

## Interaction Between Hot Water Immersion (HWI) and Cold Water Immersion (CWI) Methods with Gender on Decreasing Lactic Acid



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### ABSTRACT:

**Purpose:** The purpose of this study was to examine Interaction Between Hot Water Immersion (HWI) and Cold Water Immersion (CWI) Methods With Gender on Decreasing Lactic Acid.

**Materials and Methods:** This research is an experiment with 2x2 factorial design. The population of this study were all 40 PJKR students in Sukabumi City. Data collection was carried out by means of a test, which included a pre-test and post-test for lactic acid levels after running 100 m. Data analysis in this study used two way anava with a significance level of <0.05. Then proceed with the paired samples test to compare the averages of the two related samples taken from the same population.

**Results:** Based on the results, in the male group there was an average decrease in lactic acid of 3,621 for the HWI method, with a standard error of 0,183. The 95% confidence interval in the male group for the HWI method ranged from 3,249 to 3,993. As for the CWI method, there was an average decrease in lactic acid of 3,304 with a standard error of 0,183. The 95% confidence interval in the male group for the CWI method ranged from 2,932 to 3,676. In the women's group, the average decrease in lactic acid was 3,200 for the HWI method, with a standard error of 0,280. A 95% confidence interval in the women's group for the HWI method was not available in the data presented. Meanwhile, for the CWI method, there was an average decrease in lactic acid of 3,217 with a standard error of 0,280. The 95% confidence interval in the female group for the CWI method ranged from 2,648 to 3,785.

**Conclusions:** Based on the research results, it can be concluded that there is no significant interaction between HWI and CWI therapy methods and gender in reducing lactic acid. The effect of HWI and CWI therapy on reducing lactic acid did not differ between men and women. There is an effect of HWI therapy on decreasing lactic acid. There is an effect of CWI therapy on decreasing lactic acid

**KEYWORDS:** CWI, HWI, Anaerobic Exercise, Lactic Acid, Gender

### INTRODUCTION

Sports is one form of physical education, as it helps participants develop and hone basic motor skills and specific sports techniques (Bangun, 2016). Exercise, in a broad sense, is any activity that a person does to maintain or improve his physical and mental health (Social et al., 2015). Sport is an effort to improve the quality of human life, in addition to aiming to form an ideal body, it is also beneficial for mental health, including creating a human body system that can run smoothly (Saputra & Agus, 2021). In the context of physical activities, sports include both planned and unplanned movements, so unplanned activities such as household chores and worship are still considered sports. However, if the sport is planned, the movement and the goal is to achieve a certain goal is called achievement sports (Supriatna, 2015).

In sports achievements or in preparing for certain events a coach or athlete not only focuses on the training program designed and its application in the field, but besides that a coach must also pay attention to the process *Recovery* athlete (Hermawan et al., 2020). The training program will be successful if the athlete who is the executor or object of training gets the recovery process (*recovery*) which is appropriate for overcompensation to occur. Overcompensation is the adjustment of a stimulus to an excess load (*overload*), Where in the next load the stimulus has capabilities above its initial ability. So to get the peak performance of an athlete, it needs harmony between training and *Recovery* (Matjan, 2009).

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When there is a lot to do without enough time to rest, the body uses energy from anaerobic glycolysis as its main fuel source. This can lead to a buildup of lactic acid in the blood, which in turn prevents muscle cells from taking in oxygen-rich blood and oxygen, leading to fatigue (Made Yoga Putra, 2015). The inability to maintain muscle contractions is what is about muscle fatigue. The three types of fatigue are central fatigue, muscle fatigue, and neuromuscular fatigue. When lactic acid builds up in muscles, it can cause fatigue (Sandi, 2019). Decreased muscle receptivity to stimulation is a direct result of lactic acid buildup. Depletion of energy reserves can be caused by several factors, including energy supply problems, ATP + PC, anaerobic glycolysis, accumulation of products in the form of H<sup>+</sup>, lactic acid, mechanical inability of muscles to concentrate, and changes in the nervous system (Ariani, 2011).

Fatigue is more common in women than men because of biological variations between the sexes, namely monthly biological cycles in a woman's body system that can affect her physical and psychological health and cause fatigue. affects the increase in lactic acid production (Heza, 2018). On the other hand, in general, compared to women, men have larger muscle mass, higher hemoglobin concentration, more blood volume, and higher maximum oxygen consumption. (Zhang & Ji, 2016)

The term "burnout" refers to a decrease in performance and output that may occur as a direct result of engaging in certain types of work or physical activity. Physical and mental fatigue are both possible results of exercise fatigue and it is clear that people cannot function properly when exhausted (Bafirman, 2013). Negative effects of fatigue can be expected if circumstances cannot be predicted with recovery as training continues (overtraining).

By relaxing the body and slowing the heart rate, warm water therapy can also lower blood pressure (Malibel, 2020). Reducing fatigue and increasing muscle endurance are two of the many benefits of hot water therapy (Festiawan, 2021). Cold water therapy, also known as Cold Therapy, has many advantages, including its low cost, speed, and ease of application (Nurusyaikhi et al., 2022). Cold water immersion immediately after exercise is believed to reduce muscle damage and discomfort, possibly contributing to faster recovery of neuromuscular function (Setiawan & Kusumawardhana, 2021). Cold water immersion can reduce muscle stiffness and the amount of post-workout damage after strenuous eccentric activity. Therefore, a sportsman must be in excellent physical condition, with a lot of strength and stamina, for that there needs to be a treatment to overcome the decline in muscle function and efforts to prevent injuries to sportsmen (Harun & Syafriani, 2021).

Based on the problems in this study, it is necessary to limit the problem because of the limitations of the author, the problem is limited to the following areas: the effect of cold water immersion and hot water immersion therapy methods on lactic acid reduction in terms of gender. in terms of gender (experimental study on Physical Education, Health and Recreation students in Sukabumi).

### METHOD

This research was carried out with 40 PJKR students in Sukabumi City. The training will be divided into 4 predetermined groups. The purpose of this study was to investigate the effect of cold water immersion and hot water immersion therapy after anaerobic exercise on the reduction of lactic acid in terms of gender (experimental study on Physical Health and Recreation Education students in Sukabumi). The study was an experiment with a 2x2 factorial design, a comparative research pattern that allows researchers to analyze the impact of four independent variables (Hadi, 2011). This investigation protocol is as follows.

**Table. Experimental Design with 2x2 Factorial Design**

	THERAPY METHODS (A)	
GENDER (B)	<i>Cold Water Immersion (A1)</i>	<i>Hot Water Immersion (A2)</i>
Male (B1)	a1b1	A2B1
Female (B2)	a1b2	A2B2

Information:

a1b1 : Group of male students with Cold Water Immersion against Decreased lactic acid levels

a1b2 : Group of female students with Cold Water Immersion against Decreased lactic acid levels

a2b1 : Group of male students with Hot Water Immersion against Decreased lactic acid levels

a2b2 : Group of female students with Hot Water Immersion against Decreased lactic acid levels

Data collection was carried out by means of a test, which included a pre-test and post-test for lactic acid levels after running 100 m. The test carried out in this study was the measurement of lactic acid before and after being given treatment. Measurement of lactic acid levels using accutrend plus, test strips for lactic acid levels, sterile needles, cotton and alcohol. Group

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I did a 100 m sprint. After running, the sample was checked for lactic acid levels and then given the CWI treatment. Next, group II did a 100 m sprint. After running, the sample was checked for lactic acid levels and then given the HWI treatment. Blood collection was carried out using a sterile needle by cleaning the sample's fingertip with a cotton swab that had been given alcohol, then the needle was shot at the fingertip and pressed so that the blood would come out. After that, the blood is directly touched to the side edge of the lactate strip that has been attached to the device. The blood will immediately seep to the end of the strip and wait a moment for the results to appear on the screen. Results are recorded on an assessment blank.

In this study using ANOVA 2x2 factorial design. Using two way anava in the SPSS 25 Test of Between Subject Effects with a significance level of <0.05. If the P value is greater than 0.05 then the data is declared to have no significant effect, conversely if the P value is less than 0.05 then the data is declared to have a significant effect.

### RESULTS

**Table 1. The Effect of Interaction Between Therapy Methods and Gender on Decreasing Lactic Acid**

Gender	Method	Mean	Std. Error	95% Confidence Interval		F	Sig.
				Lower Bound	Upper Bound		
Man	HWI	3,621	0,183	3,249	3,993	0,499	0,484
	CWI	3,304	0,183	2,932	3,676		
Woman	HWI	3,200	0,280	2,632	3,768		
	CWI	3,217	0,280	2,648	3,785		

This study aims to investigate the effect of the interaction between Hot Water Immersion (HWI) and Cold Water Immersion (CWI) therapy methods with sex on lactic acid reduction. The data provided included mean lactic acid reduction, standard error, 95% confidence interval, F value, and significance level (Sig.).

Based on the results presented in the table, in the male group there was an average decrease in lactic acid of 3,621 for the HWI method, with a standard error of 0,183. The 95% confidence interval in the male group for the HWI method ranged from 3,249 to 3,993. As for the CWI method, there was an average decrease in lactic acid of 3,304 with a standard error of 0,183. The 95% confidence interval in the male group for the CWI method ranged from 2,932 to 3,676.

In the women's group, the average decrease in lactic acid was 3,200 for the HWI method, with a standard error of 0,280. A 95% confidence interval in the women's group for the HWI method was not available in the data presented. Meanwhile, for the CWI method, there was an average decrease in lactic acid of 3,217 with a standard error of 0,280. The 95% confidence interval in the female group for the CWI method ranged from 2,648 to 3,785.

Furthermore, the results of the analysis using the F test showed an F value of 0,499 with a level of significance (Sig.) amounted to 0,484. Based on the F value and the level of significance obtained, it can be concluded that there is no significant interaction between HWI and CWI therapy methods with sex to lactic acid reduction.

**Table 2. The effect of the HWI method on the reduction of lactic acid**

Pair 1	Paired Differences	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	Df	Sig. (2-tailed)
					Lower	Upper			
					PRETES – POSTES	5.56000			

Based on the data presented, it was found that the average difference between pretes and postes was 5,56, with a standard deviation of 0,61955 and a mean standard error of 0,13854. The 95% confidence interval for this difference is in the range of 5,27004 to 5,84996. The results of the statistical test show that the calculated t value is 40.134 with a degree of freedom (df) of 19. The significance value (Sig.) obtained is 0,000, which is smaller than the significance level of  $\alpha$  (usually 0,05). Therefore, there is a significant difference between the values of pretes and postes after HWI therapy against lactic acid reduction.

The effect of CWI therapy method on lactic acid can be seen in the following table:

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**Table 3. The effect of the CWI method on the reduction of lactic acid**

		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PRETES POSTES	6.06500	.63951	.14300	5.76570	6.36430	42.413	19	.000

The results of this analysis, paired sample tests were carried out (paired samples test) to test the effect of therapeutic methods *Cold Water Immersion* (CWI) against lactic acid decrease. The table presented shows the pairwise difference between pretest (before therapy) and postes (after therapy) values in the same sample.

Based on the data presented, it can be seen that the average difference between pretes and postes is 6,065, with a standard deviation of 0,63951 and a mean standard error of 0,14300. The 95% confidence interval for this difference is in the range of 5,76570 to 6,36430. The results of the statistical test showed that the calculated t value was 42,413 with a degree of freedom (df) of 19. In addition, a significance value (Sig.) of 0,000 is obtained, which is smaller than the significance level of  $\alpha$  (usually 0,05). Therefore, it can be concluded that there is a significant difference between pretest and postes values after CWI therapy against lactic acid reduction.

### DISCUSSION

Exercise that is carried out routinely or programmed certainly has an effect or influence on the body which is the stimulus and also has the ability to endure or VO2Max. Planned exercises provide benefits for the body, namely forming an ideal body posture, normalizing body movement functions, strengthening the body's physiological and anatomical systems (Falaahudin et al., 2022). Conversely, if the training is not carried out according to training principles, the form of training that is not properly planned according to the needs and conditions of the athlete will have a negative impact on the athlete (Iwandana et al., 2021). Regarding sports, it has to do with exercise, in training, of course, there is volume, intensity and so on (Lestari et al., 2022). Various forms of exercise, both aerobic and anaerobic, are a support system to support the success of training. Exercise, both aerobic and anaerobic, especially at high-intensity exercise, can cause fatigue, which in turn causes a buildup of lactic acid. The fast running style is defined as all types of running that are carried out at maximum speed from the start of the race to (Nurhayati, 2018).

Hot water impressions were carried out at C36C, with immersion times examined in the literature ranging from 10-24 minutes (Versey et al., 2013). Full body immersion is usually performed; however, similar to CWI, one study has examined the effect of local heating on a body part (arm). Participants are usually passive during immersion, although underwater jets are often available for massage. Hot pools may be more widely available than cold pools because they may be part of a swimming pool complex, and hot temperatures are easier to achieve than cold ones in a home or hotel bath. Similar to the CWI, a portable tub or pool attached to a heating unit may be more practical in some competition or training venues. Hot water promotes vasodilation, causing increased blood flow and facilitating the supply of oxygen and antibodies, clearance of metabolites, and reduction of muscle spasms and pain (Tavares et al., 2018).

The goal of cold therapy is to lower the temperature of the injured area by absorbing the calories there. And also to reduce tissue temperature through the mechanism of cold therapy for recovery after exercise is largely attributed to its vasoconstrictor effect, which reduces inflammatory reactions through decreasing cell metabolism by losing the body's natural heat (conduction). Because the body must expend energy to melt the ice, wet ice therapy is more effective at lowering the temperature than using packaged ice. Recovery techniques such as cold water immersion (CWI) are frequently used by elite athletes. It is routinely recommended as beneficial for enhancing physiological and psychological recovery after exercise, especially as it reduces delayed onset muscle soreness. Indeed, it has been suggested that CWI may be useful for improving subsequent training quality and ultimately competitive performance through better recovery and the accumulative effect of increasing the quality and quantity of training. The use of cold on the body to relieve symptoms of illness or injury is known as cold therapy. There are a number of applications for cold therapy, including ice packs and cold showers. Cryotherapy refers to the practice of using extremely cold temperatures to cause tissue damage; often, liquid nitrogen is used for this purpose. To relieve the symptoms of many physical conditions, cold treatment (cold therapy) sometimes involves using ice packs or other cold methods such as ice and cold sprays. Alternating hot-cold immersion is one of the most popular techniques and is practiced with increasing frequency in aiding recovery after physical training and competition. This can be given at 10°C for 10 or 20 minutes. The blood test results from this study also showed a negative effect of CWI on recovery. Post-exercise peak blood lactate concentrations showed a significant decrease after

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CWI when compared with the first exercise test and control tests. It is proposed that CWI may improve recovery by reducing edema and inflammation after exercise-induced muscle damage (Rowell et al., 2014).

### CONCLUSION

Based on the research results, it can be concluded that there is no significant interaction between HWI and CWI therapy methods and gender in reducing lactic acid. The effect of HWI and CWI therapy on reducing lactic acid did not differ between men and women. There is an effect of HWI therapy on decreasing lactic acid. There is an effect of CWI therapy on decreasing lactic acid

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