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THE EFFECT OF COLD WATER IMMERSION AFTER HIGH INTENSITY TRAINING ON LACTATE CLEARANCE RATE AND AEROBIC CAPACITY IN RUGBY ATHLETES

(Research article)

Nyoman Sudarmada [a]

[a] *Universitas Udayana, Indonesia*

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Abstract

This study aimed to determine the effect of CWI after high-intensity training on lactate clearance rate and aerobic capacity. Sixteen male rugby athletes participated in the study: eight in the CWI treatment group and eight in the passive rest control group. Blood lactate levels were measured before exercise, immediately after exercise, and 30 minutes and 60 minutes after exercise. Aerobic capacity was measured using the MFT test one day before (pre-test) and one day after (post-test). The results showed that measurements at 30 minutes after the end of the exercise showed a greater rate of lactate decline in the treatment group than in the control group. Lactate levels almost reached the level before exercise at 60 minutes after exercise in both the treatment and control groups. While VO2 Max measurements in both groups showed no difference between the pre-test and post-test values.

Keywords: High Intensity Training, Lactate Clearance Rate, Aerobic Capacity, Rugby Athletes.

[1]Corresponding author (Nyoman Sudarmada). ORCID ID.: 0000-0002-9260-3014 E-mail: inyomansudarmada@gmail.com

1. Introduction

Optimal athlete performance in a match occurs when they have optimal physical performance and are mentally prepared to compete. To achieve peak performance, a balance is needed between the stimulus of the training load given and an adequate recovery phase (Lastella et al., 2018) . Intensive training loads in the long term without being balanced with sufficient recovery will cause overtraining syndrome (Bedford, 2022). Various recovery methods have been developed, one of which is the most popular are cold water immersion (CWI) method (Dupuy et al., 2018). The development of this recovery method is based on physiological changes that occur in the body's physiological system due to training loads. Cold water immersion as one of the post-training recovery methods is currently gaining high attention and popularity among athletes to reduce fatigue and accelerate the recovery process (Ihsan et al., 2016). CWI with its main attributes of lowering body tissue temperature and blood pressure, is believed to improve the quality of recovery by improving hyperthermia conditions and subsequent changes in the central nervous system (CNS), reducing fatigue and cardiovascular strain, stimulating vasoconstriction and venous blood reversal, reducing the amount of muscle metabolic waste, reducing muscle damage due to training, reducing swelling and pain in the muscles, and improving the function of the autonomic nervous system (Bedford, 2022; Ihsan et al., 2016).

Knowing the athlete recovery status is very important to determine the effectiveness of the training program being run and to determine the athlete's level of readiness to carry out the next training program. In line with the decline in physical and neuro-mechanical performance, training that stimulates fatigue causes metabolic disorders characterized by changes in chemical analytes that can be measured in body fluids such as blood, saliva and urine which act as biomarkers (Pérez-Castillo et al., 2023). Blood lactate clearance rate show During high-intensity training, lactic acid levels increase very high as an accumulation of residual energy metabolism. Lactic acid levels can be a parameter used to determine the athlete's recovery level. Measuring the rate of lactate decrease in the blood indicates an athlete's recovery ability. Understanding the effects of CWI intervention on the rate of lactate decrease will provide perspective on the efficiency of the recovery method provided. Comparison with other recovery methods provides a new perspective on the benefits of CWI intervention after training on the athlete's recovery speed.

The recovery speed influenced by the recovery model carried out by the athlete after a training phase affects the athlete's readiness to carry out the next training. The quality of recovery affects the physical capacity and performance of an athlete. One of the main components of physical condition is cardiovascular endurance which can be represented in the value of maximum oxygen volume (VO2 max). VO2 max is a measure of the body's maximum ability to circulate and use oxygen during dynamic exercise involving large muscle groups (Powers & Howley, 2018). VO2 max capacity is influenced by the quality of exercise and recovery.

2. Method

This research design uses the non-randomized control group pretest-posttest design. 16 male rugby athlete include in this study, divide into 2 group; one as treatment group given CWI treatment and other as control group. The type of data in this study is quantitative data. Consisting of blood lactate data sourced from blood lactic acid level measurements using a portable lactate level meter brand Lactate Pro and VO2Max data obtained from field tests with the Bleep test instrument. Blood lactate levels were measured using Lactate pro at rest to obtain pretest values. After being given training and CWI method intervention post exercise, blood lactate levels were measured again at 0, 30 and 60 minutes after exercise. VO2Max capacity for the treatment and control groups was taken before the treatment was given as a pretest value. After being given treatment, VO2Max measurements were carried out again using the Bleep test instrument. Data analysis was carried out descriptively to see the speed of decrease in blood lactate levels after exercise and treatment in both the treatment and control groups. Lactate level data at 0, 30 and 60 after the end of exercise were compared for both groups. To determine the effect of CWI on blood lactate levels and VO2 Max, an independent t-test was conducted by comparing the post-test values of the treatment group and the control group.

3. Result

In this study, the number of research subjects was 16 male rugby athletes from Buleleng Regency. The characteristics of the research subjects used in this study can be seen in the following table 1.

Table 1. characteristic of sample; average age, body mass index, blood lactate and VO2 max before treatment

Group	N	Age	BMI	Blood lactate	VO_2max
CWI	8	17,0 ± 1,5	23,1 ± 2,1	2,0 ± 0,4	41,4 ± 2,5
Control	8	17,4 ± 1,5	22,1 ± 1,5	1,9 ± 0,3	42,0 ± 1,6

Table 1 show that the number of samples for each group was 8 athletes with an average age of 17.0 years old in the CWI treatment group and 17.4 years in the control group. The body mass index for the CWI and control groups was 23.1 and 22.1, respectively. Blood lactate levels were measured before exercise with an average of 2.0 mM in the CWI group and 1.9 mM in the control group. The VO2 max value was estimated from the blep test results with an average of 41.4 ml/kg in the CWI group and 42.0 ml/kgbb in the control group.

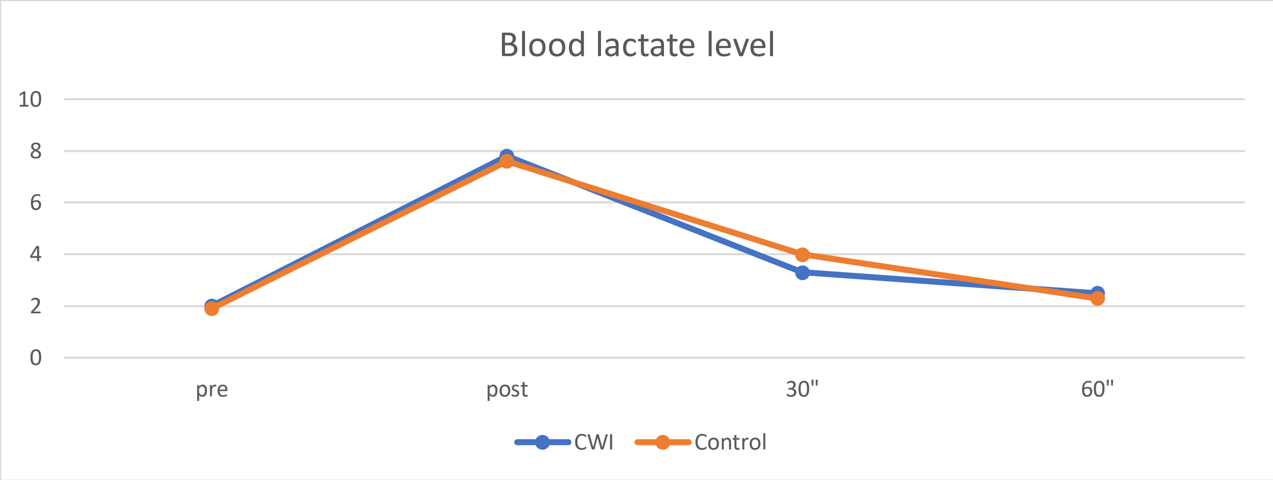
The recovery method treatment with CWI was given after the athletes carried out high-intensity exercise with a sprint interval training model. CWI was carried out on the treatment group immediately after the athletes carried out the exercise. The athletes were immersed in a tub filled with cold water at a temperature of 10^0C for 10 minutes. Immersion was carried out on the lower extremities of the athletes up to the waist. While the control group carried out passive recovery activities.

Blood lactate levels were measured immediately after exercise ended, 30 minutes after exercise and 60 minutes after exercise. The results of measurements using The Edge Blood Lactate Monitoring System can be seen in table 2.

Table 2. blood lactate level post exercise (0 minute), 30 minutes, and 60 minutes after exercise

Group	N	Pre	Post	30”rest	60”rest
CWI	8	2,0 ± 0,4	7,8 ± 0,6	3,3 ± 0,4	2,5 ± 0,3
Control	8	1,9 ± 0,3	7,6 ± 0,9	4,0 ± 0,3	2,3 ± 0,3

Based on table 2, it can be seen that the blood lactate values of the CWI treatment group and the control group have almost the same values immediately after the exercise ended. The CWI group had an average of 7.8 mMol/L while the control group was 7.6 mMol/L. After resting for 30 minutes, blood lactate levels were measured again in each group with the results of the CWI group averaging 3.3 mMol/L while the control group was 4.0 mMol/L. This shows that the treatment group experienced a decrease in average blood lactic acid levels faster than the treatment group. Blood lactate levels were measured again 60 minutes after the exercise was completed. The measurement results showed that the lactic acid levels of both groups had returned to their initial levels before the exercise took place.



Picture 1. Graph of mean blood lactate levels in the CWI treatment group and the Control group.

VO2 max capacity measurements were conducted on a different day from the treatment. The pre-test was conducted the day before the treatment was given with the Bleep test. The test was conducted in the afternoon. The post-test was also conducted in the afternoon at the same place 24 hours after the treatment was given. This time span was given to reduce the effects of fatigue due to the exercise on VO2Max capacity. The results of the VO2 max capacity measurements can be seen in the table 3:

Table 3. VO2 Max capacity of treatment and control group.

Group	N	Pre	Post
CWI	8	41,4 ± 2,5	41,7 ± 2,3
Control	8	42,0 ± 1,6	41,9 ± 1,6

The results of the VO2 Max capacity measurement 24 hours after treatment showed a very small difference with the value before the treatment was given. In the CWI group, there was a change of 0.3 from 41.4 to 41.7 ml/kg/min while in the control group there was a change in the VO2 Max value of 0.1 ml/kg/min.

The result of the Lavene test with a significance value of 0.896 shows that the two groups being compared are homogeneous. The results of the independent t-test on the VO2 max post-test value between the CWI treatment group and the control group showed no significant difference between the means being compared. This can be seen from the significance value of the t-test which is 0.849 which is greater than 0.05.

4. Discussion

The results showed that the levels of lactic acid in the treatment group and the control group had relatively the same values. Likewise, the VO2 max capacity before training had relatively the same value. This shows equality or homogeneity between the control group and the treatment group. Equality of ability between groups can reduce bias in research results due to differences in group abilities.

Of all blood lactate value measurements, differences occurred in measurements after a 30-minute rest, where the blood lactate levels of the treatment group were smaller than those of the control group. Meanwhile, in measurements immediately after exercise and 60 minutes after exercise, there was no difference in blood lactate levels. This shows the effect of CWI treatment on the speed of returning blood lactate levels to the initial threshold value.

When exercise continues at high intensity and for a long enough duration, the oxygen supply cannot meet the body's needs. As a result, 6 most of the pyruvic acid produced cannot be fully oxidized in the mitochondria to produce energy. Instead, pyruvic acid is converted into lactic acid through a reaction catalyzed by the enzyme lactate dehydrogenase (LDH). This is the body's response to achieving a fast source of energy despite a lack of oxygen. CWI with its main attributes of lowering body tissue temperature and blood pressure, is believed to improve the quality of recovery by improving hyperthermia and subsequent changes in the central nervous system (CNS), reducing fatigue and cardiovascular strain, stimulating vasoconstriction and venous blood reversal, reducing the amount of muscle metabolic waste, reducing muscle damage due to exercise, reducing swelling and pain in muscles, and improving the function of the autonomic nervous system (Bedford, 2022; Ihsan et al., 2016). CWI is an effective recovery method after high-intensity exercise with positive effects on muscle strength, muscle soreness levels, CK and perception of fatigue after 24 hours (Moore et al., 2022). CWI can accelerate the release of metabolites from metabolism during exercise from within the muscles. Hydrostatic pressure due to immersion increases hemodilution which accelerates the movement of fluid from the interstitial tissue to the blood vessels. The rapid movement of interstitial fluid is filled by intracellular fluid which results in an increase in the osmotic gradient between the intravascular and intracellular tissues. This increase in osmotic gradient increases the movement of metabolites from intracellular tissue to the blood vessels (Stocks et al., 2004). This accelerates the release of metabolic products including lactate from muscle tissue into the bloodstream.

The increase in VO2 max due to physical exercise is not only influenced by the exercise model but also by the recovery method used. Several studies have shown that different recovery methods after exercise have different effects on changes in VO2 max. In rowing athletes who were given cross-country and fartlek training (Izzuddin et al., 2022), as well as in research samples given high intensity interval training (Wibowo et al., 2019), the passive recovery method had a better effect on increasing VO2 max capacity. VO2 max capacity is a dynamic variable that can change due to physical activity and exercise, and is also influenced by heredity, age, gender, altitude and pollution as well as cardiorespiratory disease (Howley & Thompson, 2017). Result of this study show that no difference between pre and post exercise value of VO2 Max in all group. This result indicate that one time recovery treatment does not have enough time to influence the physiological respon of the body. There is needed physiological adaptation of the body to improve VO2 max.

5. Conclusion

The results showed that measurements at 30 minutes after the end of the exercise showed a greater rate of lactate decline in the treatment group than in the control group. Lactate levels almost reached the level before exercise at 60 minutes after exercise in both the treatment and control groups. While VO2 Max measurements in both groups showed no difference between the pre-test and post-test values. These results indicate the effectiveness of the effect of CWI treatment on reducing lactate levels after high-intensity exercise

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Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest.

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