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STATIC STRETCHING ENHANCES START ENTRY DISTANCE OF MALE SWIMMERS

RICHARD l. COMPTON jr
rcom_pto@hotmail.com

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by

Richard lee Compton

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Southern Illinois University Edwardsville
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Richard I. Compton

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Approved by:

Dr. Juliane P. Wallace, Chair

(Dr. Philip M. Anton)

Graduate School

Southern Illinois University Carbondale

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CHAPTER 1

INTRODUCTION

Warming-up prior to physical activity is a universally accepted practice in a sport setting. The objective of warm-up is to prepare for the upcoming event both mentally and physically. Despite limited scientific evidence supporting one protocol over another, this practice is believed to reduce injury and enhance athletic performance.

Despite the widely held opinion that warm-up is an essential part of training and performance, it is often overlooked. There are numerous benefits of a warm-up that have been suggested, but there are just as many repercussions for those who do not complete a proper warm-up, such as lack of oxygen to the heart which can result in abnormal heart performance.

In addition to facilitating optimal heart performance, a proper warm-up is theorized to contribute to increases in strength and power output, as well as improved nerve transmission speed and reaction time (Draper & Hodgson, 2008). Other proposed benefits of warm-up include: increase in the rate and strength of muscle contraction, increased muscle coordination and metabolic rate, increased work capacity and anaerobic capacity, increased efficiency of the neuromuscular system, and a reduction in the possibility of injury through increased muscle elasticity and improving joint range of motion (Siff & Verkhoshansky, 1999).

Warm-up is also theorized to elicit a reduction in the possibility of injury through increased muscle elasticity and improved joint range of motion (Siff & Verkhoshansky, 1999). An increased range of motion could also potentially prolong one's active sporting life, as well as improve the ability to delay the onset of muscular fatigue and decrease the severity of injury. All of these benefits are useful to individuals from both an exercise training and performance perspective (Siff & Verkhoshansky, 1999).

Many coaches have different opinions of what a warm-up is or even how to develop a proper warm-up for their athletes. One definition from Siff and Verkhoshansky (1999, 160) "is to raise the body to the necessary work capacity". The authors describe different types of warm-ups, general and specific. The general warm-up is designed to "increase the functional potential of the body in a whole" and the specific warm-up is designed to "establish the optimal relationship between the forthcoming movement and the activities of the central nervous system which are associated with that movement."

In the past, warm-up consisted of static-stretching exercises, but in the last decade, the use of dynamic stretching during warm-up has gained popularity (American Red Cross, (2009). Yamaguchi and Ishii (2005), found that dynamic stretching increased leg extension power significantly in healthy college males. It is possible that an increase in leg extension power could translate to an improvement in sport-related skills.

As stated earlier, the effect of a stretched muscle is believed to help reduce muscular injuries, but stretching has been found to have a negative effect on force production. One study showed static stretching to be a detriment to lower body power as measured by the Biodex System 3 isokinetic dynamometer at four joint angles (41,61,81 and 101 degrees) (Herda, Cramer, Ryan, McHugh, & Stout, 2008). The population used was 25 years of age and none were competitive athletes but all were recreationally trained. The results showed that peak torque decreased after static stretching at angles 81 and 101degrees but not other angles. Dynamic stretching resulted in no changes in peak torque at any angle.

Young and Elliot (2001) examined combination stretching techniques. The authors found that a combination of static stretches and proprioceptive neuromuscular facilitation (PNF) stretching produced greater explosive force production and enhanced jumping performance compared to static stretching alone. In this study, static stretching alone was found to elicit a significant decrement in performance, particularly related to jumping.

Beedle, Rytter, Healy, and Ward (2008) found no significant differences in power output in the bench press or leg press between dynamic or static stretching; however there were variations in the results generated by the different techniques. In this study, both genders were examined. In the male participants, the static stretching condition elicited a performance that was 7.1 Newtons (N) greater in the bench press than the dynamic condition, but the no stretch condition had 1.2 (N) greater than the static stretch group. For the female group bench press, the dynamic stretching condition had a 3.1 (N) increase over the static stretch condition but the no stretch group had 1.4 (N) over the dynamic stretch group. As for the leg press, the dynamic stretch condition outperformed the static stretch condition in the male group by 57.4 (N) but the no stretch condition was greater than the dynamic stretch condition by 23.9 (N). In the female category, there was a different outcome. The dynamic stretch had the overall best outcome. The dynamic stretch condition had 1845.9 (N) which outperformed the static stretch condition by 22 (N), and the no stretch condition by 17.8 (N). The results of this study may indicate that there may be gender differences as well as muscle group differences in the effect of stretching protocol.

Another study had results that were somewhat similar to the Beedle et al. study. Church, Wiggins, Moore and Crist (2001) measured lower body force production with the vertical jump under three different conditions, static stretching, PNF stretching, and no stretching. The researchers found static stretching to have much better results than that of PNF stretching; however no stretching had the best results of the three.

The relationship between strength and starting performance has been examined in a number of sports (bobsleigh, track & field and football). Interestingly, in the studies that have examined the influence of different stretch routines on start performance, the results have been mixed. Some show static stretching is a detriment, while dynamic and no stretch had no advantage. Others have shown that dynamic stretching is imperative to have positive results. Jaggers, Swank, Frost, & Lee (2008) compared the difference between ballistic, dynamic, and no stretching on vertical height, power, and force. The data was collected on a Kistler Quattro Force Plate. The subjects were ten women and ten men (healthy college students) between the ages of 21-34. The results showed no difference between no stretch and ballistic stretch, or between no stretch with dynamic stretch for jump height or force.

To date, no studies have been completed focusing on the impact of differing stretch routines on start entry distance in collegiate swimmers. A greater distance reached off the blocks at the start of a swimming event could be the difference between winning and losing. If a specific warm-up will enable a better start entry distance for a swimmer, this could contribute greatly to their chance of success. The purpose of this study was to compare the effect of a dynamic warm up with that of a static-stretch warm up or no warm up on the start entry distance of male collegiate swimmers. The independent variable is the type of warm-up stretching and the dependent variable is the start entry distance. The dynamic warm up protocol mimicked the power requirements of many sports, so I hypothesized that it would result in performance enhancement relative to the static warm up or no warm up conditions.

CHAPTER 2

METHODS

This study was designed to determine the effects of static stretching, dynamic stretching, or no stretching on the start entry distance of male swimmers.

Participants

Participants included eight male swimmers from the Southern Illinois University swim team, with height measurements ranging from 173 – 196 cm, a mean age of 21 years, a mean body mass of 81 kg and a mean body fat percentage of 9 percent. The average years of swimming experience for the participants ranged from twelve to seventeen. All participants were eligible to participate in intercollegiate athletics according to the guidelines established by the National Collegiate Athletic Association (NCAA). All subjects were free from injury and able to perform stretching techniques and start movements without pain. Written informed consent was gathered from each participant on an SIUC Human Subject Committee approved form.

Measurements and Apparatus

The participants were weighed and measured on a digital scale (Tenita BWB-800), and the video was captured on a Sony Handy cam DCR-HC26. The stabilizing mechanism was a tripod from One Source Network (OSNUSA MX 2000).

Procedures

The purpose and procedures of the study were explained to the participants prior to testing. Participants reported to the pool for testing on three separate occasions. On the first day, informed consent was completed, anthropometric status was determined and the participants were randomly assigned to one of the three conditions (dynamic, static or no stretching). Each participant went through a warm-up then reported to their conditioning group to complete the prescribed stretching routine.

In each session, the quadriceps, hamstrings, adductors, abductors, hip flexors plantar flexors, and lower back muscles were stretched in either a dynamic or static stretch routine, as these are the prime movers in the start for swimmers. The exception was the control group, in which no stretch was prescribed. Prior to a usual training or performance session, the subject typically engaged in a swimmers warm-up routine.

Static stretches included:

One-leg hurdler:

Sitting on the floor, with the right leg bent, with your right heel just outside your right hip. The left leg is straight, bending at the hips reach towards the left toes until you feel a stretch, hold for the time assigned. Know slowly lean straight back until you feel a stretch in the quadriceps. Ensure you keep the knee on the ground.

Butterfly:

Sitting on the floor, put the soles of your feet together and hold onto your toes. Gently pull yourself forward, bending from the hips, until you feel a stretch in your groin.

Bent-knee calf stretch:

Stand a little ways from a solid support and lean on it with your forearms, head resting on your hands. Bend one leg and place your foot on the ground in front of you, with the other leg straight behind. Slowly move your hips forward, keeping your lower back flat. Be sure to keep the heel of the straight leg on the ground, with toes pointed straight ahead or slightly turned in as you hold the stretch.

Side quad stretch:

Lie on your left side and rest your head in your left palm. Hold the top of your right foot with your right hand between the toes and ankle joint. Gently pull the right heel toward the right glute to stretch the ankle and quadriceps

Kneeling hip thrust:

This stretch will stretch the muscles in front of the hip, called the iliopsoas. Move one leg forward until the knee of the forward leg is directly over the ankle. Your other knee should be resting on the floor. Now, in this position with one knee on the floor and the other foot forward lower your hip downward to create an easy stretch. Hold this position then switch legs.

Seated pretzel:

Sit with your legs crossed, the left leg on the bottom, left heel just off the right hip. The right leg crosses on top of the left, and the knee is high in front of the midline of the body, with the sole of the foot resting on the floor. Wrap your left arm around your right leg, left elbow near right knee. Ensure you sit tall or the benefits of the stretch will be lost. Know twist clockwise, bringing your right arm behind you to assist in propping you up, hold.

Seated figure four:

Sitting on the floor, straighten the right leg as you keep the left leg bent. The sole of the left foot should be facing the inside of the right upper leg. This will put you in the straight leg bent knee position. Now, to stretch the hamstring and the left side of the lower back bend forward from your hips until the slightest, easiest feeling of the stretch is created. Then switch legs and follow the same procedures.

Knee tuck to chest:

Lying on your back with legs straight and your arms straight back, pull both knees into your chest grabbing with your hands. Slowly curl your head up toward your knees until you feel a stretch, hold.

Each of these static stretches was performed to a point of mild discomfort for thirty seconds. Thirty seconds was chosen because this is the normal time duration for stretches to be performed by athletes (Roundtree, 2008).

In the dynamic stretch routine, the stretches consisted of:

Walking bent over ankle grab and hold:

This exercise you will take a step bend at the waist grab the lead ankle and hold for a two second count. Continue until you have covered a twenty yard distance alternating ankles.

Standing ankle grab:

Your weight is on your left foot as your right knee flexes and the right hand takes the top of the foot or ankle, your knee should remain under your hip and inline with the left knee. The waist is level, and the shoulders are square. Now kick your right foot into your right hand sending into space.

Standing knee hug:

In a standing position flex the hip bringing your knee towards your chest, grab your knee with both hands and pull towards your chest. Hold this position for a three count and repeat the other knee.

Bent knee twist:

Sitting up with leg crossed, the left leg on the bottom, left heel just outside the right hip. The right leg crosses on top of the left, and the knee is high in front of the midline of the body, with the sole of the foot resting on the floor. Wrap your left arm around your right leg, left elbow near right knee. Sit tall inhale and rotate clockwise, bring your right arm behind you to help prop you up as your exhale twist.

Walking figure four:

Standing tall bring your right ankle toward your groin or midline of your pelvis, grab ankle with left hand and push your knee toward the floor with the right hand, continue for a twenty yard distance.

Cat-camel:

Start with hands and knees on the floor, resting the tops of your feet on the floor. Move into the camel position by lifting your tailbone high tilting your pelvis forward, dropping your belly towards the floor, drawing your chest forward, and keeping your shoulders low as you gently look up. On the exhalation move or the "cat" position, scoop the tailbone under; tilt the pelvis back, and round your back and shoulders while your bellybutton draws toward your spine. Continue moving from cat camel positions for prescribed reps.

These stretches were performed in a dynamic movement for repetitions of five on each stretch or a twenty yard distance.

For each testing condition, once all stretches were completed, the swimmers performed 3 starts from the starting platform, and each start was measured with a measuring tape in the pool, placed on the lane buoys, while I was in the pool to mark the entry point and video recorded to ensure accuracy of measurement. Each measurement was taken at the finger tips of the entry, by each participant. Once the three starts were completed, the subjects were encouraged to proceed with their normal activities until the next testing day. There was a seventy hour window between testing sessions to ensure the participant recovered from the last testing session. The participant would start on their own cadence and then the participant would have two minutes between each of the three starts. Each of the three groups came in at separate times so none of the participants had any extra wait time due to waiting for a group to finish.

Analysis

Differences in start distances in this within participant design were analyzed using a simple repeated measures analysis of variance (PASW 18). Differences were considered statistically significant if $p < .05$. The video camera was set up to video the area where the participant would enter the water. Within the view of the camera was a measuring tape so confirmation could be made after results where collected.

CHAPTER 3

RESULTS

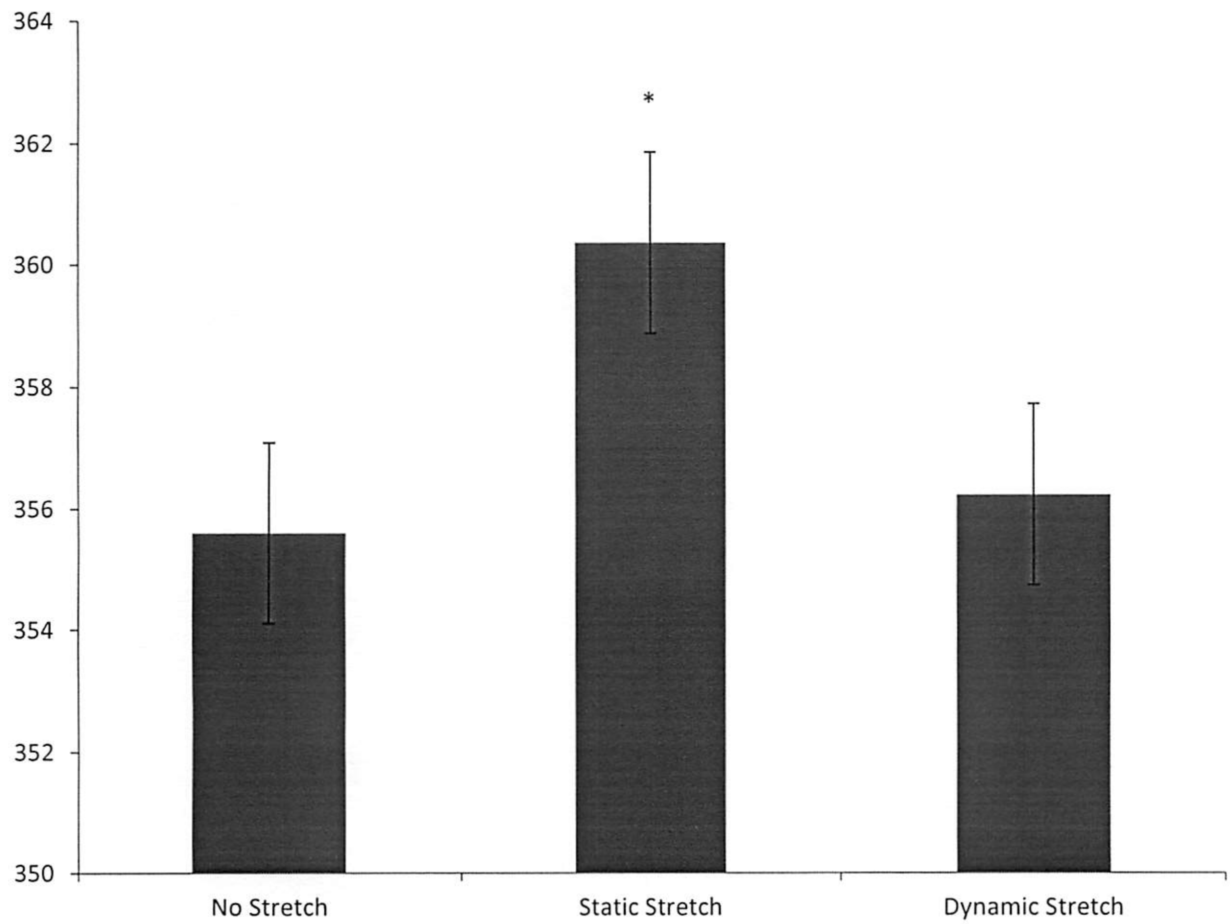
Table 1. Participant characteristics

Number of Participants	Age (yrs)	Height (cm)	Body mass (kg)	Bodyfat %
8	21 ± 2	183 ± 10	81 ± 9	9 ± 5

Mean ± standard deviation

The static stretch trials resulted in a significantly greater start entry distance (*p<.05)* than dynamic or no stretch trials. In Figure 1, the static stretch showed results at 360cm ± 2cm, and dynamic stretch at 356cm ± 2cm. The no- stretch condition was not different than the dynamic stretch condition.

Figure 1. Start entry distance (cm)



CHAPTER 4

DISCUSSION

The aim of this study was to determine what warm-up elicited the best start entry distance in male collegiate swimmers. As stated in the introduction, research on the impact of different warm-up techniques is somewhat mixed (Beedle et al, 2001; Church et al., 2001; Herda et al., 2008; Jaggers et al., 2008; Yamaguchi & Ishii, 2005; Young & Elliot, 2001) but the prevailing opinion among most exercise professionals is that dynamic stretching is the superior technique (American Red Cross, 2009; Draper & Hodgson, 2008; Siff & Verkhoshansky, 1999). Ironically, the opposite was true in this study, with static stretching having slightly better start entry distance over the dynamic or no stretch protocols.

During the review of literature, no studies were found concerning the effects of different stretching routines on the start entry distance of swimmers. As stated earlier,most of the studies completed have looked at the differences in lower body force production, for example the study by Church, Wiggins, Moode, & Crist (2001). The relationship between strength and starting performance has been shown to exist in other sports other than swimming (bobsleigh, track & field and football). Interestingly, in the studies that have included different stretch routines, the results have been mixed (Jaggers, Swank, Frost, Lee, 2008). Some show static stretching is a detriment, while dynamic and no stretch had no advantage. While some have shown that a dynamic stretch is imperative to have positive results.

Young and Elliot (2001) found that a combination of static stretches and PNF stretching produced greater explosive force production and enhanced jumping performance compared to static stretching alone. Even though this is not swimming related the movements are comparable. The static stretching was found to have a significant decrement in performance, and resulted in the worst performance results in jump performance. Church, Wiggins, Moore and Crist (2001) found static stretching to have much better results than that of PNF stretching, but ironically no stretching had the best results of the three. It is clear that there is still a lot of confusion regarding the most appropriate warm up technique; however, the study does give some support to the use of static stretching.

It should be noted that static stretching has shown to be a beneficial form of warm up stretching for general non athletic populations (Beedle, Rytter, Healy, Ward, 2008). The fact that differences were observed might be a function of the population studied. Due to the quantity of training and the ability of the body to adapt to the stress being applied, low active populations can show different results compared to highly active populations and this may have had a influence on the results of our study.

It must be noted that the start entry distance differences between the techniques was quite small: 4 cm ± 2. Four centimeters equates to roughly 1.6 inches, which is approximately the distance from the middle knuckle to the tip of the finger. Whether or not a distance advantage this small would equate to a significantly improved performance time would be a matter of considerable debate. Athletes are always looking for any advantage they can find ("every inch counts") and it is possible that this start distance advantage could be the difference between winning and losing. If you take into consideration that the difference between gold and silver medals in one swimming event at the most recent Olympics was a mere one-thousandth of a second which was less than one inch, it is possible that any advantage will help at high level athletes in competition.

Even though steps were taken to control variability, sources of potential error still remained in the present study. The participants were not monitored for their nutritional intake or activity level during their rest period, this could have affected the results specifically, if the participant had a high fat meal prior to one test then a high carbohydrate meal on another or didn't get enough sleep the night prior. This could affect the energy levels available to the athlete, which could affect the final results. Another source of potential error would be the camera used to record the start trials. The camera was a common video recorder and wasn't zoomed in on each participant's attempt. With the small measurement difference of 4 ± 2cm between the conditions, this could easily have created discrepancy of the final measurements and further reduced the practical significance of the group differences. The sample size was relatively small; if there was a larger sample size then the results may have been different as a larger sample size more accurately mimics the population being studied.

As there are more studies done to determine the best warm up and stretching styles to use, coaches and researchers may want to look at a neuromuscular explanation as to the decrease in force production following stretching. Avela, Kryolainen, and Komi (1999), measured reflex sensitivity of muscles following repeated passive stretching, with results showing a decrease in force production following stretching. They claim these results were attributed to a reduction in the sensitivity of the muscle spindles to repeated stretching.

In conclusion, the goal for the study was to determine if there was a significant swim start performance advantage with a particular stretch mechanism following a general warm-up. This study demonstrated that a static stretch protocol could have at least a minor positive effect on swimmers starts. It is possible that the extremely small distance differences shown in this study could be valuable to a sprint swimmer but may not have an advantage for a distance swimmer.

Maximum performance in athletics is an important goal regardless of the event. Coaches and athletes are continuously striving to find every advantage in competition. If a specific warm-up and stretching protocol can provide that advantage, then it could be the difference between winning and losing. It is worth noting that even with no stretch or a dynamic stretch routine, the results were not detrimental as was the case in other studies on power production. Athletes have participated in many different styles of warm-up routines that they are comfortable with. Even though there are many positives to a warm-up such as decreasing the chances of injury, and increasing the core temperature, the best method of warm-up stretching routine still needs to be determined with greater certainty.

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VITA

Graduate School

Southern Illinois University

Richard I. Compton Jr.

rcom_pto@hotmail.com

Southern Illinois University at Edwardsville

Bachelor of Science, Kinesiology, May 2005

Research Title:

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Major Professor: Juliane P. Wallace, Ph.D.