THE EFFECTS OF STATIC AND DYNAMIC STRETCHING ON SPRINT SPEED OF THE PHYSICALLY ACTIVE

A THESIS

Submitted to the Faculty of the School of Graduate Studies and Research of California University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Science

by

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THESIS APPROVAL

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INTRODUCTION

Stretching has been widely accepted within the athletic population for decades. Static stretching was once dominant for a pre-activity warm-up. However, recent studies have shown that static stretching may lead to an increased risk of injury and also a decrease in performance. There has also been an increasing number of studies\textsuperscript{1-7} identifying the positive effects of dynamic stretching when compared to static stretching. Therefore, there has been a significant shift towards dynamic stretching as part of a pre-activity warm-up.

The purpose of this study is to investigate the effect of three different stretching protocols on the sprint performance of physically active individuals. These three stretching protocols include static stretching, dynamic stretching, and a combination of static and dynamic stretching. Furthermore, this study is intended to provide statistical evidence in order to determine which stretching protocol would be most beneficial for physically active individuals.
Every athlete wants to perform at the highest level possible. Stretching as part of a warm-up may increase performance; however, the type of stretching performed is essential to perform at an optimal level. Static stretching before competition has been the traditional method to utilize in order to prepare the muscular system for work.

Speed may be one of the most important aspects of performance. Studies have shown that dynamic stretching is appropriate to achieve optimal speed performance. Siatras et al\(^4\) investigated the acute effect of a stretching protocol, including warm-up and static and dynamic stretching exercises, on speed during vaulting in gymnastics. The results showed that the static stretching protocol significantly decreased the speed performance during vault execution. Therefore, it may not be advisable to include static stretching exercises just prior to vault execution.

Similar to Siatras et al,\(^4\) Fletcher\(^5,6\) conducted two studies testing the speed of athletes after performing different stretching protocols. In the first study,\(^5\) the researchers were interested in determining the effect of different static and dynamic stretch protocols on 20-m sprint performance. The Active Dynamic Stretching group had a significant decrease in sprint time (increase in
performance). The decrease in performance for the two static stretch groups was attributed to an increase in the musculotendinous unit (MTU) compliance, leading to a decrease in the MTU ability to store elastic energy in its eccentric phase. Static stretching as part of a warm-up may decrease short sprint performance, while active dynamic stretching seems to increase 20-m sprint performance.

Following this study, Fletcher\(^6\) investigated the effects of incorporating passive static stretching in a warm-up. The purpose of the study was to investigate the effect of manipulating the static and dynamic stretch components associated with a traditional track-and-field warm-up. The active dynamic stretch group resulted in significantly faster times compared to any other group tested. Passive static stretching in a warm-up decreases sprint performance, despite being combined with dynamic stretches, when compared to the solely dynamic stretching protocol.

There are many studies suggesting the benefits of including a dynamic warm-up prior to activity.\(^1\)\(^-\)\(^6\) There has also been research performed to study the possible negative effects of static stretching on speed.\(^7\)\(^-\)\(^9\) Kistler\(^7\) found that previous research has shown static stretching has an inhibitory effect on sprinting performances up to 50 m. The
purpose of this study was to determine if the same effects would take place at longer distances such as those seen in competition. Results showed a significant slowing in performance with static stretching in the second 20 (20-40) m of the sprint trials. In conclusion, it seems potentially harmful to include static stretching in the warm-up protocol of collegiate male sprinters in distances up to 100 m.

Winchester\(^8\) also used track-and-field athletes in his study which aimed to establish whether the deleterious effects of static stretching would diminish the performance enhancements obtained from the dynamic warm-up. The results showed that the no stretching group vs. the static stretching group was significantly faster for the entire 40 m. Similar to Kistler\(^7\), this study suggests that performing a static stretching protocol following a dynamic warm-up will inhibit sprint performance in collegiate athletes.

In a study by Nelson,\(^9\) the researcher attempted to establish whether the deleterious effects of passive stretching seen in laboratory settings would manifest in a performance setting. Four different stretching protocols were performed which included no stretch of either leg, both legs stretched, forward leg in the starting position stretched, and rear leg in the starting position stretched.
Three stretching exercises were performed (hamstring stretch, quadriceps stretch, calf stretch) for the stretching protocols. The three stretching protocols induced a significant increase in the 20 m sprint time. They concluded, pre-event stretching may negatively impact the performance of high-power short-term exercise. This study suggests that static stretching is more detrimental to performance than no stretching at all.

Many studies have shown that static stretching may be detrimental to athletic performance. However, some studies suggest that static stretching may not be detrimental to athletic performance. A study by Little\textsuperscript{10} examined the effects of different modes of stretching within a pre-exercise warm-up on high-speed motor capacities important to soccer performance. Eighteen professional soccer players were tested in vertical jump, stationary 10-m spring, flying 20-m spring, and agility performance after different warm-ups consisting of static stretching, dynamic stretching, or no stretching. There was no significant difference among warm-ups for the vertical jump. The dynamic stretching protocol produced significantly faster 10-m sprint times than did the no-stretching protocol. The dynamic and static stretching protocols produced faster flying 20-m sprint times as opposed to the no stretching
protocol. The dynamic stretching protocol also produced significantly faster agility performance than both the static and no stretching protocol. In conclusion, static stretching does not appear to be detrimental to high-speed performance when included in a warm-up for professional soccer players. However, dynamic stretching during the warm-up was most effective as preparation for high-speed performance.

Similar to Little,\textsuperscript{10} Knudson\textsuperscript{11} studied the serving percentage and radar measurements of ball speed to examine the acute effect of stretching on tennis serve performance. There was no short-term effect of stretching in the warm-up on the tennis serve performance of adult players. So, adding stretching to the traditional five minute warm-up in tennis does not affect serve performance. These two studies suggest that static stretching may not be detrimental to the performance of either the lower or upper extremity, however it is crucial that more research be performed.

The ideas of static stretching and flexibility have been around for years. Athletes have incorporated static stretching not only in their warm-up but also as part of their training programs. The thought of increasing flexibility through static stretching to improve athletic performance has been the driving factor in research on
stretching protocols. However, recent research suggests that static stretching may have negative results on athletic performance. Performance areas that can be negatively affected include muscle strength, power, agility, and speed.

Research has shown that a different type of stretching protocol may be most beneficial. Since these studies have been published, there has been a massive shift from traditional static stretching to a dynamic warm-up before athletic activity. Athletic trainers must provide the best possible care for athletes. By reading and interpreting the recent literature, athletic trainers must adapt stretching protocols, especially if a certain type of stretching protocol could potentially be harmful towards the athlete. If dynamic stretching is more effective as a warm-up than static stretching, additional research should be performed to apply validity and reliability to the study to begin implementing a change from solely static stretching to a dynamic warm-up.
METHODS

The primary purpose of this study was to examine the effect of three different stretching protocols on sprint speed. The three stretching protocols include: Static Stretching Protocol, Dynamic Stretching Protocol, and a Combination (both static and dynamic) Stretching Protocol. This section will serve to provide an overview of how the experiment was conducted. It will include sections dedicated to Research Design, Subjects, Instrumentation, Procedures, Hypotheses, and Data Analysis.

Research Design

This research utilized a quasi-experimental design, in which the subjects served as their own control. The independent variable was the stretching protocol utilized before testing. This variable had three levels, a static stretching warm-up protocol, a dynamic stretching warm-up protocol, and a combination warm-up protocol including both static and dynamic stretches. The dependent variable was
the time it took the subject to complete a 40 yard sprint. A strength of the study was that the subjects performed each stretching protocol in a counterbalanced order.

Subjects

The subjects in this study consisted of 16 physically active individuals (n=16). For this study, physically active is defined as an individual that partakes in moderate to intense physical activity such as running, biking, elliptical, stair climber, and/or lower extremity weight training at a minimum of three days a week for at least 30 minutes per session. All subjects were college students and had not sustained a lower extremity injury requiring medical care within the past six months. The volunteers were chosen as a sample of convenience. The subjects were asked about previous history of lower extremity injuries, and those who have had such injuries within the past six months were excluded from the study. All subjects in the study signed an Informed Consent Form (Appendix C1) prior to participation in the study. Along with the Informed Consent Form, each subject signed a Physical Activity Readiness Questionnaire, PAR-Q (Appendix C2) to determine if they were able to participate in this
study. Also, the researcher gathered information from each subject’s college entrance physical examination. First, each subject signed a waiver (Appendix C3) in order for this information to be collected. The information taken regarded each subject’s physical activity recommendation, given by their physician. Also, in order to determine if each subject was physically active, they were asked to complete a Physical Activity Survey (Appendix C4) to determine their level of activity.

The study was approved by the Institutional Review Board at California University of PA. Each subject’s identity remained confidential and was not included in the study. To maintain confidentiality, each subject was given a number prior to participating in the study.

Preliminary Research

A pilot study was conducted for this research project. Three subjects who fit the inclusion criteria were used to review the study protocols. Each pilot study subject performed all of the testing procedures. The researcher used these trials to determine the subject’s ability to understand directions and determine the amount of time it would take to complete the tasks.
Instruments

The testing instrument that was used in this study was the Speed Trap II timing system. The Speed Trap II Timer™ (Appendix C5) is a timing system that starts timing when pressure is released from the starting pad, and stops when the subject crosses the reflective beam at the finish line. The times are recorded on the clock that sits on top of the beam. This timing system is accurate to 1/100th of a second, and is capable of timing an athlete up to 55 yards accurately. This piece of equipment was used to measure the speed at which each subject could run the 40 yard sprint.

Speed is movement distance per unit time and is typically quantified as the time taken to cover a fixed distance. Tests of speed are not usually conducted over distances greater than 200 m because longer distances reflect aerobic capacity more than absolute ability to move the body at maximal speed. The 40 yard sprint is a simple way of assessing sprint speed. A starting point is marked. From this position, 40 yards are measured ending with a finish point which is also marked. The subject sprints from starting point to finish point. This test was performed in
the gymnasium in Hamer Hall. The subjects performed this test on a basketball court. Their attire included a t-shirt, mesh shorts, and running sneakers. The 40 yard sprint was scored using the time recorded from the Speed Trap II Timer™. The Speed Trap II Timer™ was used to measure the speed in seconds of each subject to determine how fast the subject could complete the 40 yard sprint.

Procedures

The study was approved by the California University of Pennsylvania Institutional Review Board (IRB) (Appendix C7) prior to any data collection. A random sample of volunteer physically active subjects, who had not sustained a lower extremity injury in the past six months. Prior to the subject’s involvement in the study, the researcher held a group meeting that each volunteer subject attended. This meeting consisted of explaining the concept of the study and everything it entailed to each of the subjects. At this meeting, each subject completed the Informed Consent Form (Appendix C1), a PAR-Q form, a Physical Activity Survey, and also a waiver allowing the researcher to gather information on their physical
examination. Also at this meeting, an explanation of the procedure as well as the risks involved were addressed.

Each subject was informed they would be tested on three separate days with at least 48 hours separating each testing session. Each subject was assigned a time slot so only one subject was participating at a time. This was utilized to ensure proper timing for each subject to perform the given tasks. One stretching protocol was performed on each of the testing days. On each of the testing days, the subjects were randomly assigned to one of the stretching protocols in counterbalanced order; static stretching warm-up, dynamic stretching warm-up, or a combination warm-up. Each subject randomly selected one of six possible testing procedures. For example, Subject 1 performed the Static Stretching Protocol on day one, Dynamic Stretching Protocol on day two, and Combination Stretching Protocol on day three. Subject 2 performed the Dynamic Stretching Protocol on day one, Static Stretching Protocol on day two, and Combination Stretching Protocol on day three. Each stretching protocol was randomized until all six testing procedures were fulfilled. Subject 7 performed the same testing procedure as Subject 1.

On testing days, each subject was first given instruction on the specific stretches that would be
included that day. This was done to ensure each subject performed each stretch correctly. On each of the testing days, each subject performed a 5 minute light jog warm-up at their own pace before any stretching or testing. After the warm-up, subjects were given one minute to rest. Immediately after the one minute of rest, subjects were asked to perform their randomly assigned protocol.

The static stretching warm-up protocol (SS) (Appendix C6) that was used consisted of a hamstring stretch, quadriceps stretch, hip flexor stretch, adductor stretch, abductor stretch, gluteal stretch, and a gastrocnemius/soleus stretch. Each stretch was held for 25 seconds, each bilaterally. The subject was given 5 seconds to rest in between each stretch.

The dynamic stretching warm-up (DS) (Appendix C6) that was used included: high knees (gluteals and hamstrings), butt kicks (quadriceps and hip flexors), lateral shuffles (abductors and adductors), Russian walks (hamstrings), walking lunges (hip flexors), figure fours (abductors), and heel to toe walks (gastrocnemius/soleus). Subjects performed each of these stretches for 40 seconds, while having 20 seconds of rest in between. Both the static and dynamic protocols took the same amount of time to complete. The dynamic stretching protocol gave the athlete more time
to rest because they are stretching dynamically, as the athlete should not become fatigued.

The combination warm-up (CS) (Appendix 6) consisted of performing four static stretches that are most common for any physically active person to do. These four static stretches include hamstring stretch, quadriceps stretch, hip flexor stretch, and adductor stretch. Each subject was randomly assigned to perform three of the seven dynamic stretches, before testing. The time allowed for each stretch was the same as the previous two conditions, so the overall time was the same.

The researcher prepared a tape recording that instructed the subjects when to change the stretch to ensure the protocols were consistent between each subject. After the subjects were finished with their assigned protocol, they were given another rest period of two minutes in order to prepare for their performance test. They then performed three trials of the 40 yard sprint with another two minutes of rest in between trials. The three trials were timed using the Speed Trap II timing system, and the best of the three trials was recorded. These results were recorded on the data collection forms (Appendix C5). This process was repeated until all subjects performed each of the protocols.
Hypothesis

The following hypothesis is based on previous research and the researcher’s intuition based on a review of the literature.

1. There will be no significant difference for the 40 yard sprint time for sprint speed between the three stretching protocols.

Data Analysis

All data was analyzed by SPSS version 18.0 for Windows at an alpha level of 0.05. The research hypothesis was analyzed using a repeated measures analysis of variance.
RESULTS

The purpose of this study was to examine the effect of three different stretching protocols on sprint speed. The three protocols include: a static stretching protocol, dynamic stretching protocol, and a combination of both static and dynamic protocol. Each volunteer subject completed one stretching protocol per testing session. Each subject completed 3 trials of a 40 yard sprint after each protocol. The following results section will be divided into two sections: Demographic Information and Hypothesis Testing.

Demographic Information

Subjects used in this study (N=16) were volunteers from California University of Pennsylvania. The subjects included eleven males and five females. The subjects age ranged from 18-23 years. Each subject was physically active as defined by the physical activity survey. For this study, physically active means each subject must partake in
moderate to intense physical activity. Such activity may include running, biking, elliptical, stair climber, and/or lower extremity weight training. Subjects must participate in this type of exercise at a minimum of three days a week for at least 30 minutes per session.

Hypothesis Testing

Hypothesis Testing was performed on the data using SPSS software. All subjects were tested for sprint speed following each of the stretching interventions. A repeated measures analysis of variance was used with an alpha level of .05.

Hypothesis 1: There will be no significant difference for the 40 yard sprint time for sprint speed between the three stretching protocols.

Conclusion: To test the hypothesis, each subject’s fastest time was recorded for each of the three warm-up protocols. These include: the Static Stretching protocol, the Dynamic Stretching protocol, and the Combination Stretching protocol. A repeated measures ANOVA was used to compare the times for the subjects under each condition.
Table 1 illustrates the mean times for each condition. A significant effect was found ($F_{2, 30} = .03, p < .05$).

Since the ANOVA results were significant, post-hoc analysis of the data was performed. In order to perform post-hoc testing, protected dependent t tests were utilized. With this testing, all three warm up conditions were compared to one another. The Static Stretching protocol was compared to the Dynamic Stretching protocol. The Static Stretching protocol was compared to the Combination Stretching protocol. Lastly, the Dynamic Stretching protocol was compared to the Combination Stretching protocol. Conducting three tests has the potential to inflate the Type I error rate, so a significance level of .017 (.05/3) was used to maintain an overall significance level of .05. Follow-up protected t tests revealed that times decreased significantly between the Static Stretching protocol (5.660s +/- .492) and the Combination Stretching protocol (5.575s +/- .496). The differences in time between all three stretching protocols are summarized in Table 2.
### Table 1. 40 Yard Sprint Descriptive Statistics

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<td>Combination</td>
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### Table 2. Differences in Time Between Stretching Protocols

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<tr>
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DISCUSSION

The following discussion is divided into three subsections: Discussion of Results, Conclusions, and Recommendations.

Discussion of Results

Stretching prior to activity has been widely accepted within the athletic population for decades. Static stretching was once dominant for a pre-activity warm-up, however, recent studies have shown that static stretching may lead to a decrease in performance.\textsuperscript{7-9} There has also been an increasing number of studies\textsuperscript{1-7} identifying the positive effects of dynamic stretching when compared to static stretching. Therefore, there has been a significant shift towards dynamic stretching as part of a pre-activity warm-up.

The purpose of this study is to investigate the effect of three different stretching protocols on the sprint performance of collegiate athletes. These three stretching
protocols include static stretching, dynamic stretching, and a combination of static and dynamic stretching. Furthermore, this study is intended to provide statistical evidence in order to determine which stretching protocol would be most beneficial for physically active individuals and athletes prior to performance.

It was hypothesized that there would be no significant difference for the 40 yard sprint time for sprint speed between the three stretching protocols. Performance of the 40 yard sprint was measured in seconds by the Speed Trap II timing system.\textsuperscript{12} Statistical analysis revealed that there was a significant difference in performance between the three stretching protocols. As shown in Table 1, combination stretching intervention produced the fastest mean scores.

During the stretching interventions, subjects were asked if they felt one of the warm ups better prepared them for participation in the study. Many of the subjects reported that dynamic stretching prepared them best for the 40 yard sprint. However, five subjects felt more prepared after the static stretching intervention. These subjects were unfamiliar with dynamic stretching, and have always performed static stretching only before exercise. These subjects also reported that they had felt minor fatigue
after performing the dynamic stretching intervention, which may have impacted their time.

The results of this study are similar to those reported by Siatras et al,4 Fletcher,5,6 and Little10. These studies all found significant differences in sprint speed between the stretching conditions.

This study is similar to the studies within the literature in that they use anaerobic measurements of performance. All the studies utilized tests that averaged under twelve seconds to complete. The study by Siatras et al,4 measured vaulting speed from the start of the runway until contact with the vault was made, which is about 7.5 seconds. The results showed that the static stretching protocol significantly decreased the speed performance. The studies by Fletcher5,6 measured the time to sprint twenty meters and fifty meters respectively. For the twenty meter test, all times were under 4 seconds. For the fifty meter test, all times were under 7.5 seconds. In a study by Little,10 the researchers measured the time to complete a 10 meter sprint and also a 20 meter flying sprint. Both of these tests took less than 5 seconds to complete. These findings support the fact that short distance anaerobic events positively benefit from dynamic stretching and do not benefit from static stretching.
Two studies have looked at using a combination of both static and dynamic stretching. In the first study by Winchester, the researchers had subjects perform dynamic stretching followed by static stretching. They were interested in determining if static stretching would have deleterious effects on performance enhancement gains from dynamic stretching. Winchester found that static stretching resulted in a significantly faster forty meter time. Similar to Winchester, Wong et al. used a combination of both static and dynamic stretching and measured their effect on a twenty meter sprint. Each subject performed one of three static stretching protocols followed by the same dynamic stretching protocol following a given static stretching protocol. This study differed from Winchester in that the subjects performed static stretching before dynamic stretching. They found that there was no significant difference between the stretching protocols. This study did not compare solely static vs. dynamic vs. combination of both.

There may be a few explanations as to why the results of this study differed from the literature. According to the majority of the literature, dynamic stretching is the best method of warm-up for athletes. However, this study used physically active individuals. The subjects may not
have been used to dynamic stretching or stretching at all. This may have affected their ability to run a 40 yard sprint. Subjects were also unaccustomed to performing a dynamic warm-up. During this stretching protocol, some subjects became fatigued and it may have altered their performance while running the 40 yard sprint. Most athletes are very involved with stretching both before and after activity. It is possible that the subjects in this study do not stretch efficiently before they workout. Overall, the combination stretching protocol produced the fastest mean times. The static stretching part of this warm-up may have increased range of motion and elongation of the stretched muscle. Then, the dynamic stretching part of this warm-up increased blood flow to musculature and provided a stretch throughout the entire range of motion. This may be more beneficial for physically active individuals than athletes. However, more research must be done in order to determine if a combination stretching warm-up is more beneficial for athletes as well.

Conclusions

This study revealed that the type of stretching protocol (Static stretching, dynamic stretching, or
combination stretching) had a significant effect on a timed 40 yard sprint of physically active individuals. This significance is important in running a 40 yard sprint. The results showed a significant difference in times which are key in terms of sprint performance. The subjects in this study performed each stretching protocol once, followed by three trials of a 40 yard sprint. Results showed that there was a significant decrease in sprint time when preceded by a combination of static stretching followed by dynamic stretching. Although not significant, the dynamic stretching protocol did produce faster mean 40 yard sprint times as compared to the static stretching intervention. According to the literature, it is essential to incorporate dynamic stretching as part of a warm-up, however it may also be beneficial to incorporate static stretching prior to a dynamic warm-up. The results of this study suggest that performing solely static stretching should be avoided prior to physical activity. Based on the results of this study and the literature, a proper dynamic warm-up should be included prior to physical activity. Static stretching may be beneficial to increase range of motion and tissue length while a dynamic warm-up will increase blood flow and prepare musculature for activity. Further research must be performed to determine if a combination of static
stretching followed by dynamic stretching is more beneficial compared to just a dynamic warm-up.

Recommendations

It is important for Certified Athletic Trainers to remain up-to-date on the research regarding stretching in order to implement the safest and most beneficial warm-up techniques for athletes. Many studies investigating stretching and warm-up focus on short distance sprinting. It may be beneficial to incorporate a study which determines which type of stretching is beneficial for longer distances.

One area from this study that could be modified is the duration of the dynamic stretching protocol. Many subjects reported that they were semi-fatigued. A shorter dynamic stretching protocol may have produced faster times than the results indicate.

Another area that could be modified is to use athletes. Physically active individuals were used in this study, who may not be accustomed to sprinting for 40 yards. Using athletes who are accustomed to this type of activity may be more beneficial. Athletes who participate in sports
such as football, basketball, and soccer would be useful subjects.

Another possibility is to incorporate different stretching protocols. It may be beneficial to have multiple static stretching protocols, dynamic stretching protocols, and combination stretching protocols. All of these suggestions could add to the current research and knowledge athletic trainers have regarding stretching protocols as part of an athlete’s warm-up.
REFERENCES


APPENDIX A

Review of Literature
REVIEW OF LITERATURE

This review of the literature will examine the effects of static and dynamic stretching techniques on athletic performance. There has been much debate about the effectiveness of static and dynamic stretching as part of an athlete’s warm-up before athletic activity. There has been a shift in the thought of which stretching technique is more beneficial for the athlete. For many years, static stretching was thought to be the most effective part of the warm-up, the act of moving a muscle into a stretch position and holding it for a number of seconds. However, there has been a recent shift, accompanied by supporting research, which encourage the utilization of a dynamic warm-up before athletic activity. Thus, the purpose of this literature review is to examine different types of warm-up protocols and determine their overall effect on athletic performance. This review of the literature will be separated into three sections: 1) Introduction to Stretching and Flexibility 2) Speed 3) Stretching and Speed. Finally, a summary will draw conclusions from the literature reviewed.
Introduction to Stretching and Flexibility

Stretching has always been an important tool that athletes use as part of a warm-up before athletic activity. From youth athletics to professional athletics, stretching has been at the forefront as part of the warm-up. However, the evolution of different stretching protocols in the literature has left many athletes, as well as athletic trainers, contemplating which type of stretching is most beneficial before athletic activity. There is the potential that some types of stretching may have many benefits, however there is also the potential that stretching may have detrimental effects. In order to understand the literature concerning the effect of stretching on performance, it is crucial that one understands the neurophysiologic basis of stretching.

Mechanisms of Stretching

Stretching is defined as movement applied by an external and/or internal force in order to increase muscle flexibility and/or joint range of motion. The aim of stretching before exercise is to increase muscle-tendon unit (MTU) length and flexibility.\(^1\) Stretching results in
elongation of muscles and soft tissues through mechanical and neurological mechanisms.\textsuperscript{1,5}

MTUs can be lengthened in two ways; muscle contraction and passive stretching. When a muscle contracts, the contractile elements are shortened, and the passive elements are thus lengthened. When muscle tissue is lengthening, the muscle fibers and connective tissues are elongated because of the application of external force.\textsuperscript{2} Stretching increases MTU length by affecting the biomechanical properties of muscle (range of motion and viscoelastic properties of the MTU).\textsuperscript{1-4}

Two sensory organs of MTUs, the muscle spindle and the Golgi tendon organ (GTO), are mechanoreceptors that convey information to the central nervous system (CNS) about what is occurring in a MTU and affect a muscle’s response to stretch.\textsuperscript{3} Muscle spindles are the major sensory organ of muscle and are sensitive to quick and sustained stretch. Muscle spindles are small, encapsulated receptors composed of afferent sensory fiber endings, efferent motor fiber endings, and specialized muscle fibers. The main function of muscle spindles is to receive and convey information about changes in the length of a muscle. When muscle spindles are stimulated, a reflexive response is created which causes a muscle to contract.\textsuperscript{2-3} When a muscle is put
in a stretch position, the muscle contracts preventing an overstretching of the muscle. This act is known as the stretch reflex.

The other sensory organs of MTUs are known as Golgi tendon organs. The GTO functions to monitor changes in tension of the MTU. These sensory organs are sensitive to slight changes of tension on a MTU as the result of passive stretch of a muscle or with active muscle contractions during normal movement.\(^3\) When tension within a muscle develops, the GTO fires causing a decrease in tension in the MTU being stretched. Originally, the GTO was thought to fire and inhibit muscle activation only in the presence of high levels of muscle tension as a protective mechanism. However, the GTO has a low threshold for firing, so it can continuously monitor and adjust the force of active muscle contractions during movement or the tension in muscle during a passive stretch.\(^3,4-5\)

**Injury Prevention/DOMS**

One of the main reasons why athletes stretch before participating in athletics is to avoid injury. The thought is, lengthening muscle groups by stretching will prepare the muscular system to perform. The literature relating to this idea of stretching to prevent injury needs to be
further researched. However, some studies have suggested that injury may be related to either too little or too much flexibility.\cite{6-8}

A study by Johannson et al\cite{6} investigated the effects of pre-exercise stretching on delayed onset muscle soreness. Ten female volunteers performed 10 sets of 10 maximal isokinetic eccentric contractions for knee flexion with both legs after a 5 minutes cycle ergometer warm-up. Prior to the exercise for one leg, 4 X 20 sec of static stretching for the hamstring muscle group was implemented. No differences were found when comparing stretched and non-stretched legs. In conclusion, the study suggests that pre-exercise static stretching has no preventative effect on muscle soreness, tenderness and force loss that follows heavy eccentric exercise.

In a study by Lund et al,\cite{7} the researchers found that passive stretching did not have any significant influence on muscle pain and muscle strength. In this study, the purpose was to measure if passive stretching would influence delayed onset muscle soreness and dynamic muscle strength following eccentric exercise. Seven women (28-46 years) performed eccentric exercise with right quadriceps in an isokinetic dynamometer until exhaustion. Two separate experiments were performed. In the first experiment, no
stretching was implemented. The second experiment, roughly 13-23 months later, incorporated passive stretching (3 X 30 sec) of the quadriceps. Stretching was performed before and immediately after the eccentric exercise. There was no difference in the reported variables between experiments one and two. The researchers suggest that passive stretching after eccentric exercise does prevent delayed onset muscle soreness.

Witvrouw et al. researched the relationship between the type of sports activity, stretching, and injury prevention. In this review, the researchers provided insight to the relationship between stretching and injury prevention. Several authors have suggested that stretching has a beneficial effect on injury prevention. However, clinical evidence has reported that stretching before exercise does not prevent injuries. The researchers believe that the contradictions between theories can be explained by considering the type of sports activity and individual participates in. Sports that require high intensity stretch-shortening cycles require a muscle-tendon unit that is compliant enough to store and release high amounts of elastic energy. If participants in these types of sports activities have insufficient compliant muscle-tendon unit, the demands in energy absorption and release may exceed the
capacity of the muscle-tendon unit, thus causing injury. On the other hand, sports activities that are low-intensity, there is no need for a compliant muscle-tendon unit. So, stretching may not be as advantageous.

**Stretching**

For years, stretching has been the most important component of an athlete’s warm-up. Athletes have always known that stretching their muscles before activity is important for injury prevention and performance. It is important to understand the different types of stretching. Different methods of stretching include: Static Stretching, Dynamic Stretching, Ballistic Stretching, and Proprioceptive Neuromuscular Facilitation. The importance of two of these techniques will be examined in the following sections.

**Static Stretching**

Static stretching is a commonly used method of stretching in which soft tissues are elongated just past the point of tissue resistance and then held in the lengthened position with a sustained stretch force over a period of time, usually around 30 seconds.\(^1\) Static
stretching is an effective form of stretching to increase flexibility, and is considered a safer form of stretching when compared to ballistic stretching.\textsuperscript{1,4-5} Despite utilizing static stretching as a means to increase flexibility, there is some research that suggests that static stretching may not be the most beneficial method and may even be detrimental to an athlete’s performance.\textsuperscript{20-23} Static stretching may not be the most beneficial method of warm-up because it fails to stretch a muscle group throughout the full range of motion.

During sports activity, the body is constantly moving and changing direction. In order to prepare the body for these movements, an athlete should warm-up their muscles in similar fashion. Incorporating static stretching as part of a warm-up for athletics may not prepare the muscles as well as stretching that incorporates functional movements. However, static stretching may be beneficial to use after competition to increase range of motion.\textsuperscript{10}

Although static stretching may not be beneficial for warming-up before athletic activity, it may be valuable after exercise to decrease delayed muscle onset soreness. Lucas and Koslow\textsuperscript{9} performed a study looking at static, dynamic, and proprioceptive neuromuscular facilitation stretching techniques on flexibility. Sixty-three college
women were the subjects in a 7-week study. Subjects were assigned to one of three treatment groups. There was a pretest, a midtest (after 11 days of treatment), and a posttest (after 21 days of treatment). By comparing the pretest and posttest means, they found that all three methods of stretching produced significant improvements in flexibility.

**Dynamic Stretching**

Dynamic stretching is a type of functionally based stretching that uses sports-specific movements to prepare the body for activity. Dynamic stretching places an emphasis on the movement requirements of the sport or activity rather than on individual muscles. The ability to actively move a joint throughout a range of motion is generally far more sport specific than the ability to statically hold a stretch. The use of dynamic stretches during a specific part of the warm-up provides numerous advantages: 1. Dynamic stretching helps promote the temperature-related benefits of the warm-up, 2. A number of joints can be integrated into a single stretch, 3. The muscle does not relax during the stretch but instead is active throughout the range of motion.
One study by Mann\textsuperscript{12} examined the benefits and guidelines for implementing a dynamic stretching program and to further examine static, ballistic, and proprioceptive neuromuscular facilitation (PNF) stretching techniques. The researchers concluded dynamic stretching should be implemented before sport activity. Static stretching should be utilized immediately following sport activity to increase range of motion.

**Ballistic Stretching**

Ballistic stretching is one stretching technique that is not utilized as often as static or dynamic stretching. Ballistic stretching is defined as a rapid, forceful intermittent stretch that is a high speed and high intensity stretch.\textsuperscript{3} It is characterized by the use of quick, bouncing-type movements that in which the end position is not held.\textsuperscript{3,11} Ballistic stretching may be used as a pre-exercise warm-up; however, it may injure muscles or connective tissues, especially when there has been a previous injury. Ballistic stretching usually triggers the stretch reflex that does not allow the involved muscles to relax and defeats the purpose of stretching.\textsuperscript{11}
**Proprioceptive Neuromuscular Facilitation**

Proprioceptive Neuromuscular Facilitation (PNF) is a method of stretching, mainly in order to increase flexibility. PNF techniques involve both passive movement as well as active (concentric and isometric) muscle actions. PNF may be superior to other stretching methods, however it is often impractical to use as part of a warm-up because most of the stretches require a partner with some expertise. There are three basic types of PNF stretching techniques which include: hold-relax, contract-relax, and hold-relax with agonist contraction. The hold-relax technique begins with a passive pre-stretch that is held at the point of mild discomfort for 10 seconds. The clinician then applies a hip flexion force and instructs the athlete to hold that position against resistance for 6 seconds. The athlete then relaxes and a passive stretch is performed and held for 30 seconds. The second technique, contract-relax, also begins with a passive pre-stretch that is held at the point of mild discomfort for 10 seconds. The athlete then extends the hip against resistance provided by the clinician so that a concentric muscle action through the full range of motion occurs. The athlete then relaxes, and a passive hip flexion stretch is applied and held for 30 seconds. Lastly, the hold-relax with agonist contraction
technique is identical to the hold-relax in the first two phases. During the third phase, a concentric action of the agonist is used in addition to the passive stretch to add to the stretch force.\textsuperscript{3,11} These three techniques may provide an increase in flexibility. However, it may not be appropriate to utilize this technique as part of a warm-up due to the need for an experienced clinician to instruct and execute each stretch correctly.

Speed

Most athletes are always trying to improve their athletic performance. Some areas of interest are strength, power, agility, and speed. Speed is often difficult to define and can also be difficult to improve. It is important to understand what speed is, how it is measured, muscle physiology of speed, and training techniques to improve speed.

What is Speed and How is it Measured?

One aspect of performance that many athletes try to improve is speed. Speed is movement distance per unit time and is typically quantified as the time taken to cover a fixed distance.\textsuperscript{11} More specifically, running speed is a
ballistic mode of locomotion with an alternating flight phase and single leg support phase. Sprinting is a series of running strides that repeatedly launch the athlete’s body as a projectile at maximal acceleration or velocity (or both), usually over brief distances.\textsuperscript{11} There are many tests that measure speed, the most popular being the 40 yard sprint. This test is utilized in many sports to determine the athlete’s performance level. Tests of speed are not usually conducted over distances greater than 200m because longer distances reflect anaerobic or aerobic capacity more than absolute ability to move the body at a maximal speed.\textsuperscript{11}

**Training Techniques Used to Improve Speed**

Improving an athlete’s speed can often be a difficult task. The implementation of certain speed drills is essential in increasing an athlete’s speed. As seen in an article by Cissik\textsuperscript{13}, many aspects of speed are examined, including flexibility, fatigue, technique, stride length, and frequency. These are all areas that must be improved in order to increase an athlete’s speed. This article also provides a series of exercise drills designed to improve training technique. Studying sprint technique more in depth was Cronin\textsuperscript{14}. In this study, the biomechanical differences
between the acceleration phase and the maximum velocity phase of sprinting are considered. Research on the various resisted sprinting techniques are examined, linking these techniques to the biomechanics of the acceleration phase. Lastly, suggestions are made regarding the application of these findings to the training of athletes.

In a study by Harrison,\textsuperscript{15} the researchers investigated whether a resistance sprint training intervention would enhance the running speed and dynamic strength measures in male rugby players. Fifteen male rugby players (mean age 20.5) were randomly assigned to either a control or resistance sprint groups. The resistance sprint group performed two sessions per week for six weeks, while the control group did no training. The results show a significant decrease in time to 5 m for the 30- m sprint for the resistance sprint group. In conclusion, the study suggests that it may be beneficial to employ a resistance sprint training program with the aim of increasing initial acceleration from a static start for sprinting.

**Stretching and Speed**

Every athlete wants to perform at the highest level possible. Stretching as part of a warm-up may increase
performance, however, the type of stretching performed is essential to perform at an optimal level. Static stretching before competition has been the traditional method to utilize in order to prepare the muscular system for work. However, there has been much research to suggest that static stretching is not the most beneficial means of warm-up.\textsuperscript{16-23}

McMillian et al\textsuperscript{16} compared the effect of a dynamic warm up with a static-stretching warm up on different measures of power and agility. Thirty subjects completed the study (16 men, 14 women, 18-24 years). On three consecutive days, subjects performed 1 of 2 warm up routines or performed no warm up. The warm up protocols lasted 10 minutes. The tests included a T-shuttle run, underhand medicine ball throw for distance, and 5-step jump. The results showed there were better performance scores after the dynamic warm up for all three tests. Warm up routines that use static stretching as the stand-alone activity should be reevaluated and/or replaced with a dynamic warm up.

In a similar study Arabaci\textsuperscript{17} examined the acute effects of dynamic, static, and no stretching within a warm-up on vertical jump, agility, maximal speed, anaerobic power, and reaction time of young elite soccer players. The results showed that the dynamic stretching results were better than
the results of static stretching and no stretching. There was a significant difference between the results of the dynamic warm-up as compared to static or no stretching. Dynamic stretching should be the preferred warm-up for young elite soccer players.

Faigenbaum et al.\textsuperscript{18,19} conducted two studies which are very similar. In the first study, Faigenbaum\textsuperscript{18} compared the acute effects on youth fitness of three different warm-up protocols utilizing static stretching or dynamic exercise performance. Sixty children (mean age 11.3 years) performed three different warm-up routines in random order on nonconsecutive days. The warm-up consisted of 5 minutes of walking and 5 minutes of static stretching, 10 minutes of dynamic stretching, or 10 minutes of dynamic exercise plus 3 drop jumps from 15-cm boxes. After each warm-up, subjects were tested on the vertical jump, long jump, shuttle run, and v-sit flexibility. Results showed that vertical jump and shuttle run performance declined significantly following the static stretch warm-up compared to the two dynamic warm-ups. There were no significant differences in flexibility following the three warm-up treatments. In conclusion, children should perform moderate to high intensity dynamic exercise prior to sport activities that require a high power output.
In the second study conducted by Faigenbaum\textsuperscript{19}, the researchers examined the acute effects of pre-event static stretching, dynamic stretching, and combined static and dynamic stretching on vertical jump, medicine ball toss, 10-yard sprint, and pro-agility shuttle run. Thirty teenage athletes (mean age 15.5 years) participated in three testing sessions in random order on three nonconsecutive days. Before testing, subjects performed 5 mm of walking/jogging followed by one of three warm-up protocols. Results showed an increase of performance for all performance areas except agility after the dynamic and combined warm-ups as compared to just the static warm-up. The study indicates that pre-event dynamic exercise or static stretching followed by dynamic exercise may be more beneficial than static stretching alone in teenage athletes who perform power activities. These studies suggest that dynamic stretching may be more beneficial than static stretching. The results show that dynamic stretching increases important aspects of performance including power, agility, and speed.

Speed may be one of the most important aspects of performance. Studies have shown that dynamic stretching is appropriate to achieve optimal speed performance. Siatras et al\textsuperscript{20} investigated the acute effect of a protocol,
including warm-up and static and dynamic stretching exercises, on speed during vaulting in gymnastics. Eleven boys were asked to perform three different protocols consisting of warm-up, warm-up and static stretching, and warm-up and dynamic stretching on three nonconsecutive days. The results showed that the static stretching protocol significantly decreased the speed performance during a run of vault. Therefore, it is not advisable to include static stretching exercises just prior to vault execution.

Fletcher\textsuperscript{21,22} conducted two studies testing the speed of different athletes after different stretching protocols. In the first study by Fletcher\textsuperscript{21}, the researchers were interested in determining the effect of different static and dynamic stretch protocols on 20-m sprint performance. Ninety-seven male rugby players were randomly assigned to four groups: passive static stretch (PSS), active dynamic stretch (ADS), active static stretch (ASST), and static dynamic stretch (SDS). All groups performed a standard 10-minute jog warm-up, followed by two 20-m sprints. The 20-m sprints were then repeated after subjects had performed their assigned stretch protocol. The PSS and ASST groups had a significant increase in sprint time, while the ADS group had a significant decrease in sprint time. The
decrease in performance for the two static stretch groups
was attributed to an increase in the musculotendinous unit
(MTU) compliance, leading to a decrease in the MTU ability
to store elastic energy in its eccentric phase. In
conclusion, static stretching as part of a warm-up may
decrease short sprint performance, while active dynamic
stretching seems to increase 20-m sprint performance.

Following this study, Fletcher\textsuperscript{22} investigated the
effects of incorporating passive static stretching in a
warm-up. The purpose of the study was to investigate the
effect of manipulating the static and dynamic stretch
components associated with a traditional track-and-field
warm-up. Eighteen experienced sprinters were randomly
assigned in a repeated-measures, within-subject design
study with three interventions: active dynamic stretch
(ADS), static passive stretch combined with ADS (SADS), and
static dynamic stretch combined with ADS (DADS). A
standardized 800-m jogged warm-up was performed before each
different stretch protocol, followed by two 50-m sprints.
Results showed that the SADS intervention yielded
significantly slow 50-m sprint times then either the ADS or
DADS protocols. It was concluded that passive static
stretching in a warm-up decreases sprint performance,
despite being combined with dynamic stretches, when compared to the solely dynamic stretching protocol.

Kistler\textsuperscript{23} found that previous research has shown that static stretching has an inhibitory effect on sprinting performances up to 50 m. The purpose of this study was to see what would happen to these effects at longer distances such as those seen in competition. Eighteen male subjects completed both static stretching and no stretching conditions across two days of testing. On each day, all subjects first completed a generalized dynamic warm-up routine that included a self-paced 800-m run, followed by a series of dynamic movements, sprints, and hurdle drills. After this warm-up subjects were assigned to either a static stretching or a no-stretching condition. They then immediately performed 2 100-m trials with timing gates set up at 20, 40, 60, and 100 m. Results showed a significant slowing in performance with static stretching in the second 20 (20-40) m of the sprint trials. In conclusion, it seems harmful to include static stretching in the warm-up protocol of collegiate male sprinters in distances up to 100 m.

Winchester\textsuperscript{24} also used track-and-field athletes in his study which aimed to establish whether the deleterious effects of static stretching would wash out the performance
enhancements obtained from the dynamic warm-up. Eleven males and eleven females, who were athletes of a NCAA Division 1 track team, performed a dynamic warm-up followed with either static stretching or rest. After the warm-up was completed, three 40 m sprints were performed to investigate the effects of the static stretching condition on sprint performance when preceded by a dynamic warm-up. The results showed that the no stretching group vs. the static stretching group was significantly faster for the entire 40 m. Similar to Kistler\(^{23}\), this study suggests that performing a static stretching protocol following a dynamic warm-up will inhibit sprint performance in collegiate athletes.

In a study by Nelson\(^{25}\), the researchers wanted to establish whether the deleterious effects of passive stretching seen in laboratory settings would manifest in a performance setting. Sixteen subjects (11 males, 5 females) on a Division I NCAA track athletics team performed electronically timed 20m sprint with and without prior stretching of the legs. Four different stretching protocols were performed which included no stretch of either leg, both legs stretched, forward led in the starting position stretched, and rear leg in the starting position stretched. Three stretching exercises were performed (hamstring
stretch, quadriceps stretch, calf stretch) for the stretching protocols. The three stretching protocols induced a significant increase in the 20 m time. In conclusion, pre-event stretching may negatively impact the performance of high-power short-term exercise. This study suggests that static stretching is more detrimental to performance than no stretching at all.

Many studies have shown that static stretching is detrimental to athletic performance. However, some studies suggest that static stretching may not be detrimental to athletic performance. A study by Little\textsuperscript{26} examined the effects of different modes of stretching within a pre-exercise warm-up on high-speed motor capacities important to soccer performance. Eighteen professional soccer players were tested in vertical jump, stationary 10-m spring, flying 20-m spring, and agility performance after different warm-ups consisting of static stretching, dynamic stretching, or no stretching. There was no significant difference among warm-ups for the vertical jump. The dynamic stretching protocol produced significantly faster 10-m sprint times than did the no-stretching protocol. The dynamic and static stretching protocols produced faster flying 20-m sprint times as opposed to the no stretching protocol. The dynamic stretching protocol also produced
significantly faster agility performance than both the static and no stretching protocol. In conclusion, static stretching does not appear to be detrimental to high-speed performance when included in a warm-up for professional soccer players. However, dynamic stretching during the warm-up was most effective as preparation for high-speed performance.

In a study by Knudson\textsuperscript{27}, the researchers studied the serving percentage and radar measurements of ball speed to examine the acute effect of stretching on tennis serve performance. Eighty-three tennis players from beginning to advanced level volunteered to serve following traditional warm-up and traditional plus stretching conditions. There was no short-term effect of stretching in the warm-up on the tennis serve performance of adult players, so adding stretching to the traditional 5-minute warm-up in tennis does not affect serve performance. These two studies suggest that static stretching may not be detrimental to performance, so it is crucial that further research be conducted.
Summary

Before any type of athletic activity, athletes stretch their muscles. As an athletic trainer, it is important to educate athletes about stretching. Through an understanding of the physiology of the musculotendinous unit as well as by reading up to date literature on the matter, athletic trainers will be able to choose a stretching protocol that will be most beneficial to the athlete. It is important that athletic trainers educate athletes not only about how stretching can improve performance, but also that stretching may prevent injury and increase flexibility. However, more research must be done to determine whether different stretching protocols are advantageous in reducing injury rates.

Overall, the majority of the studies that compare different stretching protocols reveal the same conclusions. Almost all the studies examined found dynamic stretching to be most beneficial. There was no literature found suggesting that dynamic stretching is detrimental to performance. Some studies have found static stretching to be detrimental to the performance of athletes in various areas. Other studies conclude that dynamic stretching is more beneficial than static stretching. These results have
caught the interest of athletes, coaches, and sports medicine professionals. Through observation, many athletes are beginning to stray away from the traditional static stretching protocol and switch to an active dynamic warm-up.
APPENDIX B

The Problem
STATEMENT OF THE PROBLEM

Statement of the Problem

Stretching has been widely accepted within the athletic population for decades. Static stretching was once dominant for a pre-activity warm-up. However, recent studies have shown that static stretching may lead to an increase risk of injury and also a decrease in performance. There have also been more studies on the positive effects of dynamic stretching. So, there has been a massive shift towards dynamic stretching as part of a pre-activity warm-up. The purpose of this study is to investigate the effect of different stretching protocols on the sprint performance of physically active adults.

The purpose of this study is to investigate the effect of three different stretching protocols on the sprint performance of physically active adults. These three stretching protocols include static stretching, dynamic stretching, and a combination of static and dynamic stretching. Furthermore, this study is intended to provide statistical evidence in order to determine which stretching protocol would be most beneficial for a collegiate athlete.
Definition of Terms

The following definitions of terms will be defined for this study:

1) Flexibility – The ability to move a single joint or series of joints smoothly and easily through an unrestricted, pain-free ROM.\(^3\)

2) Stretching – Movement applied by an external or internal force in order to increase muscle flexibility and/or joint range of motion.\(^1\)

3) Static Stretching – Holding a stretch for a period of time with little or no movement.\(^1,3\)

4) Dynamic Stretching – Controlled movement through the active range of motion.\(^1\)

5) Golgi Tendon Organ (GTO) – Sensory nerve endings located in tendons that sense change in muscle tension.\(^3\)

6) Muscle Spindles – Proprioceptors found in skeletal muscle that are sensitive to stretch, and signals muscle length and rate of change in muscle length.\(^3\)

Basic Assumptions

The following are basic assumptions of this study:
1) The subjects did not perform any other stretching other than the stretching asked of them in this study.

2) The subjects performed the 40-yard sprint to the best of their ability.

3) The equipment was calibrated and utilized properly during the course of this study.

4) The 40-yard sprint is a valid test for assessing sprint speed.

5) The subjects were “physically active” according to the physical activity survey

Limitations of the Study

The following are possible limitations of the study:

1) Subjects may not put forth maximal effort.

2) Some subjects may be in better shape than others.

Delimitations of the Study

The following are possible delimitations of the study:

1) The same person serves as the researcher, the data collector, and the Athletic Trainer.

2) The subjects were volunteers by a convenience sample.

3) The results can only be generalized to physically active adults.
Significance of the Study

The ideas of static stretching and flexibility have been around for years. Athletes have incorporated static stretching in not only their warm-up but also as part of their training programs. The thought of increasing flexibility by static stretching will improve athletic performance has been the driving factor in research on stretching protocols. However, recent research suggests that static stretching may have negative results on athletic performance. Performance areas that can be negatively affected include muscle strength, power, agility, and speed.

Research has shown that a different type of stretching protocol may be most beneficial. Since these studies have been published, there has been a massive shift from traditional static stretching to a dynamic warm-up before athletic activity. Athletic trainers must provide the best possible care for athletes. By reading and interpreting the recent literature, athletic trainers must adapt stretching protocols, especially if a certain type of stretching protocol could potentially be harmful towards the athlete. If dynamic stretching is more effective as a warm-up than static stretching, additional research should be performed to apply validity and reliability to the study to begin
implementing a change from solely static stretching to a dynamic warm-up.
APPENDIX C

Additional Methods
APPENDIX C1

Informed Consent Form
1. Mark Webber, who is a Graduate Athletic Training Student at California University of Pennsylvania, has requested my participation in a research study at California University of Pennsylvania. The title of the research is, The Effect of Static vs. Dynamic Stretching on Sprint Speed.

2. I have been informed that the purpose of this study is to study the effects of static stretching, dynamic stretching, and a combination of both stretches on sprint speed of physically active individuals. I understand that I must be 18 years of age or older to participate. I understand that I have been asked to participate along with 29 other individuals because I have not sustained a lower extremity injury within the last 6 months, nor do I have any other health conditions that would prevent me from participating in this study. I am also physically active, as defined as participating in moderate to intense exercise at least 3 times a week. I understand that I will be asked to complete a survey related to my physical activity to determine if I meet the definition of physically active for this study.

3. I have been invited to participate in this research project. My participation is voluntary and I can choose to discontinue my participation at any time without penalty or loss of benefits. My participation will involve completing this informed consent form before beginning this study. For the experimental portion of this study, I will be asked to complete three different stretching protocols on three separate days with at least 48 hours separating each test day. I will perform a 5 minute jog at my own pace, then I will be instructed to perform either a static stretching protocol, a dynamic stretching protocol, or a combination of static and dynamic stretching protocol. Following the stretching protocol, I will complete 3 trials of a timed 40 yard sprint.

4. I understand there are foreseeable risks or discomforts to me if I agree to participate in the study. With participation in a research program such as this there is always the potential for unforeseeable risks as well. The possible risks and/or discomforts include possible soreness due to activity. With any intense physical activity, there is a risk of cardiovascular incidents such as cardiac arrest and exacerbation of other health issues. To minimize these health risks I will complete a physical activity readiness questionnaire (PAR-Q) and allow the researchers to obtain information from my CalU physical on file with the Student Health Center. To minimize risks of muscle and joint injury and discomfort the researcher has included a proper warm-up consisting of a 5 minute jog before participating in the performance testing.

5. I understand that, in case of injury, I can expect to receive treatment or care in Hamer Hall’s Athletic Training Facility. This treatment will be provided by the researcher, Mark Webber, under the supervision of the CalU athletic training faculty, all of which can
administer emergency care. Additional services needed for prolonged care will be referred to the attending staff at the Downey Garofola Health Services located on campus.

6. There are no feasible alternative procedures available for this study.

7. I understand that the possible benefits of my participation in the research will provide more current research, adding to the existing research, which will contribute to which type of stretching protocol will be the most effective in terms of improving performance as well as decreasing injury in athletics.

8. I understand that the results of the research study may be published but my name or identity will not be revealed. Only aggregate data will be reported. In order to maintain confidentially of my records, Mark Webber will maintain all documents in a secure location on campus and password protect all electronic files so that only the student researcher and research advisor can access the data. Each subject will be given a specific subject number to represent his or her name so as to protect the anonymity of each subject.

9. I have been informed that I will not be compensated for my participation.

10. I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by:

   Mark C. Webber, ATC
   STUDENT/PRIMARY RESEARCHER
   Web2404@calu.edu
   774-266-6383

   Dr. Thomas West Ph.D., ATC
   RESEARCH ADVISOR
   West_t@calu.edu
   724-938-5933

11. I understand that written responses may be used in quotations for publication but my identity will remain anonymous.

12. I have read the above information and am electing to participate in this study. The nature, demands, risks, and benefits of the project have been explained to me. I knowingly assume the risks involved, and understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, rights, or remedies. A copy of this consent form will be given to me upon request.

13. This study has been approved by the California University of Pennsylvania Institutional Review Board.
14. The IRB approval dates for this project are from: 01/01/12 to 12/31/12.

Subject's signature:___________________________ Date:________________

Witness signature:____________________________ Date:________________
APPENDIX C2

Physical Activity Readiness Questionnaire (PAR-Q)
PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES NO
1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
2. Do you feel pain in your chest when you do physical activity?
3. In the past month, have you had chest pain when you were not doing physical activity?
4. Do you lose your balance because of dizziness or do you ever lose consciousness?
5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
7. Do you know of any other reason why you should not do physical activity?

If you answered

YES to one or more questions
Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.
- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions
If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:
- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to be active. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional.
Ask whether you should change your physical activity plan.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction.

NAME ________________________________
SIGNATURE ________________________________
DATE ________________________________

SIGNATURE OF PATIENT OR GUARDIAN (for participants under the age of majority) ________________________________
DATE ________________________________
WITNESS ________________________________

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

© Canadian Society for Exercise Physiology  www.csep.ca/forms
Appendix C3

Physical Examination Release Waiver
Physical Examination Release Waiver

I ______________________________ give the University Health Center permission to provide the researcher (Mark C. Webber) and research advisor (Dr. Thomas West) my physical. I understand that the information gathered by the researcher will be used to determine recommendations my physician has given regarding my physical activity.

Student Signature______________________________ Date: _________
Appendix C4

Physical Activity Survey
Physical Activity Survey

1. How many days per week do you partake in moderate to intense exercise? ___ days

2. For each of the following activities, please indicate how much time you spend per week. (Note: each activity must be done at a moderate to intense level of exertion)

   a. Running (road, track, treadmill):
      ____________________
   
   b. Biking
      ____________________
   
   c. Elliptical
      ____________________
   
   d. Stair Climber
      ____________________
   
   e. Weight Training
      ____________________
Appendix C5

Functional Instruments
http://nats.us/cm-combines/cm-drills/cm-drills-speed.html
Speed Trap II Timer™
http://www.powersystems.com/nav/closeup.aspx?c=19&g=1354#
Appendix C6

Stretching Protocols
## Static Stretching Protocol

<table>
<thead>
<tr>
<th>Stretch</th>
<th>Muscles</th>
<th>Sets</th>
<th>Repetitions</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamstring Stretch</td>
<td>Hamstrings</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>Quad Stretch</td>
<td>Quadriceps</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>Hip Flexor Stretch</td>
<td>Hip Flexors</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>Adductor Stretch</td>
<td>Adductors</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>Abductor Stretch</td>
<td>Abductors</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>Gluteal Stretch</td>
<td>Gluteals</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>Gastroc/Soleus Stretch</td>
<td>Gastrocnemius and Soleus</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
</tbody>
</table>
KEY:
A) Hamstring Stretch
B) Quadriceps Stretch
C) Adductor Stretch
D) Hip Flexor Stretch
E) Abductor Stretch
F) Gluteal Stretch
G) Gastroc/Soleus Stretch
## Dynamic Stretching Protocol

<table>
<thead>
<tr>
<th>Stretch</th>
<th>Muscles</th>
<th>Sets</th>
<th>Repetitions</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Knees</td>
<td>Gluteals/Hamstrings</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
<tr>
<td>Butt Kicks</td>
<td>Quadriceps/Hip Flexors</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
<tr>
<td>Lateral Shuffles</td>
<td>Abductors/Adductors</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
<tr>
<td>Russian Walks</td>
<td>Hamstrings</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
<tr>
<td>Walking Lunges</td>
<td>Hip Flexors</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
<tr>
<td>Figure Fours</td>
<td>Abductors</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
<tr>
<td>Heel to Toe Walks</td>
<td>Gastrocnemius/Soleus</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
</tbody>
</table>

### Images

A) ![High Knees Image](image_a.png)
B) ![Butt Kicks Image](image_b.png)
C) ![Lateral Shuffles Image](image_c.png)
D) ![Russian Walks Image](image_d.png)
KEY:
A) High Knees
B) Butt Kicks
C) Lateral Shuffles
D) Russian Walks
E) Walking Lunge
F) Figure Four
G) Heel to Toe Walk
## Combination Stretching Protocol

<table>
<thead>
<tr>
<th>Stretch</th>
<th>Muscles</th>
<th>Sets</th>
<th>Repetitions</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamstring Stretch</td>
<td>Hamstrings</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>Quad Stretch</td>
<td>Quadriceps</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>Hip Flexor Stretch</td>
<td>Hip Flexors</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>Adductor Stretch</td>
<td>Adductors</td>
<td>1</td>
<td>25 s, bilaterally</td>
<td>5 s, bilaterally</td>
</tr>
<tr>
<td>High Knees</td>
<td>Gluteals/Hamstrings</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
<tr>
<td>Butt Kicks</td>
<td>Quadriceps/Hip Flexors</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
<tr>
<td>Lateral Shuffles</td>
<td>Adductors/Abductors</td>
<td>1</td>
<td>40 s.</td>
<td>20 s.</td>
</tr>
</tbody>
</table>
Appendix C7

Institutional Review Board

California University of Pennsylvania
PROTOCOL for Research Involving Human Subjects

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects.

(Reference IRB Policies and Procedures for clarification)

Project Title: The effects of static and dynamic stretching on sprint speed.
Research/Project Director: Mark Christopher Webber
Phone #: 714-266-4381  E-mail: web249@calh.edu
Faculty Sponsor (if required): Dr. Thomas West
Department: Health Science
Project Dates: January 1, 2012 to December 31, 2012
Sponsoring agent (if applicable) __________

Project to be Conducted at: California University of Pennsylvania

Project Purpose: ☐ Thesis ☐ Research ☐ Capstone Project ☐ Other

Keep a copy of this form for your records.

Approved, September 12, 2005 / (updated 02-08-09)
Please attach a typed, detailed summary of your project AND complete items 2 through 6.

1. Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(es) or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual.

The primary purpose of this study is to examine the effect of three different stretching protocols on sprint speed.

This research includes a quasi-experimental design, in which the subjects serve as their own control. The independent variable is the stretching protocol utilized before testing. This variable has three levels, a static stretching warm-up protocol, a dynamic stretching warm-up protocol, and a combination warm-up protocol including both static and dynamic stretches. The dependent variable is the time it takes the subject to complete a 40 yard sprint.

The subjects in this study will consist of up to 25 physically active individuals. All subjects will be physically active college aged students, who have not sustained a lower extremity injury within the past six months. Since the subjects will be required to sprint as part of the testing, subjects will need to be more than minimally physically active. For this study subjects will need to participate regularly in MODERATE TO INTENSE lower extremity weight bearing physical activity. The volunteers will be chosen by a sample of convenience. The subjects will be asked about previous history of lower extremity injuries, and those who have had such injuries within the past six months will be excluded from volunteering. All subjects in the study will sign an Informed Consent Form prior to participation in the study. Also, each subject’s identity will remain confidential and will not be included in the study.

A random sample of volunteer subjects will be obtained by seeking volunteers from CalU classes by making in class announcements with instructor permission. Prior to the subject’s involvement in the study, the researcher will hold a group meeting that each volunteer subject must attend. This meeting will consist of explaining the concept of the study and everything it entails to each of the subjects. At this meeting, each subject will complete the Informed Consent Form. Also at this meeting, an explanation of the procedure as well as the risks involved will be addressed.

Each subject will be informed that they will be tested on three separate days with at least 48 hours separating each testing session. Each subject will be assigned a time slot so only one subject will be participating at a time. This will be utilized to ensure proper timing for each subject to perform the given tasks. One stretching protocol will be performed on each of the testing days. On each of the testing days, the subjects will be randomly assigned to one of the stretching protocols in counterbalanced order; static stretching warm-up, dynamic stretching warm-up, or a combination warm-up. Each subject will be randomly selected to one of six possible testing procedures.

On testing days, all subjects will perform a 5 minute light jog warm-up at their own pace before any stretching or testing. After the warm-up, subjects will be given one minute to rest. Immediately after the one minute of rest, subjects will be asked to perform their randomly assigned protocol.

The static stretching warm-up protocol that will be used consists of a hamstring stretch, quadriceps stretch, hip flexor stretch, adductor stretch, abductor stretch, gluteal stretch, and a gastrocnemius/soleus stretch. Each stretch will be held for 25 seconds, each bilaterally. The subject will be given 5 seconds to rest in between each stretch. Pictures of the stretches are included with this document.

The dynamic stretching warm-up that will be used includes: high kicks (gluteals and hamstrings), butt kicks (quadriceps and hip flexors), lateral shuffles (abductors and adductors), Russian walks (hamstrings), walking lunges (hip flexors), figure fours (abductors), and heel to toe walks (gastrocnemius/soleus). Subjects will perform each of these stretches for 40 seconds, while having 20 seconds of rest in between. Both the static and dynamic protocols will take the same amount of time to complete. The dynamic stretching protocol will give the athlete more time to rest because they are stretching dynamically, the athlete should not become fatigued. Pictures of the exercises are included with this document.

Approved, September 12, 2005 / (updated 02-09-09)
The combination warm-up consists of performing four static stretches that are most common for any physically active person. These four static stretches include hamstring stretch, quadriceps stretch, hip flexor stretch, and adductor stretch. Each subject will then perform three dynamic stretches, before testing. The three dynamic stretches will be high knees, butt kicks, and lateral shuffles. The time allowed for each stretch will be the same as the previous two conditions, so the overall time will be the same.

The researcher will prepare a tape recording which instructs the subjects when to change the stretch to ensure the protocols are consistent between each subject. After the subjects are finished with their assigned protocol, they will be given another rest period of two minutes in order to prepare for their performance test. They will then perform three trials of the 40 yard sprint with another two minutes of rest between trials. The three trials will be timed using the Speed Trap II timing system, and the best of the three trials will be recorded. These results will be recorded on the data collection forms. This process will be repeated until all subjects perform each of the warm up protocols.

2. Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.

a. How will you insrene that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.

The possible risks and/or discomforts include possible soreness due to activity. The minimize these risks and discomforts, the researcher has included a proper warm-up consisting of a 5 minute jog before participating in any stretching or performance testing. There is also a risk for musculoskeletal injury (muscle/tendon strain or sprain) injury during the 40 yard sprint. To minimize the risk of falls, all testing will be performed on a clean sports surface with participants wearing appropriate footwear. In case of injury, the subject can expect to receive care from the researcher who is a Certified Athletic Trainer. In the event additional services be needed, the researcher will refer the subject to Student Health Services on the campus of California University. The subjects understand that they will be responsible for payment of any services provided above and beyond those provided by the student researcher.

b. How will you insrene that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.

The purpose of the research is to compare the effects of static stretching, dynamic stretching, and a combination of both on sprint performance of physically active adults. In this study, it is necessary to use 25 college aged adults who fit the inclusion/exclusion criteria to determine which stretching technique will most benefit these populations. Participation is completely voluntary and any subject may leave the study at any time. No vulnerable populations will be used and subjects will be free from coercion.

c. How will you obtain informed consent from each participant or the subject's legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.

Each potential subject's participation will involve filling out an informed consent form before beginning the study at an informational meeting. At this time subjects will be free to ask any questions about the study and their participation.
d. Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects’ responses and provisions for maintaining the security and confidentiality of the data.

The results of the research study may be published but the names and/or identity of the subjects will not be revealed. In order to maintain confidentiality of the subjects’ records, Mark C. Webber will maintain all documents in a secure location in the Graduate Athletic Training Program Director’s office which only the student researcher and research advisor can access. Confidentiality will be maintained by the subjects being assigned a number and will be referred to only by those numbers before, during, and after testing. Electronic data files will be password protected and stored on University maintained servers.

3. Check the appropriate box(es) that describe the subjects you plan to use.

- Adult volunteers
- CAL University Students
- Other Students
- Prisoners
- Pregnant Women
- Physically Handicapped People
- Mentally Disabled People
- Economically Disadvantaged People
- Educationally Disadvantaged People
- Fetuses or fetal material
- Children Under 18
- Neonates

4. Is remuneration involved in your project? □ Yes or ☒ No. If yes, Explain here.

5. Is this project part of a grant? □ Yes or ☒ No If yes, provide the following information:
   - Title of the Grant Proposal
   - Name of the Funding Agency
   - Dates of the Project Period

6. Does your project involve the debriefing of those who participated? □ Yes or ☒ No
   If Yes, explain the debriefing process here.

7. If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix ___ in the Policies and Procedures Manual.

Approved, September 12, 2005 / (updated 02-09-09)
California University of Pennsylvania Institutional Review Board  
Survey/Interview/Questionnaire Consent Checklist (v021209)

This form MUST accompany all IRB review requests.

Does your research involve ONLY a survey, interview or questionnaire?
☐ YES—Complete this form
☐ NO—You MUST complete the “Informed Consent Checklist”—skip the remainder of this form

Does your survey/interview/questionnaire cover letter or explanatory statement include:
☐ (1) Statement about the general nature of the survey and how the data will be used?
☐ (2) Statement as to who the primary researcher is, including name, phone, and email address?
☐ (3) FOR ALL STUDENTS: Is the faculty advisor’s name and contact information provided?
☐ (4) Statement that participation is voluntary?
☐ (5) Statement that participation may be discontinued at any time without penalty and all data discarded?
☐ (6) Statement that the results are confidential?
☐ (7) Statement that results are anonymous?
☐ (8) Statement as to level of risk anticipated or that minimal risk is anticipated? (NOTE: If more than minimal risk is anticipated, a full consent form is required—and the Informed Consent Checklist must be completed)
☐ (9) Statement that returning the survey is an indication of consent to use the data?
☐ (10) Who to contact regarding the project and how to contact this person?
☐ (11) Statement as to where the results will be housed and how maintained? (unless otherwise approved by the IRB, must be a secure location on University premises)
☐ (12) Is there text equivalent to: “Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective mm/dd/yy and expires mm/dd/yy”? (the actual dates will be specified in the approval notice from the IRB)?
☐ (13) FOR ELECTRONIC/WEBSITE SURVEYS: Does the text of the cover letter or explanatory statement appear before any data is requested from the participant?
☐ (14) FOR ELECTRONIC/WEBSITE SURVEYS: Can the participant discontinue participation at any point in the process and all data is immediately discarded?

Approved, September 12, 2005 / (updated 02-09-09)
California University of Pennsylvania Institutional Review Board
Informed Consent Checklist (v021209)

This form MUST accompany all IRB review requests

Does your research involve ONLY a survey, interview, or questionnaire?
☐ YES—DO NOT complete this form. You MUST complete the "Survey/Interview/Questionnaire Consent Checklist" instead.
☐ NO—Complete the remainder of this form.

1. Introduction (check each)
   ☐ (1.1) Is there a statement that the study involves research?
   ☐ (1.2) Is there an explanation of the purpose of the research?

2. Is the participant? (check each)
   ☒ (2.1) Given an invitation to participate?
   ☒ (2.2) Told why he/she was selected.
   ☒ (2.3) Told the expected duration of the participation.
   ☒ (2.4) Informed that participation is voluntary?
   ☒ (2.5) Informed that all records are confidential?
   ☒ (2.6) Told that he/she may withdraw from the research at any time without penalty or loss of benefits?
   ☐ (2.7) 18 years of age or older? (if not, see Section #9, Special Considerations below)

3. Procedures (check each).
   ☒ (3.1) Are the procedures identified and explained?
   ☒ (3.2) Are the procedures that are being investigated clearly identified?
   ☒ (3.3) Are treatment conditions identified?

4. Risks and discomforts. (check each)
   ☒ (4.1) Are foreseeable risks or discomforts identified?
   ☒ (4.2) Is the likelihood of any risks or discomforts identified?
   ☒ (4.3) Is there a description of the steps that will be taken to minimize any risks or discomforts?
   ☒ (4.4) Is there an acknowledgement of potential unforeseeable risks?
   ☒ (4.5) Is the participant informed about what treatment or follow up courses of action are available should there be some physical, emotional, or psychological harm?
   ☒ (4.6) Is there a description of the benefits, if any, to the participant or to others that may be reasonably expected from the research and an estimate of the likelihood of these benefits?
   ☒ (4.7) Is there a disclosure of any appropriate alternative procedures or courses of treatment that might be advantageous to the participant?

5. Records and documentation. (check each)
   ☒ (5.1) Is there a statement describing how records will be kept confidential?
   ☒ (5.2) Is there a statement as to where the records will be kept and that this is a secure location?
   ☒ (5.3) Is there a statement as to who will have access to the records?

Approved, September 12, 2005 / (updated 02-09-09)
6. For research involving more than minimal risk (check each),
   □ (6.1) Is there an explanation and description of any compensation and other medical or counseling treatments that are available if the participants are injured through participation?
   □ (6.2) Is there a statement where further information can be obtained regarding the treatments?
   □ (6.3) Is there information regarding who to contact in the event of research-related injury?

7. Contacts (check each)
   ✗ (7.1) Is the participant given a list of contacts for answers to questions about the research and the participant’s rights?
   ✗ (7.2) Is the principal researcher identified with name and phone number and email address?
   ✗ (7.3) FOR ALL STUDENTS: Is the faculty advisor’s name and contact information provided?

8. General Considerations (check each)
   ✗ (8.1) Is there a statement indicating that the participant is making a decision whether or not to participate, and that his/her signature indicates that he/she has decided to participate having read and discussed the information in the informed consent?
   ✗ (8.2) Are all technical terms fully explained to the participant?
   ✗ (8.3) Is the informed consent written at a level that the participant can understand?
   ✗ (8.4) Is there text equivalent to: “Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective nn/mm/yy and expires mm/mm/yy”? (the actual dates will be specified in the approval notice from the IRB)

9. Specific Considerations (check as appropriate)
   □ (9.1) If the participant is or may become pregnant is there a statement that the particular treatment or procedure may involve risks, foreseeable or currently unforeseeable, to the participant or to the embryo or fetus?
   □ (9.2) Is there a statement specifying the circumstances in which the participation may be terminated by the investigator without the participant’s consent?
   □ (9.3) Are any costs to the participant clearly spelled out?
   □ (9.4) If the participant desires to withdraw from the research, are procedures for orderly termination spelled out?
   □ (9.5) Is there a statement that the Principal Investigator will inform the participant or any significant new findings developed during the research that may affect them and influence their willingness to continue participation?
   □ (9.6) Is the participant is less than 18 years of age? If so, a parent or guardian must sign the consent form and assent must be obtained from the child.
   □ Is the consent form written in such a manner that it is clear that the parent/guardian is giving permission for their child to participate?
   □ Is a child assent form being used?
   □ Does the assent form (if used) clearly indicate that the child can freely refuse to participate or discontinue participation at any time without penalty or coercion?
   □ (9.7) Are all consent and assent forms written at a level that the intended participant can understand? (generally, 8th grade level for adults, age-appropriate for children)

Approved, September 12, 2005 / (updated 02-09-09)
California University of Pennsylvania Institutional Review Board
Review Request Checklist (403209)

This form MUST accompany all IRB review requests. Unless otherwise specified, ALL items must be present in your review request.

Have you:

☐ (1.0) FOR ALL STUDIES: Completed ALL items on the Review Request Form?
Pay particular attention to:

☐ (1.1) Names and email addresses of all investigators

☐ (1.1.1) FOR ALL STUDENTS: use only your CalU email address

☐ (1.1.2) FOR ALL STUDENTS: Name and email address of your faculty research advisor

☐ (1.2) Project dates (must be in the future—no studies will be approved which have already begun or scheduled to begin before final IRB approval—NO EXCEPTIONS)

☐ (1.3) Answered completely and in detail, the questions in items 2a through 2d?

☐ 2a: NOTE: No studies can have zero risk, the lowest risk is "minimal risk". If more than minimal risk is involved you MUST:

   ✔ i. Delineate all anticipated risks in detail;
   ✔ ii. Explain in detail how these risks will be minimized;
   ✔ iii. Detail the procedures for dealing with adverse outcomes due to these risks.

   ✔ iv. Cite peer reviewed references in support of your explanation.

☐ 2b. Complete all items.

☐ 2c. Describe informed consent procedures in detail.

☐ 2d. NOTE: to maintain security and confidentiality of data, all study records must be housed in a secure (locked) location ON UNIVERSITY PREMISES. The actual location (department, office, etc.) must be specified in your explanation and be listed on any consent forms or cover letters.

☐ (1.4) Checked all appropriate boxes in Section 3? If participants under the age of 18 years are to be included (regardless of what the study involves) you MUST:

☐ (1.4.1) Obtain informed consent from the parent or guardian—consent forms must be written so that it is clear that the parent/guardian is giving permission for their child to participate.

☐ (1.4.2) Document how you will obtain assent from the child—This must be done in an age-appropriate manner. Regardless of whether the parent/guardian has given permission, a child is completely free to refuse to participate, so the investigator must document how the child indicated agreement to participate ("assent").

☐ (1.5) Included all grant information in section 5?

☐ (1.6) Included ALL signatures?

☐ (2.0) FOR STUDIES INVOLVING MORE THAN JUST SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:

☐ (2.1) Attached a copy of all consent form(s)?

☐ (2.2) FOR STUDIES INVOLVING INDIVIDUALS LESS THAN 18 YEARS OF AGE: attached a copy of all assent forms (if such a form is used)?

☐ (2.3) Completed and attached a copy of the Consent Form Checklist? (as appropriate—see that checklist for instructions)

Approved, September 12, 2005 / (updated 02-09-09)
☐ (3.0) FOR STUDIES INVOLVING ONLY SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:
  ☐ (3.1) Attached a copy of the cover letter/information sheet?
  ☐ (3.2) Completed and attached a copy of the Survey/Interview/Questionnaire Consent Checklist? (see that checklist for instructions)
  ☐ (3.3) Attached a copy of the actual survey, interview, or questionnaire questions in their final form?

☒ (4.0) FOR ALL STUDENTS: Has your faculty research advisor:
  ☒ (4.1) Thoroughly reviewed and approved your study?
  ☒ (4.2) Thoroughly reviewed and approved your IRB paperwork? including:
      ☒ (4.2.1) Review request form,
      ☒ (4.2.2) All consent forms, (if used)
      ☒ (4.2.3) All assent forms (if used)
      ☒ (4.2.4) All Survey/Interview/Questionnaire cover letters (if used)
      ☒ (4.2.5) All checklists
  ☒ (4.3) IMPORTANT NOTE: Your advisor’s signature on the review request form indicates that they have thoroughly reviewed your proposal and verified that it meets all IRB and University requirements.

☒ (5.0) Have you retained a copy of all submitted documentation for your records?
Project Director's Certification
Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any changes in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

Project Director's Signature ________________________________
Department Chairperson's Signature __________________________

Student or Class Research

Student Researcher's Signature ____________________________
Supervising Faculty Member's Signature ______________________

Department Chairperson's Signature _________________________

ACTION OF REVIEW BOARD (IRB use only)

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. Provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. Uses appropriate methods to obtain informed, written consent;
3. Indicates that the potential benefits of the investigation substantially outweigh the risk involved;
4. Provides adequate debriefing of human participants;
5. Provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

☐ Approved [_________________________] ☐ Disapproved

Chairperson, Institutional Review Board ________________________
Date ____________________________

Approved, September 12, 2005 / (updated 02-09-09)
Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Mark Webster successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 06/18/2011

Certification Number: 704836
Below are my responses to issues that arose during the IRB review of my proposal(#11-032) titled “the effects of static and dynamic stretching on sprint speed.” These changes resulted in a modification of the Informed Consent so it is also attached to this email. Please let me know if any additional information is needed.

--Criteria for inclusion in the study are somewhat nonspecific (“physically active” and “moderate to intense lower extremity activity”). Because the research activity (running 40m at maximum speed) is strenuous, a clearer, objective level of physical activity must be defined.

Subjects participating in this study must partake in moderate to intense physical activity. Such activity may include running, biking, elliptical, stair climber, and/or weight training. Subjects must participate in this type of exercise at a minimum of three days a week for at least 30 minutes per session. Subjects will complete the attached survey in regards to their physical activity. They must indicate that they engage in one or more of the listed exercises for a minimum total of 30 minutes per session with at least 3 sessions per week to be included in the study. (Physical Activity Survey, attached) The intention is to include individuals that regularly perform moderate to intense exercise that utilizes the lower extremity. These activities would tax the body in ways that would train aerobic and anaerobic systems and result a reduced risk of injury.

--As running 40m is an intense anaerobic activity (done 3x) this could be a significant stress on the cardiovascular and musculoskeletal system, along with other potential health implication (e.g. sickling in pts with sickle cell). The sole screening criterion (a question regarding Lower Extremity injury) appears insufficient to minimize risks. A more detailed screening is required (e.g. PARQ – physical activity readiness questionnaire could be a starting point—it is the researcher’s responsibility to decide on an appropriate protocol) along with additional evidence-based information on potential risks given to participants (e.g. risk of cardiovascular incident)—peer reviewed references are needed for this response.

I have included a PAR-Q form (attached) for each potential subject to complete to minimize any potential cardiovascular risks. Also, each student must have a physical performed by a physician on file prior to their enrollment at the University. On page four of the physical, there is a question that reads “Recommendations for physical activity (Physical Education, Athletics, etc.).” The physician checks either unlimited or limited. Any potential subject with “Limited” checked off will be excluded from the study.
Subjects will sign a waiver (attached) to allow the University Health Center to provide the researcher with this information. This physical should also be an effective screen for other potential health implications and in combination with the PARQ should adequately screen for cardiovascular risk factors.

In relation to the potential risks of a CV incident, Van Camp\(^1\) states, “it is estimated an absolute rate of exercise-related death among high school and college athletes of only 1 per 133,000 men and 1 per 769,000 women.” Another study by Borjesson and Pelliccia\(^2\) states “The incidence of sudden cardiac death (SCD) among young athletes is estimated to be 1-3 per 100,000 person years, and may be underestimated. The risk of SCD in athletes is higher than in non-athletes because of several factors associated with sports activity that increase the risk in people with an underlying cardiovascular abnormality.” Overall the risks of CV incident is very small, and the stresses of this type of test may create risks lower than those seen in athletes. Still, the researcher will watch the subjects for signs of CV distress throughout the testing session.

References:


--Where will the 40m runs be done (indoors/outdoors). Is there deceleration room? Will weather conditions be a factor?

The runs will take place indoors in the Hamer gymnasium. The runs will be run diagonally across the entire gymnasium. The length of the gym is 150 ft and the width is 110 ft. Diagonally, the test will take 120 ft (40 yards) and there is 66 ft for deceleration (roughly 20 yards). There is ample deceleration room. A diagram is provided.

--It is not clear what parameters will be measured. A sample data collection sheet should be included in the response.

A sample data collection sheet is provided. Each subject’s time, in seconds, will be recorded. The best time will be used for data analysis.
Dear Mark Christopher Webber:

Please consider this email as official notification that your proposal titled “The effects of static and dynamic stretching on sprint speed” (Proposal #11-032) has been approved by the California University of Pennsylvania Institutional Review Board as amended. The effective date of the approval is 2-23-2012 and the expiration date is 2-22-2013. These dates must appear on the consent form.

Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)

(2) Any events that affect the safety or well-being of subjects

(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).

(4) To continue your research beyond the approval expiration date of 2-22-2013 you must file additional information to be considered for continuing review. Please contact instreviewboard@calu.edu

Please notify the Board when data collection is complete.

Regards,

Robert Skwarecki, Ph.D., CCC-SLP
Chair, Institutional Review Board
Appendix C8

Data Collection Sheet
## Sprint Times for the 40 Yard Sprint

<table>
<thead>
<tr>
<th>Subject</th>
<th>Static</th>
<th>Dynamic</th>
<th>Combo</th>
</tr>
</thead>
</table>
REFERENCES


ABSTRACT

Title: THE EFFECT OF STATIC AND DYNAMIC STRETCHING ON SPRINT SPEED OF THE PHYSICALLY ACTIVE

Researcher: Mark C. Webber

Advisor: Dr. Thomas F. West

Date: May 2012

Research Type: Master’s Thesis

Context: Stretching has been widely accepted within the athletic population for decades. Static stretching was once dominant for a pre-activity warm-up. However, recent studies have shown that static stretching may lead to an increased risk of injury and also a decrease in performance. There have also been an increasing number of studies identifying the positive effects of dynamic stretching when compared to static stretching. Therefore, there has been a significant shift towards dynamic stretching as part of a pre-activity warm-up.

Objective: The purpose of this study was to investigate the effect of three different stretching protocols on the sprint performance of physically active individuals. These three stretching protocols include static stretching, dynamic stretching, and a combination of static and dynamic stretching.

Setting: The testing was done in the Hamer Gymnasium on the campus of California University of Pennsylvania.

Participants: Sixteen physically active individuals volunteered for this study (11 males, 5 females).

Interventions: Each subject completed each of the three stretching protocols on three separate days.
with 48 hours in between each testing session. Each subject then completed three trials of a 40 yard sprint.

Main Outcome Measures:
A within subjects repeated measures ANOVA was conducted to analyze the data. The independent variable was the stretching protocol used, which had three levels (Static Stretching Warm-Up Protocol, Dynamic Stretching Warm-Up Protocol, and Combination of Static and Dynamic Stretching Warm-Up Protocol).

Results: The repeated measures ANOVA revealed there was a significant effect of warm-up on performance \( (F_{2,30} = .03 p < .05) \). Follow-up post-hoc testing using protected dependent t tests was utilized. There was a significant difference between the Combination Stretching Protocol \( (5.575s \pm .496) \) and the Static Stretching Protocol \( (5.660s \pm .492) \).

Conclusion: According to the literature, it is beneficial to include dynamic stretching prior to physical activity, while static stretching should be avoided. However, the results of this study show that a combination of both static and dynamic stretching is most beneficial for physically active individuals.