International Archives of Medical Research 16:1 (2024) 18-25

ORIGINAL RESEARCH

The Effect of Cold-Water Immersion Application on Biochemical Parameters in Athletes

Received Date: 19.03.2024, Accepted Date: 26.04.2024 **DOI: 10.56484/iamr.1455752**

Ramazan ERDOĞAN[1a*], Ercan TİZAR[2b], Gönül Rezzan TİZAR[3c]

[1] Bitlis Eren University School of Physical Education and Sports, Bitlis/Türkiye
[2] Dicle University School of Physical Education and Sports, Diyarbakır/Türkiye
[3] İnönü University Institute of Health Sciences, Malatya/Türkiye

[a]*ORCID: 0000-0001-5337-942X,* [b]*ORCID: 0000-0002-3961-7417* [c]*ORCID:0000-0001-8330-1703*

Abstract

Objective: *The purpose of this study was to see what influence cold water immersion had on the athletes' biochemical parameters.*

Method: *The study included 20 elite level (Experimental 10, Control 10) male athletes who were licensed in the athletics branch and competed in national and international events. For four weeks, six days a week, the research group was subjected to a ninety-minute long-distance running regimen. Blood samples were collected from the research group's athletes twice, at the start and finish of the training session. CK, ALT, AST and LDH levels were determined in the taken blood samples. The data were analyzed using the SPSS package program. Significance level was accepted as $p<0.05$.*

Results: *According to the findings obtained in the research; According to the research results; It was determined that the trainings applied created significant changes in the CK, ALT, AST and LDH levels of the athletes in the control and experimental groups.*

Conclusion: *Furthermore, it was discovered that the cold water immersion treatment used on the athletes in the experimental group had a greater favorable effect on CK, ALT, AST, and LDH levels than the athletes in the control group.*

Keywords: *Cold water immersion (CWI), Athletics, Biochemistry, Muscle damage, Recovery.*

Corresponding author: E-mail: ramaznerdogan@hotmail.com

Introduction

The primary national and international competitions in most team sports follow a tournament schedule. On consecutive days, teams must play multiple matches. The athletes playing in these competitions all have the same problem: the time allotted for full physiological recovery between matches is short, and hence physical efficiency may suffer. Indeed, recent study has demonstrated that cumulative exhaustion from multiple encounters can have a deleterious impact on team sport performance. Many sportsmen and trainers believe that water immersion provides a cooling effect after a hard training or competition[1].

Blood lactate concentration is typically measured using portable instruments to monitor and plan exercise. Although some studies question the usefulness of blood lactate concentration as a determinant of muscle recovery after exercise, this biochemical marker is extensively employed for this purpose[2].

Strenuous athletic activities might cause muscle injury. Changes in CK plasma enzyme activity in response to activity may signal the onset of muscle injury. Strenuous exercise has been linked to increased CK activity. Athletes had higher plasma CK activity at rest than untrained people, but their CK activity increases less after exercise than non-athletes[3].

It is said that cold water immersion application speeds the biochemical process in order to get rid of these destructions created by hard exercises in athlete's metabolism with the least amount of harm and to recover quickly. Again, cold water immersion (CWIT) is a method that involves immersing a body portion in water that is less than 15°C. It is one of the most widely used therapy techniques for improving muscle recovery following high-intensity exercise. However, there is just anecdotal scientific evidence to support the efficacy of this treatment. Intense exercise disrupts many physiological processes, including muscle injury, hyperthermia, dehydration, and glycogen depletion. Inadequate/late restoration of these physiological alterations may result in poor performance in following training sessions, whereas chronic imbalance between training stress and recovery may result in overreach or overtraining syndrome[4].

Cold water immersion (CWI) after exercise is gaining popularity among athletes as a means of reducing tiredness and speeding post-exercise recovery. CWI is claimed to facilitate recovery by reducing cardiovascular strain by improving hyperthermia and subsequent changes in the central nervous system (CNS), removing accumulated muscle metabolic byproducts, reducing exercise-induced muscle damage (EIMD), and improving autonomic nervous system function. The current study seeks to provide a thorough and extensive examination of the processes that promote acute and long-term improvements in exercise performance following post-exercise CWI[5]. CWIT is vital

for recovery in sports with short rest intervals and extensive tournaments, such as athletics, football, volleyball, tennis, handball, and other sports. Despite the inexpensive cost of CWIT, the time necessary for therapists to prepare CWIT is lengthy. Furthermore, the water and ice used in CWIT can only be used once, and temperature control during treatment is problematic. LEDT devices, on the other hand, can be used multiple times without requiring lengthy preparations, but they are somewhat expensive when compared to water and ice[6]. In this situation, it is critical to recuperate from a sporting standpoint, particularly in terms of enhancing athletic performance to the highest degree or repeating it in the following competition and competition. The purpose of this study was to see what influence cold water immersion had on the athletes' biochemical parameters.

Materials and Methods

Research Group

20 elite level male athletes (Experimental 10, Control 10) licensed in the athletics branch and participating in national and international competitions voluntarily participated in the research group.

Control Group (n:10): the group doing athletics training

Experimental Group (n:10): the group in which cold water immersion was applied in addition to athletic training.

Training Program

For four weeks, six days a week, the research group was subjected to a ninety-minute long-distance running schedule. A 10-minute warm-up phase and an average of 40 stretching cooling exercises were conducted at the end of the training, in addition to the ninety-minute training program.

Collection and Analysis of Samples

CK, LDH, AST, and ALT blood samples were obtained at rest from all athletes participating in the study right before the training program for cold water immersion. Following the training routine, the experimental group was immersed in water at an average temperature of -2^{o}C for 8 minutes, with the neck of the body left exposed. To maintain a steady temperature, the water was measured with a thermometer and ice was added in between. 4 hours after the cold water immersion, CK, LDH, AST and ALT blood samples were taken from the experimental group again and analyzed. The blood samples taken from the athletes were taken in the private hospital laboratory by the experts in the sitting position and resting state by means of a fully automatic hemogram called “Coulter Stks” and analyzed.

Statistical Analysis

SPSS statistical package program was utilized in the analysis of the data. Normality analysis of the data was made and parametric tests were used for the data determined to be normally distributed. In the study, "Paired Samples t" test was used for in-group comparisons and "Independent Samples t" test was used for intergroup comparisons. The significance level was accepted as $p<0.05$.

Results

When Table 1 was assessed, it was determined that there was a statistically significant difference between the pretest-posttest values of the control group's CK, ALT, AST and LDH levels ($p<0.05$).

Table1. *Biochemical Changes of the Control Group Before and After Training*

Parameters	Pre test	Post test	t	p
CK	285,00±7,45	274,10±8,90	8,970	0,00*
ALT	34,90±3,51	31,10±2,23	4,670	0,00*
AST	37,30±2,66	30,10±1,96	7,298	0,00*
LDH	186,90±3,90	179,40±3,50	7,479	0,00*

*p<0,05

When Table 2 was examined, it was determined that there was a statistically significant difference between the pretest-posttest values of the experimental group's CK, ALT, AST and LDH levels ($p<0.05$).

Table 2. *Biochemical Changes of the Experimental Group Before and After Training*

Parameters	Pre test	Post test	t	p
CK	282,50±6,34	255,00±5,77	9,153	0,00*
ALT	34,20±4,70	27,60±3,23	7,802	0,00*
AST	37,10±3,98	26,50±1,71	6,805	0,00*
LDH	187,90±7,86	173,80±6,66	9,083	0,00*

*p<0,05

When Table 3 was examined, it was determined that there was a significant difference between the CK, ALT, AST and LDH levels of the control and experimental groups in the post-test values ($p<0.05$), and there was no significant difference between the pre-test values of the CK, ALT, AST and LDH levels ($p>0$). .05).

Table 3*. Intergroup Comparison Analysis Results*

Parameters		Control Group	Experiment Group	t	p
CK	**Pre test**	285,00±7,45	282,50±6,34	,808	0,43
	Post test	274,10±8,90	255,00±5,77	5,693	0,00*
ALT	**Pre test**	34,90±3,51	34,20±4,70	,377	0,71
	Post test	31,10±2,23	27,60±3,23	2,813	0,01*
AST	**Pre test**	37,30±2,66	37,10±3,98	,132	0,89
	Post test	30,10±1,96	26,50±1,71	4,359	0,00*
LDH	**Pre test**	186,90±3,90	187,90±7,86	-,360	0,72
	Post test	179,40±3,50	173,80±6,66	2,352	0,03*

*p<0,05

Discussion

Exercises performed on a regular basis, within the context of a specific program, and at a given intensity are known to cause changes in the organism. One of them is the organism's metabolic alterations, which are changing.

It has a negative impact on athletes and causes them to recover more slowly. Cold water immersion is one of the strategies used to prepare athletes for the upcoming events and tournaments. The purpose of this study was to see what influence cold water immersion has on athletes' biochemical parameters for post-exercise recovery. According to the research results; It was determined that the trainings applied created significant changes in the CK, ALT, AST and LDH levels of the athletes in the control and experimental groups. In addition, it was observed that the cold water immersion application applied to the athletes in the experimental group positively affected CK, ALT, AST and LDH levels more than the athletes in the control group. When the studies are examined, de Oliveira Ottone et al., (2014) discovered that CWI (15°C) was a suitable strategy to provide rapid parasympathetic reactivation after exercise, TWI (28°C), and They stated that HWI (38°C) should not be used for this special purpose[7]. Wiewelhove et al., (2018) determined in their study that CWI and massage method were more effective than active and passive listening in recovery after long-term jogging exercises[8]. In a different study, Kwiecien and McHugh (2021) noted that traditional cryotherapy procedures often alleviate pain after soft tissue injury and reduce pain after harmful activity[9]. Guo et al. (2022) discovered that cold water immersion (CWI) was more effective than contrast water therapy (CWT) in reducing blood Interleukin-6 and Prostaglandin E2 levels as well as muscle soreness after exercise[10]. In their study, Matsumura et al. (2022) discovered that applying liquid ice 48 hours after high-intensity activities reduced muscular

stiffness more than ice application[11]. In another study, Laia et al. (2022) found that wearing a cooling vest after exercise helped to lower body temperature, lower blood lactate concentrations above resting levels, and improve recovery[12]. Tabben et al. (2018) investigated physical performance, hematological stress markers, and 10-meter-long physical performance after 24 hours of cold water immersion (CWI) applied following a simulated mixed combat tournament (3x5 minute mixed fights separated by 1 minute passive rest). They discovered that sprint performance has a beneficial effect[13]. Bouzid et al. (2018) discovered in their study that 10 minutes of cold water immersion (CWI-10°C) and thermo-neutral water immersion (TWI-28°C) following an intermittent shuttle run reduced muscle injury and felt muscle pain in professional football players. They discovered that it increased physical performance recovery[14]. Durmaz et al. (2017) found in their study that the training program they implemented caused changes in some biochemical values of the athletes[15]. Sánchez-Urea et al. (2017) discovered that long-term and intermittent cold water immersion methods used on basketball players were helpful in lowering tiredness symptoms and, in particular, delaying the development of muscle discomfort[16]. Schimpchen et al. (2017) reported in a different study that cold water immersion (CWI) as a result of 3-day rigorous exercises had no favorable effect on the athletes[17]. Cold water immersion (CWI) has an effect on improving performance and reducing muscle soreness in athletes, but not on muscle strength, according to Alshoweir (2016)[18]. A study by C. Bleakley and G. Davison (2009) states that immersion in cold water for 5 minutes or less has significant effects on the body. These effects include increased heart rate, increased blood pressure, changes in respiratory minute volume and acceleration of metabolism, which may lead to various physiological and biochemical changes in the body.[19] In the study conducted by Gregson et al (2011), it was stated that lower water temperatures have a potential effect on the treatment of exercise-induced muscle damage and injury rehabilitation, and this is associated with a decrease in blood flow in the muscles. It has been suggested that this may reduce inflammation by accelerating the recovery process.[20] The study by Bleakley et al (2012) indicates that post-exercise cold water immersion significantly reduces muscle pain and fatigue compared to passive intervention.[21]

Conclusion

Finally, the study found that cold water immersion (CWI) had a favorable effect on muscle injury markers and metabolic parameters in athletes when compared to passive rest. According to this information, we believe that the CWI application to be used after the exercises will improve the athletes' early recovery and athletic performance.

References

1. **Ronglan LT, Raastad T. Borgesen A.** Neuromuscular fatigue and recovery in elite female handball players. Scandinavian journal of medicine & science in sports, 2006;16,267–273. https://doi.org/10.1111/j.1600-0838.2005.00474.x
2. **Howatson G, Goodall S, vanSomeren KA.** The influence of cold water immersions on adaptation following a single bout of damaging exercise. Eur J Appl Physiol 2009; 105:615–621. https://doi.org/10.1007/s00421-008-0941-1
3. **Halson SL, Quod MJ, Martin DT, Gardner AS, Ebert TR, Laursen PB.** Physiological responses to cold water immersion following cycling in the heat. Int J Sports Physiol Perform, 2008; 3:331–346. https://doi.org/10.1123/ijspp.3.3.331
4. **Ihsan M, Watson G, Abbiss CR.** What are the physiological mechanisms for post-exercise cold water immersion in the recovery from prolonged endurance and intermittent exercise?. Sports Medicine, 2016; 46, 1095-1109. https://doi.org/10.1007/s40279-016-0483-3
5. **Stanley J, Peake JM, Buchheit M.** Consecutive days of cold water immersion: effects on cycling performance and heart rate variability. Eur J Appl Physiol, 2013; 113(2):371–84. https://doi.org/10.1007/s00421-012-2445-2
6. **Wilcock IM, Cronin JB, Hing WA**. Physiological response to water immersion: a method for sport recovery? Sports Med, 2006; 36:747–765.
7. **de OliveiraOttone V, de Castro Magalhães F, de Paula F, Avelar NCP, Aguiar PF, da Matta Sampaio PF, Rocha-Vieira E.** The effect of different water immersion temperatures on post-exercise parasympathetic reactivation. PLoS One, 2014; 9(12), e113730. https://doi.org/10.1371/journal.pone.0113730
8. **Wiewelhove T, Schneider C, Döweling A, Hanakam F, Rasche C, Meyer T, Ferrauti, A.** Effects of different recovery strategies following a half-marathon on fatigue markers in recreational runners. PLoS One, 2018; 13(11), e0207313. https://doi.org/10.1371/journal.pone.0207313
9. **Kwiecien SY, McHugh MP.** The cold truth: the role of cryotherapy in the treatment of injury and recovery from exercise. European journal of applied physiology, 2021; 121(8), 2125-2142. https://doi.org/10.1007/s00421-021-04683-8
10. **Guo C, Fan Y, Kong X, Zhao C.** The effect of different water immersion strategies on delayed onset muscle soreness and inflammation in elite race walker. Journal of Men's Health, 2022; 18(3), 64. https://doi.org/10.31083/j.jomh1803064
11. **Matsumura N, Nagashima S, Negoro K, Motomura Y, Shimoura K, Tateuchi H, Nagai-Tanima M.** Theeffect of Liquid ice after high-intensity exercise on muscle function compared to Block ice. Journal of Exercise Science & Fitness, 2022; 20(1), 23-26. https://doi.org/10.1016/j.jesf.2021.12.001
12. **Laia FD, da Silva MG, Gomes BB, dosSantos AC, da Silva NV, Pinheiro JP.** The effectiveness of a cooling vest in post-exercise recovery in sprint kayaking elite male athletes. Journal of Men's Health, 2022; 18(8), 169. https://doi.org/10.31083/j.jomh1808169
13. **Tabben M, Ihsan M, Ghoul N, Coquart J, Chaouachi A, Chaabene H, Chamari K.** Cold water immersion enhanced athletes' wellness and 10-m short sprint performance 24-h after a simulated mixed martial arts combat. Frontiers in physiology, 2018; 9, 1542. https://doi.org/10.3389/fphys.2018.01542
14. **Bouzid MA, Ghattassi K, Daab W, Zarzissi S, Bouchiba M, Masmoud, L, Chtourou H.** Faster physical performance recovery with cold water immersion is not related to lower muscle damage level in professional soccer players. Journal of thermal biology, 2018; 78, 184-191.

15. **Durmaz C, Şermet A, Tizar E, Ayhan S, Akpolat V**. Comparison of Plasma Visphatin and Eotaxin Levels Before and After Training of Women and Man Sports in the Dicle University Handball Team. International Archives of Medical Research, 2017;9(2):25-29.
16. **Sánchez–Ureña B, Martínez–Guardado I, Crespo C, Timón R, Calleja-González J, Ibañez SJ, Olcina G.** The use of continuous vs. intermittent cold water immersion as a recovery method in basketball players after training: a randomized controlled trial. The Physician and sports medicine, 2017; 45(2), 134-139. https://doi.org/10.1080/00913847.2017.1292832
17. **Schimpchen J, Wagner M, Ferrauti A, Kellmann M, Pfeiffer M, Meyer T.** Can cold water immersion enhance recovery in elite Olympic weightlifters? An individualized perspective. The Journal of Strength&Conditioning Research, 2017; 31(6), 1569-1576. https://doi.org/10.1519/JSC.0000000000001591
18. **Alshoweir N.** Theeffect of coldwaterimmersion on recreationallyactiveyoungadults and therecovery of elite rugby playersafterintenseeccentricexercise (Doctoraldissertation, Manchester Metropolitan University), 2016.
19. **Bleakley C.M, Davison GW.** What is the biochemical and physiological rationale for using cold-water immersion in sports recovery? A systematic review. British journal of sports medicine, 2010; 44(3), 179-187.
20. **Gregson W, Black M.A, Jones H, Milson J, Morton J, Dawson B, Green, D.J.** Influence of cold water immersion on limb and cutaneous blood flow at rest. The American journal of sports medicine, 2011; 39(6), 1316-1323.
21. **Bleakley C, McDonough S, Gardner E, Baxter D, Hopkins T, Davison G, Costa M.** Cold-water immersion (cryotherapy) for preventing and treating muscle soreness after exercise. The Cochrane database of systematic reviews, 2012; 2, CD008262. https://doi.org/10.1002/14651858.CD008262.pub2.