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INFLUENCE OF RETRIEVAL TIMES ON SWIMMING PERFORMANCE

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ABSTRACT
The research team behind this project hopes their findings will shed light on the importance of warming up before sporting events like practices and games. However, the warm-up should be long and strenuous enough to have the athlete sweating. Most athletes may benefit from a slow warm-up that helps get their muscles and joints ready for more strenuous training. The need of a good warm-up increases with the difficulty of the activity. By increasing blood flow to the working muscle, a complete warm-up may minimize muscular stiffness, injury risk, and even boost performance. The physical and emotional effects of warming up are similar. From a physiological standpoint, a proper warm-up allows the circulatory system to provide more oxygen to the muscles, which in turn allows the muscles to use the oxygen more quickly. One apparent advantage of swimming is that, in contrast to many land-based activities, it puts less strain on a person's muscles and joints. Micro-tears develop in muscle as a protective mechanism against further damage during high-stress activities like resistance training and aerobic threshold intervals. Acute inflammation initiates the repair process immediately after exercise. This is why it's crucial to give yourself time to rest after strenuous workouts or swimming contests. This fact motivates the current investigation into the impact of different amounts of post-warm-up recovery time on performance in a 100-meter time trial swim.

KEYWORDS: Retrieval Times, Swimming Performance, physical and emotional effects

INTRODUCTION

Ancient cave drawings show that our ancestors experimented with different floating and swimming techniques to move themselves through the water. It's fascinating to trace the evolution of modern competitive water sports back to its origins in the 19th century, when myths about sea monsters in the Middle Ages drove people afraid of the ocean. The human race has a long history of discovering and perfecting novel swimming techniques. (Prof. Melinda Biro's 2015 dissertation)

Competitive swimming rose to popularity once the modern Olympics began include swimming sports, first solely for men but subsequently adding events for women as well. Before FINA was established, competitive swimming only included the freestyle (crawl), backstroke, breaststroke, and butterfly strokes, each of which had its own peculiar competitions.

Since swimmers use alternating arm and leg strokes to drive themselves forward, it stands to reason that the application of Newton's third rule of motion—"The Law of Action and Reaction"—is fundamental to the sport of swimming. A swimmer must pull the water behind them with their hands in order to move forward; they must kick down with their legs in order to keep their bodies in a streamline position in the water; and if they are swimming along and decide they want to stop and stand up, they must pull their hands down, shifting their bodies' orientation from horizontal to vertical, causing their legs to swing down and landing them in an upright position. From this, we may infer that propelling one's body through the water when swimming demands a great deal of strength and stamina. When competing in swimming competitions, athletes must draw on a wider range of physiological systems than those used in vehicle racing. Therefore, in order to maintain and improve their performance over time, swimmers must engage in rigorous training that has been strategically organized using scientific rationale.

Swimming is often cited as an example of human creativity since it combines the skills of floating and propelling oneself. In fluid sports, athletes compete while in a state of suspension, and they move by exerting force against the fluid rather than a solid surface. This results in two significant drawbacks in comparison to land-based sports. The first is that the propulsive efforts of swimmers are met with less resistance in water than those of runners are met with while pushing against the ground. On the other hand, swimmers face far more resistance while moving forward in water due to the density of the medium. That's why it's so important to warm up before swimming, according to coaches and swimmers alike, so that the muscles are toned, the risk of injury is reduced, and the swimmer's range of motion is maximized so that he or she can swim more effectively.

No athlete can successfully engage in specialized training without first laying the groundwork. Most athletes benefit from practicing certain motions progressively before engaging in a challenging exercise or competition. By increasing blood flow to the working muscles, most athletes may reduce muscular stiffness, injury risk, and maximize their performance during competition."

Active Warm-Up and Swimming Performance

Active warm-up is any act of exercising, involving specific and/or non-specific body movements, with the purpose of increasing metabolic activity and heat production in preparation for an upcoming main activity. Active warm-up is traditionally the preferred method used by practitioners and is the most commonly investigated type; 89% of the studies about warm-up in swimming are about active warm-up. Improvements were shown only in 67% of the twelve studies that compared the use of active warm-up with no warm-up. Five of these studies showed an improvement in performance after warm-up, and three others suggested positive effects in the physiological and biomechanical changes. The remaining studies did not find that warm-up had any effect on swimming performance.

The first studies suggested that warm-up allowed the swimmers to go 1% faster for short distances (up to 91 m). This positive influence was later confirmed for long distances, with a higher stroke length (~0.07 m) observed in the final meters of 368.5 m and lower lactate concentrations (~2 mmol/l) after 200 m of intense swimming. There were early ideas that priming exercises are beneficial to performance, but higher peaks in the lactate concentration after 2 min of high intensity swimming (13.66 ± 2.66 vs. 9.53

± 2.22 mmol/l, $p \leq 0.05$) have been reported. Additionally, Bobo (1999) failed to find significant differences in 91.4 m performance between three conditions (exercises in the water, dry land exercises, and no warm-up). The methods used could be questioned, as performance was assessed using a set of five repetitions of 91.4 m freestyle at maximum intensity. In addition, beyond comparing the mean times of all repetitions performed, the author analyzed the best repetition performed, which is similar to a study that tested a single repetition. A recent study found that usual warm-up leads to improved 100 m swimming performance, prolonging the controversy. There have been inconclusive results on a swimmer's performance for shorter distances after warm-up. One study reported that warm-up did not have any favorable effects on 50 m crawl performance, while participants in another study had a trend toward significantly faster times on the 45.7 m freestyle (~0.2 s, $p = 0.06$) and higher propelling force with 30 s of maximal tethered swimming (~13% for the mean force and 18% for the maximal force, $p \leq 0.05$), as reported by Balilionis et al. (2012) and Neiva et al. (2011), respectively, for warm-up.

The effects of active warm-up depend on several components such as the volume, intensity and recovery time. Some changes in the characteristics of the external training/warm-up load could be essential to influencing the subsequent performance and the results obtained. Furthermore, dry-land movements are usually performed before swimmers enter the pool, and the effects of these movements should not be disregarded. The relevance of these presented categories and their effects on swimming performance require deeper analysis.

Dry-land Warm-Up

Dry-land warm-up is any type of active practice performed out of the water; dry-land warm-up includes calisthenics, strength/activation exercises and stretching. Swimmers often perform some sort of physical activity out of the water (e.g., arm rotation) before entering the water to activate the body. However, these exercises are used to complement and not as an alternative to the in-water warm-up. Six studies have focused on the effects of dry-land warm-up as a different type of active warm-up other than the usual in-water procedures. Three studies have shown that the use of calisthenics exercises does not influence swimming performance compared to the no warm-up condition. Although there were no statistically significant differences, the results of Romney and Nethery (1993) showed that swimmers were 0.65 s faster in the 91.4 m freestyle with dry-land warm-up than without warm-up. This difference corresponds to an increase of 1.23% in the performance, which can substantially affect a swimming race. The author claimed that the amount of weight used may not have been heavy enough to stimulate the swimmers and may have interfered with the results. In fact, Kilduff et al. (2011) showed no differences in the 15 m starting time after activation with loaded squats (3 x 87% of 1 maximal repetition) compared with in-water warm-up. These weight exercises with a high load can have positive effects by inducing high frequency stimulation of motor neurons, resulting in an improved rate of force production, which has already been confirmed for explosive efforts. Strength

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exercises involving large major muscle groups, with few repetitions and high loads, could better prepare swimmers for competing.

In most swim meets, there is a considerable time interval between the in-water warm-up and the swimming event, diminishing its possible beneficial effects. Moreover, some facilities do not have extra swimming pool available, requiring swimmers to rely on alternatives to in-water warm-up. Dry-land warm-up is as a possible warm-up procedure, which is supported by some studies. It is also recommended that the whole body should be stimulated instead of focusing on specific muscle groups. To the authors' knowledge, no study on the addition of these practices to in-water warm-up has been conducted, even though it could be a method of optimizing the swimmer latency period between the warm-up and the swimming event. Swimmers commonly use stretching exercises, but, to the best of our knowledge, no study has been conducted on the effects of stretching on swimming performance. Additionally, little attention has been given to the question of stretching as a practice that influences the injury risk. By reducing muscle strain and increasing the range of motion of joints, stretching is expected to reduce the resistance of the movement, allowing for easier movement that optimizes the activity and prevents muscle and joint injuries. Despite these possible benefits, pre-exercise static stretching does not produce a reduction in the risk of overuse injuries, and it could lead to a severe loss of strength and performance impairment. Yet, a decrease in strength when using dynamic stretching exercises has not been demonstrated, suggesting that stretching may be part of a warm-up routine if these are usual practices of the swimmers. Further investigation is needed to determine the effects of stretching alone as well as in combination with other warm-up activities.

In-Water Warm-Up: the Effect of Volume

The acute effects of different warm-up volumes on swimming performance have been previously researched in four studies; two found positive effects for volumes between 1000 m and 1500 m compared to a lower volume (i.e., lower than 200 m). A higher volume (1371.6 m) allows the swimmers to maintain higher stroke length (3.76%) in the last meters of 365.8 m at ~95% of maximal oxygen uptake (VO2max), with similar values of blood lactate concentration and heart rate. This was later corroborated for shorter testing distances, verifying better 45.7 m performance (1.22%) after warming up for approximately 1300 m (men: 1257 ± 160 m; women: 1314 ± 109 m) instead of a 91.44 m warm-up. It is possible that the lower volume was not sufficient to cause significant metabolic changes during the performance trial.

The remaining study on the influence of warm-up volumes did not find differences in the 91.4 m freestyle when warming up for either 2011.7 m or 4023.4 m with similar intensities. Swimmers may expend too much energy during warm-up, or they may not have enough time after warm-up to replenish their phosphocreatine and adenosine triphosphate levels, compromising the energy supply and negatively affecting their performance. For instance, swimmers traditionally complete long warm-ups, even for short races, to achieve greater water sensitivity and to be better prepared for the competitive event. However, a long duration of exercise has a higher energy consumption that can contribute to the early onset of muscle fatigue, especially for high intensities. When subjected to a continuous activity at moderate intensity, the body increases its temperature and stabilizes between 10 and 20 min after the start. Although this time could be set as a rule of thumb, the volume of the warm-up performed before swimming competitions differs considerably. The first study on active warm-up verified that swimming for 110 m or 2.5 min positively affected the swimming performance. The level of the swimmers (untrained) may explain these positive results with such a light warm-up volume. With lower physical preparedness, a shorter volume is required to activate the body to the main task. A slightly longer warm-up as required for De Vries (1959) allowed verification of the improvements in the swimming performance of competitive swimmers (457 m). Nevertheless, the volumes presented were completed in less than 10 min; this could be the reason why the following studies focused on longer warm-ups. Using the control condition of no warm-up, the 91.4 m and 100 m freestyle times and a propelling force in 30 s of tethered swimming were improved after approximately 15 min of swimming (~1000). Moreover, a warm-up of 1000 m reduced the changes in the acid-base balance after 200 m (2 min) of intense swimming. There are some studies in which the performance was similar or even impaired after warm-up when compared to the no warm-up condition. There were no differences in the 91 m freestyle after 731.5 m of moderate swimming or on the 50 m front crawl after 1000 m of habitual warm-up. Some possible reasons for these results are the time between the warm-up and maximal swimming (not allowing a sufficient time to recover) and/or the volume and intensity of the warm-up, which most likely were not sufficient to cause desirable metabolic effects.

To understand the recovery patterns of selected physiological variables.

The body's reaction to exercise and the efficacy of the recovery process may be better understood by looking at the recovery patterns of certain physiological variables. Some widely tracked physiological indicators and their associated recovery times are as follows:

1. Heart Rate (HR): During the recovery phase after exercise, HR naturally drops. Exercise intensity, fitness level, and individual variances may all affect how quickly the heart rate recovers to resting values after physical activity. Better cardiovascular fitness and a speedier heart rate fall are signs of speedier recovery.
2. Oxygen Consumption (VO2): During recuperation, VO2, which is a measure of the body's metabolic activity, drops gradually. A person's fitness level, the intensity of their workout, and the length of their workout all have a role in how quickly their VO2 recovers to its pre-exercise levels. A speedier return to pre-injury oxygen consumption rates is indicative of a successful recovery.
3. Levels of blood lactate, a marker of anaerobic metabolism, tend to rise rapidly during strenuous activity and then fall steadily as the body

recovers. How quickly lactate is removed from the circulation is a good indicator of how well the body is recovering. The ability to bounce back quickly signals quicker clearing.

4. The number of breaths taken per minute, or respiratory rate, falls steadily as the body repairs itself. As the body heals, the breathing pattern normalizes and becomes more calm and regular. A slower and steadier breathing rate is indicative of a more rapid and completes recovery.
5. Muscle tiredness and Strength: Muscle tiredness may be measured both subjectively and objectively, for example by measuring how painful or tired you feel after a workout. Muscle exhaustion has a different pattern of recovery for different exercise intensities and durations. During the recovery phase, muscular fatigue typically diminishes and strength restores to pre-exercise levels.

It's vital to keep in mind that recovery patterns of physiological variables may vary from person to person and be affected by a wide range of circumstances. Individual patterns may be identified, and recovery procedures can be optimized for improved performance and well-being, by monitoring and analysis of these variables over time and over a range of recovery settings.

CONCLUSION

A swimmer's performance might be affected by how much time is spent recovering after warming up. After an intensive warm-up, recovery durations of up to 20 minutes, related to temperature mechanism. Several studies have focused on the optimal amount of time between the conclusion of a warm-up and the beginning of a competition or test; these range from 3 minutes to 5 minutes to 8 minutes to 10 minutes. Despite the importance of the period of time between a swimmer's warm-up and their performance, relatively little research has been done on this topic. The effect of post-warm-up recovery prior to competition/event/performance (200m time trial) has only been studied in two studies, both of which were conducted by (Thomas Zochowski, 2007) (10 minutes and 45 minutes recovery) and (Daniel J West, 2013) (10 minutes and 45 minutes recovery). This fact motivates the current investigation into the impact of different amounts of post-warm-up recovery time on performance in a 100-meter time trial swim. Ten male national-level swimmers who had competed at least five times for the state of Assam were randomly chosen for the research on the assumption that they would have been exposed to a variety of training methods and would be familiar with the need of a proper warm-up. Participants averaged 19 years of age, give or take 2. All of the trainees were at least 5 years old. All participants were asked about their medical histories and were encouraged to disclose any conditions that impede their ability to exercise, whether permanently or temporarily. There was no attrition among the study's subjects. Thus, all 10 individuals' data (n=10) were accounted for in the analysis. It was assumed that the participants followed a similar schedule on a daily basis. To prevent sequencing effects and guarantee internal validity, the time trial (treatment) sessions were randomly allocated to participants in a counterbalanced fashion. All required procedures were followed to prevent residual effects.

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