The variability of the effect of pre-start warm-up on the activation of a swimmer's competitive performance

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Abstract

Objective of the study was to assess the efficacy of different warm-up techniques employed by swimmers in enhancing their athletic abilities.

Methods and structure of the study. After examining the available literature in the Scopus and RSCI databases, a retrospective analysis was conducted on the approaches, content, and methodological frameworks for pre-swim warm-up in swimming, with a focus on the evolution of theory and methods in sports training.

Results and conclusions. It was discovered that the ideal pre-swim warm-up for a swimmer involves a moderate initial activity of swimming at a distance of 1000 meters at a speed of 60-80% of their maximum oxygen consumption. To optimize performance in the short term, it is more beneficial to take a short rest period of 3-10 minutes. In this context, a longer or more intense warm-up can lead to an excessive activation of energy systems, potentially triggering various biomechanical and physiological responses, which can be both beneficial and detrimental, depending on the demands of the competition.

Keywords: *swimmer's warm-up, preliminary activation of the functional state, physiological reactions of athletes.*

Introduction. Athletes and coaches systematically improve approaches to improving the content of warm-up, which contributes to the improvement of sports results. In particular, a 5-10-minute active warm-up of moderate intensity can significantly improve short-term results in solving a number of sports problems. The launch of cardiovascular and neuromuscular processes under the influence of an active warm-up occurs with a delayed effect after 3-5 minutes, which lasts for 5-10 minutes after its completion [2].

Although a high-intensity warm-up can cause a state of acute fatigue, it is significantly reduced during the first few minutes of recovery, providing an opportunity to extract the ergogenic benefit of the improved state. This effect is defined in the literature as activation of performance, which should be considered as one of the tasks of the warm-up [3]. Research has shown that warming up in water has a positive effect on swimmers' performance, especially in events longer than 200 m. It is recommended that swimmers' warm-ups should be conducted over a distance of 1000 to 1500 m and include short, specific exercises at an intensity similar to that of the competition. It is important to allow sufficient rest time after the warm-up to avoid early fatigue and ensure restoration of energy reserves (15-20 minutes) [10]. In addition to exercises performed in water, a large number of studies have been published in recent years examining alternative warm-up methods, with a growing trend towards using exercises on land and various combinations with other means [4].

Objective of the study was to assess the efficacy of different warm-up techniques employed by swimmers in enhancing their athletic abilities.

Methods and structure of the study. A retrospective analysis of approaches, content and methodological algorithms of pre-start warm-up of swimmers, associated with the development of the theory and methodology of sports training in swimming, was conducted. The instrumental basis of the work included a

review of literary data in the international Scopus and RSCI databases in accordance with the main stages of review studies. These include: preliminary formulation of the research question; compilation of a research bank on the topic; selection of the most relevant studies within the topic; compilation of a structured data portfolio; comparison, generalization, formulation of conclusions.

The criteria for selecting a source for inclusion in the data bank were: the study was controlled according to the «before-after» scheme; the participants in the study were qualified swimmers over 13 years old; studies assessing the urgent reaction of swimmers to the warm-up immediately before the start; the content of the warm-up included exercises on land and in water in relation to a specific exercise of the competitive program. The effectiveness of warm-up exercises was assessed based on traditional factors influencing subsequent performance, including the type, duration and intensity of the warm-up. The assessment was based on the dynamics of kinematic parameters (time, distance, speed, length and stroke rate); kinetic parameters (strength, power); physiological parameters (lactate level, temperature, heart rate, oxygen saturation, hemoglobin concentration). In this study, swimming time parameters were used as the primary outcome reflecting the response to the warm-up.

Results of the study and discussion. When comparing the results of competitions with a warm-up in the water without physical activity before the start, despite the different observed reactions of swimmers, it can be concluded that the inclusion of a warm-up in the water before 50-100 m swims can lead to improved results compared to no warm-up, if the intensity of the warm-up is sufficient and the necessary rest time is provided between the warm-up and the start. Studies by various authors have not found any differences in the results in 100 m freestyle swimming when conducting a 20- and 10-minute warm-up at HRmax 60%, which suggests that 10 minutes of activity is enough to trigger the physiological mechanisms of activation, and the chosen intensity is not high enough to cause fatigue after a longer warm-up [5].

When comparing a standard 1200 m warm-up with shorter (600 m) and longer (1800 m) warm-ups, no difference was found between the short and standard warm-ups (15-20 min), while the 100 m swim performance was 1,46% and 1,34% faster, respectively, compared with the long warm-up (30 min). Swimmers achieved the lowest blood lactate concentration ([La−]) after the long warm-up due to stimulation of the buffering capacity by prolonged low-intensity exercise [8].

Thus, a certain duration of warm-up is required in swimming; however, prolonged warm-ups increase the dependence on aerobic systems, which is counterproductive in sprint swimming competitions, in which anaerobic metabolism is a significant source of energy. In a study of the effects of a warm-up including 400 m swimming, high-speed starts over a distance of 2 × 15 m, followed by a variety of: a) 3 × 3 squats with a load of 27 to 68 kg; b) 3 × 3 sets of jumps with a weight of 15% of body weight; c) jumps from a 1 m springboard 2 × 5 times [11], it was found that the start time for 15 m improves only after squats with weights, which can be a simple way to stimulate the lower limbs in urgent preparation for the start [1]. When planning the intensity of the warm-up, the characteristics of the physiological reactions of athletes should be taken into account [7]. Due to the large volume of low-intensity training, swimmers may have an increased proportion of slow fibers that respond poorly to high-intensity stimuli. In this case, the inclusion of low-intensity exercises with an increase from moderate to high during the warm-up is intended to elicit a positive response from swimmers.

In studying the effects of warm-up in water, including elements of external load, various equipment and gear were used. Warm-up in water with a volume of 1000-1200 m with the development of maximum efforts when swimming in 8x12.5 m series paddles and subsequent 2-6-minute rest leads to a decrease in maximum traction efforts and force impulse, which is a consequence of the development of excessive fatigue and insufficient rest interval. On the other hand, an increase in rest time will lead to the athletes' body leaving the state of greatest activity [6]. After swimming on a tether 3×10 with a series of strokes with one arm followed by an 8-minute rest, a deterioration in the competitive result in 50 m swimming and stroke length is observed, which may be associated with changes in the kinematics of swimming, body position, and arm movement trajectory compared to real swimming [9]. Distorted biomechanical parameters do not correspond to real swimming conditions, which cannot have a positive effect on athletic performance.

Conclusions. Although there is great variability in athletes' responses to the warm-up, it appears that the warm-up involves moderate activity (1000 m at 60-80% VO_{2max}). For maximal swimming performance

in the short term, an optimal recovery period (3-10 min) is more beneficial. Therefore, a longer or more intense warm-up may over-activate energy systems, potentially generating different biomechanical and physiological responses that may be beneficial or detrimental depending on the demands of the competitive activity.

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