

**INCREASING HAMSTRING STRENGTH AND FLEXIBILITY DURING
ARABESQUE IN COLLEGIATE DANCERS**

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

Increasing Hamstring Strength and Flexibility During Arabesque in Collegiate Dancers

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The hamstring is an important muscle group to dancers because it assists in leg and hip extension and helps maintain many classical positions in dance such as attitude derrière and arabesque. Additionally, the hamstring is a common injury in dance caused by insufficient warm up or lack of flexibility, strength, or a combination of both. The purpose of this study was to analyze the difference between strength and flexibility training and its effect on a dancer's hamstrings during arabesque. Having proper hamstring strength and flexibility increases performance in regard to execution and safety. The subject pool was selected from a group of volunteer university dance students. These dancers were randomly placed into either a strength group (n=1), flexibility group (n=1), or control group (n=1). Throughout the course of the study, dancers were given exercises that corresponded to their selected groupings and performed these exercises after going through a warm-up protocol. This seven-week study was conducted using pre and post testing, including hamstring flexibility and strength tests. The subjects underwent a training week, followed by 4 weeks of intervention.

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CHAPTER I

INTRODUCTION

Background

The hamstrings are muscles on the posterior side of the body made up of three different, separate muscles, the biceps femoris, the semitendinosus, and the semimembranosus, that simultaneously work together to make a dancers' legs move. In dancers, the hamstring muscle group is used in *développé en croix*, and *arabesque derrière*. Because of this, the muscles must be warm, strong, and yet, have a sense of flexibility in order for a class or performance to be successful. Dancers are becoming more accustomed to problems with their hamstrings because of improper warm-up techniques, improper class preparedness, lack of information about the specific muscle group, how to treat them properly, and overuse. Hamstring injuries are common in the world of dance, and they are also common in many sports. With the lack of information, they are also recurrent (O'Sullivan, 2009). Injuries to the hamstrings can consist of all three grades of sprains worsened by overuse. As the hamstring becomes tighter due to insufficient warming up, cooling down, and correct technique, a dancer could sprain their hamstring and be unable to dance. When a dancer's hamstring becomes injured, what do they do in order to regain their full flexibility and strength? In many dancers, hamstring flexibility is lost due to age and lack of proper knowledge on stretching techniques. Therefore, this study was designed to evaluate which Pilates techniques are more effective to combat this problem. Current research now shows that stretching does not benefit muscles at all if not completed after a warm up, or if it is not held for a certain amount of time (Brandy, 1997). Rather, stretching at the beginning of class has an adverse effect on the muscles.

Pilates

Pilates is a system of exercises that was created by Joseph Pilates in the 1920s. This practice has been utilized by dancers and recognized for its importance in rehabilitation, and how it can increase flexibility and strength (The History of Pilates, 2020). Pilates and dance have similar philosophies in training and execution such as the focus of core alignment, efficiency of movement, centering, and focus. Many variations of exercises are derived from the dance world as well as some of the terminology used within the Pilates Method. Utilizing this information, an intervention program was created to determine if Pilates exercises can help increase the hamstring flexibility and strength.

The Study

This seven-week study was conducted using pre and post testing to include hamstring flexibility and strength tests as well as execution of simple barre exercises common in dance. Hamstring flexibility was measured using the Sit and Stretch Test, Straight-Leg test using the goniometer and height measurements were taken in arabesque. Hamstring strength was measured using the Manual Muscle test and the Exo Chair Strength Test. The purpose of this study was to analyze the difference between strength and flexibility training and its effect on a dancer's hamstrings during arabesque.

Importance

The findings of the proposed study will help determine if a muscle strengthening regime is more beneficial to a dancer if it is focused on flexibility or strength. This research is important because dancers do not have a plethora of information to better themselves, in addition to how they can strengthen and take care of their overall muscle health.

CHAPTER II

METHODS

Participants

Three female subjects (age = 18 +/- 1, height = cm + SD, mass = kg + SD) who were enrolled in a ballet and/or modern class three times a week completed the study. Participants were excluded from the study if they had a lower extremity injury within the past 6 months and/or were not currently enrolled in a university level dance course. Two subjects were dismissed from the study due to injuries sustained outside of the study.

Ethical Approval

The study was approved by the Texas A&M University Institutional Review Board, and the participants signed consent forms.

Data Collection

Subjects participated in pre and post testing which included a warm-up, the Straight-Leg test utilizing a goniometer, the Sit and Stretch test, a Hamstring Manual Muscle Test, the Pilates Exo Chair Strength Test and were videoed performing an arabesque. After pre-testing, the participants attended 3, 20-minute training sessions for participants to learn the exercises they would be performing. Participants were required to partake in training sessions three out of the seven days of the week with at least one rest day in between. Exercises were taught for mechanics, correct alignment and timing. During the 4-week intervention period, the participants met 3 times a week for 15-20 minutes in order to perform their assigned exercises. These intervention sessions were monitored by the researchers with Pilates experience to ensure correct execution. The intervention exercises for the strength group utilized the Pilates Exo Chair

(see Table 1) while the intervention exercises for the flexibility group utilized the Balanced Body Pilates Reformer (see Table 2). The study concluded with the post-test which repeated the same tests included in the pre-test session.

Exercise Procedures

Table 1. Strength Group

<i>Pilates Exo Chair – Strength Group</i>	
Bridge with Leg Pump	Start with 5 pumps, increase rep by 2X each week
First Position Leg Pump	Start with 4 pumps on each leg, increase 1 rep each week
Swan	Start with 5 reps, increase by 2 reps each week
Hamstring Pump	Start with 3 pumps per leg, increase by 1 each week
Push up with Leg Pump	Start with 3 pumps per leg, increase by 2 each week
Hamstring Stretch with Torso Lift	Start with 3 roll downs, increase by 1 roll down each week

Table 2. Flexibility Group

<i>Pilates Reformer – Flexibility Group</i>	
Elephant	Start with 5 reps, increase rep by 2X each week
Seated Hamstring Extension	Start with 5 reps, increase rep by 1X each leg each week
Up-Stretch in Arabesque	Start with 3 reps on each leg, increase rep by 2X each leg each week
Front Splits	Start with 4 reps on each leg, increase rep by 2X each leg each week
Russian Splits	Start with 4 reps on each leg, increase rep by 2X each leg each week
Eve's Lunge	Start with 2 sets of 20 second hold on each leg, increase rep by 1 hold on each leg each week

Statistical Analysis

The data from the pre and post-tests were averaged for the analysis. Due to the lack of participants for the study, the statistical analysis was limited and traditional statistical tests could

not be used. However, Dartfish Analysis (Dartfish Express for iOS, version 7) was utilized to analyze the angles of the arabesque. The angles measured on the participants were from the anterior superior iliac spine on the front of the pelvis to the mid forefoot. Manual Muscle Test and the Exo Chair Strength Test were used to test the strength of the hamstring while extended posteriorly. While the Sit and Stretch Test and the Straight Leg Test utilizing the Goniometer were used to closely inspect the laxity of the hamstrings on the anterior coronal plane of the body.

CHAPTER III

RESULTS

Due to small sample size in each group, traditional statistical tests could not be used. Overall percent differences were used to show overall results in the pre and post test of each individual participant. Dartfish Analysis (Dartfish Express for iOS, version 7) was used to analyze the angles of arabesque. The straight leg test on the right side showed no difference in flexibility pre to post testing among the subjects. On the left side, the control group increased in flexibility 44%. As shown in percent differences of the manual muscle test, the strength of the participants varied from pre and post testing. Participant 301 increased in their strength 67% while participant 101 decreased -20%. Participant 201 did not increase or decrease from pre to post test on the left leg. In the Exo Chair Strength Test (see Figure 1), overall participants increased in strength from pretest to post-test. Participant 301 had a 1100% increase in strength while participant 101 had a 100% increase. Participant 201 did not show a difference from pre to post test. In the sit and stretch test (see Figure 2), participant 201, representing the flexibility group, increased in flexibility on both legs. The strength group increased some as well, as did the control group. In the dartfish analysis of the arabesque overall height increased in both intervention groups, but not the control group (see Figure 3). These tests show that the training methods presented in this study may improve the overall performance of arabesque.

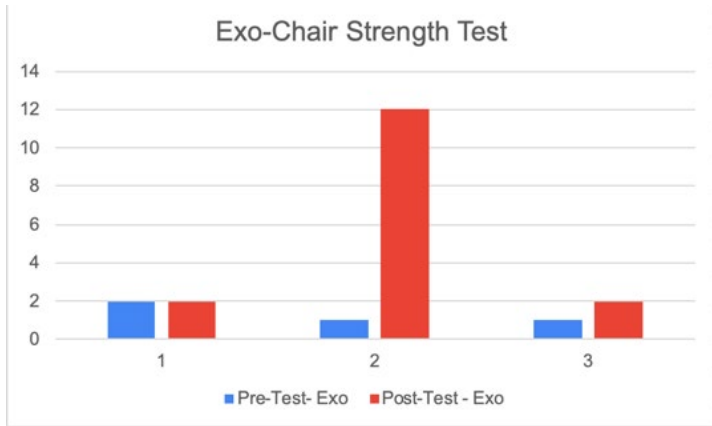


Figure 1. Exo-Chair Strength Test

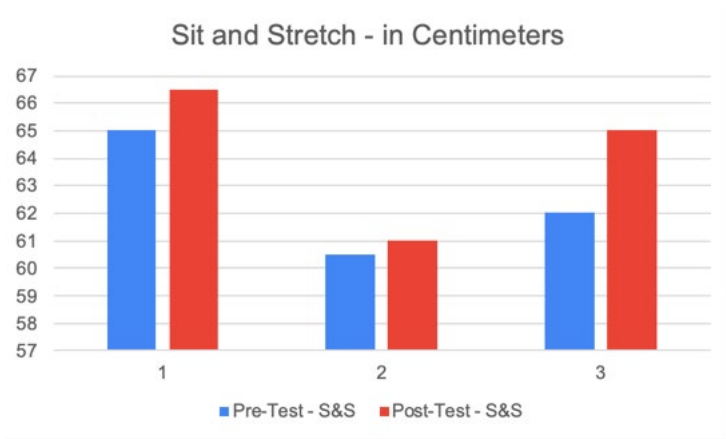


Figure 2. Sit and Stretch- in Centimeters

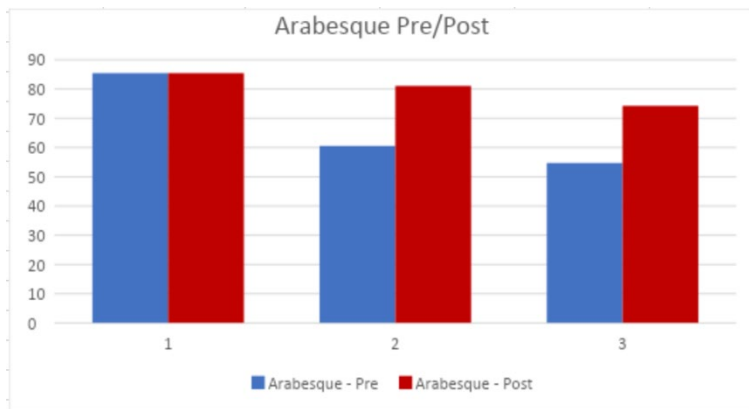


Figure 3. Arabesque Pre/Post

CHAPTER IV

CONCLUSION

In the field of Dance Science, there is a small amount of research dedicated to how strength and flexibility impact dancers' overall muscle health and technique. This research is important to assist dancers, as well as other athletes, to recognize how they can better their muscle health, and how they can improve in the most beneficial way. During this study, the Strength group increased in the strength portion of the post test, in addition to increasing in the arabesque position. Our flexibility group increased in the flexibility portion of the post test, in addition to increasing in the arabesque position. However, due to limited study participants, more research will need to be conducted in order to determine if these findings will still be seen in a larger subject pool. Due to the low number of participants, it cannot be determined if either intervention would be effective in increasing arabesque height in dancers.

Discussion

Research in the field of dance is limited. Because of this, research findings for this study were not based in dance but rather on stretching, strengthening, and warm-up and their effects on the hamstrings. Many of the intervention exercises were derived from Pilates, a type of exercise regime formulated by Joseph Pilates in the 1920s (The History of Pilates, 2020). Using this type of exercise, the participants used the Exo Chair and the Balanced Body Reformer, both of which were created for Pilates exercises to be performed on. During the course of the study, both groups trained using Pilates. However, participants were also involved in other types of physical activity like dance classes and working out on their own time. Because of these circumstances, the groups' variance could be due to other factors other than the specific study itself.

Due to the fact that there was limited research, the study could have been more specified in how we targeted the muscle group in question had there been more information available. Participation in the study was limited due to unforeseen circumstances and if the study were to be replicated an increase in participation would be recommended. Due to technological errors, the original goal of the study had to be amended.

The field of Dance Science is a limited field; therefore, it was difficult to find an adequate amount of literature on hamstring strength and flexibility. However, the literature that was found supports our practice of a proper warm-up before physical activity is done, and therefore, participants were required to warm-up before participation in the study (O'Sullivan, 2009; Wiktorsson-Moller, M. et al., 1983). As literature was being cultivated and it became apparent that information on the subject matter was lacking, therefore the investigation of the topic further blossomed in our own study.

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