THE EFFECT OF A NOVEL WARM-UP ON LOWER BODY POWER IN DIVISION 1 MALE SOCCER PLAYERS

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Abstract

of

THE EFFECT OF A NOVEL WARM-UP ON LOWER BODY POWER IN DIVISION 1 MALE SOCCER PLAYERS

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The purpose of this study was to examine the effect of implementing AIS as part of a warm-up upon vertical jump performance in division one male soccer players. This study compared a new stretch modality, active isolated stretching (AIS) versus dynamic stretching on vertical jump performance.

The study consisted of 18 male collegiate soccer players, 18 to 22 year old, all of which were forwards, midfielders, defenders, and goalkeepers. Participants, randomly placed in one of two groups, underwent two testing conditions on two non-consecutive days. First test condition consisted of a general warm-up plus a series of dynamic exercises. The second test condition consisted of a general warm-up plus a series of AIS stretch exercises. All participants were tested on their vertical jump after both test conditions were administered. Results indicated no significant difference between the two stretch modalities after a general warm-up on vertical jump performance.
Despite no significant difference between the groups, the AIS group did perform about the same to the dynamic group. This result may indicate that when necessary, AIS can be a substitute for dynamic stretching. Future research should compare AIS to other modalities such as static or PNF stretching when it affects performance measures. Also, AIS should be tested on other test measures such as speed, agility, and/or strength. An investigation to evaluate AIS's effectiveness on female athletes may be another avenue for future researchers. Longer testing days and acquiring more subjects can also be manipulated for further research. Finally, testing AIS on athletes who are completely familiar with AIS should be conducted to see if it may impact performance significantly.

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Secondly, I would like to thank both my parents Sergio Sr. and Teresawho have stood by me through thick and thin. Both who have provided me with a lot of support, encouragement, great advice, and above all plenty of love. In fact, I believe none of my accomplishments would have happened if it was not for them. I will forever be grateful and am very fortunate to have them both in my life. This is definitely for them.

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Strength and Conditioning coaches have continued to formulate the best training plans to improve overall performance for their athletes. It can also be agreed upon that many coaches have come to the consensus that one of the most critical components of training is having an impeccable pre-event warm-up strategy. Prepping the body by enhancing blood flow, stimulating the central nervous system (CNS), and/or allow for pain-free range of motion prior to training is critical. Ignoring these components can have negative consequences on performance.

The warm-up should be structured in such a way that allows for increases in flexibility or pain-free range of motion (ROM) at the joint to promote optimized levels of physical performance (Shellock & Prentice, 1985; Smith, 1994); and/or simply to reduce the potential for injury (Ekstrand, Gillquist, Moller, Oberg, & Liljedahl, 1983; Safran, Seaber, & Garrett, 1989). However, the structure of the warm-up, especially the type of stretch component incorporated as part of the warm-up, has been of great debate over the past years. There has been conflicting evidence presented previously in terms of the preferred type of stretch component of the warm-up and its effect on performance. There are a number of stretching modalities that have been used as part of the warm-up process. They include: Static (SS), dynamic (DS), ballistic (BS), and proprioceptive neuromuscular facilitation (PNF) stretching. Both SS and PNF have been examined and have been associated with decreases in strength, power, and running speed (Bacurau,
Monteiro, Ugrinowitsch, Tricoli, Cabral, & Aoki, 2009; Flethcer & Anness, 2007; Herda, Cramer, Ryan, McHugh, & Stout, 2008; Samuel, Holcomb, Guadagnoli, Rubley, & Wallmann, 2008; Sayers, Farley, Fuller, Jubenville, & Caputo, 2008; Young & Elliot, 2001). Dynamic stretching on the other hand has been shown to increase short-term high-intensity muscular performance (Faigenbaum, Belluci, Bernieri, Bakker, & Hoorens, 2005; Fletcher & Jones, 2004; Holt & Lambourne, 2008; Little & Williams, 2006; Mohr, Pink, Elsner, & Kvitne, 1998; Pearce, Kidgell, Zois, & Carlson, 2009).

Active isolated stretching (AIS) is another stretching modality available that has been implemented by clinicians, therapists, personal trainers, and professional athletes. AIS involves a two second stretch, while simultaneously contracting the agonist muscle, thus creating a neurological response called reciprocal inhibition. The end result is a further relaxation of the antagonist muscle and an improved response to stretching (Kochno, 2002). AIS was developed by Aaron Mattes, kinesiologist, and Jim and Phil Wharton, regular columnists for Runner's-World magazine highly endorse this form of stretching (Mattes, 1996). Research involving AIS is limited to only three studies that examined the effect of AIS on range of motion (Leimohn, Mazis, & Zhang, 1999; Marino, Ramsey, Otto, & Wygand, 2001; Middag & Harmer, 2002). However, no prior research on AIS is available to assess its effectiveness as part of a warm-up for sports performance.
Statement of Purpose

The purpose of this study was to examine the effect of implementing AIS as part of a warm-up upon vertical jump performance in division on male soccer players.

Significance of Thesis

To date, there is no available research concerning the effect of combining a warm-up with AIS. And no previous research is available on the effect AIS has on overall athletic performance. After an extensive review of literature, research suggests dynamic stretching is the best form of stretching for pre-event/training purposes and is therefore recommended for all types of sports. This investigation is important to the field of strength and conditioning, as the results will indicate whether AIS may aid in performance in soccer players. And if so when necessary, AIS can be a great substitute to dynamic stretching when space to warm-up is a factor.

Definition of Terms

Active Isolated Stretching: Active isolated stretching refers to actively taking a limb through a full range of motion, holding for two seconds while simultaneously contracting the opposing muscle group and then releasing while allowing the limb to return to its starting position (Mattes, 1996).

Dynamic Stretching: Dynamic stretching refers to a controlled movement through
the active range of motion for one or more joints (Fletcher & Anness, 2007; Fletcher & Jones, 2004).

Musculotendinous Unit: Musculotendinous unit refers to contractile component (muscle fibers) in parallel with one elastic component (muscle membranes) and in series with another elastic component (tendons) (Avela, Kyrolainen, & Komi, 1999).

Post Activation Pontentiation: Post activation pontentiation refers to the temporary increase in the contractile ability of muscles after previous contraction sessions (Sale, 2002).

Series Elastic Component: Series elastic component (SEC) refers to passive elasticity derived from tendons when a muscle is stretched (Potach & Chu, 2000).

Sherrington's Law of Reciprocal Inhibition: Sherrington's law of reciprocal inhibition refers to relaxation that occurs in the muscle opposing the muscles experiencing the increase tension (Moore & Hutton, 1980).

Static Stretching: Static stretching refers to slowly applied stretch torque to a muscle maintaining the muscle in a lengthened position from six and up to sixty seconds (Mohr, Pink, Elsner, & Kvitne, 1998).
Stretching: Stretching refers to the act of applying tensile force to lengthen muscles and connective tissue (Amiri-Khorasani, Sahebozamani, Tabrizi, & Yusof, 2010).

Delimitations

1. This study only used healthy Division 1 male collegiate soccer players.
2. The training occurred during the team’s off-season training period.
3. The training focused only on the lower body.
4. All of the players involved were classified as intermediate to advance in skill level.
5. All athletes were free of injury to the lower body in the past six months.

Limitations

1. The subjects and research assistants were aware of the structure of warm-up protocols and the test to be administered.
2. All subjects had administered some kind of stretching routine in the past four months prior to participating in the study.
3. The results of this investigation were limited to healthy male collegiate soccer players who had used some type of stretching modality for a minimum of four months.
Assumptions

1. All subjects followed the specific instructions of refraining from any stretching or fatiguing activity that would hinder their performance during testing.

2. All subjects accurately reported their physical activity and training status.

3. All subjects adhered to the stretching protocols to best of their abilities.

4. All subjects continued their regular physical activity during the study.

Hypotheses

1. There will be no significant increase in performance in the warm-up incorporating active isolated stretches compared to the warm-up combined with dynamic stretches.

2. There will be no significant increase in performance in the warm-up incorporating dynamic stretches compared to the warm-up combined with active isolated stretches.
Chapter 2
REVIEW OF LITERATURE

Soccer is a sport that relies predominantly on quick and explosive movements such as kicking, jumping, dribbling, and sprinting (Ekblom, 1986; Little & Williams, 2005; Reilly, 1990). The first consideration for both the coach and athletes alike is to begin training with an adequate warm-up. The warm-up is designed to increase motor performance levels, increase body heat plus circulation, and physiological response which may help avoid potential injury with the overall goal of improving performance levels (Holcomb, 2000). However, the structure of the warm-up, specifically the type of stretching modality included in training, has been debated over the past years (Bishop, 2003). The purpose of this study was to examine the effect of implementing AIS as part of a warm-up on vertical jump performance in division one male soccer players.

Purpose of Stretching

Stretching in general has become a fundamental portion of the warm-up process in athletics (Bandy, Irion, & Briggler, 1997; Cornwell, Nelson, & Sidaway, 2002; Davis, Ashby, McCale, McQuain, & Wine, 2005; Faigenbaum, et al., 2006; Gribble, et al., 1998; Witvrouw, Machieu, Danneels, & McNair, 2004). Stretching can be defined simply as the act of executing a level of tensile force upon muscles and connective tissue in attempts to lengthen them (Amiri-Khorasani, Sahebozamani, Tabrizi, & Yusof, 2010). Traditionally, stretching is used as part of the warm-up process to increase flexibility or pain-free range of motion (ROM) with the intent to allow for adequate performance
levels (Shellock, & Prentice, 1985; Smith, 1994) and/or to reduce the potential for injury (Alter, 2004; Bixler & Jones, 1992; Ekstrand & Gillquist, 1983; Ekstrand, Gillquist, Moller, Oberg, & Liljedahl, 1983; Garrett, 1990; Safran, Seaber, & Garrett, 1989). According to Smith (1994), stretching benefits athletes in several ways. First, stretching improves flexibility overtime which is crucial for explosive human movement in sports. Stretching also impacts running economy, optimizes athletic performance, and increases joint ROM. It also contributes to athletic function during rehabilitation treatment. Finally, stretching may also reduce muscle soreness following a bout of tough or long physical activity (Smith 1994). However, Needham, Morse, and Degens (2009) stated that there is no concrete evidence to suggest that stretching prevents or reduces delayed onset muscle soreness (DOMS).

Description of Static, Dynamic, Proprioceptive Neuromuscular Facilitation, And Active Isolated Stretching

Static Stretching

According to several studies, static stretching as part of a warm-up routine has been the most common stretch modality used in a multitude of sports (Church, Wiggins, Moode, & Crist, 2001; Little & Williams, 2006; Taylor, Brooks, & Ryan, 1997; Young & Behm, 2002; Young &Behm,2003). Static stretching is widely used because it is considered easy and safe (Woolstenhulme, Griffiths, Woolstenhulme, & Parcell, 2006; Yamaguchi & Ishii, 2005). This type of stretching modality requires one to take a muscle to its end range and maintain the position for six and up to sixty seconds in duration (Bandy & Irion, 1994; Bandy, Irion, & Briggler, 1997; Davis, et al., 2005). Smith (1994)
stated that with the slow build-up in tension caused by static stretching, the inverse stretch reflex is called upon; resulting in induced relaxation in the muscle which allows for continued stretching. Also, according to Beaulieu (1981), static stretching has no association with injury, and is believed to be the most effective method of stretching.

**Dynamic Stretching**

Dynamic stretching is a functional based stretching exercise that employs sport-specific movement patterns geared to prepare the body for activity (Mann & Jones, 1995). This stretching modality takes a limb through a full range of motion by contracting the agonist muscle while allowing the antagonist muscle to release/relax and be stretched (Murphy, 1994; Yamaguchi & Ishi, 2005). Dynamic stretching has demonstrated the potential to elevate "core" body temperature. It also enhances motor unit excitability, thus allowing a further ability for power production (Faigenbaum et al., 2006). Previous research has suggested that executing dynamic exercises at a moderate to high intensity level before practicing a sport activity can also increase performance by activating neuromuscular functions such as postactivation potentiation (Burkett, Phillips, & Ziuratis, 2005; Faigenbaum et al., 2006; Guillich & Schmidtleichher, 1996; Mcneal & Sands, 2003; Thompson, Kackley, Palumbo, & Faigenbaum, 2007). Postactivation potentiation can be defined as a temporary increase in the contractile ability of muscles after previous contraction sessions (Sale, 2002). According to Gelen (2010), hops, skips, arm swings, leg swings, and jumps which stress both the upper and lower extremities, are considered the heart of the dynamic warm-up exercises. Also, dynamic warm-up
exercises can include plyometric exercises, heavy-load resistance exercises, and/or or
maximum voluntary contractions (MVC).

Proprioceptive Neuromuscular Facilitation Stretching

Proprioceptive neuromuscular facilitation was described by Knott and Voss
(1968) as a technique that applies the concepts of reflex activation and inhibition.
Generally, the muscle is taken to its full lengthen position, then simultaneously one
actively contracts against manual resistance so the muscle can relax through self-
inhibition; then it is stretched into a new available end range. This procedure, best known
as the contract-relax method, is commonly used when treating tight muscles. It is
repeated a number of times per limb, each time increasing the range of movement by
stretching the muscle into its new available range of motion.

Active Isolated Stretching

Active isolated stretching (AIS), termed the "Mattes method" is a unique method
of stretching (Mattes, 1996). This stretching modality is unique as it requires one to
activate or contract an opposing muscle (agonist) which in turn allows the opposite
muscle (antagonist) to release or relax via a neurological response. This neurological
response can be described simply as Sherrington's Law of reciprocal inhibition (Moore &
Hutton, 1980). According to Mattes, the simple use of a two-second stretch hold reduces
the potential of disturbing the Golgi Tendon Organs and muscle spindles which in turn
avoids the reflexive contraction of the antagonist that reduces the stretch potential of the
muscle one is attempting to stretch (Kochno, 2002). Therefore, since the muscle one is
targeting (antagonist) is forced to relax while it’s opposite (agonist) is contracted or activated, the targeted muscle becomes an easier candidate for elongation. Mattes has also stated that AIS can have a huge, immediate impact on human movement by addressing circulatory, neuromuscular, and the myofascial systems. In fact, use of active isolated stretching over time is believed to improve overall flexibility; and may prevent acute and repetitive chronic stress injuries (Kochno, 2002).

The Effects of Stretching on Power Development

Static stretching pre-event has been thought to prevent injury and enhance athletic performance. However, over the years numerous studies have investigated the use of static stretching on athletic performance only to find contradicting results (Sayers, Farley, Fuller, Jubenville, & Caputo, 2008). There has been evidence to suggest that the use of static stretching may actually decrease performance of movements requiring maximal force production (Bacurau, et al., 2009; Behm, Button, & Butt, 2001; Cornwell, & Kokkonen, 2001; Cornwell, Nelson, Heise, & Sidaway, 2001; Cramer, et al., 2004; Cramer, et al., 2005; Cramer, Housh, Coburn, Beck, & Johnson, 2006; Curry, Chengkalath, Couch, Romance, & Manns, 2009; Evetovich, Nauman, Conley, & Todd, 2003; Faigenbaum, Bellucci, Bernieri, Bakker, & Hoornes, 2005; Holt & Lambourne, 2008; Kokkonen & Nelson, 1998; McNeal & Sands, 2003; Nelson, Guillery, Cornwell, Kokkonen, 2001; Nelson, Kokkonen, & Arnall, 2005; Samuel, Holcomb, Guadagnoli, Rubley, & Wallmann, 2008; Young & Elliot, 2001; Yamaguchi & Ishii, 2005; Yamaguchi, Ishii, Yamanaka, & Yasuda, 2006). In a recent study of twenty-seven male
soccer players, vertical jump heights were significantly greater in the active warm-up and
dynamic stretching groups when compared to the static stretching group (Fletcher &
Monte-Colombo, 2010). Also, according to Needham (2009), the decrements in strength
and explosive power following static stretching can remain for 15 minutes and up to 2
hours.

Most studies have come to the consensusthat the decreases in performance caused
by static stretching is due to the fact that it softens the musculotendinous unit (MTU) and
decreases muscle stiffness. The decrease in MTU stiffness causes acute neural inhibition
and decreases the ability to produce force and speed thereby leading to reductions in
power production in the muscles (Avela, Kyrolainen, & Komi, 1999; Knudson, Bennett,
Corn, Leick, & Smith, 2001; Nelson, Driscoll, Landin, Young, & Schexnayder, 2005;
Rosenbaum & Henning, 1995). Strength, power and speed are important attributes in a
sport like soccer. Causing a reduction in any of these attributes by the use of static
stretching negatively impacts performance and is why more people are turning their focus
more to the use of dynamic stretching (Fletcher & Monte-Colombo, 2010).

Previous research has demonstrated that dynamic stretching has just the opposite
effect of static stretching. It has been associated by numerous studies with improvements
in short-term high-intensity muscular performance (Faigenbaum, et al., 2005; Holt &
Lambourne, 2008; Little &Williams, 2006; Manoel, Love, Danoff, & Miller, 2008;
Pearce, Kidgell, Zois, & Carlson, 2009; Mcmillian & Moore, 2006). In the study by
Faigenbaum, McFarland, Schwerdtman, Ratamess, Kang, and Hoffman (2006), eighteen
healthy active females had significantly greater vertical jumps after moderate-intensity to high-intensity dynamic stretches when compared to the static stretching group. The dynamic group was said to have performed better due to dynamic stretching itself. The researchers agreed dynamic stretching was more appropriate for warm-up purposes because it is designed to prepare the athlete optimally for competition.

Recent studies conducted on the acute effects of proprioceptive neuromuscular facilitation (PNF) have shown that this stretching technique may result in a significant reduction or no change on jump performance and power output (Bradley, Olsen, & Portas, 2007; Church, Wiggins, Moode, & Crist, 2001; Knudson, Bennett, Corn, Leick, & Smith, 2001; Little & Williams, 2006; Power, Behm, Cahill, Carroll, & Young, 2004; Wallmann, Mercer, & McWhorter, 2005; Unick, Keifer, Cheeseman, & Feeney, 2005; Young & Behm, 2003; Yuktasir & Kaya, 2009). In a recent study of ten recreationally active females and nine recreationally active males, proprioceptive neuromuscular facilitation (PNF) stretching caused decrements in power during post-stretching when compared to pre-stretching (Marek, et al., 2005). Some studies may have concluded that the reductions in power after a session of PNF stretching may have been attributed by the level of stress and/or fatigue placed upon the muscles due to PNF stretching itself (Church, Wiggins, Moode, & Crist, 2001; Young & Elliott, 2001).

The Effects of Stretching on Sprint Performance

A study by Nelson, Driscoll, Landin, Young, and Schexnayder, (2005) found that static stretching during the warm-up phase had a negative impact on 20-m sprint performance. Sprint performance was reduced after static stretching, and stretching the
muscles in one leg had the same negative effect as stretching both legs when compared to the no-stretch group suggesting a central nervous system (CNS) mechanism. The investigators of this study also concluded that the performance reductions may have been associated with reduced stiffness of the musculotendinous unit. In another study by Fletcher and Jones (2004) using 97 male rugby union players, a similar relationship between static stretching and sprint performance was found. They also agreed performance levels were negatively affected due to reduced stiffness of the musculotendinous unit. The investigators noted that static stretching changes tendon structure (tightness) resulting in an increased compliance of the tendon. As a result, lowered capability of force production and delayed muscle activation occurs. Shorten (1987) reported that the amount of elastic energy that can be stored in the musculotendinous unit is a function of stiffness. Because static stretching reduces the stiffness of the musculotendinous unit, less elastic energy can then be retained and used after a session of static stretching (Potach & Chu, 2000). Also neurologically, it has been suggested that stretching may cause a decrease in neural transmission from CNS to the muscle, a phenomenon known as neural inhibition (Kubo, Kanehisa, Hawakami, & Fukunaga, 2001; Nelson, Driscoll, Landin, Young, & Schexnayder, 2005; Rosenbaum & Henning, 1995).

Similarly, protocols involving static stretching have been compared to dynamic stretching. Little and Williams (2006) conducted a study using 18 professional soccer players and engaged them in dynamic, static, or no-stretch warm-up. On a 10-m standing acceleration, they found that a dynamic warm-up, but not the static warm-up provided an
improvement in performance. Gelen (2010) stated that dynamic exercises performed during warm-up process may increase explosive-power production increasing neuromuscular functionality which aids in sprint performance. Thus, dynamic stretching may elicit postactivation potentiation (PAP) known as a temporary increased contractile ability of muscles after previous contraction and may contribute to sprint performance (Sale, 2002).

The Effects of Stretching on Agility

Additional research has focused on the effects of stretching on agility performance. The study by Little and Williams (2006) tested the effects of dynamic, static, and no-stretch on professional soccer players agility capabilities. The dynamic stretch protocol produced greater agility performance than both the no-stretch protocol and the static stretch protocol. Amiri-Khorasani, Sahebozamani, Tabrizi, and Yusof (2010) also examined static, dynamic, combined stretch (SS+DS) and no-stretch on agility performance. Their results demonstrated that static stretching presented slower times in agility performance compared to dynamic stretching as well. The authors concluded that dynamic stretching during a warm-up was most effective for preparation of agility performance. Another study done on the effects of stretching on agility using thirty Military cadets (McMillian, Moore, Hatler, & Taylor, 2006) also found that static stretching pre-event revealed worse times as opposed to dynamic stretching. The authors concluded that the reasons for improvements in performance associated with dynamic warm-up are reasons cited by Bishop (2003). Bishop (2003) stated that dynamic stretch warm-ups improve short-term performance and raises core temperature. Also, decrease
stiffness of the muscles and joints, increase transmission rate of nerve impulses, and changes in the force-velocity relationship can occur. Finally, improved glycolysis plus high-energy phosphate degradation potential is also made possible by dynamic stretching.

Summary

Previous research clearly finds dynamic stretching to be superior to other stretching modalities in terms of its effect on power, sprint, and agility performance. Yet, no research has looked at the effects of combining active isolated stretching (AIS) as part of the warm-up. Additionally, no research has been presented on the effect AIS has on power, agility, and/or sprint performance in any given sport. Based on the effects of other stretching methods used and their effect on power, a study is warranted to investigate whether the use of AIS as part of a warm-up will provide a similar or an even better effect on power performance when compared to other stretching modalities. The purpose of this study was to examine the effect of implementing AIS as part of a warm-up upon vertical jump performance in division one male soccer players.
Chapter 3

METHODS

The purpose of this study was to examine the effect of implementing AIS as part of a warm-up upon vertical jump performance in division on male soccer players. Assessment of the athletes took place in terms of power (vertical jump).

Subjects

The subjects used in this study were 18 volunteer soccer players from the Sacramento State University men's soccer team. The athletes were transitioning into their off-season training cycle. The athlete’s age ranged from 18 to 22 years old. All of the athletes that were involved in this study were skilled position players. The athletes used for this study were forwards, midfielders, defenders, and goalkeepers. All subjects were free from injury and were experienced in training and competed for at least one year at the collegiate level. The University’s Review Board approved the research and all subjects read and signed an informed consent and health questionnaire form before participation.

Research Design

This study was completed using a between-groups design to investigate the effects of Dynamic (DS), vs. Active Isolated Stretching (AIS) on vertical jump performance in college soccer players after a general warm-up. Soccer players conducted two different warm-up protocols on two non-consecutive test days. The eighteen subjects
were placed in one of two groups at random (Group 1: N=9, Group 2: N=9). The two warm-up protocols were applied at random between the groups. Each test day would be conducted more than 24 hours after a match or hard physical training in attempts to minimize the fatiguing effects from previous exercise. All of the athletes completed both of the warm-up protocols within a fifteen-day time span. The warm-up protocols differed only by the mode of stretching method used. The exercises used in the warm-up were identical in nature. There were two treatment groups, one of which received dynamic stretching and the other active isolated stretching. Subjects for both groups were asked to perform a standardized self-paced five-minute jog around a flat track. Then they rested for two minutes. Next, the subjects underwent one of the stretching protocols. After the stretch protocol had been conducted, another rest-interval of two minutes was allowed. Finally, the soccer players complete three attempts back to back on the performance test. The performance test consisted of a vertical jump.

The power test consisted of a vertical jump. The vertical jump is a countermovement jump where the athletes are instructed to jump straight up vertically. It is an explosive movement that requires full and complete ankle, hip, and knee extension.

Procedures

Before data collection, all subjects participated in an introductory mini-lecture to become familiar with the structure of the entire testing procedures. All subjects would report to the football field for testing on two non-consecutive days. All subjects performed the two randomized warm-up conditions, with at least 24hr and no more than
72hr between sessions. The participants were asked to refrain from stretching and fatiguing activity other than those they were already performing at team practice and exercise sessions. Participants were also asked to refrain from caffeine intake on each testing day and to avoid food consumption in the two hours prior to testing. Additionally, sessions were performed at the same time of day (afternoon) to avoid any diurnal variations. Finally, the participants were asked to be consistent in their pre-experiment activities on those days.

The DS protocol consisted of a five-minute-self-paced jog followed by a series of lower body dynamic stretches. The exercises chosen for this study were the following: form run, heel-to-butt walk, knee-tuck walk, knee cradle walk, walk-to lunge, "Spiderman" hip flexor/hamstring stretch, and carioca. These particular stretches are ordinarily used by soccer players and are very familiar. These movements were carried out covering a 15 yard span (a walk back recovery was employed between exercise sets to minimize any chances of fatigue). The athlete’s performed each exercise twice, meaning walking forward 15 yards, and coming back 15 yards. The duration of the entire dynamic warm-up routine was approximately 10 minutes. These stretches should be considered active dynamic stretches since the movements were carried out while jogging (Fletcher & Jones, 2004).

The AIS protocol consisted of a five-minute-self-paced jog followed also by a series of lower body AIS stretches. Each stretch exercise was demonstrated to the group once, and then each stretch exercise was performed with the group. A verbal signal to begin was given; following two seconds a "release," signal was given to indicate the
The exercises chosen were the following: quadriceps-stretch (in the prone position one pulls a rope attached to the front of the foot), hamstring-stretch (in the supine position one pulls a rope attached to the bottom of the foot), hip-flexor stretch (in the kneeling position one applies a forward lean at the hip), abductor-stretch (in the supine position one pulls a rope attached to the ankle away from the body laterally), adductor-stretch (in the supine position one pulls a rope attached to the ankle across the body medially), and the gluteus maximus-stretch (in the prone position with one's hands a pull behind the knee is applied); all of these exercises were designed by Aaron Mattes (1996). All the stretches require that the athletes provide a two-second stretch to the muscle being targeted (antagonist) while simultaneously contracting the opposing muscle (agonist) (Mattes, 1996; Kochno, 2002). The athletes performed 10 repetitions per leg, repeated for all of the stretches. All AIS stretches were performed while lying stationary on the ground. These particular stretches were also designed to stretch the same muscles as the DS protocol.

Instrumentation

The power portion of the experimental protocol involved the vertical jump test. The vertical jump was tested using a Vertex vertical jump tester.

Data Collection

The data for this study was collected upon completion of each test. Each athlete was responsible for having the researcher present to observe the actual attempts that the
athletes would take. The mean of the three trials and the mean of the groups were recorded and were used for this study.

Statistical Analysis

An independent $t$-test (SPSS) was used to test for between group differences for both the dynamic stretch group and the AIS group. The independent variables in this study were the dynamic and AIS stretch groups. The dependent variable in this study was vertical jump heights. The level of significance was set at $p<.05$. 
Chapter 4

RESULTS

Initially, 24 subjects were recruited for this study. Due to injury and/or illness, only 18 players participated in the study. Subjects in the present study were male, and of the same age range (18-22). All had previous soccer playing experience through club, high school, and some collegiate experience. Each subject was randomly placed into one of two stretching groups, which were, the dynamic stretch group, and the active isolated stretch group.

Vertical Jump

In the vertical jump, the dynamic group averaged 24.23 ± 3.09 inches while the AIS group averaged 24.35 ± 3.22 inches. An independent samples t-test revealed no significant difference between the groups in the vertical jump (t = -.116, p = .908).

Table 1.
Mean and SD of performance measures for test conditions (n=18).*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Countermovement jump (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS</td>
<td>24.23 ± 3.09*</td>
</tr>
<tr>
<td>AIS</td>
<td>24.35 ±3.24*</td>
</tr>
</tbody>
</table>

Note. DS=dynamic warm-up; AIS=active isolated warm-up.
Hypotheses

1. There will be no significant increase in performance in the warm-up incorporating active isolated stretches compared to the warm-up combined with dynamic stretches. This hypothesis was supported by the results of the data.

2. There will be no significant increase in performance in the warm-up incorporating dynamic stretches compared to the warm-up combined with active isolated stretches. This hypothesis was supported by the results of the data.

Summary

There was no significant difference (P<.05) found in the vertical jump between the groups. Results for this study led to the acceptance of both hypotheses one and two, which stated that there would be no significant difference in vertical jump performance between the groups. Results showed that AIS stretching did not elicit improvements in vertical jump performance any further than dynamic stretching.
Chapter 5

DISCUSSION

The purpose of this study was to examine the effect of implementing AIS as part of a warm-up on vertical jump performance in division one female soccer players. This study examined a comparison between a new stretching modality versus a traditional stretching modality after a warm-up on vertical jump performance. The new stretching modality was active isolated stretching, and the traditional stretching modality was dynamic stretching.

Although no previous studies have reported the effect AIS on power, previous studies have found dynamic stretching to be superior to other stretch modalities on power (Fletcher & Jones, 2004; Fletcher & Anness, 2007; Little & Williams, 2006; Mcmillan et al., 2006; Yamaguchi & Ishii, 2005). However, results from this study did show an almost similar performance outcome when comparing AIS to dynamic stretching.

Vertical Jump

Results from this study showed neither significant improvements nor decrements in vertical jump performance between groups. Previous studies have shown significant decrements in performance using static, ballistic, and/or PNF stretching when compared to dynamic stretching (Behm, Button, & Butt, 2001; Cornwell, Nelson, & Sidaway, 2002; Fletcher & Anness, 2007; Nelson, Allen, Cornewell, & Kokkonen, 2001; Nelson & Kokkonen, 2005). Thus, it was interesting to find no difference between AIS and DS.
Recommendations for Future Studies

Although many studies exist having examined the effects of dynamic stretching on performance, lack of sufficient evidence on the effects of AIS exist. Therefore, more research is warranted to determine exactly if AIS can in fact improve performance. Future studies may test AIS on other performance measures such as agility, speed, and/or strength, or compare AIS to other modalities like static or PNF stretching on such performance measures.

Another future direction for researchers to pursue would be to test the effect of using AIS on another type of sport. Also, the majority of studies discussed in this paper used male college or professional athletes. A study using female athletes would help determine if any differences may exist between male and female athletes when using AIS. Since the team used in this study was new to AIS, the next step for researchers would also be to study the effects of AIS on athletes who are completely familiar and/or already incorporate AIS as part of their training regimen.

Other factors that can be tested by future research are the number of assessment days used and number of subjects used. Unlike this study, most studies had an average of three tests days on three non-consecutive days (Amiri-Khorasani, Abu-Osman, & Yusof, 2011; Faigenbaum et al., 2006; Little & Williams, 2006; Yamaguchi & Ishii, 2005; Yamaguchi, Ishii, Yamanaka, & Yasuda, 2006). Also, most of the studies discussed in this paper had an average of 21 subjects used which is more than this study was allowed.
Further studies could manipulate some of these factors and potentially reveal different results.

Conclusion

Past studies have come to the agreement that DS is the best and most appropriate stretch method for warm-up purposes. Aside from the DS group results in this study however, the AIS group did not result in an increase in performance nor a decrease any further than the DS group. One can then conclude that when if necessary, AIS may be a substitute to DS during a warm-up. If space is not available for warming-up for example, one can simply locate a spot on the ground and begin a series of AIS stretches before training or competition. Decreasing performance by incorporating static or PNF stretching with the warm-up is out of the question. Therefore, AIS may be included as part of the warm-up without worry of compromising power performance.
APPENDIX A

Consent to Participate in Research

You are being asked to participate in research which will be conducted by Sergio Pena, a graduate student in Kinesiology at California State University, Sacramento. The purpose of this study will be to examine the effects of implementing active isolated stretching as part of a warm-up on vertical jump performance in collegiate soccer players.

You will be asked to complete a questionnaire about your health history on whether you were subject to any recent musculoskeletal injury. If you have nothing in your health history that would exclude you then you may participate in this study. You will be asked to participate in an introductory session and then in two testing sessions on two nonconsecutive days. The total time commitment for participating in this study is approximately 30:00 minutes. During the two testing sessions you will be asked to perform a five-minute self-paced jog around a flat track. You will be allowed two minutes to recover. Then you will participate in one stretching routine on one day and the other stretching routine on the following day. The first routine will consist of undergoing a series of dynamic stretches to the lower body that are commonly used in training. The second routine will consist of undergoing a series of active isolated stretches to the lower body. All of the routines will be run by the researcher of this study. You will rest another two minutes after stretching and then participate in a vertical jump test.

There will be minimal-risk to you as a participant in this study. The tests and stretching protocols involved in this study should not increase your risk of injury beyond those encountered in normal activities of daily living. However, there is some risk associated with these testing and stretching techniques, such as rapid breathing, increased heart rate, increased blood pressure, sweating, some muscular discomfort, and some fatigue mostly during the testing procedures for this study.

You may gain additional knowledge on another form of stretching modality that may be useful to an athlete of your sport. It is hoped that the results of the study will be beneficial for both Coaches and Athletes alike who may have considered or already use this type of stretching modality. The results will provide an answer as to whether active isolated stretching is effective or not in positively aiding in performance.

Your responses on the questionnaires will be kept confidential. A pseudonym will be used when collecting all data. Your test results will be kept separately from your health history & informed consent document. All documents will be kept stored away in a computer only I, the researcher can see. Any and all results will be
reported in aggregate form only and without the release of information that could be used to identify you.

You will not receive any compensation for participating in this study.

If you have any questions about this research, you may contact Sergio Pena at (xxx) xxx-xxxx or by e-mail xxxxxxx@netzero.net.

Your participation in this research is entirely voluntary. You have the right to discontinue participation in this research project at any time without penalty or loss of rights to which you are otherwise entitled. If you encounter a research related injury you will be referred to the Student Health Center at (916) 278-6461. Your signature below indicates that you have read this page, had any and all of your questions regarding this research answered and agree to participate voluntarily in the research.

__________________________________________  _____________
Signature of Participant                      Date
APPENDIX B

Physical Activity Readiness Questionnaire (PAR-Q)

Please take a second to complete this questionnaire with full honesty in attempts to ensure your full safety while participating in this study.

(Please circle answer)

1. Have you ever fallen over or ever lost consciousness as a result of dizziness during or after exercise? **Yes No**
2. Has a doctor ever said that you have high blood pressure? **Yes No**
3. Has a doctor ever said that you have a heart condition and recommended only medically supervised physical activity? **Yes No**
4. Do you ever experience chest pain or an irregular heart-beat as a result of exercise? **Yes No**
5. Do you have a bone or joint problem that can be aggravated by the proposed physical activity? **Yes No**
6. Do you suffer at all from lower back pain, i.e., chronic pain or associated numbness in the lower extremity? **Yes No**
7. Is there a good physical reason, not mentioned here, as to why you should not participate in the proposed physical activity? **Yes No**
8. Have you had any surgery as a result of an injury to the back or lower extremity (ankle, knee, hip) in the last 6 months? **Yes No**
   If YES, please specify

   

9. Have you had a recent (within the last 6 months) injury to the lower body that has received medical attention? **Yes No**

I certify that the above statements are true and correct. I understand that a Doctor's note may be requested. If a note is requested, I should not proceed with this experiment until the note is received.

_________________________  ________________________
Signature of Participant             Date
REFERENCES


