The effect of cold on performance and muscle damage during intensive training

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Abstract

Objective of the study was to assessing the effects of cold immersion on muscle damage and performance during intense training.

Methods and structure of the study. A meta-analysis of publications was performed on the problem of using cold immersion for the purpose of recovery after physical activity. Using the keyword cold water immersion, 2,650 articles were found over the past 20 years, and when adding the words sport and/or exercise, 703 results were found. 120 articles with the highest citation index were selected based on the five-year period after the article was published.

Results and conclusions. Most of the work indicates the positive effects of cold immersion on recovery processes after intense physical activity. At the same time, positive effects are recorded mainly when using a temperature not lower than 10-15 ° C and a duration of over 15 minutes (or two short sessions with a small interval) and appear within the first day. Refrigeration at lower temperatures must be used with caution. It is also not recommended to exercise during the first hours after the cold immersion procedure.

Keywords: *recovery, cold immersion, exercise, muscle injury, performance*

Introduction. Exercise-induced muscle damage is a common consequence of intense exercise, which may require several days for muscle recovery to reach its baseline state [12]. Following a series of damaging exercises, muscle tissue regeneration depends on the inflammatory response [15], but an excessive response delays the regenerative process [15, 16]. Therefore, strategies aimed at optimizing the inflammatory response may be beneficial for the regenerative process and may ultimately accelerate muscle recovery. In this regard, cold water immersion (CWI) is a popular recovery method. However, data on its effect on muscle function recovery remain controversial. In addition, Tipton M.J. et al. [14] convincingly demonstrated in their fundamental review the contradictory effects of cold immersion, which can be significantly negative and even lead to death.

Objective of the study was to assessing the effects of cold immersion on muscle damage and performance during intense training.

Methods and structure of the study. A meta-analysis of publications on the problem of using cold immersion for recovery after physical exercise was performed. The keyword cold water immersion yielded 2650 articles over the past 20 years, and 703 results were found when adding the words sport and/or exercise. 120 articles with the highest citation index were selected based on the five-year period after the article was published.

Results of the study and discussion. The authors evaluate the effects of CWI using several groups of criteria. Most often, they evaluate based on the restoration of motor skills (running speed, jump height). The presence of pain is also evaluated. A number of authors use immunological and biochemical criteria to evaluate inflammation and metabolism. Some studies evaluated the state of neuromuscular interaction, complex coordination movements, and heart rate variability. Running was most often used as a load, sometimes in combination with jumping. In a number of

studies, studies were conducted on team sports players (football, rugby) after a match. The effects were most often evaluated within 24 hours, although there were also studies with a retrospective of up to three days. Of the 120 articles analyzed, 80 studies indicated positive effects of CWI for the recovery of athletes, 32 studies indicated no effect or minor negative effects, and 8 studies indicated inconsistency of the results obtained.

Vieira et al. [15] studied the effects of cold water immersion at 5 and 15°C on recovery from exercise-induced muscle damage. After training, subjects in the cold water immersion groups immersed their lower limbs in cold water for 20 minutes. Knee extensor isometric torque, counter-propulsion jump, muscle soreness, and creatine kinase levels were measured before, immediately after, 24, 48, 72, 96, and 168 hours after training. There were no differences between groups in isometric strength recovery (p=0,73). However, counter-propulsion jump recovery was faster in the cold water immersion groups compared to the control group (p<0,05). The counter-movement jump returned to baseline at 72 hours at 15°C, the 5°C group recovered at 96 hours, and the control group did not. Additionally, creatine kinase returned to baseline at 72 hours in the 15°C group, while it remained elevated at 168 hours in both the 5°C and control groups. At 24 hours post-exercise, there was a trend toward decreased muscle soreness (p=0,06) in the 15°C group compared to control.

A number of studies have shown similar results - partial immersion in water with a temperature of 10-15 degrees had an optimal effect for 1-2 days on the restoration of motor functions [1, 2, 10]; reduction of pain [1, 2, 6]; inflammation indicators [2, 11]; creatine kinase content in muscles [1]; heart rate variability [3].

The work [7] showed that in rugby players after performing a special exercise protocol (40 minutes) followed by immersion in cold water (8,9 ± 0,6 ° C; 9 minutes with 1 minute out of water, repeated twice). The results of the test with a continuous jump for 30 seconds immediately decreased, but increased 12 hours after immersion in cold water compared to the control. In studies where positive effects of CWI on the recovery process were absent, single immersion of less than 10 minutes duration and water temperature below 10°C were predominantly used. Thus, in study [9], under such conditions, there were no changes in plasma creatine kinase activity, sensations of soreness, and the strength of maximum voluntary contraction of the quadriceps femoris after CWI. In study [8], repeated CWI was used three times every 24 hours after exercise. In this case, maximum voluntary contraction of the knee extensors, creatine kinase activity, muscle soreness, range of motion, and limb girth did not differ between the experimental and control groups. In study [13], no effects of CWI on neuromuscular transmission parameters were found.

The position of a person during passive recovery
Note – on the left – full immersion in water (TWI), on the right – being in a room (CON)

It is also worth noting that in the work [10], along with the positive effects of CWI, they simultaneously note a decrease in the stiffness of the ankle joint, which increases the risk of injury. In addition, the need for a cautious approach to the use of cooling for the recovery of athletes is indirectly evidenced by works that showed that preliminary cooling negatively affected speed-strength qualities, agility, and also increased the risk of injury [4, 5].

Conclusions. To summarize the above, the following can be noted: most studies indicate positive effects of cold immersion on recovery processes after intense physical activity. Moreover, these effects are manifested both at the level of subjective omissions, and in the effectiveness of motor actions and in physiological indicators.

At the same time, positive effects are recorded mainly when using a temperature of at least 10-15°C and a duration of over 15 minutes (or two short sessions with a short interval) and appear within the first day.

Cooling with lower temperatures should be used with caution. Physical activity is also not recommended during the first hours after the CWI procedure.

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