Effect of immersion in cold water after training on subjective pain in the muscles in the aspect of theoretical analysis

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Abstract

Objective of the study was to conduct a meta-analysis of English-language literature sources on the issue of the effect of immersion in cold water after exercise on subjective muscle pain.

Methods and structure of the study. A search was made for English-language scientific papers by keywords in various electronic databases (Pubmed, PEDro, Elsevier) for the period 2002-2022. Among the selected articles, those that addressed delayed muscle soreness syndrome and the effects of cold water immersion (CWI) immediately and/or 24 hours and/or 48 hours after high-intensity exercise were highlighted.

Results and conclusions. It has been shown that the duration of such immersion influences the severity of pain sensations. At the same time, the temperature of the water had no effect on the severity of these sensations. It is best to use cold water immersion immediately after exercise. The article also presents the likely limitations of the study designs used, which must be taken into account when designing your own studies using cold water immersion.

Keywords: *krepatura, delayed muscle soreness syndrome, DOMS, cooling, immersion in water, CWI.*

Introduction. Effective management of recovery processes after high-intensity physical activity remains an urgent problem, especially in conditions of limited time intervals of rest. The discrepancy between the rate of recovery processes and the depth of fatigue leads to the accumulation of fatigue, which can lead to negative consequences for the athlete's body. To eliminate this discrepancy, it is possible to use an active directed influence on the course of recovery processes. In sports practice, various means are used - pedagogical, psychological and medical. Cold water immersion (CWI) has a certain popularity [11]. The results of studies indicate that CWI can accelerate recovery processes, including reducing muscle damage caused by exercise [4]. At the same time, there is evidence of its negative impact on work performance [8], as well as the assumption of a placebo effect [9].

Objective of the study was to conduct a meta-analysis of English-language literature sources on the issue of the effect of immersion in cold water after exercise on subjective muscle pain.

Methods and structure of the study. A search was made for English-language scientific papers by keywords in various electronic databases (Pubmed, PEDro, Elsevier) for the period 2002-2022. according to the PRISMA protocol [9] – 1) cold water immersion OR cooling OR ice bath; AND 2) exercise performance OR sports performance; AND 3) fatigue OR recovery. Among the selected articles, those were highlighted that dealt with Delayed Onset Muscle Sorness Syndrome (DOMS) and the effects of cold water immersion immediately and/or 24 hours

and/or 48 hours after high-intensity exercise. For the qualitative selection of publications on this topic, the criteria for inclusion and exclusion of individual independent original studies in the meta-analysis were determined. The studies were supposed to involve people who received cold water immersion after training, where CWI was immersion in water with a temperature of ≤15°C. Selected studies were randomized controlled trials and crossover designs that examined the effect of post-exercise CWI on subsequent muscle soreness. Studies were excluded if the design of the experiment did not meet the requirements, there was a duplication of publication, the experiment was conducted on animals, the publication language was different from English. Data analysis was carried out using Revman 5.4 software.

Results of the study and their discussion. Seven articles were selected for analysis (see table) containing DOMS scores immediately, 24 and 48 hours after exercise. The results showed that the level of DOMS in the CWI group was significantly lower than in the control group immediately after 24 hours (0 h: SMD -0.59, 95%CL -0.90 to -0.28, n=6); (24 h: SMD -0.34, 95%CL -0.65 to -0.04, n=7). However, no significant difference was found at 48 hours (48 hours: SMD -0.25, 95%CL -0.58 to 0.07, n=6). Heterogeneity was found between literature data at 24 hours and 48 hours (24 hours: I2=67%; 48 hours: I2=66%), so a random effects model was chosen. The results showed that CWI immediately after training had a pronounced effect on the reduction of subjective pain sensations. While after 24 and 48 hours, there is no such effect.

To investigate whether interstudy heterogeneity was due to individual studies, a sensitivity analysis was performed using itemized literature exclusion. Heterogeneity was found to have decreased after the exclusion of Ingram, J. (2009), but the effect size did not change significantly (24 h SMD -0.26 95% CL -0.69 to 0.16, n=6) (48 h: SMD -0.08 95% CL -0.42 to 0.26, n=5). All this indicates stable results of the study. It should be noted that the water temperature did not affect the severity of DOMS.

Most of the studies had a high or unclear risk of bias, leaving the validity of most results uncertain. The main bias was caused by the disclosure of information in the experiments, since the use of the blind method in this case was limited.

The second problem was the distribution concealment procedure. Only four studies used random assignment of participants, two studies used an envelope to conceal allocation, and others used a computer to ensure random assignment.

A third limitation is that some studies used randomized trials and some used crossover trials. In crossover studies, there may be a risk of some pass-through effects that are not present in randomized control designs. Thus, it is necessary to qualitatively approach the formation of research design.

Characteristics of research objects selected for analysis

Study, year	Sample (gender (male:female), age)	Environmental conditions (T°C, humidity)	Exercise Protocol	Load intensity	Immersion in cold water	Control group	Variable and registration time after exercise (hour)
Amir et al., 2017	physically healthy young men; (16:0); 21.6 ± 2.3 years		Plyometric Loading Protocol	high	15 min at 15±1°C	15 min passive cooldown	DOMS (24; 48)
Argus et al., 2017	men; (13:0); 26±5 years		Weight training protocol (50 min)	high	14 min at 15°C	14 min passive cooldown	DOMS (0)
Glasgow et al., 2014	healthy volunteers; (32:18); 18-35 years old		Eccentric Load to Failure protocol (posterior thigh muscle group)	high	CWI 6: 10 min at 6°C; CWI 10: 10 min at 10°C	10 min passive cooldown	DOMS (24; 48)
Ingram et al., 2009	athletes; (11:0); 27.5±6.0 years		Game simulation (80 min) + shuttle run to failure (20 min)	high	5°C 2 min at 2.5 min intervals at 10°C	15 min passive cooldown	DOMS (0; 24; 48)
Machado et al., 2017	healthy men; (60:0); 18-25 years old	21°C-23°C; 40%-60%	Eccentric load (knee joint) - 5 °C 15 (30 seconds of rest between repetitions)	high	CWI 9: 15 min at 9°C; CWI 14: 15 min at 14°C	15 min passive cooldown	DOMS (0; 24; 48)
Peiffer et al., 2010	cyclists; (10:0); 29±6 years	35.0±0.3°C; 40.0±3.0%	Cycling (1 km at maximum speed)	high	15 min at 35°C air + 5 min at 14°C water	20 min at 35°C air	DOMS (0)
Wiewelhove et al., 2018	runners; (46:0); 30.5±10.9 years		Half marathon	high	15min at 15±1°C	15 min passive cooldown	DOMS (0; 24)

Conclusion. Thus, CWI immediately after training reduced DOMS, but did not have a significant effect after 24 and 48 hours. Using sensitivity analysis, it was found that heterogeneity between DOMS groups may be caused by the results of Ingram J. (2009). The reason for this may be the short duration of the CWI. It can be assumed that short-term immersion is less effective in relieving exercise-induced muscle soreness.

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