

**Effects of Warm Tub  
Immersion Versus Cold  
Tub Immersion To Relieve  
Delayed Onset Muscle  
Soreness In Division 2  
Collegiate Athletes.**

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## Introduction

One of the first modalities an Athletic Trainer uses for treating muscle soreness is ice. The two most common uses of ice are after an injury to treat pain and decrease inflammation and after a tough practice to decrease Delayed Onset Muscle Soreness (DOMS). Most athletes will swear by its effectiveness while others may just like the way it looks after it is wrapped on various limbs. With a therapy technique as common as the application or use of ice, it would be assumed that there is a vast amount of literature regarding its effectiveness on treating delayed onset muscle soreness. Heat is a modality commonly used to treat muscle spasm and pain. Some experts have recently suggested and explored using heat to decrease DOMS. Although there is a vast amount of literature examining the effect of Cold Water Immersion to decrease DOMS, there is very little research comparing Hot water Immersion and Cold Water Immersion.

Delayed onset muscle soreness is caused by a buildup of lactic acid, local ischemia, muscle tightness, connective tissue damage, and muscle inflammation. The effects are felt the most strongly within 24 to 48 hours post exercise. When cold therapy is used it is known to constrict blood vessels which may enable the removal of waste products after muscle damage has occurred. Metabolism decreases which causes a decrease in the inflammatory response. Ice is an analgesic, but only temporarily. It numbs the pain, but when the treatment is over the pain will reoccur. Heat has been suggested to have a potential to help decrease DOMS because it is an analgesic as well. However, it does not completely numb the pain during treatment. With hot water immersion, pain relief may be due to a psychological effect. It promotes blood flow which also can aid in the removal of lactic acid, while also contributing to muscle relaxation and tissue elasticity. These effects may help decrease DOMS.

When ice is an ineffective treatment option for the athlete, heat is usually the next modality that will be tested. Athletes who find ice uncomfortable will most likely prefer heat whether it is a warm tub or a hot pack. Because most athletes do not understand the physiological effects of their modality of choice, it is important to also take into consideration how they feel and to which treatment their body responds the best.

Hot tubs or cold tubs have many benefits. One of the greatest reasons why they are used is due to their ability to treat large areas of the body, where ice packs or hot

packs can only target small areas. This modality can also treat a several athletes at a time. This is a safe and cheap investment for an Athletic Training facility compared to other modalities on the market.

## **Literature Review**

Range of motion, vertical jump, sprint time, strength, blood tests, and self perceived fatigue were all different ways to measure effectiveness of water immersions throughout articles. One measurement that was most common while looking into literature was the perception of fatigue. Various studies asked their participants to rate their fatigue on a number scale before treatment, after treatment, and throughout their workouts. This helped asses improvement from the athletes perspective.

The articles that we found most often compared cold water therapy with contrast water therapy. Between the two, cold water immersion appeared to be more effective than contrast in almost all the articles. Another article concluded that the combination of cold water therapy and stretching did not prove more effective in combination than when observed separately. A few articles also factored in the treatment parameters like temperature, duration, and amount of time passed between activity and treatment. If the athletes were immediately immersed in an ice bath after exercise this seemed to be more effective than various times after exercise. A longer treatment time was proven more effective with cold water therapy. Treatment times that were less than ten minutes proved to show no effectiveness on the recovery process. One study found that cold water therapy was more effective for the athletes' jump performance after 48 hours post training in comparison to 24 hours post training. This means that this therapy was indeed effective, however, it just took a little while for its effectiveness to take place.

The article that was most helpful with our study contrasted warm tub immersion and cold water immersion. This article concluded that athletes who participated in warm tub therapy recovered a day faster than those who had cold water therapy. Throughout our research in literature what we have ultimately found is a lot of controversy. Some articles concluded cold water immersion as an effective way to decrease delayed onset muscle soreness, and others have disproved its effectiveness. Likewise, one article concluded that hot water immersion is an effective way to decrease DOMS, and another

article concluded that hot water immersion is ineffective. Before conducting this research, we had high hopes of bringing clarity to what the best method of practice may be for the athlete and treating their delayed onset muscle soreness.

## **Methods**

We first proposed our research study to Division II collegiate coaches and athletes at Cedarville University who were in their off season at the beginning of the fall semester. These teams were baseball, softball, basketball, and tennis. We send the coaches an introductory letter explaining the study and asking permission to present the opportunity to their athletes (see appendix for letter). We obtained permission from the baseball, softball, and women's basketball coaches. We then sent out an email to the athletes of these teams explaining the study and asking for their participation. We got responses from twelve baseball players and one softball player. We then decided to narrow the population down to just baseball players since there was such a positive response from their team. We then sent out another email to the baseball team only and received twenty responses. We held a meeting to inform the volunteers about the study and what would be required of them and we had them sign the consent form.

Exclusion criteria included athletes who had lower body injuries during the time of the study and any individual who had a cold or heat allergy. The volunteers signed a consent form (see appendix) and were randomly assigned into groups. One group received the Cold Water Immersion intervention, one group received the Warm Water Immersion intervention, and one group acted as a control group that did not receive any intervention.

We baseline tested each participant's vertical jump height, peak torque of the quadricep muscle groups, peak torque of the hamstring muscle groups, and received a self reported muscle soreness score before they participated in their first off-season weight lifting workout of the week we tested. Vertical jump height was tested via a Tandem Vertical Challenger, a tool used to measure vertical jump height. To measure reach height, we had each athlete raise one of his hands as high as he could and then walk under the instrument. We then had each athlete jump as high as he could and hit the highest section of the instrument to measure vertical jump height. We had them

jump three times and used the highest jump out of the three. We then subtracted the the highest jump height from the reach height to get each athlete's true vertical jump height. Peak torque of the quadricep and hamstring muscle groups measured through the use of a Biodex isokinetic machine. Self perceived muscle soreness was measured by each participant's response to the questions: "On a scale of 0 to 10, 0 being not at all and 10 being unable to function normally, how sore do you feel?"

Each participant then participated in a normal off season weight lifting workout. We then had the participants immerse themselves in either a cold or warm tub from the waist down for 15 minutes. The control group did not receive any treatment. The water temperature was approximately 45 degrees fahrenheit for the Cold Tub intervention and 96 degrees fahrenheit for the Warm Tub intervention. Each participant participated in his regular off-season weight lifting workout for 4 days and received his respective intervention after every workout. The athletes were re-tested in each measure the day after each intervention before they participated in their workout.

## **Results**

We used SPSS version 25 with a p-value set at 0.05 to analyze our statistics. We ran a mixed ANOVA which compares the differences between groups with two factors. Our two factors were a "within-subjects" factor and a "between-subjects" factor. Our within subjects factor was "time", which compared the five time points. Our "between-subjects" factor was "group", which compared the control group with the two intervention groups. There were no significant differences in the groups for any of the measures.

## **Discussion**

The results of our study showed that there is no significant differences between cold tub immersion, warm tub immersion, and no intervention in trying to relieve DOMS. In other words, we found no evidence suggesting that cold tub immersion or warm tub immersion had any effect on DOMS. However, throughout the course of the study we had several athletes tell us that they liked the treatment they were receiving and felt like it was making a difference. Some even considered continuing the intervention they were receiving after the study ended.

Limitations of our study include, lack of blinding, variability in the athletes' workouts, variability in times the athletes were baseline tested, learning curve regarding the testing measures, and instrument errors when testing. Lack of blinding was a limitation because there was no way to blind the participants as to which intervention received. Knowing what type of intervention they received could have had a psychological impact on their next day testing performance. We as researchers also were not able to be blinded as to which treatment each participant received due to a limited number of researchers. Another limitation was that there was no way to give the participants a uniform workout to make them sore because they all played different positions and had workouts specific to the positions they played. We as researchers could not intervene in the workouts the coaches gave them. The different workouts led the athletes to experience different levels of DOMS and, therefore, could have caused them to respond to treatment differently. Some of the pitchers were not required by their coach to exercise on the third day of the study while all of the position players were. This could have skewed the results because they did not participate in activities that would create DOMS that day, while all of the other participants in the study did. The position players also had to come in very early in the morning on the third day of the study for their scheduled practice while the pitchers did not. Getting tested early in the morning could have impacted their performance on the pre-practice testing because they were accustomed to getting tested in the afternoon. One limitation we also experienced was the isokinetic machine's errors. The machine we used was old and the seat moved when we were testing the athletes. It also did not always record the data. Another limitation was that we did not acquire an instrument to test the athletes' vertical jump height until we had tested two of them. We also learned how to better use the instrument as time went on. For this reason, some of the vertical jump measures may not be accurate.

In the future, other researchers can build upon our research by determining if Warm Water Immersion is effective in treating DOMS compared to Contrast Water Therapy. They can also build upon it by testing Warm Water Immersion as an effective way to treat DOMS in specific populations such as soccer players, power-lifters, cross-country runners, football players, etc. Future researchers should use other means to

determine the degree of DOMS the athlete is experiencing such as creatine kinase levels, sprint time, muscle girth, etc because the literature showed that these measures were also effective in determining the degree of DOMS the athlete is experiencing.

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## **Appendices**

**Appendix A: Informed Consent Form**

**Appendix B: Letter to the Coaches**

Appendix A: Informed Consent Form

**Title of Project: Effect of Warm Tub Immersion Versus Cold Tub Immersion to Relieve Delayed Onset Muscle Soreness in Division II Collegiate Athletes**

**Background Information:**

Overview of The Study:

You are being invited to participate in a research study directed by Erin Ackerson, Lindsey Ford, and Kelsey Caldwell. This study will examine whether Cold Water Immersion or Warm Water Immersion is more effective in treating the effects of Delayed Onset Muscle Soreness. Cold Water Immersion (Ice Baths) has been used to alleviate Delayed Onset Muscle Soreness for years and recent research has shown that Warm Water Immersion may also be an effective treatment. This study aims to discover which treatment is more effective.

### **Details of the Study**

**Purpose of the Study:** to determine which treatment (Cold Water Immersion or Warm Water Immersion) is more effective in treating Delayed Onset Muscle Soreness.

**Invitation to Participate:** You are invited to participate in the study if you are a Division II Collegiate athlete and if you have no current musculoskeletal injuries from the waist down.

### **Description of Testing and Intervention:**

**Daily Testing Sessions:** Testing will be conducted in the Athletic Training Facility before your first practice back from the summer and before practice each day of the study. The study will last five days. Testing will last approximately thirty minutes and will involve the following:

*Quadriceps and Hamstring Strength Testing:* This test will involve using a piece of equipment in the Athletic Training Facility. You will be asked to sit in a chair and straighten and flex your knee against resistance as hard as you can for five repetitions. You will complete 3 sets of this brief exercise, each against increasing resistance.

*Vertical Jump Height Testing:* You will be asked to jump as high as you can three times with a rest in between. Your jumps height will be measured each time.

*Reported Soreness Level:* You will be asked how sore you feel on a scale of zero to ten, with zero being not sore at all and 10 being unable to function in normal daily activities.

You will be asked to perform one of the following tests before practice each day.

**Cold Water Immersion:** If assigned to this group, you will be immersed in 45°F water for 15 minutes from the waist down.

**Warm Water Immersion:** If assigned to this group, you will be immersed in 96°F water for 15 minutes from the waist down.

Control Group: If assigned to this group, you will not receive any intervention, but will still be tested each day before practice.

To protect the validity of the study, participants will be randomly assigned to groups and will not get to choose which intervention they receive.

### **Risks**

There are minimal risks for participating in this study. These risks are not anticipated to occur, but they include frostbite or skin burn (if the temperature of the water is not monitored) and possible allergic reactions to heat or cold. We intend to minimize these risks by constantly monitoring the temperature of the water and by constantly monitoring the athletes while they are undergoing their respective interventions.

### **Benefits**

You may experience less DOMS and be able to participate in practice more easily the following day after the intervention. The findings of this study may provide Athletic Trainers and athletes an alternative and more pleasant way to minimize DOMS.

### **Exclusions**

You will not be considered for this study if you have a current injury to the lower body or if you have a heat or cold allergy.

### **Confidentiality**

All information obtained from this study will be strictly confidential and your anonymity will be protected at all times. This information will only be seen by investigators and information made public will be generalized data and will not mention any individual participant.

### **Voluntary Nature of Study/ Freedom to Withdraw or Participate**

Participation in this study is completely voluntary. You may withdraw from this study at any time.

### **Statement of Subject and Signature**

I have read and understand the consent form for this study. I have read the purposes, procedures, and technical language of this study explained to me. I have been given sufficient time to consider the above information and seek advice if I chose to do so. I have had an opportunity to ask questions and the questions have been answered to my satisfaction. I am voluntarily signing this form. I will receive a copy of this consent form for my information.

If at any time I have further questions, problems or adverse events, I can contact:

Kelsey Caldwell at 215-771-7735

By signing this consent form , I am indicating that I agree to participate in this study. I am aware that I may refuse to participate or withdraw at any time for any reason without any penalty of any kind.

Signature of Subject:

Date:

Signature of Witness:

Date:

**Statement of Investigator:**

I have carefully explained to the participant the nature of the above research study. I certify that, to the best of my knowledge, the participant understands clearly the nature of the study and demands, benefits, and risks involved to participants in this study.

Signature of Investigator:

Date:

Appendix B: Letter to the Coaches

Dear Coaches,

To introduce ourselves our names are Kelsey Caldwell, Lindsey Ford, and Erin Ackerson and we are junior Athletic Training majors in a Research for Exercise Science course this spring. In this course we are required to develop some sort of research project. In our project we are trying to determine the answer to the following question: Is Warm Tub Immersion versus Cold

Tub Immersion more effective in decreasing self-reported next day muscle soreness and increasing next day strength in Division II collegiate athletes?

We are contacting you to seek your approval for proposing this study to your athletes during the fall off-season. With your approval we would propose the study to your athletes and ask for any volunteers to be participants. The study will be completed over five days and be conducted with three groups; Warm Tub Immersion, Cold Tub Immersion, and a no treatment control group. All athletes willing to participate will be randomly assigned into the three groups. The study will begin with athletes reporting to the Athletic Training Room (ATR) to be baseline tested in vertical jump height, peak torque quadriceps and hamstring muscle strength, and self reported muscle soreness. They will then complete a normal practice/workout then come to the ATR to complete 15 minutes in their respective treatment groups. The next day the athlete will report back to the ATR to complete testing on strength, vertical jump height, and self reported muscle soreness. They will then participate in the practice/workout of the day and report back to the ATR afterwards to receive treatment. This type of pattern will continue for the five days the study will be conducted.

The current literature contains conflicting results as to whether Cold Water or Warm tub immersion is more effective in treating Delayed Onset Muscle Soreness. Where one article has proven either cold water immersion or hot water immersion most effective for Delayed Onset Muscle Soreness, another article may disprove its effectiveness as well. After this research, we hope to bring clarity to what the best method of practice may be for the athlete and treating their Delayed Onset Muscle Soreness. This type of study should not have any detrimental effects and will only have possible benefits for the athletes. The pre-practice testing will be very minimal and will not affect the athlete's ability to participate in practice. We would like to hear your

response to this by August 10, 2018 and are available by email for any questions/concerns you would like to discuss.