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Evaluating the Effects of a Stretching Routine on the Peak Torque of the Hamstrings

Christopher Thorson
University of North Dakota

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EVALUATING THE EFFECTS OF A STRETCHING ROUTINE ON THE PEAK TORQUE OF THE HAMSTRINGS

by

Christopher Thorson
Bachelor of Science in Physical Therapy
University of North Dakota, 1997

An Independent Study
Submitted to the Graduate Faculty of the
Department of Physical Therapy
School of Medicine
University of North Dakota
in partial fulfillment of the requirements
for the degree of
Master of Physical Therapy

Grand Forks, North Dakota
May
1998
This Independent Study, submitted by Christopher Thorson in partial fulfillment of the requirements for the Degree of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Faculty Preceptor)

(Graduate School Advisor)

(Chairperson, Physical Therapy)
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Signature [Christopher Thorsen]

Date 12-15-97
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I would like to thank my advisor, Mark Romanick, for his patience, input, and help with this study. I would also like to thank all the other faculty and staff who were able to tolerate my constant presence in the department and help show my lost subjects where to go during the summer that this study was run. Finally, I would like to thank my parents and my sister for encouraging and supporting me throughout college and especially when applying to the Physical Therapy School. Without their support, I never would have been able to reach this level of achievement.
ABSTRACT

Stretching has long been an accepted method of enhancing one's performance in most athletic events. However, while there has been other research performed on the subject of stretching benefits, there has been very little research found in the area of muscle performance being positively affected by stretching. In this study, 19 male subjects between the ages of 18 and 25 with no previous knee pathology volunteered to have their knee flexion torque tested on a Kin-Com isokinetic dynamometer. They were tested once with prior hamstring stretching and once without prior hamstring stretching. There was no significant difference found between the two testing trials, but variability was very high, suggesting difficulties keeping the test controlled. Despite the results of this study, most literature agrees that stretching is important and that there needs to be more research performed to better understand the complete effects of stretching.
CHAPTER 1
INTRODUCTION

Muscle is a strangely powerful mechanism. Millions of microscopic sarcomeres contract by filaments that make up these tiny muscular structures sliding on each other. These tiny contractions combine to produce movements that allow the performance of everyday actions such as walking, talking, and writing. At the same time, rarely considered is the power that is available in our own bodies. Some people are able to produce unimaginable amounts of force, such as lifting and moving a car on their own, in high stress situations. In addition, Schneck\(^1\) states that if all the muscle fibers in our body were to maximally contract at once in the same direction, we would produce a force of at least 25 tons.

Because of these enormous amounts of force that muscle is capable of producing, people are continually searching for ways to increase efficiency and strength of muscle. One activity that is yet to be thoroughly examined for its positive effects on strength and efficiency of muscle is stretching. Stretching has been a long accepted method of enhancing one's performance in most athletic events. Many athletes give testimony that they even feel better when competing or working out after a thorough stretching routine. As stated by Prentice,\(^2\) "Most sports therapists would agree that good flexibility is essential to successful
physical performance, although their ideas are based primarily on observation rather than scientific research."

Many agree that good flexibility, which is achieved by stretching, can enhance an athlete's performance in various ways. However, very little research has been done in the area of muscle performance being enhanced by stretching. More specifically, no research was found in the area of muscle torque being positively affected by stretching. This is what this study proposes to examine.
Before discussing stretching and its potential benefits, the components involved with the stretch reflex need to be discussed. As discussed by Mohr,3 Schneck,1 and Pansky et al,4 there are two principle structures involved with the stretch reflex, the muscle spindle and the Golgi tendon organ (GTO). Each one will be examined individually with some discussion of how they interact with one another.

The first structure to be examined is the muscle spindle. The muscle spindle is composed of two types of fibers, nuclear bag and nuclear chain, and is innervated by three types of nerve fibers, two afferent and one efferent. The nuclear bag and nuclear chain fibers each have nuclei in the equatorial region of their fibers and contractile portions at the ends (poles) of each fiber. The two afferent nerve fibers innervate the central portions of the bag and chain fibers around the nuclei. The annulospiral type Ia fibers innervate both the bag and chain fibers and are sensitive to changes in length along with the velocity of length changes. The flower spray type II fibers innervate just the chain fibers and are sensitive only to length changes. Meanwhile, the efferent nerve fibers, sometimes known as the gamma motor system, innervate the contractile portions of the bag and chain fibers. The gamma motor system signals these areas to
contract when the muscle spindle is shortening, thus keeping the spindle “set,” so that feedback from the la and II fibers is still possible. This “setting” of the spindle is termed gamma bias.\(^3\)

While the type la and II fibers are sensitive to similar stimuli, they relay completely opposite signals to the alpha motorneuron that controls contraction of the muscle in which they are located. When the spindle is lengthened, the type la fibers send excitatory signals to the alpha motorneuron and the type II fibers send inhibitory signals. In addition to sending inhibitory signals to the agonist alpha motorneuron, the type II fibers also send excitatory signals to the antagonist alpha motorneuron, a phenomenon termed reciprocal inhibition. However, the inhibitory signals sent by the type II fibers don’t override the signals from the type la fibers until a certain “danger point” of length is reached by the muscle. Until then, the la and II fibers are both firing, but the la is firing more frequently than the II, thus overriding its signal. What ideally occurs is that a muscle will lengthen (stretch), inducing the la fibers to fire which then causes the muscle to contract and shorten. If the muscle is contracting, but still lengthening, the type II fibers fire more frequently and gradually override the la signal, causing the agonist to relax and the antagonist to contract in order to hopefully avoid muscle damage.

The problem with this system is that a muscle can still be damaged before it reaches that “danger point” because of a large build-up of tension and the inability of the muscle to overcome the force being applied to it. This is the part at which the GTO comes into play. The GTO is innervated by type Ib nerve
fibers and is sensitive to tension changes within the tendons of muscles. It relays an inhibitory signal to the alpha motorneuron of the agonist muscle in a similar proportion to the amount of tension being detected. Similar to the type II fibers in the muscle spindle, the Ib fibers from the GTO also reinforce the inhibition by sending an excitatory signal to the antagonist alpha motor neuron. While there seems to be a general agreement about the basic function of the GTO, there is some disagreement as to the function of the GTO during passive stretch. Schneck\(^1\) states that the GTO is more sensitive to tendon stretch caused by active motion and has little function during passive stretch. However, Prentice\(^2\) believes that the GTO begins causing relaxation of the agonist muscle after about six seconds of passive stretch, allowing beneficial stretching of the muscle to occur.

This beneficial stretching is achieved because of the elastic properties of the soft tissues supporting each joint.\(^5\) But in order to properly elongate these tissues, the appropriate type of stretch has to be chosen. In reviewing literature, there are three major types of recognized stretching. These are ballistic stretching, proprioceptive neuromuscular facilitation (PNF), and static stretching.\(^2,6,7,8\) In the past, ballistic stretching has been questioned because of its potential harmful forces applied to muscles, but it has been found to be functional for certain athletes. Ballistic stretching provides numerous quick stretches to a muscle, causing the muscle spindle to fire without having the relaxing effect caused by the GTO. This has been considered functional by Prentice\(^2\) for such sports as soccer during which the hamstrings have to
eccentrically contract to decelerate the lower leg during the kick, similar to the eccentric contraction occurring because of the muscle spindle during each quick stretch. PNF is normally performed with the contract-relax method in which the subject isometrically contracts a muscle against resistance and then is stretched further when relaxing. This has been reported by Smith⁸ and Prentice² to be an effective stretching method, but has drawbacks because it often requires a partner. Finally, static stretching involves stretching of a muscle for at least 15 seconds 3 to 4 times. Both static stretching and PNF are considered to be safer than ballistic stretching.⁷,⁸ Beaulieu⁷ states that static stretching is the safest form of stretching and that when it is done correctly, the chances of injury are quite low. In addition, Smith⁸ states that static stretching is generally considered to be preferred for people that train on a limited basis.

When reviewing the literature addressing stretching, there can be differing views on the true effectiveness of stretching depending upon the study that was conducted. Taylor et al⁹ found that static stretching causes a prolonged elongation of the muscle-tendon unit, further suggesting that regular stretching will result in greater flexibility. Also, Cureton¹⁰ observed during the 1932 Olympic games that athletes who were more flexible performed better than athletes that weren't as flexible. In contrast, De Vries¹¹ found that athletes that had large increases in flexibility from stretching didn't have a significant change on their exercise economy or expenditure of energy in a 100-meter sprint. In addition to that study, a study performed by Gleim et al¹² that found that subjects who were
loose and flexible had significantly worse oxygen consumption when walking or jogging on a treadmill compared to subjects who had decreased flexibility.

Needless to say, there isn't a unanimous consensus on the effects of stretching on the economy of exercise. However, there is other support for other positive effects of stretching. For instance, Smith\(^8\) reported in his literature review that there is a great amount of support for stretching being important for injury prevention and nearly as much support for athletic flexibility being enhanced by stretching. Stamford\(^5\) states that there is less likelihood for overstretch of muscles when they were more flexible, most likely reducing the risk of injury. In correlation with this, Worrell et al\(^13\) and Joenhagen et al\(^14\) found that hamstring injured athletes were less flexible even on their noninjured side compared to either leg on hamstring noninjured athletes, suggesting that hamstring tightness may have predisposed the hamstring injured athletes to injury. Smith\(^8\) also noted that some studies reported that musculoskeletal injury occurrence was decreased when athletes stayed with a consistent stretching program throughout their respective seasons.

In addition to the above well-known benefits of stretching, there are other potential benefits that should be considered. One of these potential benefits is reduced muscle soreness after activity. Anderson and Burke\(^6\) state that stretching after exercise can significantly reduce muscle soreness that is experienced the day after a vigorous workout. However, further examination of the literature reflects otherwise. High and Howley\(^15\) found that static stretching doesn't prevent delayed-onset muscle soreness that results from exhausting
exercise. Furthermore, Smith et al\textsuperscript{16} found that static stretching actually induces more delayed onset muscle soreness than ballistic stretching.

Yamashita et al\textsuperscript{17} found a benefit of stretching that is most likely unknown to many people. They found that stretching a muscle 20\% beyond its resting length significantly increased the conduction of Ca\textsuperscript{2+} along the nerves in the area of the stretched muscle, having a positive effect on the possibility of transmitter release at the nerve terminal. A limiting factor of this study is that it was performed with rats as subjects.

While some studies and researchers disagree on the exact benefits of stretching, there has been a general consensus that stretching is an important part of the warm-up prior to exercise. Since stretching is considered an important part of pre-exercise warm-up, potential benefits should continue to be researched. As stated earlier, one of the potential benefits of stretching that has not yet been researched is whether or not stretching has a positive effect on the strength of the muscle, as measured by torque. This study examines what effects stretching has on the peak torque of the hamstrings as measured by a Kin-Com isokinetic dynamometer.
CHAPTER 3
METHODS

Guidelines for performing the study with human subjects were established by the researcher and were approved by the Institutional Review Board at the University of North Dakota. Subject participation for this study was limited to males between the ages of 18 and 30 that had no previous knee pathology. Nineteen males currently attending the University of North Dakota who met the age and knee injury criteria for the test knee volunteered to participate in the study. All subjects signed a consent form that informed them of the study’s procedure and intent and that by signing their name, they agreed to participate.

Subjects were scheduled for two separate times to be tested on a Kin-Com isokinetic dynamometer, no more than two to three days apart. The Kin-Com isokinetic dynamometer has been found to have a reliability of at least 0.88 for measuring concentric and eccentric torque. One testing trial consisted of performing three hamstring stretches for 30 seconds each before being tested and the other would have the subjects tested without performing hamstring stretches before testing. Subjects were randomly selected to perform stretches during the first session or to refrain from stretching during that session. They would then do the opposite on the second testing session. The leg tested on all subjects was the leg believed to be dominant, which was determined by asking
each subject on which leg they would hop if they had to hop one-legged. The first stretch involved placing the heel of the dominant leg on a low plinth and reaching for the toes until a stretch was felt in the hamstrings. The second stretch involved long sitting with the foot of the nontest leg placed against the test leg and followed by reaching for the test leg’s toes until a stretch was felt. The third stretch involved lying supine with the researcher raising the test leg until a stretch was felt in the hamstrings by the subject. Pictures of each stretch are shown in Figures 1, 2, and 3.

Before each testing trial, subjects rode a stationary bike for five minutes for a general warm-up to decrease any chance of injury during testing. The researcher entered each subject’s name, age, weight, and the leg to be tested into the computer at this time. After riding the stationary bike, the researcher adjusted the settings of the Kin-Com to fit the subject, recording the length of the lever arm into the computer. Each subject was then allowed a practice session with the test protocol during the initial scheduled testing date to help decrease the learning effect, followed by five minutes of rest before the actual test began. On the second scheduled testing session, the subjects would just ride the bike before being tested or performing the stretches and wouldn’t perform another practice session before the testing protocol.

When deciding upon the protocol to be used, some basic biomechanics of knee flexion needed to be examined. The main factor for determining the amount of torque produced by the hamstrings in knee flexion is the length of the muscle. According to Mohr, the hamstrings are able to produce the most
Figure 1. Hamstring stretch #1.
Figure 2. Hamstring stretch #2.
Figure 3. Hamstring stretch #3.
torque when the hip is flexed and the knee is in about 30° of flexion. This is supported by Westing and Seger\textsuperscript{20} who tested concentric isokinetic knee flexion and extension at five different speeds and found that peak torque was exerted at very near 30° for each speed. This information helped with the decision of what range of knee motion should be used in the protocol.

The protocol used for testing had concentric knee flexion and eccentric knee flexion at 60°/s (noted by Prentice\textsuperscript{2} to be the most common test speed for concentric testing), range of motion of 15° to 80° for testing, maximal contractions of six repetitions with verbal encouragement by the researcher, and the subject contracting during the concentric knee flexion phase and relaxing during the eccentric knee flexion phase. During the eccentric portion of the test protocol, the weight of the subject's leg, as well as pressure applied by the researcher, helped the dynamometer arm rise up to the start position with no active assistance by the subject. Also, before each testing trial and the practice trial, subjects were secured on the Kin-Com seat with a thigh stabilizer, a shoulder strap, and a waist strap.

The peak torque, measured as ft-lb, of each subject during concentric knee flexion was recorded. This data was analyzed by the paired-samples t-test with significance set at the .05 alpha level.
CHAPTER 4
RESULTS

No consistent pattern of torque increases or decreases were found among the subjects. The mean of peak torque without prior hamstring stretch was 134.53 ft-lb while the mean peak torque with prior hamstring stretch was 133.32 ft-lb. The results were highly variable with the paired-samples t-test showing a mean difference of 1.21 ft-lb of torque with standard deviation of 16.86 and a standard error mean of 3.87. It also showed no significant difference between the two groups with a two-tailed significance of 0.758. In addition, there were no patterns that indicated a learning effect among the subjects. One interesting finding was that over half of the subjects voluntarily told the researcher that performing the testing felt better when they stretched before being tested than when they performed the test without stretching.
As the results stand, they indicate that stretching may actually slightly reduce the amount of torque produced by the hamstrings. However, when examining individual results of each subject, 10 subjects had a greater amount of torque produced when they stretched before testing, compared to 9 subjects that had a lesser amount of torque produced when they stretched. In addition, results from two subjects were found to have higher variability than may have normally been found. One had 35 ft-lb more torque following stretching and the other had 46 ft-lb less torque following stretching. Despite these results, many subjects voluntarily said that they felt better when performing the trial with prior stretching. This may suggest that stretching enhances the subjective feeling about one’s well-being.

The high variability of the results leads to the questioning of the original design of the study. Many different obstacles, some expected and some unexpected, were encountered while running the study. Some of these difficulties most likely affected the results of the study and need to be considered if future studies are performed.

One area of expected and unexpected problems was with the subjects participating in the study. First of all, there were a low number of subjects at just
19 because of difficulty recruiting subjects during the summer that this study was run. As stated by Gravetter and Wallnau, a larger sample size helps decrease variability and better represent the population from which the sample is selected.

Secondly, subjects would forget to appear when they were scheduled for testing. This caused there to be more than three days in between testing for many subjects. Finally, the researcher was unable to ascertain whether or not each subject was maximally contracting during each testing trial. This problem is a given for a study with an isokinetic device but still may affect results.

In addition to problems encountered with subjects, there were a couple other possible limitations of the study. First of all, even though there was no pattern indicating a learning effect among the subjects, there still could have been a learning effect for some of the subjects. Second, there was no way to evaluate the effects of outside events or factors on subjects, especially when they went longer than three days between testing trials.

While there were many problems encountered during the study, there are ways to avoid these obstacles in future studies. One suggestion would be to have the study more controlled by testing subjects at the same time of the day for each trial and by only allowing one to three days between testing trials. This would be easier to achieve with a larger number of subjects, allowing the researcher to discard the results of subjects who fail to show up for their second test within the time limit. As mentioned earlier, a larger number of subjects would also most likely decrease the variability of the results.
In addition to more control of the study and recruiting more subjects, there are other possible options that may help avoid the obstacles that this study encountered. One option would be to measure the amount of hamstring tightness of each subject prior to the study and possibly break the subjects into two groups, flexible and not flexible. Another option would be to offer incentives for subjects to show up for each scheduled session. Not only would this most likely help with subjects showing up for their scheduled times, but it may also help increase participation in the study. Finally, in order to further decrease the potential learning effect, a separate session for performing the practice session could be added.

One final option for improving the study would be to completely alter the format. In particular, it may be a good idea to have subjects perform the stretches that were performed in this study for six weeks, stretching once or twice a day. This would allow the researcher to examine long-term effects of stretching on force produced by the hamstrings, rather than the short-term effects that were examined in this study. They could be tested with the same parameters on the Kin-Com before they start the routine and after they are done with the six weeks of stretching. However, when the routine of a study is altered so much, many different variables and potential obstacles need to be considered.
A majority of the literature agrees that stretching is important for various reasons. Some of the more significant reasons are for injury prevention when it is included as part of a warm-up, reduced muscle soreness after activity, and increased athletic flexibility. This study was unable to show any correlation between stretching and torque produced by the hamstrings; however, more research needs to be performed in this area. A positive correlation between stretching and increased muscle torque would provide another reason for athletes of all levels to perform stretching prior to activity.
APPENDIX A

INSTITUTIONAL REVIEW BOARD DOCUMENTATION AND CONSENT FORM
This study proposes to examine whether performing a stretching routine for a muscle group, the hamstrings, prior to exercise has an effect on the peak torque of that group, compared to not stretching at all. Peak torque will be measured by a Kin-Com isokinetic dynamometer. Physical therapists use such machines to track the progress of patients' strength after various surgeries and injuries. The results of this study could be useful for patients and physical therapists when testing is performed on an isokinetic dynamometer. If a significant difference is found between two groups tested (stretching and not stretching), it would imply that physical therapists would need to stay consistent with the routine they follow (having the patient stretch or not stretch) when testing a patient on an isokinetic dynamometer for results to be the most accurate. In addition, further evidence may be found on the
benefits of stretching before activity.

The Kin-Com isokinetic dynamometer is a non-invasive device that measures peak torque and force of various joint motions. The subject would sit in an upright seat, be stabilized by Velcro straps, and have their lower leg attached to the moveable arm of the machine with Velcro straps. Two groups would be formed from the subjects: one that performs stretching before being tested and one that doesn't. Subjects will be male students, aged approximately 18-28, that are currently attending UND. All subjects will come in to the department on two separate occasions. The first time will be to familiarize themselves with the machine to reduce the chance of progressive error by learning. The second time will be to perform the testing. All subjects will also ride a stationary bike for 4-5 minutes as a warm-up. Since we are examining questions about stretching affecting muscular force in humans, it is necessary to use humans as subjects to guarantee the validity of the study.
PLEASE NOTE: Only information pertinent to your request to utilize human subjects in your project or activity should be included on this form. Where appropriate attach sections from your proposal (if seeking outside funding).

2. PROTOCOL: (Describe procedures to which humans will be subjected. Use additional pages if necessary.)

Subjects will come in to the Physical Therapy department on two separate occasions at scheduled times individually. On the first visit, the subjects will be positioned on the Kin-Com seat, have the seat and movable arm settings adjusted to their body size, and be stabilized by the Velcro straps around their body and their lower leg that’s connected to the dynamometer arm. All settings for each subject will be recorded by the researcher. After such setting is determined, each subject will perform approximately 10 repetitions of knee flexion for practice, with at least 2 maximal efforts. Subjects will then be randomly assigned to either the group that performs stretching or the group that doesn’t. The subjects will come in to the department for the second time after they have been assigned to either group. All subjects will ride a stationary bicycle for 4-5 minutes as a warm-up before proceeding. The subjects from the stretching group will then perform a series of 3 hamstring stretches, 1 repetition of each that will be held for approximately 30 seconds each. All subjects will then position themselves on the Kin-Com seat and the settings will be set the same as the first visit. Subjects will then perform 6 repetitions of submaximal knee flexion on the machine as a warm-up. Following the warm up, 6 repetitions of maximal effort will be performed. The peak torque and force produced by the maximal contractions will be saved and recorded. Once each subject has completed the testing on the second visit, they have completed their role in the study. Results from each group will be tabulated and statistically compared.

3. BENEFITS: (Describe the benefits to the individual or society.)

This study will potentially benefit the field of physical therapy and people in society who actively exercise. First of all, it will benefit physical therapy because there may be evidence for improved accuracy of testing on an isokinetic dynamometer when therapists stay with a consistent routine for performing stretching while preparing a patient for testing. Second of all, it may indicate whether stretching prior to exercise has an effect on the strength exhibited by a muscle or muscle group stretched.

4. RISKS: (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject’s dignity and self-respect, as well as psychological, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to insure the confidentiality of data obtained, including plans for final disposition or destruction, debriefing procedures, etc.)

While participating in this study, subjects will not be exposed to any major risks, other than the remote chance of minor muscle injury (i.e. muscle strain) from muscle exertion during the testing. The amount of exertion required for the subjects to perform will be no greater than an average exercise program, which would also require a few maximal efforts to be performed. To further reduce the minimal risk for injury, all subjects will have 4-5 minutes to warm up on an exercise bike. This study adds no additional risks to the subjects other than what has been stated above.

5. CONSENT FORM: A copy of the CONSENT FORM to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no CONSENT FORM is to be used, document the procedures to be used to assure that infringement upon the subject’s rights will not occur.

Describe where signed consent forms will be kept and for what period of time.

Consent forms will be locked in the UND Physical Therapy Dept. and they will be destroyed upon three years after
completion of the study.

6. For FULL IRB REVIEW forward a signed original and thirteen (13) copies of this completed form, and where applicable, thirteen (13) copies of the proposed consent form, questionnaires, etc. and any supporting documentation to:

   Office of Research & Program Development  
   University of North Dakota  
   Box 8138, University Station  
   Grand Forks, North Dakota 58202

On campus, mail to: Office of Research & Program Development, Box 134, or drop it off at Room 101 Twamley Hall.

For EXEMPT or EXPEDITED REVIEW forward a signed original and a copy of the consent form, questionnaires, etc. and any supporting documentation to one of the addresses above.

The policies and procedures on Use of Human Subjects of the University of North Dakota apply to all activities involving use of Human Subjects performed by personnel conducting such activities under the auspices of the University. No activities are to be initiated without prior review and approval as prescribed by the University's policies and procedures governing the use of human subjects.

SIGNATURES:

__________________________  DATE: _____________
Principal Investigator

__________________________  DATE: _____________
Project Director or Student Adviser

__________________________  DATE: _____________
Training or Center Grant Director

(Revised 8/1992)
May 30, 1997

Office of Research and Program Development:

My name is Chris Thorson and I am a graduate Physical Therapy student. I am writing to you in regards to my independent study that you had granted me permission to run in the middle of April. The title of the study is "Evaluating the Effects of a Stretching Routine on Peak Torque of the Hamstrings." After consulting one of my instructors about my study, there is one minor change that I would like to make.

Originally, I was to have each subject randomly assigned either to a group that performs stretches before being tested or one that does not. The instructor I spoke to and I both felt that the validity of my results would be greatly increased if I was to have each subject perform the stretches followed by being tested, and not perform the stretches followed by being tested. The rest of the study would remain the same, but some subjects may need to come in one extra time than I originally planned for. I have spoken to most of my subjects and they would be agreeable to the change if it is approved.

I have altered my information and consent form to show the change in protocol. I will be attaching a copy of it with this letter. Thank you very much.

Sincerely,

Chris Thorson
INFORMATION AND CONSENT FORM

TITLE: Evaluating the Effects of a Stretching Routine on Peak Torque of the Hamstrings

You are being invited to participate in a study being conducted by Chris Thorson, a physical therapy student at the University of North Dakota. The purpose of this study is to examine whether performing stretching before exercise has an effect on the force generated by the muscle group that’s stretched. I hope to determine if stretching has any further positive or negative effects other than ones that are known right now. Only normal, healthy subjects will be asked to participate in this study.

You will be asked to perform two testing trials on a Kin-Com isokinetic machine with a warmup trial provided at the beginning of your first visit so that you may become familiar with the machine. Each trial consists of bending your knee against resistance 6 times with maximal efforts. Before each testing trial, you will need to ride an exercise bike for 4-5 minutes as a warm-up. You will then either perform 3 different hamstring stretches (one repetition of each) after your warmup, followed by your first testing trial on the machine, or be tested without stretches after your warmup on your 1st visit. For your second trial, if you didn’t perform the hamstring stretches before being tested your first time, you will perform the hamstring stretches and be tested, or vice versa. There will be at least one day between the time of your practice trial and your testing trial.

Each trial will take approximately 15-30 minutes each, with a possible total time commitment of one hour. You will be asked to report to the Physical Therapy Department in the Medical Science North building on the UND campus at a time for which you will sign up. You will then be asked to change into gym shorts for the experiment. I will first record your age, weight, and height. During the testing trial, I will be recording the amount of force your hamstrings produce during your maximal efforts.

Although the process of physical performance testing always involves some degree of risk, the investigator in this study feels that the risk of injury or discomfort is minimal. To help reduce the already minimal risk of injury, the 4-5 minute time period to warm up on an exercise bike mentioned above will be provided. In order for me to record the force your hamstrings are producing, your lower leg will be attached to the moveable arm of the testing machine with Velcro straps. After your leg is attached to the moveable arm, you will be stabilized in the seat by Velcro straps secured across your body, much like a seatbelt. The amount of exercise you will be asked to perform will be minimal.

Your name will not be used in any reports of the results of this study. Any information that is obtained in connection with this study and that can be identified with you will
remain confidential and will be disclosed only with your permission. The data will be identified by a number known only to the investigator. The investigator or participant may stop the experiment at any time if the participant is experiencing discomfort, pain, fatigue, or any other symptoms that may be detrimental to his/her health. Your decision whether or not to participate will not prejudice your future relationship with the Physical Therapy Department or the University of North Dakota. If you decide to participate, you are free to discontinue participation at any time without prejudice.

The investigator involved is available to answer any questions you have concerning this study. In addition, you are encouraged to ask any questions concerning this study that you may have in the future. Questions may be asked by calling Chris Thorson at the following phone number: 772-3546, or Mark Romanick, advisor, at 777-2831. A copy of this consent form is available to all participants in the study.

In the event that this research activity (which will be conducted at the Physical Therapy Department in the Medical Science North Building on the UND campus) results in a physical injury, medical treatment will be available, including first aid, emergency treatment and follow up care as it is to a member of the general public in similar circumstances. Payment for any such treatment must be provided by you and your third party payment, if any.

ALL OF MY QUESTIONS HAVE BEEN ANSWERED AND I AM ENCOURAGED TO ASK ANY QUESTIONS THAT I MAY HAVE CONCERNING THIS STUDY IN THE FUTURE. MY SIGNATURE INDICATES THAT, HAVING READ THE ABOVE INFORMATION, I HAVE DECIDED TO PARTICIPATE IN THE RESEARCH PROJECT.

I have read all of the above and willingly agree to participate in this study explained to me by Chris Thorson.

Participant's Signature Date

Witness (not the scientist) Date
REFERENCES


