Comparison between Cold Water Immersion and Active Recovery on Perceived Pain Relieve among Male Football Players

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DOI: https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0733

Received: 27 November 2025; Accepted: 04 December 2025; Published: 12 December 2025

ABSTRACT

The purpose this study was to investigate the comparison between Cold Water Immersion (CWI) and Active Recovery (AR) on perceived pain relieve after performing High Intensity Interval Training (HIIT) among male football players. The study used a quasi-experimental method as its research design. A random sample of 36 footballers from a public university age ranging from 18 to 23 years old was selected for the study. They were assigned to two groups, namely CWI (n=18) and AR (n=18). All participants performed ―Tabata Training for 20 minutes before undergo recovery intervention. Recovery intervention using CWI was conducted for 10 minutes with temperature of 15°C, while AR was conducted for 10 minutes by cycling on cycle ergometer with speed of 60 RPM, load 50w with moderate intensity of 50%-60%. Both recovery interventions were performed immediately, after 24 hours and 48 hours. Visual Analog Scale was used to measure perceived pain relieve on 24 hours, 48 hours and 72 hours. Repeated Measure One-way ANOVA was utilized for data analysis. ANOVA result revealed there was no significant difference between CWI and AR after 24 hours of recovery [$F(1,34) = 0.507$; $p>0.05$]. However, there was a significant difference on perceived pain relieve between CWI and AR during 48 hours [$F(1,34) = 92.53$; $p<0.05$] and 72 hours [$F(1,34) = 326.96$; $p<0.05$]. In addition, the finding also showed that there was a significant interaction among CWI during 24 hours, 48 hours and 72 hours [$F(2,34)= 2332.60$; $p<0.05$]. Besides, there was a significant interaction among AR during 24 hours, 48 hours and 72 hours [$F(2,34)=1051.91$; $p<0.05$]. In conclusion, the data revealed that there was a significant effect for perceived pain relieve after performing HIIT for both interventions. The implication of the study highlights that both methods of recovery process could be used by football players for pain relieve after training and competition.

Keywords: Cold Water Immersion (CWI), Active Recovery, High Intensity Interval Training (HIIT), Delay Onset Muscle Soreness (DOMS), Perceived Pain Relieve.

INTRODUCTION

In recent year, Tabata Training become common people choose as an exercise program that introduce by Japanese scientist known as Izumi Tabata [1]. Tabata Training also known as a High Intensity Interval Training (HIIT) program that involved short duration of exercise. By using the interval training a higher metabolic demand will be placed in our body in a shorter period [2]. The demand of an individual exercise and rest interval duration during training mimics that of to a sport activity [3]. According to [4], stated that different level intensity of exercise may lead to several types of chances for example musculoskeletal fatigue, nervous and metabolic systems. According to [5] it was also reported that Delay Onset Muscle Soreness (DOMS) will happens after some microscopic tears in area of muscle tissues in 48 hours after performing an exercise. According to [6], [7], process of recovery was the body restoring physiological aspect and will allows athletes to return in sport event with the best performance level. Critical part of recovery it was used to minimize the risk of injury and to avoid symptom of overtraining. Athlete that train hard without having enough rest may lead to the symptoms such as overtraining, mental burnout and poor performance [8]. Reduction of heart rate, respiratory rate and ventilation, restoration of energy and ion balance, waste products removal of metabolism, decrease level of muscle stress and reduction of the activity of the central nervous system it was several indicators that should be measure for degree of recovery [9].

In addition, recovery was important because it increases the level regeneration of energy, maintaining individual performance, maintaining acid base balance and decrease level of fatigue [10]. The importance of recovery was now widely used by the team sports such as cycling event, football, rugby, and track events where the qualifying and final events occur in same day. The combination of short period recovery and high intensity event has been identified as a key of factor performance [11]. To improve body recovery from exercise, there were several methods of recovery strategies has been used for example massage therapy, compression garments, stretching, rolling foam, electrical stimulation and water immersion therapy. However, there were conflicting evidence about what kind recovery intervention were applied between Cold Water Immersion and Active Recovery that may give the best result to coaches, therapists and athletes to recover from the high intensity activity.

Cold Water Immersion (CWI) other type of hydrotherapy was higher recommended method to improve recovery process from training and competition for elite athletes. It has been supported by several authors from [12], [13], that CWI has a chosen process of recovery that was used to improve recovery process after performing the exercise. There were some evidence that shows the positive result from CWI from [9], also stated that with CWI, it may restore level of hydrogen ion (H+), decrease level of muscle tension and remove the waste products. Furthermore, it also has been supported in the study from [13], stated that effect of CWI process to decrease level of DOMS after performing high intensity exercises but it had no effect on eccentric exercise.

In addition to that, other studies by [12], on comparison between groups that used CWI and did not used indicated reduction level of Creatine Kinase (CK), myoglobin, and C- reactive protein (CRP) concentration is the effects of CWI recovery process on a junior football player. Besides that, according to [14], CWI also shows positive result on muscle stiffness that reduces level of an inflammation, force of generation and pain. According to [15], revealed that CWI was the effective technique to decrease level of muscle injury (DOMS). In addition, recovery with cold water also enhances the process of maintaining body temperature level, increase oxygen consumption, muscle spasm and local vasoconstriction [14]. Moreover, water immersion also shows a significant result on muscle soreness and the decrease in isometric leg flexion and extension performance in 10°C temperature [16]. The result also has been supported by [17], that a 10-minute water immersion at 10°C decreases the level of muscle soreness, myoglobin concentration and decrease in knee flexor maximal voluntary contraction (MVC) after performing interval shuttle run. To start in an active recovery procedure, intensity needs to be kept in moderate ([8], [18]. According to [19], active recovery was used for cooling down after training and game in professional football players. Active recovery helps to improve sport performance and physiological, sprint interval, maintaining blood flow to active muscle and removal of byproduct. According to [20], active recovery allows oxidative pathway to activate muscle work and allowing Adenosine Triphosphate (ATP) to contribute during exercise in bout. The ability can maintain high rate of ATP and blood flow was very important to reduce level of muscle fatigue during exercise in high intensity [21].

According to [22], finding, active recovery has an advantage if compare with a passive recovery during conducting Wingate test protocol. Furthermore, others finding shown from [23], by using active recovery also help to increase recover of blood lactate, muscle lactate compare with passive recovery. Thus, the result from all findings shows that active recovery was more positively compare with passive recovery. Therefore, the objective of this study was to determine the comparison between methods of recovery phase which were cold water immersion and active recovery on perceive pain relieve afterward performing High Intensity Interval Training (HIIT) among UiTM Pahang male football players. This study also will measure which method of recovery provide beneficial effect on perceived pain relieve after performing HIIT among UiTM Pahang male football players.

METHODOLOGY

All participants underwent three sessions of recovery processes which were immediate, 24 hours and 48 hours for duration of both recoveries process was 10 minutes. Participants were allocated into two groups. Most important, the researchers ensure that full efforts were invested in each session and closer supervision on recovery process was given. A brief explanation about the recovery process was explained by the researcher.

A question-and-answer session was held to clear up any doubt that participant had about the recovery process program. After complete answer session, all participants were distributed an informed consent to each participant. In the informed consent, all the detail about participant were stated together and screening question to confirm that the participants were in our inclusion criteria. Before the recovery processes were given, all participants filled the Physical Activity Readiness Questionnaire (PARQ) to ensure all the participants were ready to involve in this study and free from any disease or injury. Before undergoing to recovery process, all the participants were performed High Intensity Interval Training (HIIT) were Tabata Training [1]. The Tabata Training was consisting of 20 seconds exercise, 10 seconds rest period that need to continue by eight cycles of exercise with total of duration consist of four minutes. The numbers of repetition for Tabata Training were as much repetition with maximal effort for 20 seconds exercise duration The Tabata Training was performing four rounds for total 20 minutes for all sessions. The Tabata Training from this study involving exercise that used body weight and free weight. Movement that applied from this program was included eccentric and concentric movement. Moreover, the Tabata Training was performed more focus on lower limb movement of exercises that involve several muscles for examples quadriceps, hamstring and gluteus maximus. After practicing until proficient at all the exercises, each participant needs to be familiar with the exercise before proceeding to perform Tabata Training. The Tabata Training protocol was explained in Table 1. Participants completed as much repetition as possible with maximal effort for each exercise in 20 seconds followed by 10 seconds of rest. There were one minute of rest interval between each session. According to Table 1, all participants will perform each exercise was repeated twice in succession at ratio 20 seconds exercise and 10 seconds rest during four rounds with total four minutes.

Table I Exercises included in the 20 minutes 'Tabata Training'

	Round 1	Round 2	Round 3	Round 4
Exercise 1	Squat	Squat	Dumbbell Swing	Dumbbell Swing
Exercise 2	Lunges (Alternate)	Lunges (Alternate)	Jumping Lunges	Jumping Lunges
Exercise 3	Jump Squat	Jump Squat	Burpee	Burpee
Exercise 4	Squat with Plate	Squat with Plate	Squat Overhead Press	Squat Overhead Press

Cold Water Immersion

Cold Water Immersion (CWI) was one of recovery technique that athletes immerse water to the hip level or middle of sternum for a period time. The duration for CWI was 10 minutes and temperature at 15°C. These protocols were selected based on previous study from [24], that using similar protocol after post exercise on cyclist athletes. This protocol that used was 15 minutes duration recovery and level of temperature was 10°C. Another study using this protocol was Brophy-William et al., (2011) on well-trained team sport athletes. It also was supported by [12], reported that CWI at temperature at range 10°C has significant effect on muscle soreness and muscle performance among junior national league footballer. The CWI techniques that participants need to enter in a tube tab without any takes out their shirt and pant to avoid skin become ice burn and injury. Then, participant need to enter tube tab with standing position with the water levels completely reached at sternum level. Next, during immersed in water, participants usually passive during immersion in still water. CWI technique was performing within ten minutes duration with 15°C level of cold water. To control the level of temperature during immersion thermometer was applied to maintain the level temperature of the water during CWI recovery. After completing ten minutes duration of recovery process, participants were given a towel to recover their body and extra precaution were given due to avoid any bad things happens. The intervention of CWI will perform immediately after exercise of HIIT, 24 hours and 48 hours.

Active Recovery

For second experimental group, the participants were received Active Recovery (AR) technique that participants need to perform active movement (cycling) in cycle ergometer. AR was performing cycling on cycle ergometer for 10 minutes duration with speed 60 RPM with load 50w with moderate intensity range between 50%-60% of maximum heart rate. The intensity was selected was therefore at level 12 - 13 on Borg's 6-2- RPE scale. After completed 10 minutes duration of cycling, participants will rest and did not make any movement until pain sensation were measured. Participants were instructed not to use other form of recovery (massage, roller form, and many more) during the two experimental sessions.

Outcome Measure

The Visual Analog Scale (VAS) was used to measure pain intensity which been widely used because it was easy to conduct and can be used in a wide variety of setting [25]. The VAS was a continue scale consist of a horizontal and vertical line that usually used 10 centimeter (100 mm) in length that required verbal descriptor for each symptom [25]. For the pain intensity, the scale commonly used by the range of scale by no pain (0 mm) from severe pain (100 mm) using the ruler to determine the level of pain intensity among participants [26]. The different pain intensity experience by participant will impact on mood of participant, quality of sleep, quality of life and physical function. According to Breivik et al. (2006), individual who experience with severe level of pain intensity will limit the movement and ability to perform intense physical activity, difficult to walk and lifestyle physical activities also affected disturbed movement of daily activity such as difficult to getting up and sitting down. To classify the categories of pain scale in the VAS score, it was classified into four categories which were no pain (0-4 mm), mild pain (5-44 mm), moderate pain (45-74 mm) and severe pain (75-100 mm) [26]. To identify the perceived pain relieve among participants, VAS scale was used for measure pain intensity. To quantifying the pain levels among participants, the researcher used the standard protocol for stimulus application with palpation technique. Each participant was asked to mark the perceived pain relieve on the VAS scale when the researcher applied the pressure to the lower extremities. During the pressure assessment, the researcher placed his index and middle finger over the site and applied pressure for three seconds [27]. The pressure was hard enough to induce an uncomfortable feeling in the muscle area. The palpation movement techniques used by researcher were longitudinal and transverse. It was recommended movement of palpation based on previous study by [27], revealed that longitudinal and transverse produce greater pain compare with circular. Therefore, the researcher used similar protocol and kept as consistent as possible between days and among participants

RESULT

Table 2 shown the descriptive data of the participants regarding to age, weight, height, body mass index (BMI) and body fat percentage by using frequency, percentage, mean and standard deviation. There were 36 male UiTM football players involved in this study and were divided into two groups of recovery process i.e. Cold Water Immersion (CWI) (n=18) group and Active Recovery (AR) (n=18) group. Average age of CWI group was 20.0 years ± 1.23, while average age of AR group was 20.2 years ± 1.22. Average height of CWI group was 1.59 m ± 0.40, while average height of AR group was 1.66 m ± 0.03. Moreover, average weight of CWI group was 62.4 kg ± 4.48, while average weight of AR group was 62.5 kg ± 3.29. Furthermore, average Body Mass Index (BMI) of CWI group was 21.9 ± 1.37, while average Body Mass Index (BMI) of AR group was 22.6 ± 1.00. Average body mass index score of both groups in this study showed in normal range. Average Body Fat Percentage of CWI group was 18.5 ± SD 2.57, while average Body Fat Percentage of AR group was 17.7 ± SD 3.09.

Table 2 Demographic Data

Group /Criteria	Cold Water Immersion	Active Recovery
Age (Years)	20.0 ± 1.23	20.2 ± 1.22

Weight (kg)	62.4 ± 4.48	62.5 ± 3.29
Height (m)	1.59 ± 0.40	1.66 ± 0.03
BMI (kg.m²)	21.9 ± 1.37	22.6 ± 1.00
Body Fat Percentage	18.5 ± 2.57	17.7 ± 3.09

The researcher used Visual Analog Scale (VAS) to identify the level of pain. Pain intensity can be classified as no pain with score range between 0-4 mm, mild pain to score range between 5-44 mm, moderate pain score range between 45-74 mm, and severe pain score range between 75-100 mm (Jensen et al., 2003).

Refer to tables 3 indicated the mean of pain level for 24 hours, 48 hours and 72 hours on VAS for perceived pain relieve between CWI and AR. For VAS score during 24 hours after recovery intervention, mean score for CWI was 82.16 mm and mean score AR showed 83.16 mm indicating similar level of pain i.e. under severe pain. After 48 hours of intervention, the mean of perceived pain relieve in CWI was 31.83 mm, indicating mild pain, while mean score for AR was 50.22 mm indicating moderate. It showed different rating of pain whereas CWI group showed better pain relieve i.e. mild pain compared to AR group in moderate pain relieved. After 72 hours of intervention, the CWI group were in better recovery on perceived pain relieve with the mean score of perceived pain relieve of 1.72 mm which was categorized as no pain, while mean score for AR was 19.28 mm which was categorized as mild pain.

Table 3 The Mean of Perceived Pain Level on VAS for 24 hours, 48 hours and 72 hours on VAS Scale between Cold Water Immersion and Active Recovery

	Group (Perceived Pain Relieve)	
	Cold Water Immersion	Active Recovery
24	82.16 (Severe)	83.16 (Severe)
48	31.83(Mild Pain)	50.22 (Moderate)
72	1.72 (No Pain)	19.28 (Mild Pain)

The one-way repeated measure ANOVA was used to measure the Visual Analog Score (VAS) on perceived pain relieve between Cold Water Immersion (CWI) and Active Recovery (AR) groups on 24 hours, 48 hours and 72 hours. Finding from this study showed that both recovery methods showed significant difference from 24 hour, 48 hours and 72 hours for perceived pain relieve on VAS scale ($p=0.05$). However, to compare recovery process between CWI and AR on 24 hours, 48 hours and 72 hours VAS scale indicated there was no significant difference ($p=0.507$) during 24 hours for both recovery methods. Meanwhile, CWI and AR showed there was significant difference ($p=0.05$) for 48 hours and 72 hours for both recovery methods. It concluded that, the result of CWI and AR groups showed significant difference between 24 hours, 48 hours and 72 hours on VAS scale. However, when comparing between groups, the result indicated there was no significant difference between CWI and AR on VAS scale for 24 hours. In contrast, the result for 48 hours and 72 hours showed there was significant difference between CWI and AR groups on VAS scale.

Table 4 Repeated One-way ANOVA on 24 hours, 48 hours and 72 hours for Perceived Pain Relieve on Cold Water Immersion and Active Recovery Groups.

	Perceived pain relieve (VAS)			Sig.p
	24 hours	48 hours	72 hours	
Cold water immersion (N=18)	82.16 ± 3.87	31.83 ± 5.02	1.72 ± 0.82	0.05*
Active recovery (N=18)	83.16± 4.49	50.22± 5.11	19.28± 4.07	0.05*
Sig.p	0.507	0.05*	0.05*	

*Result is significant when $p<0.05$

Inferential Statistic for Repeated Measure One-way ANOVA indicated that there was significant difference in perceived pain relieve using VAS on Cold Water Immersion group for 24 hours, 48 hours and 72 hours among UiTM football players after three days of intervention [$F(2, 34) = 2332.60$, $p = 0.005$]. For Active Recovery Group indicated that there was significant difference in perceived pain relieve using VAS for 24 hours, 48 hours and 72 hours among UiTM football players after three days of intervention [$F(2, 34) = 1051.91$, $p = 0.05$].

DISCUSSION

The ability of an athlete to recover quickly was being critical part to get best performance especially compete in sport consisted of many variations of movement and back-to-back activity throughout the day. According to [28], if an athlete gets enough recovery time between training session, they can be improved on their training session in term of quality, volume or intensity of the training, and potential the muscle or stimulus to improve on the training adaptation. Nowadays, there were many types of post exercise recovery techniques used to help athlete to return in pre-exercise state level. Thus, the purpose of this study is to investigate effects between two methods of recovery process consist of cold water immersion recovery and active recovery on muscle recovery after performing high intensity interval training among UiTM Pahang male football players. Furthermore, the study objective is to identify better recovery methods between cold water immersion and active recovery on perceived pain relieve for 24 hours, 48 hours, and 72 hours after performing High Intensity Interval Training (HIIT). The main finding from this study suggested there was no significant difference between cold water immersion and active recovery during 24 hours of recovery. However, the result indicated there was significant effect between cold water immersion and active recovery in perceived pain relieve on VAS scale after performing HIIT training after 48 hours and 72 hours. Furthermore, study findings also indicated there were significant differences between three recovery duration i.e. after 24 hours, 48 hours and 72 hours for both CWI and AR on perceived pain relieve. This agrees with study conducted by [29], reported that soreness sensation on muscle recovery decrease gradually from 24 hours to 72 hours after performing high intensity exercise. This study finding indicated that cold water immersion was effective on muscle recovery because they reported no pain on their lower body after cold water immersion comparing to active recovery. This result also supported by [30], stated that cold water immersion had effect to reduce pain and increase performance related with delay onset muscle soreness. Furthermore, study from [31], who used cold water immersion after conducted intermittent shuttle run performance. All the participants completed 90 minutes of intermittent shuttle run and received cold water immersion recovery on both legs with temperature of 10°C, immersed ten minutes immediately after performing exercise. The result showed that muscle soreness among participants was reduced at 24 hours and 48 hours, suggesting that cold water immersion is effective to eliminate muscle soreness immediately after exercise. According to [32], [33], reported positive results in muscle recovery after cold water immersion in a pool with ice for 19 minutes among jiu-jitsu fighters. It supported by [33], stated that soreness and pain perception showed to be higher in the cold water immersion groups after 48 hours of recovery on the effect of post exercise cooling on muscle performance and soreness perception among 20 healthy college athletes. Furthermore, study conducted by [34], regarding the effectiveness of cold water immersion in muscle soreness management compared with passive recovery, besides to identify degree of

water temperature in producing best result on muscle recovery. Their study indicated that using cold water immersion as a post exercise recovery technique and muscle relief soreness pain using temperature of 11°C to 15°C, provided better result on reduction of muscle soreness after performing exercise. The positive effect from cold water immersion as post exercise recovery was supported by [31], [35], reported that cold water immersion can be used as a technique to reduce blood flow that causing vasoconstriction of the blood. Moreover, the decrease of pain sensation due to muscle soreness was associated with analgesia to reduction of muscle pain. [36], conducted the study on nerve pain using cryotherapy reported that cooling was able to decrease the skin temperature (10°C to 13°C) and decrease 10% - 33% on nerve pain after applied cryotherapy on post exercise recovery. It was also supported by [37], that cold water immersion can provide vasoconstriction, increase blood venous return and decrease oxygen saturated of blood in blood vessel. Furthermore, according to [14], stated that cold water immersion provides reduction in nerve conduction and decreased in muscle pain and spasm. The study from [38], also stated that rugby players reduced their muscle soreness sensation of pain, markers of muscle damage (creatine clearance) using cold water immersion method recovery after one hour, 18 hours and 42 hours post-match is found much better compared to active recovery.

Study finding indicated that was no significant difference between two recovery processes on perceived pain relieve on 24 hours after recovery. Both of recovery methods i.e. CWI and AR showed similar in perceived pain rating as severe after 24 hours completed the intervention using VAS scale. The study result was similar with study conducted by [15], among recreational active participants to investigate the delay onset muscle soreness, Creatine Kinase (CK) on post exercise recovery immediately, 24 hours, 48 hours and 72 hours on exercise was drop jump performance between cold water immersion and control group. They found that both groups showed no significant difference on both measurements. It was supported by [39], conducted a study for comparison between cold water immersion and no treatment on CK and muscle soreness among physically active population. Measurement was taken on 1 hour, 24 hours, 48 hours and 72 hours after post exercise intervention. They reported there was no significant difference between cold water immersion group and control group on both measurements.

According to [40], research on effect of cold water immersion on 48 hours performance testing in college football players, indicated that there was no significant difference with cold water immersion. The study was conducted to assess two recovery methods i.e. cold water immersion as experimental group and passive recovery as control group on performance of repeated yoyo intermittent recovery test. The study result showed that there was no significant difference between intervention conditions on yoyo intermittent performance. The current study finding showed that both recovery methods on 48 hours post exercise on perceived pain relieve revealed significant difference between cold water immersion and active recovery. In this finding, active recovery group showed better number of pain perception and sensation on muscle recovery compared with 24 hours but cold water immersion appear to be more effective than active recovery on pain perception and sensation of muscle recovery for 48 hours post exercise. Like previous study on effect of cold water immersion, the researcher report that immediate post exercise recovery has shown the positive result to subsequence performance on exercise. Study conducted by [33], to determine the effect of post exercise cooling on muscle performance and pain sensation among college students to compare two recovery methods i.e. cold water immersion and control group after performing exercise. Cold water immersion indicated positive effect on muscle performance outcome and soreness pain sensation after 24 hours and 48 hours when compared with control group.

Furthermore, [41], conducted a study to find out effect of chronic cold water immersion in elite rugby players. They found that cold water immersion was beneficial in reducing muscle soreness and improve muscle performance after performing cold water immersion recovery process. These results also related with previous literature review on positive effect of cold water immersion enhancing muscle performing for up to 48 hours after rugby training or competition [38], Moreover, the significant effect of cold water immersion on muscle recovery after performing high intensity exercise were like study conducted by [42], on immediate effect and delayed cold water immersion after a high intensity exercise following by run performance among football players. The finding stated that immediate cold water immersion recovery after exercise has significant effect on running performance compared to three hour delayed cold water immersion and passive recovery. It was supported by other researcher, stated that performed cold water immersion immediately as post exercise recovery showed positive results compared with active recovery. In addition, [31], show that improvement in

repeated sprint performance on 48 hours after immediately performed cold water immersion compared to contrast water immersion and control group. This current study on immediately cold water immersion as post exercise recovery has similar result on muscle performance and muscle pain sensation among participant after performing high intensity exercise compared with active recovery.

ACKNOWLEDGMENT

The author thanks to the participants who take part in this study.

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