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Comparison Of Stretching And Cold Water Immersion With Stretching And Water Contracts In Reducing Athletic Pain

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Abstract

Athletes often experience muscle pain called delayed onset muscle soreness (DOMS) after strenuous exercise that overloads the muscles, symptoms that arise in the form of muscle pain, muscle cramps, muscle weakness, and even can cause muscle tissue tears. This study aimed Their qualifications and experience intervention was better for reducing DOMS pain in athletes running as far as 3000 meters. The research was carried out in the athletics field, experimental in nature with a pretest and posttest two-group design. Male athletes were divided into two groups of nine each and underwent interventions to assess changes in pain tolerance after a 3000-meter run. Group I experienced a significant increase in pain tolerance after 48 hours following an intervention combining stretching and coldwater immersion. Similarly, Group II showed a significant increase in pain tolerance after the same timeframe with an intervention combining stretching and regular water immersion. However, statistical analysis revealed that the intervention involving cold water immersion (Group I) was more effective in reducing Delayed Onset Muscle Soreness (DOMS) compared to the regular water immersion (Group II).

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INTRODUCTION

Decreased physical endurance will impact a person's fitness, if fitness declines, it will significantly affect work or daily activities (Rieker et al., 2023). The impact will result in a decrease in activity, which will inevitably lead to a decline in the physical capabilities of organs such as the heart, lungs, and metabolic system. Endurance is the body's ability to perform an activity continuously for a relatively long time or in aerobic conditions, requiring oxygen intake from the outside air, especially in muscle cells, to generate energy or contract (Mileva & Zaidell, 2022).

Sports are activities performed to train a person's body. Everyone has different goals when engaging in sports, some exercise to improve or maintain their stamina for good health, while others do it to enhance performance, for recreation or entertainment, and more (Shoxrux, 2023). Competitive sports are usually pursued by those who have an interest and talent in the field of sports, and are developed professionally in order to achieve accomplishments (Xiang et al., 2024).

The achievements of Indonesian athletics have never placed in the top three and still need to be improved, as can be seen from the performance of Indonesian athletics in the Asian Games. In the first Asian Games in New Delhi in 1951, Indonesian athletes won a total of 5 bronze medals, all of which came from athletics. In 1962, Indonesia hosted the Asian Games, winning two gold medals and one bronze in the sprint events. Then in 1970, during the Asian Games, Indonesia won two bronze medals in the 100 meter and 200 meter sprints. In 1998, Indonesia won the final in the 5000 meter long-distance race with a record time of 54.45 seconds. After that, Indonesia's performance experienced a decline. Until it returned in 2014, Indonesia won the gold medal in long jump held in South Korea.

Indonesia's achievements in the 2018 Asian Games improved significantly compared to the 2014 Asian Games. In terms of ranking, Indonesia placed fourth in 2018, while in 2014, it was ranked seventeenth. This significant improvement in performance is due to the efforts of the athletes, who have been fully supported by the government through training and coaching, as well as the enhancement of sports facilities and infrastructure in the period leading up to the Asian Games. The government has established a new policy requiring each sports federation to recruit sports science professionals from universities. With the presence of sports science, coaching and training become more measurable and performance-oriented.

When athletes train at very high intensities, fitness will improve, but fatigue also increases and can lead to the occurrence of delayed onset muscle soreness (Mizumura & Taguchi, 2016), as seen in the 3000-meter run. Running a distance of 3000 meters in a time of 11 minutes utilizes aerobic energy metabolism, which is a metabolic process that requires oxygen (O2) intake for it to function effectively in producing ATP. “During exercise, the body's two energy reserves-carbohydrate stores (blood glucose, muscle and liver glycogen) and fat stores in the form of triglycerides-contribute to the rate of aerobic energy production in the body”. To regenerate ATP, the body will utilize three energy reserves: carbohydrate stores (glucose, glycogen), fat, and also protein. Among the three, carbohydrate and fat reserves are the main sources of energy during exercise (Volek et al., 2015). Running 3000 meters in a time of 11 minutes (with a minimum intensity of 90%) can lead to issues in the body such as fatigue and dehydration (Vaher et al., 2015). “Delayed onset muscle soreness (DOMS) occurs physiologically due to prolonged

and continuous muscle contractions, prompting the body to respond to the imposed load". The body's response with sensations of twitching or soreness in the muscles, pain in specific areas such as the gastrocnemius and soleus (Amalraj et al., 2020).

DOMS is a condition characterized by pain and discomfort that arises in the muscles, nerves, and metabolic system approximately 24 hours after a competition or workout (Cardoso et al., 2020), peaking between 24 to 72 hours later, with effects gradually diminishing after 5 to 7 days (P Pearcey et al., 2015). This is caused by microdamage to the muscle fibers due to a prolonged and continuous factor. The type of exercise that more frequently causes DOMS is exercise with an eccentric contraction pattern (Muscles must withstand loads and contractions while in an elongated state). As a result, micro-tears occur due to compensation from the existing load (Douglas et al., 2017).

The management of DOMS in athletes is urgently needed because in athletics, athletes can compete one to two times a day in different events (Rawson et al., 2018). If the recovery phase after the first round of the competition is not managed well, it will lead to a decline in the athlete's performance and affect their achievements, resulting in fatigue during the second round and potentially causing injuries to the athlete. With the presence of DOMS, athletes will experience pain, limited movement, muscle tension, decreased proprioception, reduced strength, and an increased risk of injury, while in other events, they will also compete, making proper recovery essential (Heiss et al., 2019).

Methods to reduce DOMS include several ways such as stretching, cold water immersion, contrast water immersion, and others. Stretching, which is the most commonly practiced method by athletes both after training and after competitions. The purpose of stretching is to achieve elastic and comfortable muscles, which is usually done before and after exercise. Stretching is performed by elongating several muscle groups to restore the flexibility of those muscles (Babault et al., 2021). There are several types of stretching, one of which is auto stretching. This stretching is done gradually until reaching the point of resistance or until it feels slightly painful, then holding the stretched position for a while (Ada et al., 2020).

At the time of stretching, When a muscle is stretched, the primary response happens within its elastic components, specifically the proteins actin and myosin. This stretching leads to a rapid increase in tension within the muscle. "The sarcomere lengthens, and if this is done continuously, the muscle will adapt, but this adaptation only lasts temporarily for the desired muscle length" (Tomalka, 2023). Thus, an additional method is needed besides stretching, namely a soaking system.

There are two methods of immersion: cold water immersion and contrast water immersion. Cold water immersion aims to reduce fatigue and accelerate recovery after exercise, preventing more extensive tissue damage. Applying cold to injured tissues reduces blood flow, which helps minimize the inflammatory response that follows exercise or competition (Higgins et al., 2017). "In addition, it can reduce acute inflammation caused by muscle damage and has short-term analgesic effects by decreasing nerve conduction velocity, muscle spindle activity, stretch reflex response, and spasticity, thereby interrupting the pain cycle" (Peake et al., 2017).

Another opinion suggests performing contrast water immersion after training or sports competitions (Crowther et al., 2017). Contrast water

immersion therapy, a thermal treatment, involves alternating between hot and cold water soaks with specific parameters to improve muscle strength, reduce pain, and accelerate muscle recovery (An et al., 2019). Contrast water therapy is an appropriate and effective method to accelerate recovery from intense workouts for both men and women. Additionally, it can speed up the reduction of lactate buildup and help decrease muscle tension (Argus et al., 2017).

Recovery in athletes plays a very important role in achieving performance (Kellmann et al., 2018). After training or competing, every athlete will experience fatigue that leads to a decline in their ability to perform physical activities. During high-intensity running, the working muscles will increase their metabolism to meet energy demands, producing metabolic waste in the form of lactic acid. The accumulation of lactic acid can lead to the occurrence of DOMS (Delayed Onset Muscle Soreness). Through recovery, some of the lactic acid can be recycled into energi (Jones et al., 2016).

Due to the importance of addressing DOMS in athletes, with various methods available during training or competitions, both aerobic and anaerobic, the researcher is interested in conducting a study to determine the extent of the difference between Comparative effects evaluating the efficacy research suggests that stretching techniques combined with cold water immersion or contrast water therapy may be effective in reducing DOMS following a 3000-meter run.

METHODS

The type of research is experimental, with the research design being a pretest and posttest two-group design (Counsell & Cribbie, 2017). The research subjects were divided into two groups. Group 1 subjects received an intervention consisting of stretching and coldwater immersion, while Group 2 subjects received an intervention of stretching and contrast water immersion. The research was conducted at the Athletic Field.

Sampling Techniques

Describe the procedures for selecting participants, including (a) the sampling methods if a systematics sampling plan was used; (b) the percentage the sample approached that participated; and (c) the number of participants selected themselves into the sample. Describe the settings and locations in which data were collected as well as any agreement and payment made to participants. When applying inferential statistics, take seriously the statistical power consideration associated with the test of hypothesis (Rahi, 2017).

Research Instrument

The instruments used in the data collection process of the research are:

1. The informed consent form is used for the acceptance of being a respondent.
2. The HS-3V-1RDT is a high-precision stopwatch manufactured in Japan, capable of measuring time with an accuracy of 0.01 seconds.
3. The Onemed 200 is a sphygmomanometer, manufactured in Indonesia, designed to measure blood pressure with an accuracy of +/- 2 mmHg.
4. The Krisbow brand infrared thermometer, manufactured in Indonesia, offers a measurement accuracy of +/- 2%.
5. 6 people water reservoir

6. *Heart rate monitor Garmin model Vivoactive 3 made in Taiwan.*
7. Writing tools for recording data.
8. DOMS measurement form
9. Camera for documenting research activities.

Research Procedures

The procedure for this research data:

1. Determining the field for a 3000-meter running track.
2. Request for approval from respondents (informed consent) by providing verbal and written explanations about the research objectives, the benefits of the research, and the rights of the respondents, with the sample being the category of sons.
3. The sample is divided into 2 treatment groups, namely: P1 and P2. P1 is the group that receives stretching and coldwater immersion interventions, while P2 is the group that receives a protocol involving stretching and contrast water therapy interventions.
4. Informing participants about the study's goals and outlining the procedures they will be expected to follow.
5. Evaluating height, weight, and maximum pulse rate to determine exercise intensity.
6. The athlete warmed up and was then asked to run a distance of 3000 meters in a time of 660 second (It is done alternately between Group one and Group two).
7. Conducting a pre-test measurement.
8. Subsequently, participants underwent a combined intervention, either stretching techniques having immersion coldwater or water immersion contrast.
9. Then a re-measurement was conducted at 24 hours and 48 hours on the DOMS scale.
10. Next, analysis data and conclusions of the study will be conducted.

Analysis Data

The data obtained from the preparation and implementation (pretest and posttest) were processed using IBM SPSS Statistics 25. The data being tested are as follows:

1. **Descriptive Data Test**
   Used to obtain a description of the physical characteristics of the sample, including age, body mass index, height, and weight.
2. **Normality Test of Data**
   The test was conducted with the Shapiro-Wilk. The conclusion of the data analysis results is that the data has a normal probability density function if $p > 0.05$, and the data does not have a normal probability density function if $p < 0.05$ (Nisfiannoor, 2009). In this study, this data distributed normally.
3. **Homogenity Test**
   Levene's test for homogeneity. The test is conducted to determine the distribution of data. The data demonstrated no significant differences between groups, as indicated by a p-value exceeding the 0.05 threshold, supporting the assumption of data homogeneity.
4. **Paired T-Test**
   A paired t-test was conducted to assess the within-subject differences in DOMS levels before and after the application of stretch combined with either cold immersion water or immersion water contrast in two groups of participants who

performed a 3000-meter run. The analysis yielded a significant result ($p < 0.05$), indicating a substantial decrease in DOMS within each group following the interventions.

5. **Unpaired T-Test**
   An independent t-test was employed to examine the between-group differences in DOMS reduction between participants who underwent the use of cold water immersion during stretching (Group I) and those who received the use of contrast water therapy during stretching (Group II) after a 3000-meter run. The statistical analysis yielded a significant result ($p < 0.05$), suggesting that the cold water immersion group experienced a greater reduction in DOMS compared to the contrast water immersion group.

RESULT

A. Characterization Of The Study Subject

Table 1. Analysis of subject data across age, weight, height, and BMI.

Karakteristik Subjek	Group 1 (Rerata ± SB)	Group II (Rerata ± SB)	p`
Age (th)	17,33±1,00	17,55±0,88	0,624
Height (cm)	166,55±6,14	164,44±3,91	0,397
Weight (kg)	59,77±2,54	60,22±3,03	0,740
IMT	21,63±1,88	22,29±1,06	0,379

Statistical analysis of pre-training data demonstrated no significant between-group differences in age, height, weight, and BMI ($p > 0.05$). This finding supports the assumption of baseline equivalence between the groups, which is crucial for the internal validity of the study.

B. Analysis of Normality

Table 2. Results of Evaluation of Normality in DOMS Pain Measurements: Pre- and Post-Intervention in Calf Muscle

	Before (Rerata ± SB)	p
Group I	153,00±7,76	0,448
Group II	154,00±8,35	0,292
	After (Rerata ± SB)	**p**
Group I	206,00±8,32	0,124
Group II	188,44±6,95	0,650

The Shapiro-Wilk test was employed to evaluate the normality assumption of the DOMS pain data in both groups. The analysis yielded non-significant p-values ($p > 0.05$) for both pre- and post-intervention measurements in both Group I and Group II, confirming the normality of the data distribution.

C. Homogenity Test

Table 3. Results of Homogeneity Test before measuring DOMS pain in the Calf Muscle

	Group 1 (Rerata ± SB)	Group 2 (Rerata ± SB)	p`
Before	153,00±7,76	154,00±8,35	0,630

The Levene Test was conducted to evaluate the homogeneity of variance assumption for DOMS pain scores between Group I and Group II before the intervention. The analysis yielded a non-significant p-value ($p > 0.05$), supporting the assumption of equal variances between the two groups.

D. Test of Different in Effects Two-Group Analysis: Pre- and Post-Training

Table 4. Results of the Difference Test for DOMS pain measurements before and after on the Calf Muscle

	Before (Rerata ± SB)	After 48 Hours (Rerata ± SB)	T	p
Group I	153,00±7,76	206,00±8,32	-18,390	0,000
Group II	154,00±8,35	188,44±6,95	-13,507	0,000

The mean difference test between Group I and Group II revealed statistically significant decreases in average DOMS pain in the calf muscle for both groups ($p < 0.05$). The analysis indicated a greater magnitude of pain reduction in Group I (25.7%) compared to Group II (18%).

E. Test for Differences Between Measurement Groups

Table 5. Results of the Difference Test between Groups for DOMS Pain Measurement in the Calf Muscle

		Group I	Group II	t	P
Before Hours (Rerata±SB)	**48**	206,00±8,32	188,44±6,95	4,858	0,000

The statistical comparison of Group one (I) and Group two (II) in Table 5.5 yielded a highly significant difference ($p < 0.000$), indicating a strong statistical evidence against the null hypothesis of no difference between the groups.

DISCUSSION

A. Subject Attributes

The sample is representative of the population of interest, which consists of 18 track and field athletes from the city of Denpasar, aged 16 to 19 years. Within this study, This sample was randomly assigned to two treatment groups, with 9 subjects receiving a Intervention that combines multiple approaches of stretching and subsequent cold water immersion, and 9 subjects receiving a combination intervention of stretching and cold water immersion. According to Table 5.1, the mean age of athletes in the stretching and coldwater immersion group (Group I) was 17.33 years, and the mean age of athletes in the stretching and contrast water immersion group (Group II) was 17.55 years, with an average weight in group I of 59.77 kg and group II of 60.22 kg. The average height in group I is 166.55 cm and in group II is 164.44 cm; this is no substantial difference between the II groups when looking at the average age, weight, and height. The research subjects in both groups exhibited similar characteristics, including age, height, and weight. Data analysis confirmed this similarity, with p-values greater than 0.05, indicating that these variables were not likely to significantly influence the study's outcomes. This suggests that both groups had comparable physical attributes and abilities. This study focused on non-professional athletes who were currently in a three-week training break after their recent championship. Their typical training regimen during the competitive season often involved only two training sessions per week.

The age of the research subjects is measured using student ID cards. The measurement of height in this study used a GEA brand anthropometer, while body weight was measured using a GEA brand digital scale. For measuring the temperature of cold and hot water, an IR thermometer ranging from -50 to 750 °C by Krisbow was used. Meanwhile, pain measurement was conducted using a One Med brand aneroid sphygmomanometer and a visual analog scale.

B. Stretching combined with Cold Water Immersion may enhance Delayed Onset Muscle Soreness (DOMS) in calf muscles following a 3000-meter run.

In the testing of group I using the paired sample t-test, a p-value of 0.000 ($p<0.05$) was obtained, indicating a significant The difference in pain intensity before and after the combined intervention of stretching and cold water immersion, both at 24 hours and 48 hours. The intervention for group I effectively lessened calf muscle pain associated with Delayed Onset Muscle Soreness.

Based on this research, a Simultaneous stretching and coldwater immersion can reduce DOMS with a pain reduction percentage of 25.8%. This result is supported by a study conducted by Machado *et al* (Machado et al., 2016) Cold water immersion at temperatures of 11-15°C is considered optimal and has a

positive impact on reducing DOMS. In the case of acute injuries, there is vasoconstriction at the arteriolar and venular levels that lasts for 5 to 15 minutes. The application of cold water immersion leads to vasoconstriction, a physiological response that decreases blood vessel diameter. This reduction in blood flow slows down bleeding and creates an environment that facilitates platelet aggregation and subsequent wound repair (Eisinger et al., 2018). A chemical reaction occurs that can cause vasodilation of the blood vessels. Vasodilation results in increased blood flow to the injured area, which can enhance the health and function of vessels this blood (Trinity et al., 2016). Reaction of the chemical that causes vasodilation also helps to leukocytes remove and toxins from the injured area (Glenn & Armstrong, 2019). The smooth circulation of blood helps to inhibit the occurrence of inflammation. The cellular response occurs simultaneously with the vascular response. A variety of chemical mediators, in addition to those triggering vasodilation, act as signals to recruit leukocytes to the site of injury that use phagocytosis to clean up, and these play cells a significant role in the repair of structures that cause swelling and edema (Ellis et al., 2018). The lymphatic system and the vascular system play a role in removing lymph and toxins from the body. In this phase, improved blood flow will help to eliminate toxins and leukocytes in the injured area (Al-Kofahi et al., 2017).

Cold water immersion has various water temperatures and durations. The research by Tipton, has shown that cold water immersion exhibits superior efficacy in attenuating nerve conduction parameters a cooling time of 10 to 15 minutes (Tipton et al., 2017). This is in line with this study, which conducted cold water immersion for 10 minutes. The sensation of pain is subjective and can hinder an athlete's level of success in their sport. “Therefore, pain reduction is very important for improving performance in athletes. Anesthetic effects resulting from cold application contribute to decreased pain perception (Tüpü et al., 2020), believe which is to be related to a decrease nerve in conduction velocity (NCV). Achieving a skin surface temperature of approximately 13.6 degrees Celsius is crucial for effective pain relief through cold therapy (Allan et al., 2022).

C. The Combination of stretching and Contrast Water Immersion can Increase the Provocation of DOMS Pain After Running 3000 meters

In the testing of group two (II) using the paired sample t-test, a p-value of 0.000 was obtained ($p<0.05$), indicating a statistically significant decrease in pain experienced 48 hours following the combined intervention of stretching and contrast water immersion. This demonstrates that the intervention implemented in group II effectively alleviated pain associated with delayed onset muscle soreness (DOMS) in the calf muscles.

This result is support from study conducted by (Moh Nanang Himawan et al., 2021) (2018), that contrast water immersion can reduce the effects of DOMS. The duration and timing of this immersion align with the research conducted by Higgins et all (2013) Those who underwent a 1-minute warm immersion and a 1-minute cold immersion for 5 cycles found that contrast water immersion significantly reduced pain perception at 24, 48, and 72 hours after eccentric exercise.

“The application of alternating cold and warm water induces a sequence of peripheral vasoconstriction, where blood vessels narrow, followed by vasodilation, where they widen” (Shoeibi et al., 2020). Blood flow to the muscles may be lower after cold application. This may be

caused by the activation of thermal nociceptors, leading to changes in sympathetic nerve activity and consequently reducing arterial flow. It is believed that cold water therapy reduces pain and inflammation by cooling the injured area. "This cooling effect decreases blood flow to the injury site, which helps to minimize swelling and reduce the inflammatory response" (Peake et al., 2017).

D. Stretching combined with coldwater immersion is more effective than stretching combined with contrast water immersion in inducing greater Delayed Onset Muscle Soreness (DOMS) pain in calf muscles following a 3000-meter run.

In this study, there are 2 treatment groups, each consisting of 9 samples. Group I underwent a treatment combining stretching and cold water immersion, whereas Group II received a combination of stretching and contrast water immersion.

In the study of group I, which received a combination stretching and immersion coldwater may be an strategy to effective reduce soreness muscle after a 3000-meter run, it ware concluded this group I decrease the experienced in DOMS pain in the calf muscle, as did group II, with a p-value of 0.000 ($p<0.05$). This indicates a statistically significant difference is found in the Multimodal intervention of stretching relative to the combined intervention of stretching and immersion water contrast regarding the reduction of DOMS pain in the calf muscle.

This with is an accordance the study conducted made (Higgins et al., 2017), this is, cold water immersion can reduce DOMS more than contrast water immersion. Furthermore, this research is supported by studies conducted (Argus et al., 2017).

In both groups, a stretching intervention was provided, where stretching can reduce tension in muscle units or tendons. This is in line with research from (Higgins et al., 2017) "Using the paired t-test with $p=0.000$ indicates that there is an effect of stretching on reducing pain due to DOMS". Active isotonic stretching exercises lead to elongation the muscles of in the tissue soft, allowing the sarcomeres and muscles to stretch maximally resistance without, which optimally stimulates the Golgi tendon organs (GTO), muscle spindles, and the stretched sarcomeres. This activation of stretch receptors in the muscles allows the muscle spindles to stretch to the maximum length of the muscle. To damage prevent muscle, the receptors stretch report changes in lengt and the rate of change to the spinal cord, which is then transmitted to the central nervous system. The stretch reflex attempts to resist changes in muscle length to prevent overstretching by contracting the stretched muscles. This process leads to muscle relaxation, resulting in increased muscle flexibility and reduced muscle pain (Muanjai et al., 2017).

The combination of stretching and coldwater immersion applied to group I caused vasoconstriction in the blood vessels. DOMS when occurs, the tissues around the injury or in the calf muscle undergo changes in tissue structure and metabolism. The structure changes in of the tissue that is damaged or torn will disrupt the activity of the muscle, preventing it from contracting maximally. Muscles Inflammation is process a alamiah that helps the body heal after an injury or infection, spasms, and weakness, Affect will which movements involving joint or movements other. Using coldwater immersi for the right amount of time and at the right intensity can help lessen muscle damage, especially when the damage isn't too severe.

The reduction in group one (I) is better of DOMS pain compared to group two (II). “This is because the intervention in group I can reduce the inflammatory response, as the cold effect applied can absorb tissue temperature, resulting in a decrease in temperature through conduction mechanisms”. The essence from the local area of injury is to absorb calories of cold therapy, resulting in a decrease in temperature; the longer the therapy lasts, the deeper the cold penetrates. Physiologically, immersed in 10-degree Celsius water for 10 minutes, your blood vessels in the affected area constrict. This narrowing of the blood vessels is triggered by two main mechanisms. In addition to causing vasoconstriction, the sensation of cold can also decrease the reactivity nerve of free endings, thereby reducing stimuli to pain sensitivity. Cold applications reduce can also cellular metabolism levels, thereby decreasing metabolic waste. In addition, cold water immersion penetrates the tissues more easily than hot water. The insulating layer of subcutaneous fat contributes to the longer-lasting cooling effects of cold applications on muscles compared to heat applications. However, subcutaneous fat hinders the effective penetration of cold energy into the muscles. For individuals with a 2 cm subcutaneous fat layer, it can take around 10 minutes for cold energy to reach the muscle tissue. Group II, on the other hand, underwent stretching interventions and contrast water immersion procedures. Short-term cold water immersion (5 x 1 minute) could potentially elevate free radical production. The heightened production of free radicals will exacerbate oxidative stress, resulting in muscle strain that exceeds the stress incurred during physical activity. Cold therapy may facilitate faster recovery compared to heat therapy (Higgins et al., 2017). While heat application can potentially exacerbate edema and inflammation, cold exposure offers several potential benefits. These include pain relief (analgesia), reduced swelling (edema) by limiting fluid leakage and blood vessel constriction, and a dampening of the inflammatory response associated with muscle damage.

CONCLUSION

Findings from this research indicate that:

1 It is hypothesized that among male track athletes experiencing DOMS after a 3000-meter run, the combination of stretching and contrast water immersion will exhibit the capacity to augment pain tolerance.
2 It is hypothesized that among male track athletes experiencing DOMS after a 3000-meter run, the combination of stretching and contrast water immersion will exhibit the capacity to augment pain tolerance.
3 It is hypothesized that among male track athletes experiencing DOMS after a 3000-meter run, the combination of stretching and cold water immersion will exhibit a superior capacity to augment pain tolerance relative to the combination of stretching and contrast water immersion.

SUGGESTION

From the conclusions that have been presented, the recommendations that can be given are as follows:

1. To reduce DOMS, athletes should consider incorporating the use of stretching in conjunction with cold water immersion immediately following their training sessions.
2. Research is essential to be conducted with the most subjective measurement tools in order to minimize bias.

3. Research needs to be conducted with a larger sample that can represent provincial and national scales, so it can serve as a basis for more comprehensive physiotherapy studies.

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