young swimmers achieve their full potential while minimizing the risk of injury or overtraining.

A current scientific and pedagogical task is to find training tools and methods aimed at accelerating the adaptation of the respiratory system of swimmers to the conditions of the mid-mountain region [1], [5]. Therefore, it is important to integrate various training methods, including strength training, technical exercises and psychological preparation, along with the use of breathing simulators (Figure 1).

Fig. 1. *Breathing simulators used in the training process of young swimmers*

This comprehensive approach ensures the all-round development of athletes, covering not only physical training, but also technical skill, mental stability and injury prevention. A concerted effort by coaches, sports scientists and medical professionals must develop integrated training programs that perfect performance outcomes while protecting the health and well-being of young swimmers throughout their development. Mental conditioning plays a crucial role in the success of young swimmers. Techniques such as visualization, mindfulness, and stress management can help athletes cope with the pressures of competition and keep focus during training. When combined with the physiological benefits of breathing simulators, mental conditioning can create a powerful synergy that enhances overall performance.

Injury prevention is another critical part of a holistic training approach. Young swimmers are particularly susceptible to overuse injuries due to the repetitive nature of swimming movements. Breathing simulators can help mitigate this risk by promoting more efficient breathing patterns, which reduce the strain on the respiratory muscles and allow for better distribution of physical effort. Additionally, incorporating strength training and flexibility exercises into the training regimen can further reduce the risk of injury and improve overall athletic performance.

An athlete’s ability to prove athletic skill in swimming determined by the ability to effectively perform physical work in a state of so-called hypermetabolic hypoxia (hypoxia of physical activity) [7], [9]. Hypoxia, a condition characterized by decreased oxygen availability, forces the body to adapt by increasing the efficiency of oxygen use. This adaptation is especially important for athletes, especially swimmers, who rely heavily on

cardiovascular and respiratory efficiency. Therefore, in sports practice there is a need to search for and apply methods and techniques aimed at improving the adaptation of athletes to hypermetabolic hypoxia [3].

The use of breathing simulators is also supported by the theory of specificity in training. According to this theory, training adaptations are highly specific to the type of exercise performed. By simulating hypoxic conditions, breathing devices provide a specific stimulus that enhances the respiratory and cardiovascular systems' efficiency, directly benefiting swimming performance.

Another relevant theory is the overload principle, which says that physiological adaptations occur when the body is exposed to a stressor that exceeds its normal capacity. Breathing simulators apply this principle by creating an added respiratory load, prompting the body to adapt by strengthening respiratory muscles and improving overall endurance.

This study employs a qualitative research method, analyzing existing literature and expert opinions to assess the impact of breathing simulators on young swimmers' training. Data were collected from peer-reviewed journal articles, books, and credible online sources, focusing on studies published within the last decade to ensure relevance and accuracy.

The analysis of the influence of breathing simulators on the physical training of young swimmers reveals several key findings, which include aspects related to enhanced endurance; improved oxygen utilization; adaptive changes; injury prevention (Figure 2).

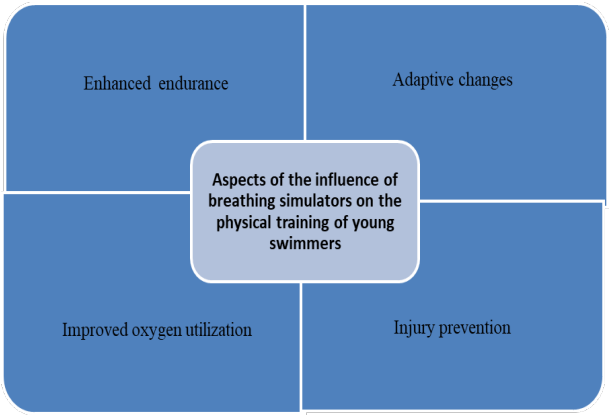

Fig. 2. *Aspects of the influence of breathing simulators on the physical training of young swimmers*

They are characterized by:

1. **Enhanced Endurance:** Breathing simulators significantly improve cardiovascular and respiratory endurance by creating hypoxic conditions that stimulate physiological adaptations.
2. **Improved Oxygen Utilization:** Regular use of breathing devices increases the efficiency of oxygen

utilization, crucial for sustained performance in competitive swimming.

3. **Adaptive Changes:** The hypoxia induced by these devices triggers adaptive changes, such as increased erythropoiesis and improved muscular oxygenation.
4. **Injury Prevention:** By distributing the physical load more evenly, breathing simulators help prevent overuse injuries common in young athletes.

The improvements in endurance and oxygen utilization are particularly noteworthy, as they directly translate to better performance in competitive settings. The adaptive physiological changes induced by hypoxia suggest that these devices can play a crucial role in preparing young athletes for the demands of high-level competition.

The research results highlight the fact that breathing simulators represent how an additional load is created on the swimmers' respiratory system, which, however, need to be used in an integrated training process, which will result in the development of breathing patterns depending on certain factors (Figure 3).

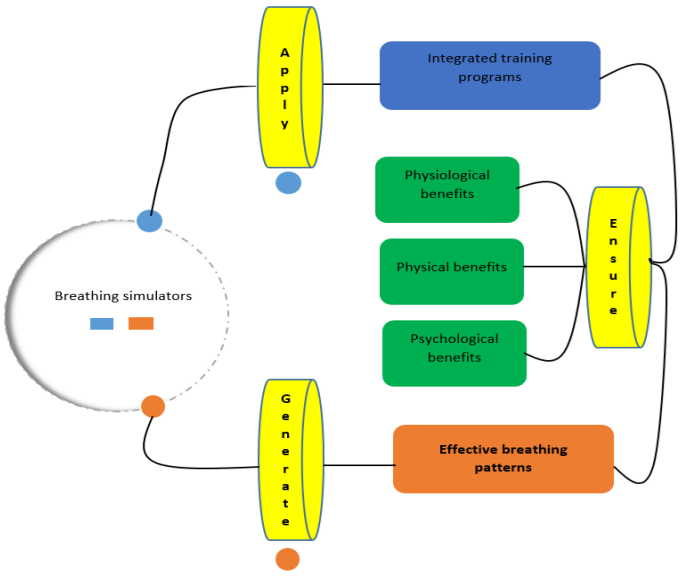

Fig. 3. *The role of breathing simulators on the training of young swimmers*

4. Conclusions

The findings underscore the significant potential of breathing simulators to enhance the physical training of young swimmers. The improvements in endurance and oxygen utilization are particularly noteworthy, as they directly translate to better performance in competitive settings. The adaptive physiological changes induced by hypoxia suggest that these devices can play a

crucial role in preparing young athletes for the demands of high-level competition.

The potential risks highlighted cannot ignored. Respiratory muscle fatigue and other adverse effects underscore the need for careful implementation and monitoring. Coaches and trainers must be educated on the proper use of these devices to maximize benefits while minimizing risks.

Further research is necessary to prove standardized protocols for the use of breathing simulators in youth sports. Longitudinal studies tracking the long-term effects on physical development and performance outcomes would offer valuable insights.

In addition to the physiological benefits, breathing simulators may also have psychological advantages. The use of these devices can enhance mental toughness and resilience by training athletes to perform under challenging conditions. This psychological edge can be crucial in competitive swimming, where mental fortitude often makes the difference between winning and losing.

Breathing simulators are a promising ergogenic aid in the training of young swimmers, offering significant benefits in terms of endurance, oxygen utilization, and adaptive physiological changes. However, their use must be carefully managed to avoid potential drawbacks such as respiratory muscle fatigue. By incorporating the insights from current research and expert opinions, trainers can improve the training conditions for young swimmers, ultimately enhancing their performance and reducing the risk of injury.

The findings of this study provide a strong rationale for the inclusion of breathing simulators in youth swimming programs. However, further research is needed to develop standardized guidelines and best practices for their use. By continuing to explore the potential of these devices, the sports science community can ensure that young swimmers receive the best possible training and support.

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