The Effects of Static Versus Dynamic Stretching on Lower Extremity Power Output and Flexibility in Dancers

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The Effects of Static Versus Dynamic Stretching on Lower Extremity Power Output and Flexibility in Dancers

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Honors Research Project

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THE EFFECTS OF STATIC VERSUS DYNAMIC STRETCHING ON LOWER EXTREMITY POWER OUTPUT AND FLEXIBILITY IN DANCERS

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The Effects of Static versus Dynamic Stretching on Lower Extremity Power Output and Flexibility in Dancers

Abstract:
Collegiate dancers require a large range of motion throughout all joints for performance success. Previous research has shown static (STA) stretching to be most effective at improving flexibility (Chaabene et al. 2019), due to this factor, warmups for dance are primarily based on STA stretching to allow dancers to reach their maximum flexibility. Previous research has also shown that STA stretching before activity can have negative effects on an athlete’s power output, and a large amount of power is essential for dance. **Purpose:** Determine the effect of STA and dynamic (DYN) stretching on lower extremity power and flexibility in collegiate dancers.

**Methods:** Subjects (N=10) were recruited from The University of Akron Dance Team. Data collection involved 3 conditions with different stretching protocols. DYN warm-up, STA warm-up, or no warm-up (CON) were completed before each independent condition of data collection. Biodex testing was performed to assess individual power output of right and left knee extension and flexion and a flexibility test was performed to test hamstring flexibility. Paired t-tests were used to assess significance. Significance was set at p<0.05. **Results:** Significance (p<0.05) was found in right knee extension mean peak torque (98.8 DYN vs 91.0 ft/lbs STA), left knee extension mean peak torque (73.5 ft/lbs CON vs 99.4 ft/lbs DYN), right knee mean flexibility (18.9 in. CON vs 20.5 in. STA) and left knee mean flexibility (18.5 in. CON vs 20.5 in. STA). No other measurements showed significance. **Conclusion:** There was a functional difference in lower extremity power output for all power measures, but only some to a statistically significant level. Previous research has demonstrated similar power output results in dancers following DYN vs. STA warmups where no significant difference was observed (Vlieg et al., 2019). The results contradicted previous research which resulted in a significant increase of flexibility from DYN versus STA stretching in dancers (D’Elia et al., 2023). Future research
should analyze flexibility and power output in dancers after being accustomed to dynamic warmups for a longer period, should analyze a different group of athletes, and analyze results after performing warmups of equal length.
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Chapter One Introduction

The growing popularity of all styles of dance and its high musculoskeletal injury prevalence has begun to raise questions on how to optimally train dancers. One study conducted by Aweto et al. (2014), reported 86.1% of dancers (n=150) to have experienced pain or a disorder over a twelve-month period. Dancers can be found through student organizations, clubs, athletics, or departments at most major universities. For the purpose of this study dancers training in the dance team style of dance were focused on (jazz, hip-hop, and pom). Static and dynamic stretching methods are primarily used during warmup before activity and have been a staple component of warmup for dancers and athletes particularly for many years. The American College of Sports Medicine (ACSM) defines static stretching as slowly stretching a muscle/tendon group and holding the position for a defined period of time (10-30 seconds). At least two, but no more than four repetitions are recommended to be completed (Liguori et al., 2022). Dynamic stretching, as defined by ACSM involves a gradual transition from one body position to another and a progressive increase in reach and range of motion as the movement is repeated several times (Liguori et al., 2022).

Dancers, especially at the collegiate level are required to have a large range of motion and flexibility throughout all joints and muscles, and static stretching is said to be effective at increasing flexibility, however, previous research has shown static stretching to have negative effects on an athlete’s power (Chaabene et al., 2019). Power is a skill related component and flexibility is a health-related component of physical fitness (Liguori et al., 2022), and an essential component for optimal performance. In the sport of collegiate dance, optimal power is essential to complete dances effectively. Having peak ability in all areas is vital for an athlete to be competitive. This investigation focuses on the flexibility and power output of the dancer's lower
extremities. Static, dynamic, and no (control) warmups were used as variables to determine impacts on lower extremity flexibility and power.

**Statement of Purpose**

The purpose of this research project was to determine the effect of static and dynamic stretching on lower extremity power and flexibility in collegiate dancers.

**Definitions**

*Static Stretching (STA)*: Stretching as slowly stretching a muscle/tendon group and holding the position for a period of time (Liguori et al., 2022).

*Dynamic Stretching (DYN)*: A gradual transition from one body position to another and a progressive increase in reach and range of motion as the movement is repeated several times (Liguori et al., 2022).

*Flexibility*: “Ability to move a joint through its complete ROM [range of motion]” (Bushman, 2016).

*Power Output*: “The rate of performing work; the product of force and velocity” (Liguori et al., 2022).

*Knee Flexibility*: Ability to move the knee joint through its complete ROM (Bushman, 2016). Measured in this study by hamstring flexibility or full range of motion of the hamstring.

*Flexion*: “Bending or decreasing the angle between the bones or parts of the body” (Dalley & Agur, 2023). Knee flexion was measured in this study and refers to the decrease in angle at the knee joint.

*Extension*: “Straightening or increasing the angle between the bones or parts of the body” (Dalley & Agur, 2023). Knee extension was measured in this study and refers to the increase in angle at the knee joint.
Chapter Two Review of the Literature

A review of the literature was conducted to identify studies that have previously focused on the effects of various types of stretching during a warmup on power output (PO) and flexibility (F). The review will examine the effects of static stretching (STA) and dynamic stretching (DYN) as a warmup on PO and F. The review will also examine the best modalities shown to measure lower extremity PO and F. Finally, an assessment of previous studies on the effects of static and dynamic stretching during a warmup on dancers will be examined.

**Significance of Stretching Method on Power Output**

Several studies have shown power output to possibly be impacted by the type or method of stretching used as a warmup to activity. The data reviewed was not the specific population used in this study, but a general review of the effects of stretching methods on power output. Holt and Lambourne (2008) found that vertical jump performance was significantly different across three groups who had completed three different types of warmups. Another study found contradictory results, however, and found no significant difference in vertical jump performance across four different warmup protocols (Eken et al., 2020). A third study showed significant differences in power between groups following six different protocols when measured via lower limb power and running speed (Mikolajec et al., 2012). The data is suggestive of stretching type affecting power output, however, more research is needed as there is no definitive study indicating the impact of stretching type on power output.

**Significance of Stretching Method on Flexibility**

Similar to the results of studies determining the impact of warmup and stretching protocol on power output, studies have found flexibility to be impacted by the warmup and stretching protocol. Eken (2020) found no significant differences in flexibility between any four
groups when four different stretching protocols were used. On the contrary, a different study found an increase in hamstring flexibility resulting from all three groups following a different stretching protocol, but the increase varied significantly by warmup and stretching type (Hsuan et al., 2017). The results of the reviewed literature were not entirely conclusive on the impact of stretching protocol on flexibility, however, research is indicative of stretching protocol having an effect.

**Significance of Static Stretching on Power Output**

Although research is not concrete regarding the effects of different stretching types as a whole have on power output, research is consistent in stating the impact that static stretching specifically has on power output. Static stretching has been shown to significantly reduce power output. This was shown across three different studies measuring power output via leg extension (Yamaguchi et al., 2006) vertical jump height (Brusco et al., 2018), and rate of force development (Naoki & Tomoo, 2021).

**Significance of Static Stretching on Flexibility**

The research on static stretching specifically is clear and states that static stretching itself is effective at increasing flexibility, but the literature is not conclusive in stating static stretching to be the most effective method for increasing flexibility. Four different studies found that static stretching increases range of motion and therefore flexibility when measured via hamstring and triceps surae flexibility (Marques et al., 2009), solely hamstring flexibility (Medeiros et al., 2016), and knee flexion range of motion (Naoki & Tomoo, 2021). Another literature review also reported the same findings indicating static stretching does significantly improve flexibility (Chaabene et al. 2019).
Significance of Dynamic Stretching on Power Output

Unlike the research regarding static stretching and its impact on power output, there are more controversial findings on the effects of dynamic stretching on power output. Yamaguchi et al. (2007) found dynamic stretching during a warmup to result in significantly greater vertical jump scores than a warmup protocol involving solely static stretching. Another study measuring jump power resulted in a significant increase in jump power when two eight-week protocols involving two different methods of dynamic stretching were followed. Both methods resulted in a significant increase in jump power but were not significantly different from each other. Therefore, findings suggest the significant impact dynamic stretching has on power output which varies by a variety of factors including specific dynamic stretching exercises being performed (Turki-Belkhiria et al., 2014).

Significance of Dynamic Stretching on Flexibility

Studies have found conflicting results on the effectiveness of dynamic stretching on flexibility. Most studies have found dynamic stretching to cause an increase in flexibility. One specific study conducted by D’Elia (2023) found an increase in flexibility resulting from both static and dynamic stretching during warmup, although dynamic stretching resulted in a greater increase. This is significant demonstrating that the benefits of increased flexibility can be obtained from both static and dynamic stretching. Another study confirmed flexibility increases after an 8 week period of using two different methods both of dynamic stretching. This study found an increase in both hip flexor and hamstring flexibility (Turki-Belkhiria et al., 2014).
Validity of Biodex for Power Measurements

In the majority of the studies referred to above, a vertical jump test was used to assess power output, however, for the purpose of this study, a more analytical measure of power output was desired. A Biodex System 3 (Biodex Corp., Shirley, NY) Pro Isokinetic Dynamometer was selected as the method to collect power output in this study. The Biodex (Biodex Corp., Shirley, NY) machine “provides constant velocity with accommodating resistance throughout a joint’s range of motion”. By doing this, the machine can collect “objective measures of human muscle function on variables related to torque, power, and endurance” (Valovich-McLeod et al., 2004). This machine has also been shown to have both reliability and validity when measuring torque, velocity, and position (Valovich-McLeod et al., 2004). These measurements are used to calculate power, thus indicating the Biodex Dynamometer (Biodex Corp., Shirley, NY) able to provide power output measures with reliability and validity. Due to detailed quantitative data being able to be documented for power output, and the device having a high validity and reliability, the Biodex Dynamometer (Biodex Corp., Shirley, NY) was selected to collect power output data.

Validity Sit and Reach for Hamstring Flexibility Measurements

Due to the validity of this test, the ease of administration, and the usage of this test in previous studies, the sit and reach test was chosen as the method to measure flexibility in this study. The sit and reach test h measures lower back and hamstring flexibility. This test is the method used in most of the studies mentioned to measure flexibility. This test has been shown to have validity as a measure of hamstring flexibility (Liemohn et al., 1994).

Effects of Static Stretching on Power Output and Flexibility in Dancers

As previously stated, research suggests that static stretching may have a negative impact on power output, and a positive impact on flexibility when performed during a warmup. Static
stretching is a method that has been used by dancers and other athletes as a warmup before activity for many years. Both flexibility and power are essential components of performance for dance, and static stretching affects both of those components. In studies looking at dancers specifically, the effects of static stretching on flexibility were contradictory. One study previously mentioned, conducted by D’Elia et al. (2023), showed static stretching to be less effective than dynamic stretching at increasing flexibility as measured by a sit and reach test after both stretching protocols were performed for six months. Morrin and Redding (2013) found that static stretching resulted in significantly more hamstring flexibility when performed by dancers. Vlieg et al. (2019) studied the effect of static stretching on power output in dancers, concluding there was no significant difference or effect on power output.

**Effects of Dynamic Stretching on Power Output and Flexibility in Dancers**

Similar to static stretching, the effects of dynamic stretching on flexibility and power, one study found dynamic stretching resulted in a greater increase in flexibility than static stretching (D’Elia et al., 2023). This is contradictory to some of the studies conducted on the effectiveness of dynamic stretching on general populations or populations that are not dancers. Like the results of static stretching on power output in dances specifically, there were no significant changes seen in power output with dynamic stretching (D’Elia et al., 2023).

**Summary**

No definitive consensus emerges as to which type of stretching is more efficacious on performance in dancers. Many studies indicate that dynamic stretching during warmup is the overall best method as static stretching can be detrimental to power output, however, there are studies that contradict this claim, and do not find similar results. Studies also suggest that static stretching is the best method to improve range of motion. However, there are other studies that
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contradict this finding. The general effects of static versus dynamic stretching on power output and flexibility may be more definitive for the general population, however, further research is warranted with dancers as current studies remain inconclusive. Dancers train through large ranges of motion and strive to augment the range in all joints beyond normal. They often rely on static stretching to enhance range of motion. Dynamic stretching may not be the best warmup method for dancers for optimal range of motion. However, static stretching could be detrimental to a dancers’ power output with negative impacts on jump height and performance. Perhaps dancers have adapted to the loss of power output throughout their training. Questions arise about the ideal warmup method, and if it should be best practices for all sports and activities—particularly dance. This study aimed to investigate these questions and add to the body of literature.

Chapter Three Methods

All methods of data collection were approved by the Institutional Review Board at The University of Akron, and all lab personnel completed Collaborative Institutional Training Initiative (CITI) training before submitting an approval request with The University of Akron Institutional Review Board. All data collected occurred in the Human Performance Lab located in InfoCision Stadium at The University of Akron.

Subjects

Subjects who were at least 18 years of age with at least five years of dance training were voluntarily recruited from The University of Akron Dance Team. All potential participants were given informed consent forms (Appendix A) explaining testing procedures and their rights as participants. Potential subjects were allotted two weeks to read the form and ask questions before volunteering for participation in the study. Any dancer who was currently being medically
withheld from participating in dance practice was disqualified from participation in this study. All subjects were able to opt out of the study at any point. A survey (Appendix B) was given to participants to document any injuries, dominant side, dance experience, and demographics to ensure subjects met criteria and were safe to participate in the study. Recruited subjects \((n=10)\) had all been a member of The University of Akron Dance Team for at least one full season. Data collection occurred over the summer during their offseason. All procedures were conducted with one subject in the lab at a time. Subjects reported for a total of three times for data collection. Each session was at least 72 hours but no more than two weeks apart and involved subjects completing a new warmup protocol each session in a randomized order monitored by lab personnel. Data collection immediately followed the warmup.

**Warmup Protocols**

At the beginning of each session either dynamic stretching, static stretching, or no (control) warmup was completed. All subjects participated in all three warmup protocols, one at each session. Warmups were monitored and demonstrated by lab personnel and conducted in a randomized order. Warmup protocols were as follows:

*Dynamic Warm up*: High knees, soldiers, glute kicks, reverse lunges, side lunges, karaoke (a dynamic hip flexibility exercise intended to target the adductors, abductors, and hip flexors), heel scoops (a dynamic flexibility exercise intended to target the hamstrings), and toe walks were carried out for 2 sets of 10 yards. The warmup lasted approximately 5 minutes dependent on the speed at which the participant moved through each exercise.

*Static Warm up*: The following stretches were held at a point of mild discomfort for 3 repetitions of 30 seconds. The warmup lasted approximately 15 minutes.
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- Standing with feet hip width distance, hip flexion with toe touch
- Standing with feet hip width distance, hip flexion with ankle touch
- Right front lunge left knee flexed and touching the ground
- Right front lunge left knee straight elbows are flexed and on the ground
- Right front lunge left knee flexed, holding foot with right hand to stretch quad
- Alternating side lunge
- Repeat all front lunges leading left
- Seated, flex right hip and knee, pulling leg to chest. Repeat the left side.
- Double pigeon, right and left side
- Butterfly
- Downward facing dog

*Control:* Subjects rested in a seated position for at least 5 minutes.

**Flexibility Testing Procedures**

A sit and reach test was administered following each warmup protocol to measure hamstring flexibility. This test was chosen as it has been shown to be a valid and reliable measure for hamstring flexibility (Liemohn et al., 1994), there was access to a device, and it has been used in previous studies assessing stretching techniques on flexibility (Castro-Piñero et al., 2009; Davis et al., 2008; Liemohn et al., 1994). Subjects were required to sit on the ground, hips flexed, and knee extended with one ankle dorsiflexed with the foot centered against the sit and reach device placed directly in front of them. Subjects then pushed the metal tab as far as they could while keeping their knee extended leg touching the ground. If the knee flexed at any time, the test was invalid. Each participant performed the test three times on both the right and left
legs. Measures were recorded in inches (in) and the best trial on each leg was recorded and used for data reporting.

**Power Testing Procedures**

Biodex (Biodex Corporation, Shirley, NY) testing was conducted after the flexibility testing. This isokinetic dynamometer testing device was chosen as the tool to measure power output in this study as it has been shown to be valid and reliable in collecting power output (Valovich-McLeod et al., 2004). The Biodex testing analyzed power output in feet per pounds (ft/lbs) with 60 degrees per second of movement during knee flexion and knee extension on both the right and left legs. Participants were placed in the chair of the Biodex machine and secured tightly to ensure power was only being produced by the quadriceps and hamstrings, the muscle groups being measured. The machine was calibrated for each participant and two to three practice repetitions were performed before testing began to allow participants to get accustomed to the machine. Two sets of five repetitions were then administered per knee per movement (flexion and extension). There was a thirty second rest period between each set and practice repetitions before the next set. The set resulting in the best peak torque in ft/lbs was recorded. These tests were conducted in the same manner and order each session.
Chapter Four Results

In this chapter, the results of this investigation are presented.

Table 1

Mean values of measured lower extremity flexibility and power:

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Static</th>
<th>Dynamic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Right Knee Flexibility (in)</td>
<td>18.9*</td>
<td>20.5*</td>
<td>20.5</td>
</tr>
<tr>
<td>Average Left Knee Flexibility (in)</td>
<td>18.5*</td>
<td>20.5*</td>
<td>20.5</td>
</tr>
<tr>
<td>Average Right Knee Flexion Power (ft/lbs)</td>
<td>47.4</td>
<td>54.2</td>
<td>54.0</td>
</tr>
<tr>
<td>Average Left Knee Flexion Power (ft/lbs)</td>
<td>38.4</td>
<td>53.2</td>
<td>58.8</td>
</tr>
<tr>
<td>Average Right Knee Extension Power (ft/lbs)</td>
<td>76.9</td>
<td>91*</td>
<td>98.8*</td>
</tr>
<tr>
<td>Average Left Knee Extension Power (ft/lbs)</td>
<td>73.5*</td>
<td>90.5</td>
<td>99.4*</td>
</tr>
</tbody>
</table>

*p<0.05

Table 1 depicts significant differences (p<0.05) observed in right knee extension mean peak torque (98.8 dynamic vs 91.0 ft/lbs static), left knee extension mean peak torque (73.5 ft/lbs control vs 99.4 ft/lbs dynamic), right knee mean flexibility (18.9 in. control vs 20.5 in. static) and left knee mean flexibility (18.5 in. control vs 20.5 in. static). No significant differences were observed for right and left knee flexion mean peak torque across conditions.
Figure 1

*Average right and left knee flexibility following the three warmup protocols.*

![Average Knee Flexibility Chart](image)

* * p < 0.05

Figure 1 illustrates a functional difference in knee (hamstring) flexibility when a warmup is performed prior to measurement. However, the difference was not significant (p ≥ 0.5). There are no significant differences between static versus dynamic stretching, both protocols resulted in a greater range of motion compared to the control session. This increase in flexibility was only significant between the control and static warmup protocols on both the right (18.9 in. control vs 20.5 in. static) and left sides (18.9 in. control vs 20.5 in. static).

Figure 2

*Average power output during knee flexion on both the right and left sides following the three warmup protocols*
Figure 2 illustrates a functional difference between the resulting power output from both the static and dynamic warmup protocols vs the control. When a warmup was performed prior to measurement, there was an increase in both right (47.4 ft/lbs control vs 54.2 ft/lbs static and 54 ft/lbs dynamic) and left knee flexion power (38.4 ft/lbs control vs 53.2 ft/lbs static and 58.8 ft/lbs dynamic), although not significant ($p > 0.5$). The increase was greater on the left side than the right. There was a greater increase in knee flexion power output on the right side resulting from a static warmup (54.2 ft/lbs static vs 54 ft/lbs dynamic) ($p > 0.5$) and a greater increase on the left side resulting from a dynamic warm up (53.2 ft/lbs static vs 58.8 ft/lbs dynamic) ($p > 0.5$).

**Figure 3**

*Average power output during knee extension on both the right and left sides following the three warmup protocols.*

![Average Knee Extension Power Output](image)

Figure 3 shows a functional increase in power output resulting from both the static and dynamic warmup conditions versus the control condition. This increase in power output was found on both the right (76.9 ft/lbs control vs 91 ft/lbs static vs 98.8 ft/lbs dynamic) and left sides.
(73.5 ft/lbs control vs 90.5 ft/lbs static vs 99.4 ft/lbs dynamic). This graph also depicts a functional difference between the static and dynamic warmup conditions (right side: 91 ft/lbs static vs 98.8 ft/lbs dynamic) (left side: 90.5 ft/lbs static vs 99.4 ft/lbs). The dynamic protocol resulted in a greater increase in power output than the static protocol, however, the static protocol did not negatively affect the power output. It is important to note the only statistically significant differences were found between the static and dynamic protocol on the right side (91 ft/lbs static vs 98.8 ft/lbs dynamic) and the control and dynamic protocol on the left side (73.5 ft/lbs control vs 99.4 ft/lbs dynamic). This may be due to most participants reporting the right side as their dominant side.

**Chapter Five Discussion**

When reviewing the literature, there were inconclusive and contradictory results on the effects of static and dynamic stretching on power output and flexibility. The most agreed upon result was that static stretching may be more effective at improving flexibility and have detrimental effects on power. There was a lack of research examining the effects of these stretching and warmup protocols on dance specifically. Sports and activities, such as dance, that require optimal range of motion and power to execute effectively, propose a complex issue to previous findings. Perhaps a combination of static and dynamic stretching could be beneficial to dancers. Studies have shown the effects of static and dynamic stretching, but future studies should focus on finding a warmup technique that is specific to dance and allows dancers to reach full potential in both power and flexibility needed for their sport. This research should not end with dance and should be continued with all sports and activities. It is likely that the warmup
protocol and whether static or dynamic stretching or a combination of both is best will be dependent on the sport or activity.

This study found the same results as a previous study with a similar population. There was no significant difference in the effects of static versus dynamic stretching on power and flexibility (Vlieg et. al., 2019). Adjustments to the current study protocol may yield different results. A larger sample size could provide evidence of significance between stretching techniques. Additionally, the duration between each technique varied which may have influenced the results. The static protocol lasted about 20 minutes while the dynamic protocol lasted around 5 minutes. The duration of the stretching may have contributed to the insignificance. The dancers in this study were also accustomed to static stretching and had been performing warmups like the protocol used in the study throughout their season prior to data collection. The stretches varied slightly, however, the duration of static stretching was similar to a typical warmup of the Akron Dance Team. This season lasted about 8 months. If the dancers were accustomed to the dynamic warmup protocol in the same way they were the static protocol, the results may have been different. It is also important to note there is a psychological aspect associated with the warmup protocol. Dancers reported feeling better prepared for activity when following the static protocol with which they were familiar. Future studies should incorporate these suggestions and repeat the study.

Chapter Six Conclusion

The objective of this investigation was to determine the effects of static versus dynamic stretching on power and flexibility of D1 dancers. This study found no significant differences in power output or flexibility comparing static and dynamic stretching. Previous research has demonstrated similar power output results in dancers following dynamic vs. static warmups
where no significant difference was observed (Vlieg et al., 2019). Factors that may have influenced results were the unequal duration of the stretch sequences, variation in effort put into the Biodex testing, and previous adaptation to the static but not the dynamic warm up. Future research should analyze flexibility and power output in dancers after being accustomed to dynamic warmups for a longer period, a different group of athletes, results after performing warmups of equal length, the effects of increased blood flow, and/or the effects of body temperature on power and flexibility.
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References


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Title of Study: The Effect of Static and Dynamic Stretching on Lower Extremity Power Output and Flexibility Among Dancers

Introduction:
You are invited to participate in a research project being conducted by Meloney George and Robert Banaga, students in the School of Exercise & Nutrition Sciences at The University of Akron, and Ronald Otterstetter, Ph.D., and Stacey Buser, Ph.D. faculty members in the School of Exercise & Nutrition Sciences at The University of Akron.

Purpose:
The purpose of this study is to determine the effect of static and dynamic stretching on resulting power and flexibility in collegiate dancers. Previous research has shown that static stretching has great benefits to flexibility but can cause performance deficits via power when used in a warm-up. However, dancers primarily use static stretching as their warm-up. This study will allow for determinations to be made about how the static stretching affects a dancer's flexibility and power output and compare that to the results of how a dynamic warm up would affect a dancer's flexibility and power output along with comparison of the muscle mass amount of each leg.

Procedures:
Prior to officially becoming a participant in the study, you will be required to fill out a demographics survey, which will be used to screen out those who are excluded from the study. Those who are under 18 years of age, are pregnant, are not actively participating in dance
through a university, have not had at least 5 years of experience in dance, or are being withheld from participating in dance by a physician will be excluded from the study. Once cleared for participation, you will be given a demonstration via a video or live demonstration of the dynamic warm up and static warm up that you will be performing on different data collection days. You will be asked to come to the lab three different days, at least 72 hours in between each visit, but no more than 2 weeks apart. You will perform either the static warm up, dynamic warm up, or no warm up followed by a sit and reach test, and Biodex testing. Biodex testing uses a computerized machine to assess power output as you perform an exercise through a range of motion. A Dual-energy X-ray absorptiometry (DEXA or DEXA scan) will be completed on the lab day where no warm up was followed to obtain bone mineral density (BMD). DEXA is a full body scan that uses low energy X-ray to view bone density. The scan will approximately take 6 minutes. You are instructed to wear proper clothing during the tests, such as sweatpants or athletic shorts and at-shirt. All metal will be required to be removed from your person before lying on the DEXA machine. This includes piercings or any belts. Age and gender will be self-reported by participants.

**Pre-Trial:**

You will report to the lab and perform either a static warm up, dynamic warm up, or no warm up which will be introduced to you beforehand. Exercise Trial: You will report to the lab and rotate through various tests: a sit and reach test to measure hamstring flexibility, and a Biodex machine that will be used to test hamstring and quadricep power output, as well as power output from dorsiflexion and plantarflexion of the foot. Each test will be performed three times nonconsecutively. You will rotate between stations.
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You will have a DEXA scan performed on the lab day where no warm up was followed. At any point during the trial period you are free to leave and/or withdraw from the study.

Post-trial: You will be permitted to leave the lab after any questions have been answered and there are no signs or symptoms of any injuries or problems abnormal muscle fatigue or pain.

**Risks and Discomforts:**

Potential risks include but are not limited to sweating, soreness, and stretched or pulled muscles in the lower extremities, minor radiation from the DEXA, and confidentiality/privacy being broken. Every precaution will be taken to prevent and/or minimize these risks. Muscle injury or fatigue is unlikely as exercises in the warm up and during data collection will be easier on the body than movements you perform in dance DEXA uses low energy X-rays to view bone density. The radiation dose is low, and risks associated are the same as any other X-ray device. (1/10th of a typical medical X-ray and much less than a CAT scan); and each of you will be asked to take part in one scan. However, it must be noted that DEXA scans are common in research and clinical settings and pose minimal risk (any radiation exposure theoretically carries some risk), but no discomforts. Your name will remain anonymous in any publications or presentations of this research, all physical data will be stored in a locked office, and electronic data will be secured with strong passwords.

**Benefits:**

You will be able to gain knowledge about how your warm up routine is affecting your performance. You will also be able to gain knowledge regarding your specific flexibility level of your hamstrings, as well as power capabilities of your quadriceps, hamstrings, and ankles. You will also gain information about your body density and body composition. This gain in knowledge can help you establish a more effective warm up routine. Your participation in this
study could benefit the field of dance by allowing more research and knowledge to create more effective and safe warm up routines specific to dance.

**Exclusions:**

You are not eligible to participate in this research project if you are under 18, if you are not actively participating in dance through a university, have not had at least 5 years of experience in dance, or are being withheld from participating in dance by a physician. You may not participate if you are pregnant due to the x-ray exposure from the DEXA scan.

**Right to refuse or withdraw:**

Taking part in this project is entirely up to you, and no one will hold it against you if you decide not to do it. Choosing to not take part in this study will not result in penalties in your participation on dance team, as the research is not correlated to the dance team in any way. If you do take part, you may stop at any time.

**Anonymous and Confidential Data Collection:**

Any identifying information collected will be kept in a secure location and only the researchers will have access to the data. You will not be individually identified in any publication or presentation of the research results, as no identifying information will be used. Only aggregate data will be used. Your signed consent form will be kept separate from your data, and nobody outside of the research team will be able to link your responses to you.

**Confidentiality of records:**

You will be assigned numbers to maintain anonymity. Only the PIs on the project will have access to the original data. Any paperwork will be stored in the PIs office for 3 years. All digital data will be protected by secured passwords.
Who to contact with questions: Meloney George 937-763-9358 or Robert Banaga 440-879-6606. This project has been reviewed and approved by The University of Akron Institutional Review Board. If you have any questions about your rights as a research participant, you may call the IRB at (330) 972-7666.

Acceptance & signature: I have read the information provided above and all of my questions have been answered. I voluntarily agree to participate in this study. I will receive a copy of this consent form for my information.

____________________________________                                           ____________________
Participant Signature                                                             Date
Appendix B: Demographics Survey

College of Exercise and Nutrition Science:

Effect That Static vs. Dynamic Stretching Has On The Power Output and Flexibility of D1 Dancers

Meloney George and Robert Banaga

Name:___________________     Date:___________________

Year (Freshman, Sophomore, etc):____________

Age:_________

How many years have you been dancing? ________________________________

Are you currently dancing through a university? Circle one.

   Yes

   No

Are you on the university’s dance team, a dance major/minor, or in a dance club? Circle all that apply.

   University Dance Team

   Dance major/minor

   Dance club

What styles of dance do you actively participate in? Circle all that apply.

   Jazz

   Ballet

   Tap

   Hip-Hop
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Pom

Contemporary/Modern

Ethnic

Other: ____________________

How many hours do you dance a week? _________________________________

What is your dominant side in dance? Circle one.

Right

Left

Are you being withheld from participating in dance by a physician or healthcare provider?

Circle one.

Yes

No

Have you had any injuries and if so how many, how long ago, and what type of injury?

Circle one.

Yes

No

How many: _____.

How long ago: ________________.

Type of injury: __________________________________________________________

Subject Signature: ___________________________ Date: _________________