A STUDY ON THE ACUTE EFFECTS OF YOGA AND DYNAMIC STRETCHING

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DEDICATION

I would like to dedicate this thesis to my parents. Thank you for all of your support and guidance along the way.

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First I would like to thank Dr. Adam Parker, for he has made this entire process possible. Without his support, guidance and feedback, I would not have been able to complete this thesis. He has put forth great time and effort through being both my research supervisor and now my committee chair, and I heartily appreciate it.

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ABSTRACT

This study was performed in order to determine which stretching style impacts acute range of motion more, static yoga stretching or dynamic stretching. Eighteen participants between the ages of nineteen and twenty four were recruited from Angelo State University. Participants were subjected to a series of range of motion tests targeting major muscle groups. These tests were performed once for a control score, then two more times following static and dynamic stretching sessions. Statistical analysis revealed significant improvement on all tests between the control scores and the interventions. Analysis also revealed that yoga improved scores significantly more than dynamic stretching in the Sit and Reach test. Based on this information it is clear that there are benefits obtained by engaging in both static and dynamic stretch routines, though for some regions of the body yoga may be more effective at increasing range of motion.

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INTRODUCTION

The efficacy of stretching as a warm-up has long been disputed throughout the realm of sports. The positive effects of stretching such as increasing flexibility, injury prevention, and acute increases in range of motion depend largely upon the specific type of stretching performed (Smith 1999; Young & Behm 2002). Stretching is frequently split into two different categories, static stretching or stretching at rest, and dynamic stretching or stretching with movement (Zakaria & Kiningham 2015). This distinction is very important when talking about an effective warm-up, as they both have different acute and chronic effects. McHugh & Cosgrave (2010) found that static stretching is generally associated with a muscular inhibitory effect that can lead to stretch-induced strength loss.

In contrast, many sports rely on a high range of motion and could benefit more from the stretch than they lose from the inhibitory effect. Those sports could include but are not limited to gymnastics, ballet, or swimming. It is also important to notice that there is a difference between the frequently tested muscular strength, and the more applicable measure of performance (McHugh & Cosgrave 2010). Mann & Jones (2000) state that dynamic stretching has the potential benefit of increasing the ability for connective tissue to react to injury causing forces; it may also warm up the muscles, preparing them for rigorous activity. Fletcher & Anness (2007) studied the effects of a mixed dynamic and static warm-up and found it to be detrimental to sprinting performance in a study on eighteen sprinters from track-and-field clubs. Fletcher & Anness' (2007) study used a traditional warm-up as the

control and a combination of jogging and designated passive stretches targeting the muscles involved with sprinting as the intervention. Fletcher and Anness (2007) attribute the worsening sprinting performance to more compliant muscle tissue after passive stretching causing the muscle to store less elastic energy and by extension less efficient force transfer from the muscle to the tendon. Fletcher and Anness (2007) divided dynamic stretching into two categories, active dynamic and static dynamic. This division helps to illustrate that stretching is more of a gradient with passive static stretching on one end and active dynamic stretching on the other (Fletcher & Anness 2007).

In the lower limbs alone the efficacy of incorporating a static stretching element in a warm-up is largely debated in regards to injury prevention. Soligard et al. (2008) study of soccer athletes reveal that a warm-up routine consisting of dynamic and static stretching can significantly lower the risk of overall injuries, overuse injuries, and severe injuries in lower extremities. There was a total 1055 players in the intervention group of which 161 were injured, and 837 players in the control group of which 215 were injured. Soligard et al. (2008) recognized that non-compliance and improper technique in the warm-up protocol causes degradation of the data. In an effort to prevent this, they held a conference to demonstrate proper form in the warm-up, contacted the coaches regularly by email and telephone, and even offered soccer balls to those clubs who completed the study. Pope, Herbert, Kirwan, and Graham (2000) also examined the effects of static stretching prior to exercise as it relates to the prevention of lower-limb injuries in army recruits during twelve weeks of training. In this study 1538 male army recruits were randomly placed into a static stretch or control group. The control performed active warm-up exercises and the static

group performed a twenty second static stretch for each major muscle group in the leg in addition to the regular warm-up. In total there was 158 injured in the static stretching group and 175 injured in the control group. While the researchers found no statistically significant effect of static stretching (Pope et al. 2000), the difference between the two groups is certainly worth noting. In contrast Zakaria and Kiningham (2015) studied a number of high school soccer teams during season using two warm-up stretch routines, a combination group with static and dynamic stretching (D+S) and another group that only performed dynamic stretching. Athletic Trainers diagnosed injuries among these athletes throughout the season and reported back to the researchers. Zakaria and Kiningham (2015) found no effect of static stretching on injury prevention.

Because of the possible sacrifice in performance in static stretching and the debated benefits, many sport instructors have turned to a purely dynamic warm-up and cut out static elements entirely (Young & Behm 2002). There are other reasons for this decision as well. Mann and Jones (2000) state that static stretching may not increase the core body temperature enough to be a proper warm-up, or that these exercises do not keep the athlete engaged and focused enough. This contributed to the decision to use yoga poses as the static stretching intervention for this research. Yoga is engaging, potentially increases core body temperature, and may overcome the negative physiological effects of traditional static stretching. By extension yoga could be recommended as a major component of a warm-up for sports involving a large range of motion. Further, yoga offers a number of proven psychological benefits that fall beyond the scope of this study, as well as proven physical benefits beyond just improving range of motion, further warranting the practice. Fishman,

Groessl, and Sherman (2014) conducted a long term study reporting on the impact of yoga for idiopathic and degenerative scoliosis. They tested twenty-five patients with idiopathic or degenerative scoliosis, measured the curvature of their spine, and then instructed them in proper technique of the side plank pose. The participant's spine was then measured three to twenty-two months later and analyzed. A significant improvement of the angle of the primary scoliotic curve was found among all patients (Fishman et al. 2014). A study performed by Kanaya et al. (2014) has shown that yoga also may be effective in improving fasting blood glucose in type II diabetes patients. This study consisted of a randomized large scale group of participants that engaged in restorative yoga, measuring it against traditional stretching in relationship to metabolic outcomes and quality of life measured at six months and twelve months. Improvements in weight, systolic blood pressure, fasting insulin, and triglyceride levels were also observed. Another study by Gothe and McAuley (2016) compared yoga with stretching-strengthening exercises. The researchers looked at a series of yoga poses in relationship to conventional stretching-strengthening exercises. They found that yoga resulted in significant improvements in balance, mobility, and flexibility suggesting that yoga may be just as effective as stretching-strengthening exercises. Gothe and McAuley (2016) go as far as to say yoga may serve as a therapy alternative in order to improve balance, mobility, and strength among older adults. This in conjunction with other research certainly warrants yoga as a topic for further studies.

While extensive research has been done on the topic of static versus dynamic stretching, a number of factors set this research apart from what has been looked at before in depth. One such factor is the use of yoga as a static stretch. A large quantity of research has

been done on static stretching, but little has been done on the acute effects of yoga specifically. Another difference is the age range targeted by this research. It seems the college aged population is less often studied when it comes to flexibility and range of motion. The last factor that sets this research apart is the wait period in between each stretching session which is often overlooked in spite of the long term effects known to be experienced after stretching. This effect was demonstrated by Weijer, Gorniak, and Shamus (2003) in a study on the lasting effects of static stretching on hamstring length. In their study, participants performed a static stretch routine in order to lengthen the hamstrings. Hamstring length was measured over the course of twenty-four hours to determine changes over time. Weijer et al. (2003) concluded that a static stretching intervention yielded a significant increase in hamstring length after twenty-four hours.

METHODS

Experimental approach to the problem

In order to determine which stretching style impacts acute range of motion the most, the independent and dependent variables were chosen to reflect the hypothesis that yoga may yield benefits similar to that of dynamic stretch routines. The major independent variable in this study was the stretching intervention. The major dependent variable in this study was the results of the range of motion tests. The participants were asked to perform three trials of three different range of motion (ROM) tests. The first test was performed as a control; the second and third tests were preceded by either a static or a dynamic stretch routine. The ROM tests consisted of the Sit and Reach test in order to measure hamstring extensibility and lumber spine flexibility, the Yardstick test to determine shoulder rotational flexibility, and the Standing Trunk Rotation test to determine overall trunk flexibility (Mayorga-Vega, D., Merino-Marban, R., & Viciana, J. 2014). These tests were chosen in order to assess the major muscle groups used in most sporting activities. Both the static and dynamic stretch routines were tailored to focus on these muscle groups as well. A number of precautions were taken in order to minimize outside factors interfering with the data. The participants were told not to engage in their own stretching routine in order to ensure that the range of motion test result was related primarily to the intervention and nothing else. Each trial was performed a minimum of one day apart in order to prevent the long term effects of stretching during the prior trial from corrupting the results (Weijer et al. 2003). In order to minimize the possibility of acute motor learning significantly impacting the test results, participants performed each range of motion test three times and the primary investigator analyzed the

best of those three. The order of the intervention was also randomized for each participant in order to see if motor learning was more impactful than the stretching intervention. This possibility would be indicated by a significant increase in performance from the first trial to the third trial regardless of the intervention itself.

Subjects

Each participant completed a questionnaire seeking information in regards to past injuries and preexisting medical conditions that would interfere with the data. Participants who were chosen for the study did not report any preexisting conditions that could have altered the results. Before taking part in this study, all participants read and signed an informed consent waiver previously approved by the Institutional Review Board at Angelo State University. Participants were Angelo State University students between the ages of nineteen and twenty-four. The investigators collected data from a total of eighteen individuals, nine females and nine males. The study was done on a volunteer basis after having contacted the investigators and having satisfied the physical requirements of the test. Many did not complete all three testing sessions, therefore the data for these participants was not included in this study.

Procedures

The participants were first screened for eligibility to participate in the study, then requested to read and fill out an informed consent form approved by the Institutional Review Board. After the participants were determined to be eligible, they then began the control session. Prior to any testing, the participant was made aware that they may experience minor

discomfort during the tests and interventions, but should it escalate to pain the participant should stop immediately and inform the investigator. The control session consisted of assigning the participants a number, collecting their height, weight, and age, and then their performance of the control tests. The control tests were three different ROM assessments performed without intervention. The first test performed was the Yardstick test as seen in Figure 1. This test consists of the participant holding a yardstick in front of his or her body

Figure 1: Yardstick Test

with both hands in full pronation, then proceeding to attempt to put it over his or her head and behind the back without a bend developing in the elbow. The closer the hands are to one another the more rotational shoulder flexibility is needed to complete the test. The tape measure on the yardstick is then observed by the investigator to determine the distance between the hands to the nearest inch. In this instance, smaller scores indicate a greater level of flexibility. The participant performed this test three times in total before moving on to the

next. After completion, the participants then performed the Standing Trunk Rotation test as seen in Figure 2. This test consists of a participant standing at a marked spot in between two posts connected by a rail with a lever attached. The participant then performs a full body rotation without moving the feet in order to push the lever from one side to the other. Once the participant has reached their maximum rotation, the investigator then observed the number

Figure 2: Standing Trunk Rotation

of inches the lever had been pushed. Flicking the lever at the end of the movement was discouraged as this could have corrupted the results of the test. The further the lever was pushed without the hand leaving the lever or the feet moving, the higher the level of full body rotational flexibility. In this test, higher scores indicate better performance. The participant performed this test three times on both the right and left side; this was achieved by having them face opposite directions on the indicated line on the floor. After a total of six valid

scores, the participant proceeded to the next test. After successful completion of the Standing Trunk Rotation, the participants then moved to the Sit and Reach test as seen in Figure 3. This test involves the participant taking their shoes off and sitting against a wall. The investigator then pushes the Sit and Reach apparatus against the feet of the participant until the feet are flat against the device and the back is flat against the wall. The participant then would reach forward to push a lever towards the end of the apparatus. The higher the number of inches, the higher the level of hamstring extensibility and lumbar spine flexibility is indicated.

Figure 3: Sit and Reach Test

After three performances, the participant was then finished with the control tests. The participants were informed to refrain from engaging in their own stretching routine during the time in which they were participating in the study. The schedule for the following two

sessions was then established with at least two days in between, and contact information was given.

The second session consisted of a series of stretches performed before the range of motion tests mentioned above. In order to randomize the type of stretching intervention that would occur first, the investigator flipped a coin, heads indicating dynamic and tails for yoga. The yoga stretching sequence consisted of four different poses aimed at stretching the muscle groups targeted by the range of motion tests. In order to better ensure quality form, the investigator demonstrated the pose prior to the participant performing it. Participants held each pose for fifteen seconds or until exhaustion. Some breathing techniques were discussed in order to increase the benefit of the stretch. The first stretch performed, "Lunge with a Twist," targeted full body rotational flexibility. The second pose, "Downward Facing Dog," aimed to increase shoulder rotational flexibility as well as hip flexibility. The third pose performed, "Criss-Cross," targeted shoulder and upper back flexibility. The final pose performed, "Pigeon Pose," intended to increase hamstring extensibility and lower spine flexibility. The participant was informed that if the stretching interventions became painful or too difficult, alternative poses may be used. None of the participants required this adaptation. The alternative stretches were "Wide Legged Forward Bend" and "Warrior 2". After having successfully performed all of the interventions, the participant then immediately began the ROM tests in the same sequence as in the control.

The final session consisted of a series of dynamic stretches in the event that the participant performed the yoga intervention first, or yoga stretches if the participant performed dynamic first. The dynamic stretching sequence consisted of three exercises

targeting the same major muscle groups as the yoga stretching and tested by the ROM tests. The investigator first gave a demonstration of the stretch, followed by the participant performing the stretch. Each stretch consisted of ten repetitions on both sides in order to keep the time frame similar to that of the yoga stretching. The first of the dynamic stretches performed was Walking Lunges. Investigators instructed participants to keep their hands above their head whilst dropping in, then bouncing out of the lunge. This stretch targeted hip and hamstring extensibility. Participants repeated the lunge movement ten times leading with one leg, then ten times leading with the other. The second dynamic stretch performed was Arm Circles. The participants were instructed to keep their arms straight and out to their sides, making circles as wide as possible, performing ten rotations forward and ten rotations backwards. This stretch promoted shoulder rotational flexibility. The final stretch performed is known as Leg Swings. The participant was instructed to hold onto an object or the wall, then proceed to keep one leg straight and swing their other leg on the inside and outside of the straight leg, ten times in front of the leg, and ten times behind, whilst attempting to get the swinging leg higher and higher. The participant was then instructed to do the same motion with the opposite leg straight. This stretch targeted improvement of hip flexibility and lower back flexibility. After the participants finished all three stretching exercises, they then immediately performed the ROM tests in the same order as the control. After the tests were completed, the participant was then shown their results with emphasis put on improvements between their control tests and their tests with interventions.

Statistical Analysis

All dependent variables were analyzed using IBM SPSS Statistics 21. Paired samples t-tests were used for each dependent variable including sit and reach, rightward trunk rotation, leftward trunk rotation, and yardstick test. An alpha level of $p < 0.05$ was used to determine statistical significance.

RESULTS

In support of the investigators' hypothesis, the primary finding as seen below is that the yoga stretching intervention positively impacted the results of the range of motion tests either similarly or, in the case of the Sit and Reach test, significantly more than the dynamic stretch routine. When comparing the results of the dynamic intervention with the yoga intervention on the yardstick test, there was no significantly better intervention ($t = 1.636$, $p = .120$). There was no significant difference between dynamic and yoga on the left or right side standing trunk rotation either ($t = .089$, $p = .893$ / $t = -.136$, $p = 0.930$). The sit and reach test was the only test showing a significantly superior intervention, that being yoga ($t = 4.44$, $p = .000$).

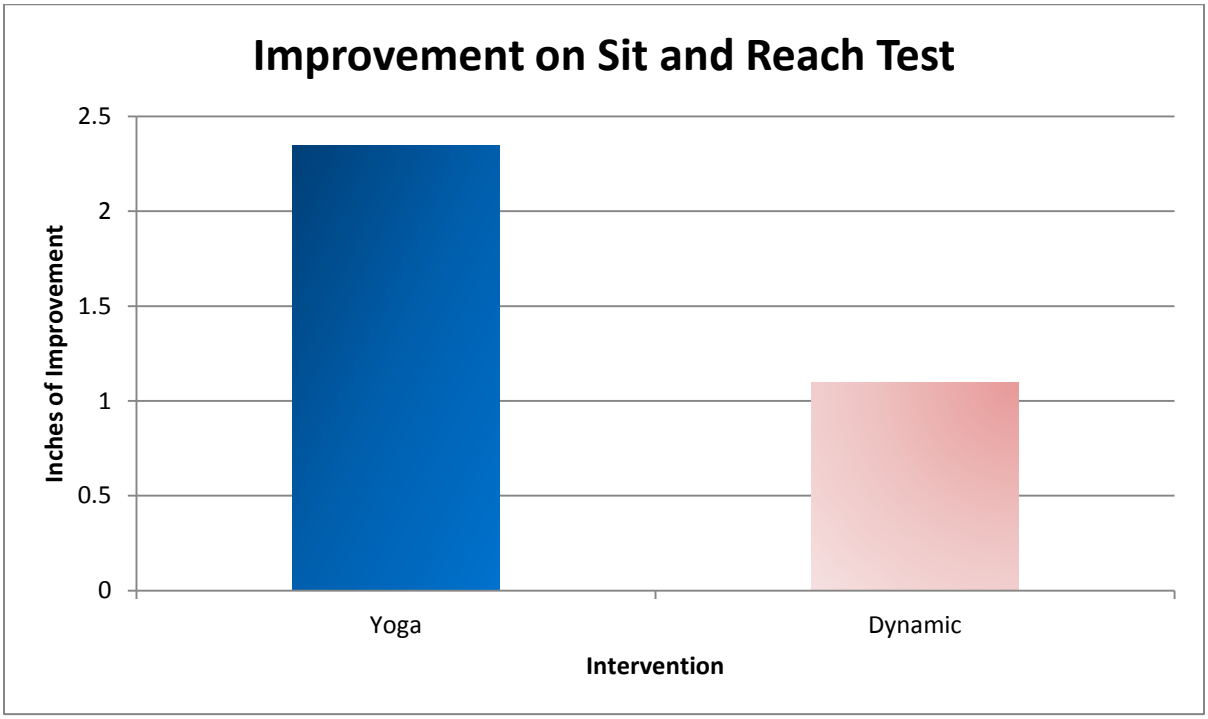

Figure 4: Improvement on Sit and Reach Test (Mean = 2.35 in. SD ±2.44 in. / Mean = 1.10 in. SD ±2.07 in.)

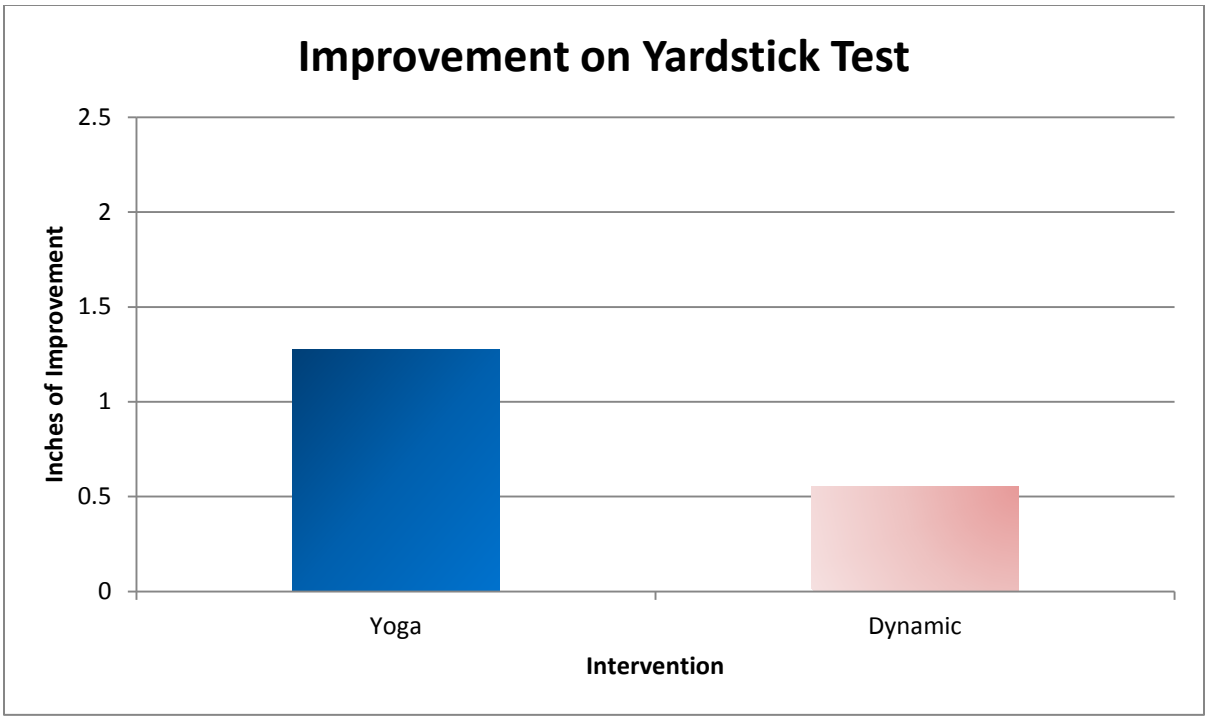

Figure 5: Improvement on Yardstick Test (Mean = 1.28 in. SD ±2.65 in. / Mean = .556 in. SD ±2.87 in.)

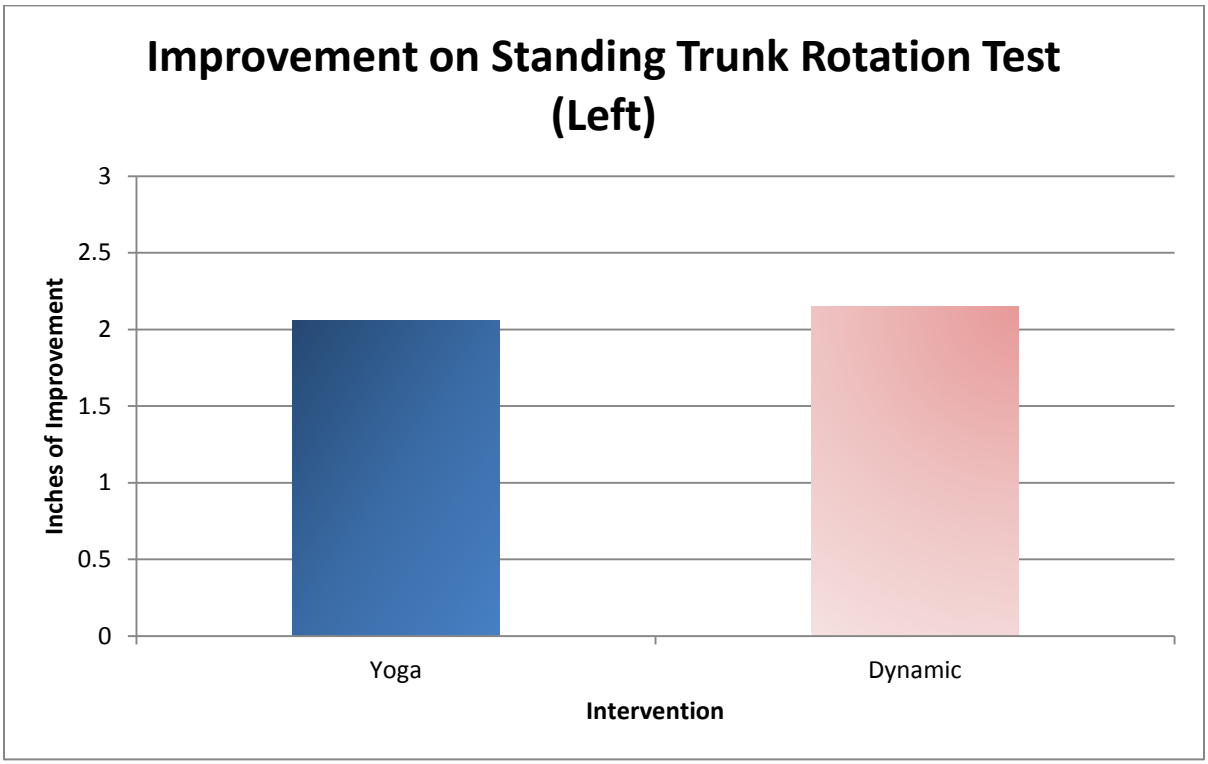

Figure 6: Improvement on Standing Trunk Rotation Test (Left) (Mean = 2.06 in. SD ±3.58 in. / Mean = 2.15 in. SD ± 3.09 in.)

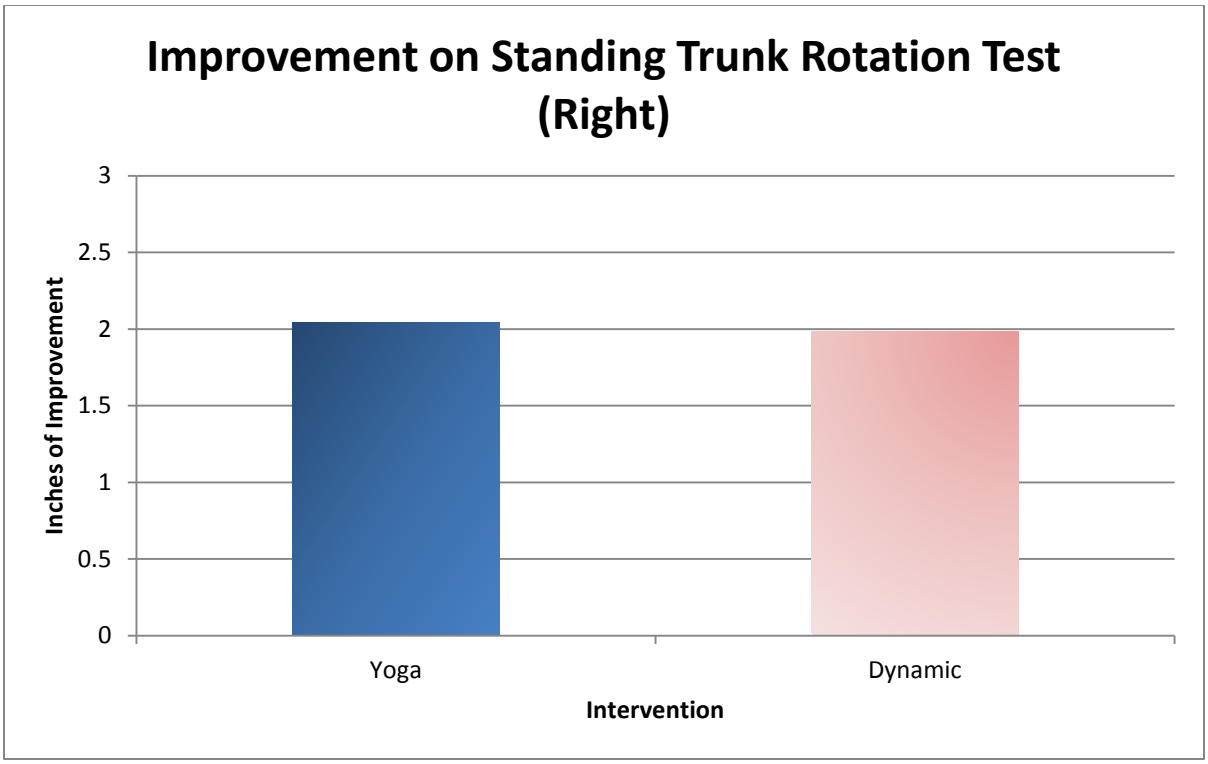

Figure 7: Improvement on Standing Trunk Rotation Test (Right) (Mean = 2.04 in. SD ±2.85 in. / Mean = 1.99 in. SD ±2.20 in.)

Significance was found in all of the intervention tests as they relate to the participant's control score. This finding, as shown in the chart below, indicates that both the dynamic and yoga stretching interventions significantly impacted joint range of motion as measured by the Standing Trunk Rotation tests, Sit and Reach test, and the Yardstick test. It is important to note that on the Yardstick test, the lower the score in inches the larger the joint range of motion.

	Avg Control (SD)	Avg Dynamic (SD)	Avg Yoga (SD)
YS	32.28 (9.49)	31.72 (10.0)	31.00 (10.1)
STR (L)	22.64 (5.35)	24.79 (4.53)	24.69 (5.96)
STR (R)	22.26 (5.53)	24.25 (5.46)	24.31 (6.16)
SR	13.99 (5.19)	15.08 (5.12)	16.33 (4.77)

Figure 8: Average Scores (Avg – Average STR – Standing Trunk Rotation, L – Left, R – Right, YS – Yardstick, SR – Sit and Reach, All scores in inches)

In the Sit and Reach test as seen in Figure 1, the participants improved an average of 2.35 inches (SD = ±2.44) from their control after the yoga stretching intervention. After a dynamic stretching intervention, they only improved an average of 1.10 inches (SD = ±2.067) from their control. The difference between these two tests proved to be statistically significant in favor of the yoga stretching intervention ($t = 4.44$, $p < 0.05$). In the Yardstick test, as depicted in Figure 2, there was an overall average improvement of 1.28 inches (SD = ±2.653 in.) from the control test after the yoga stretching intervention, whereas, with the dynamic intervention the participants only improved an average of .56 inches (SD = ±2.874 in.). The difference here did not prove to be statistically significant but warrants further investigation. Lastly in the standing trunk rotation tests, Figure 3 and 4, the participants improved an average of 2.06 inches (SD = ±3.58 in.) on the left side, and 2.04 inches (SD ±2.85 in.) on the right side after the yoga stretching intervention. For the dynamic intervention, the improvements were 2.15 inches (SD = ±3.09 in.) on the left, and 1.99 inches (SD = ±2.20 in.) on the right. The discrepancies between these two tests were negligible and it doesn't seem, based on the data, that the standing trunk rotation test is affected differently by dynamic or yoga stretching.

DISCUSSION

In support of the hypothesis, the main finding of this study is that using a static or dynamic stretch routine can significantly improve performance on joint range of motion tests. This increase in range of motion was similar for both static and dynamic interventions except in the case of the Sit and Reach test in which yoga stretching improved the performance significantly more than dynamic stretching. In general, the findings of this study are consistent with those of previous studies on static and dynamic stretching. These acute increases in range of motion could be due to any number of physiological reasons. Decreases in the stiffness of the resting muscle belly as shown in a study by Taniguchi, Shinohara, Nozaki, and Katayose (2015) involving ultrasound imaging measuring resting gastrocnemius muscles are one possible cause. Increased muscle-tendon compliance as hypothesized by Murphy, Di Santo, Alkanani, and Behm (2010) in a study on the combination of aerobic activity and static stretching on range of motion performance could be another. Yet another could be changes in viscoelastic properties of parallel series elastic components as stated by Esposito, Limonta, and Ce (2011). Regardless of the mechanism behind why there was an improvement in joint range of motion, a number of different conclusions may be drawn from these findings.

The results obtained from this study do not necessarily indicate a true increase in range of motion. The tests performed were developed in order to reflect such changes. If these tests are accurately reflecting true joint range of motion, then the conclusion could be made that static and dynamic stretching increase joint range of motion, and static stretching specifically should be used when high levels of hamstring extensibility and lower spine

flexibility are needed. From there, the practical applications must be looked at in relationship to increased range of motion from static and dynamic stretching. There are many studies aimed at measuring the impact of joint range of motion on sport performance, and there is highly conflicting data. Esposito et al. (2011) in a study measuring with a mechanomyogram (MMG) found that static stretching and by extension an increased range of motion may compromise force production through changes in viscoelastic characteristics thus degrading performance in many activities. Murphy et al. (2010) conducted a trial that combined a static stretch routine with aerobic exercises, then measured performance and range of motion. They concluded that there is in fact no impairment in their performance measures if the stretching is done under certain conditions and may in fact even increase performance in jump height, balance and movement time.

When observing range of motion as a measurement in inches, it is easy to see that greater reach can lead to greater performance in some sports. In the instance of rock climbing, an extra inch of reach can mean the difference between success and failure. Some sports may benefit more from the considerable increase in range of motion than they lose in the inhibitory effect of stretching. For sports such as these it is clear that a yoga or dynamic stretch routine prior to performance would be very beneficial. It is unclear in the scope of this study whether yoga can overcome the issues associated with traditional static stretching, though it is clear that it may be more effective than dynamic stretching at increasing range of motion in the lumbar spine and the hamstrings. Future research should target yoga poses specifically in relationship to decreases in maximal power output in order to see if the unique nature of yoga can circumvent the negative physiological changes associated with static

stretching. In the event that yoga has the same negative effect, it will still narrow down the possible physiological reasons as to why that decrease in power output is evident in so many studies.

There were a number of limitations in this study that warrant discussion. The first limitation is that the tests themselves could have acted as a form of stretching. For instance, it was clear that the yardstick test seemed to stretch the participant's shoulders a great deal, potentially impacting performance on both the Standing Trunk Rotation and Sit and Reach tests. The Standing Trunk Rotation test seemed to have a similar effect by stretching the lower back, and thus affecting the Sit and Reach results. Another possible limitation of this study is that the investigators intended for a representative sample from Angelo State University, though because of flyer placement and general interest in the study, the majority of the participants were fit and regular gym patrons. This had the potential to skew the results for a number of reasons. One such reason is that the physiology of fit individuals could differ considerably from that of those less fit as shown by Bliss (2013). Bliss (2013) examined a number of aerobically fit and unfit males in order to determine differences in physiological factors during hypoxia. He found that the fit group demonstrated higher SaO_2 (oxygen saturation of arterial blood) levels and a higher V_E (minute ventilation) during exercise in hypoxia. From that information he theorized that fit individuals may be more physiologically adapted to exercise. The population being primarily frequent patrons of the gym could also mean that some of the participants engaged in exercise prior to testing which would impact the performance on the tests as well.

Another possible limitation of this research is that the results achieved may not be as much from the interventions as from motor learning. In order to partially avoid this possibility, participants completed the test three times and the investigators took the best of those three times for analysis, assuming the test needed practice before optimum performance could be achieved. While this precaution may have limited the impact of motor learning on the results, it is also possible that as the participant performed each range of motion test more and more, they learned strategies to improve performance and thus obtained better test results regardless of the intervention. This phenomenon was shown by Frank, Land, and Schack (2016) in a study consisting of putting a golf ball towards a target to measure the influence of practice on performance. They found that practice of a given movement led to improved performance, thus it is possible that repetition of the range of motion tests led to improved performance. In order to further prevent motor learning from interfering, the investigators could have randomized the performance of all three trials, the control, the yoga stretching, and the dynamic stretching.

The delay in between testing sessions may have actually worked to further the potential skewing effect that motor learning may have had on our study as sleep has been found to increase motor learning outcomes as shown by Walker et al. (2003). Walker et al. (2003) conducted research aimed at measuring the effect of sleep on the development of motor skill learning. They had participants perform a simple finger tapping task across multiple days. The study demonstrated that there are small practice-dependent improvements possible within the session, though in addition to that there are also large improvements that develop across a night of sleep. Hand in hand with motor learning is the possibility that some

of the participants already had a history of prior action similar to, or the same as, the range of motion tests. According to Krakauer, Mazzoni, Ghazizadeh, Ravindran, and Shadmehr (2006) prior knowledge of movements that are of a similar nature to the task at hand can be shown to improve performance in the task. They proved this by looking at scores from a motor test of both the arm and the wrist. Those that had knowledge of the arm test performed better on the test of the wrist. Interestingly though, that finding was not backward compatible from the wrist back to the arm, therefore the potential for this effect to have skewed results remain unknown.

PRACTICAL APPLICATIONS

Based on the flexibility of the major muscle groups observed by this study, many athletic activities could potentially benefit from these findings. Stretching routines such as the ones performed in this study are proven to have many positive effects. In addition, it is clear that static and dynamic stretching have a place in a warm-up routine in certain sports that require a high range of motion for success. Coaches can use this information in order to educate their athletes about the potential positive effects of yoga and dynamic stretching. Yoga has many benefits not covered by the scope of this study. If incorporated on a regular basis as part of a warm-up or cool-down routine, athletes could experience the positive acute effects of the stretch as well as gain a tool they can use to improve their physical state for a lifetime.

In summary, based on the results of this study, it seems that both static yoga and dynamic stretching interventions acutely increase joint range of motion. In the lumbar spine and hamstrings, yoga poses increase range of motion significantly more than dynamic stretching. Though there were a number of limitations to the study, and there was no other significant difference between dynamic and yoga interventions, the study still proves that static yoga stretching and stretching in general can be highly beneficial on a number of levels. Rock climbing, swimming, and dancing are just a few sports in which range of motion is critical to success. These sports should be looked at further in regards to warranting a static yoga warm-up. Yoga should also be further examined as a warm-up to circumvent many of the disadvantages of traditional static stretching. With evidence that shows the range of motion increase outweighs the possible negatives of static stretching, it

may be clear in the future that yoga does have a place in a warm-up in some instances. The chronic effects of yoga and dynamic stretching should also be further examined in order to determine if the benefits compound over time.

Sports and sport performance frequently dominates the content in many kinesiology studies, though a more holistic view of the research is sometimes necessary. Stretching in particular has implications far beyond sport performance. One of the most important of these implications is found within the elderly population. For elderly women specifically, stretching on a daily basis may lead to gait adaptations that can be attributed to reduced risk of falling (Rodacki, Souza, Urginowitsch, Cristopoliski, Fowler, 2008). According to Batista, Vilar, Almeida Ferreira, Rebelatto, and Salvini (2009) increased flexibility, torque, and functional mobility are all improved through a four week knee flexor stretch routine in older adults. Zotz, Loureiro, Valderramas, and Gomes, (2014) conducted a review of twenty-four different articles in an effort to determine the effects of static stretching on elderly individuals and found that gait speed and range of motion of both the hip flexors and dorsiflexors improved. Results like these are one of the primary reasons that research on stretching is so important.

In addition to these many physical benefits, yoga may also aid the mind. Berger and Owen (1992) performed a study on the short term effects of yoga on mood and found that there was a significant improvement in short term mood. They also found that yoga when combined with swimming causes significant decreases in anger, confusion, tension, and depression when compared to an experimental control lecture course dealing with coping mechanism. The cognitive benefits of yoga are not limited to stress relief, however. Briegel-

Jones, Knowles and Eubank (2013) found that upon completion of a yoga regiment participants exhibited more awareness of sensations such as thoughts and feelings, as well as greater awareness in regards to physical activity such as swimming training and competition. Participants of this study also reported utilization of breathing techniques and poses in pre-performance routines outside of the program. Contrary to popular belief, the benefits of yoga do not only impact adults or the elderly. The psychological benefits are extensive in both depth and breadth and are found in a multitude of populations. High school students were found to be positively impacted in the realms of negative affect, total mood disturbance and tension anxiety when practicing a standard yoga protocol (Noggle, Steiner, Minami & Khalsa 2012). Children with mental illnesses in an inpatient setting have also been observed upon the addition of a twice weekly yoga routine to determine the effects on behavioral health outcomes (Mcilvain, Miller, Lawhead, Barbosa, & Anderson 2015). Mcilvan et al. (2015) found that adolescents with mental illnesses may be receptive to yoga as a behavioral intervention and it may also improve emotional intelligence scores.

Another realm in which yoga has shown to be beneficial is in rehabilitation. Schmid et al. (2015) found that patients that practiced yoga, when introduced as a complement to traditional therapy during inpatient rehabilitation, perceived significant benefits from the combined protocol. Schmid et al. (2015) also discovered that evidence exists that yoga may improve many rehabilitation-oriented outcomes in older adults, people with disabilities due to spinal cord injury, and stroke victims. These are but a few of the diagnoses that benefit from yoga; others are back pain, diabetes, cancer, arthritis, and even those considered to be in a healthy population may experience improvements in overall physical and mental wellbeing

(Schmid et al. 2015). Because of the numerous possible benefits spanning so many different aspects of wellbeing, yoga certainly warrants further research in regards to its efficacy as a warm-up in college aged individuals in order to both improve sport performance and to teach a skill that can aid someone across a lifetime.

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BIOGRAPHY

Barton (Buck) Schroeter is an Angelo State University undergraduate student from Austin, Texas. He will be graduating in May of 2016 with a Bachelor of Science in Kinesiology Exercise Science and a multi-area minor in Biology and Psychology. During his college career he has been involved with a number of organizations including the Honors Program, Student Government Association, and UREC Outdoor Adventures. Beyond his college career, Buck has survived cancer leading to his career aspirations as a Physical Therapist, and the founding of a charity organization called “Buck’s Barn”. Buck earned his Emergency Medical Technician License and the rank of Eagle Scout through the Boy Scouts of America. He plans to enroll in Angelo State University’s Doctorate of Physical Therapy Program. He has been working under the supervision of Dr. Adam Parker in the research of stretching techniques.