# The Effects of Cryotherapy and Hot-pack Treatments on Quadriceps Femoris Strength Measured by an Isokinetic Machine

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**Abstract.** The purpose of this investigation was to test the assumption that the application of heat will produce a greater increase in muscle strength as compared to the application of ice. Thirty-five male and female university students were randomly distributed into three groups: cryotherapy (ice) group (IG), heat group (HG), or control group (CG). Each participant performed a three minute warm-up on a standard Airdyne stationary cycle. Pre-test measures for five-repetition maximum knee extension strength were obtained for each participant by use of an isokinetic dynamometer. After intervention, post-test measures were obtained using the same parameters. Although no significant difference was observed between groups, trends tend to show an increase in knee extension strength following the application of a heat modality.

## 1. Introduction

Physical therapists and sports medicine professionals use a variety of modality interventions on a daily basis to treat injured patients. Valued knowledge in guiding the appropriate choice of modality is extremely important for an effective and appropriate therapy treatment. Cryotherapy or hot-pack interventions are used depending on the chronicity of the injury and it is well understood that cold treatments are beneficial in treating acute injuries, while heat is used for chronic ailments. Because of their common use in clinical settings, it is important for clinicians to know the muscular effect these modalities have on the patient, especially if the modality is applied prior to activity. Currently, little research exists on the appropriate use of modalities prior to strengthening exercises or strength rehabilitation. This study intends to provide additional knowledge in choosing an effective modality before exercise routines are conducted in the clinic. The direct purpose of this experiment is to compare muscle strength scores as measured by an isokinetic machine following application of heat, cold or no modality. We hypothesize that the application of heat will have an increase in strength when compared to the application of ice.

## 2. Experiment, Results, Discussion, and Significance

*Subjects*

A sample of convenience was taken from the population of students at Wichita State University. The sample included young adult males and females between the ages of 18 and 30 years who had not sustained lower extremity injuries or undergone surgery in the past twelve months and did not have sensitivities to hot or cold treatments. After collecting a health history questionnaire, these volunteers were further excluded if they reported neurological or musculoskeletal pathologies. Informed consent was obtained from each of the subjects, and the sample was randomly allocated into three groups. The groups were as follows: cryotherapy treatment, heat treatment, and non-treatment control group.

*Procedures*

All three groups performed a three minute warm-up on a standard Airdyne stationary cycle. Following warm-up, participants completed a five-rep maximum knee extension pre-test on the isokinetic dynamometer. Participants were then randomly placed into a control group, ice treatment group, or heat treatment. The ice treatment group and heat treatment group received a modality intervention, while the control group received no intervention. Finally, participants completed a post-test five-rep maximum knee extension following treatment.

*Five-Rep Maximum*

Participants were required to perform a five rep maximum knee extension on an isokinetic dynamometer (BIODEX®; Quick Set System 4 Pro, New York, NY, USA) provided by the Department of Kinesiology at Wichita State University. The isokinetic machine was calibrated for torque and angular velocity according to manufacturer protocols. Limb position and a torque correction for limb weight were calibrated prior to knee extension. Limb and torso alignments and machine settings were recorded at the time of baseline

and replicated for endpoint. Full range of movement within the constraints of the equipment was prescribed for knee extension movement in order to eliminate errors that could have been caused by participants who fail to complete the full repetition. Standard instructions were issued with regard to both the technique and the maximal effort required during each test. Prior to each testing set, familiarization/warm-up repetitions were completed which consisted of three submaximal repetitions followed by one maximal effort. All participants were allowed a one min recovery before recorded isokinetic tests began. Peak isokinetic knee extension torque was assessed using an uninterrupted protocol consisting of 5 consecutive contractions through a 95° range of motion at a testing velocity of 60°/sec.

*Cryotherapy Treatment*

Ice packs consisting of 2 lbs. (1.36 kg) of ice inside a 1-gal (3.79 L) plastic bag were provided for participants. The ice pack was placed on the anterior surface of the right quadriceps femoris muscle. A safety barrier, consisting of a folded towel, was placed between the cold pack and the skin in order to prevent any adverse reactions or cold intolerance. The ice pack was then applied for 10 minutes with the participant sitting on a bench, knee flexed at 90 degrees.

*Hot-Pack Treatment*

Hot packs heated in a hydroculator, set to a standard temperature of 160˚F (71˚C), provided by the Wichita State Department of Physical Therapy, were provided for the participants. The 25 cm x 30 cm hot pack was placed on the anterior surface of the right quadriceps femoris muscle and had a minimum of eight layers of toweling between the skin and the hot pack. The hot pack was applied for ten minutes with the participant sitting on a bench, knee flexed at 90 degrees.

*Statistical Analysis*

A 3 X 2 mixed design ANOVA was used to determine if there was a significant interaction between group (IG, HG, or CG) and pre-test/post-test measures of immediate lower extremity power output for young adult males and females. A Bonferonni posthoc for comparisons was conducted for pre-test/post-test measures as appropriate. Statistical significance was established at $\alpha \leq 0.05$, and analyses were performed using the SPSS statistical package (version 9.0, SPSS, Inc., Chicago, IL). All values are represented as mean ± standard deviation.

*Results*

No participants demonstrated adverse reactions to the modalities interventions. The results from our study found that there was a significant interaction between pre and post-test measures and type of modality. However, post-hoc testing showed no significant difference between groups. The following table represents the means and standard deviations for the pre-test/post-test scores of all three groups (CG, IG, HG) as measured by the isokinetic machine in ft. pounds of torque.

Table: 1
Means and Standard Deviations for pre- and post-test scores for three groups

| | | Mean ft pound of torque | |
|---|---|---|---|
| Group | N | Pre-Test | Post-Test |
| Control | 12 | 129.5 ± 25.8 | 126.4 ± 29.8 |
| Ice | 11 | 137.3 ± 24.6 | 133.9 ± 23.2 |
| Heat | 12 | 144.3 ± 44.2 | 149.5 ± 49.2 |

## 3. Conclusions

Although there was no significant difference between groups, trends appear to show an increase in knee extension strength following the application of a heat modality and a decrease in knee extension strength following application of a cold modality. Following the application of heat, approximately 80% of participants had an increase in knee extension strength, while only 33% had an increase in strength following application of ice. The control was nearly split evenly with 58% of participants experiencing an increase in strength after post-test measurements. Furthermore, the only group exhibiting a positive change score between pre and post-testing was the heat group. Future research is needed to investigate whether the use of heat therapy is more appropriate than cold therapy when attempting to increase dynamic strength in the young adult population.

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