NG ZI RU

EFFECT OF LOWER LIMB CYCLIC STRETCHING AND BALLISTIC STRETCHING IN JUMPING DISTANCE

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COMPARISON BETWEEN EFFECT OF LOWER LIMB CYCLIC STRETCHING AND BALLISTIC STRETCHING IN JUMPING DISTANCE AMONG UNDERGRADUATE STUDENTS: A COMPARATIVE STUDY

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UNIVERSITI TUNKU ABDUL RAHMAN

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By

NG ZI RU

A Research project submitted to the Department of Physiotherapy,
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COMPARISON BETWEEN EFFECT OF LOWER LIMB CYCLIC STRETCHING AND BALLISTIC STRETCHING IN JUMPING DISTANCE AMONG UNDERGRADUATE STUDENTS: A COMPARATIVE STUDY

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ABSTRACT

Background and Objective: The horizontal jump distance is a useful tool for evaluating an athlete's sports performance and leg strength, and it is used in the training of several sports that call on the ability to jump horizontally. Studies have shown that stretching before exercise can improve power, which is a crucial component of many sorts of physical activities, including jumping. Thus, this research will be studying the effect of lower limb stretching on sports performance using horizontal jump. This research is aimed to compare the effect of lower limb cyclic stretching (CS) and ballistic stretching (BS) in sports performance by comparing the effect of lower limb cyclic stretching and ballistic stretching in the jumping distance among undergraduate students using the standing broad jump test.

Methods: This was a randomized, two-armed, parallel-group quasi-experimental study. The targeted population was undergraduate students in UTAR, Sungai Long Campus and the sample size was calculated to be 42 students. Eligible participants were allocated into two intervention groups randomly which were CS and BS. Each participant visited the physiotherapy center to complete the pre-test, intervention and post-test. Each participant was assessed in one day from pre-test to post-test. Both stretching protocols consisted of three lower limb stretches which are mainly for the iliopsoas, hamstring muscles, and gastrocnemius.

Results: The total participants recruited were 44 students which consisted of 22 participants in the CS group and 22 participants in the BS group. The mean age is 20.55±1.06 in the CS group and 19.73±1.20 in the BS group. No significant difference was detected between the pre-stretching and post-stretching jumping distance in the CS group with MD=-1.22cm, $p>0.05$. Moreover, there was also no significant difference between the pre-stretching and post-stretching jumping distance in the BS group with MD=-0.06cm, $p>0.05$. When comparing the significant difference between the effect of lower limb CS and BS in jumping distance, the results showed MD= -1.16cm, p>0.05.

Conclusion: The lower limb CS has no significant effect in the jumping distance among undergraduate students using the standing broad jump test; the lower limb BS has no significant effect in the jumping distance among undergraduate students using the standing broad jump test. There is no significant difference between the effect of lower limb CS and BS in jumping distance.

Keywords: Cyclic Stretching, Ballistic Stretching, Jumping Distance

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APPROVAL SHEET

This Research project entitled "**COMPARISON BETWEEN EFFECT OF LOWER LIMB CYCLIC STRETCHING AND BALLISTIC STRETCHING IN JUMPING DISTANCE AMONG UNDERGRADUATE STUDENTS: A COMPARATIVE STUDY**" was prepared by NG ZI RU and submitted as partial fulfilment of the requirements for the degree of Bachelor of Physiotherapy (HONOURS) at Universiti Tunku Abdul Rahman.

Approved by:

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M. KANDIAH FACULTY OF MEDICINE AND HEALTH SCIENCES

UNIVERSITI TUNKU ABDUL RAHMAN

Date: 23/12/2022

PERMISSION SHEET

It is hereby certified that **NG ZI RU** (ID No: **19UMB02385**) has completed this Research project entitled "COMPARISON BETWEEN EFFECT OF LOWER LIMB CYCLIC STRETCHING AND BALLISTIC STRETCHING IN JUMPING DISTANCE AMONG UNDERGRADUATE STUDENTS: A COMPARATIVE STUDY under the supervision of MS. MAHADEVI A/P MUTHURETHINA BARATHI (Supervisor) from the Department of Physiotherapy, M. Kandiah Faculty of Medicine and Health sciences.

Yours truly,

(NG ZI RU)

DECLARATION

I hereby declare that the Research project is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

Name: NG ZI RU

Date: 23/12/2022

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LIST OF ABBREVIATIONS

PA	Physical activity
UTAR	Universiti Tunku Abdul Rahman
IPAQ	International Physical Activity Questionnaire
CS	Cyclic stretching
BS	Ballistic stretching
SBJ	Standing broad jump
BMI	Body mass index
M	Mean
SD	Standard Deviation
p	P value (Significance)
CI	Confidence interval

CHAPTER 1

INTRODUCTION

1.1 Chapter overview

This chapter will discuss about the background of the study, providing important context about the topic of interest followed by the research objectives, hypothesis as well as the operational definition of terms.

1.2 Background of study

Jumping is used as an indicator of lower body power and are common fundamental mechanism in many sports such as track and field, basketball, soccer, volleyball and others (Zhou et al., 2020). It is proven to be a predictor in predicting physical performance such as sprinting and anaerobic performance. Stretching has been proven to improve jumping performance (McMillian et al., 2006). However, stretching before, during, and after physical exercise has been discussed for decades, with several researchers finding conflicting effects due to differences in timing, length, and intensity. The effects of stretching in improving physical performance have also been discussed for decades. Thus, this study is intended to assess the effects of stretching in physical performance using jumping.

1.2.1 Jumping

Samozino et al. (2010) stated that maximal jumps include the highest vertical jump as well as horizontal jump. This is done from the acceleration of body mass from the resting state during the push-off phase which is based on the resultant force and quick lower extremities extension. Lower extremity variables associated with maximum jumps have mostly been researched using physiological or morphological factors statistically connected to jumping ability. For example, muscle mass, limb length, muscle fibre types as well as joint moment arms, which are phenotypic manifestations of the total mechanical properties of the lower extremities involved in performance (James et al., 2007). This is a common maneuver performed in many of the sports such as basketball, badminton, volleyball, gymnastics and others.

1.2.2 Standing broad jump

Standing broad jump or commonly named standing long jump is a frequently used movement in many sports and exercises. It makes an inference on the leg power using horizontal jump distance. Horizontal jump distance is a good method to assess the leg strength and physical performance of the athletes and it is implemented in the training of some sports which require horizontal jumping ability. For instance, track and field, basketball, soccer, and volleyball. The distance of landing will be rated as very poor to excellent according to males and females (Wood, 2019). The advantage is that this test is simple to perform however skill is needed. In the study of Maulder & Cronin (2005), the horizontal jump has been proven to be more effective in assessing sprint running than the vertical jump. Similarly, the horizontal jump was found to be effective as a training protocol for basketball players in the study by Ramirez-Campillo et al. (2020). Nevertheless, researchers often utilize the derivatives of the vertical leap to evaluate leg power. However, most human motion involves some mix of horizontal as well as vertical force output, especially in sports that entail running. Thus, the horizontal jump which is the standing broad jump will be applied in this study.

1.2.3 Stretching

According to Landry and Driscoll (2012), stretching can be understood as an extrinsic element of exercise that has the ability to influence the risk of injury and performance by keeping a good range of motion and muscular compliance. Stretching before, during, and after physical exercise has been discussed for decades, with several researchers finding conflicting effects due to differences in timing, length, and intensity. The American College of Sports Medicine's current stretching recommendations are restricted only to adults. When offering advice for stretching activities in the healthy pediatric population, the same recommendations are often employed. Flexibility exercises are advised at least twice a week, with an emphasis on long-term flexibility and range of motion. Stretches should be performed in a tight and slightly discomfort position for up to 30 seconds every stretch, with a repetition time of up to 60 seconds per muscle group (Garber et al., 2011). Unfortunately, while short-term flexibility improvements have been observed, there is no evidence on the theoretical long-term effects of it.

1.2.4 Effects of stretching

Studies showed that power is an essential element of many types of physical exercise including jumping and it can be enhanced by stretching prior to exercises (McMillian et al., 2006). There are several theories as to why jumping performance changed when stretching was used. Changes in the muscle-tendon unit, variations in the muscles' internal temperatures, improvements in neuromuscular function, and modifications in the neural drive to the muscle's motor units are among them (Parsons et al., 2006).

Turki et al. (2011) described that elevated heart rate, increased core temperature as well as increased the excitability of motor units and the kinesthetic sense, which in turn improves proprioception and preactivation increased nerve impulse transmission and increased muscle-tendinous unit stiffness result in beneficial alterations to the force-velocity relationship and less inhibition of antagonist muscles have been proposed as the processes through which stretching enhances muscular performance. These results suggest that stretching may improve the development of force and power. In fact, Yamaguchi and Ishii (2014) suggested that the increases in force output following dynamic stretching are brought on by an improvement in neuromuscular function and dynamic stretching had a postactivation potentiation effect on performance by increasing in the crossbridge attachments.

1.2.5 Stretching affects performance

Studies on the viscoelastic effects of stretching have clearly demonstrated that improvements in joint range of motion are related to decreases in viscoelasticity (McHugh & Cosgrave, 2010). Passive stretch resistance is defined as resistance to stretch that decreases over repeated stretches of a given period. This reduction in resistance is known as a decrease in muscle stiffness or an increase in muscle compliance. Stretching before sports performance has the key purpose of increasing the joint range of motion and decreasing resistance to stretch, allowing for a more flexible movement pattern. This is especially true for tasks that require a wide range of motion in numerous joints.

However, it is generally known that administering a series of stretches to a relaxed muscle results in an abrupt loss of strength once the stretching is done. This stretch-induced strength loss impact has mostly been studied in the knee flexors, knee extensors, and plantar flexors. Nevertheless, McHugh and Cosgrave (2010) showed that the effects of stretching on assessing performance are more significant than on assessing muscle strength and stretch-induced declines in performance are often less pronounced than declines in strength.

Nevertheless, Rubini et al. (2007) who intended to review the acute effects of stretching in strength performance and jumping performance found that studies that used stretching that preceded 120 to 3600 seconds significantly decreased strength performance and studies that used stretching that preceded 30 to 480 seconds did not show detrimental effects on strength performance.

However, most of these studies experimented on static stretching and PNF stretching while only one study experimented on ballistic stretching. Moreover, it should be emphasized that these studies employed more than one stretch for the same muscle group or stretched for longer than what is often advised in the literature and athletic activities.

1.2.6 Static and dynamic stretching

There have been several studies focused on comparing the effects of static and dynamic stretching in jumping performance. However, dynamic stretching is shown to have a better outcome in improving jumping performance as it boosts power output (Yamaguchi et al., 2007). Aguilar et al. (2012) studied on the acute effects of dynamic and static stretching on muscle flexibility and strength. The results showed a significant increase in hamstring flexibility and eccentric quadriceps strength in the dynamic group with the vertical jump. Similarly, Carvalho et al. (2012) assessed passive static stretching, active static stretching and dynamic stretching in squat jump and countermovement jump. There were significant increases in squat jump and countermovement jump in the dynamic stretching intervention than static stretching. Moreover, Merino-Marban et al. (2021) studied on the acute effect of static stretching and dynamic stretching on standing long jump in primary schoolchildren. From their result, the dynamic stretching group showed significant statistical improvement over the static stretching group in the outcome measure. These studies focus on static and dynamic stretching’s effect on physical performance improvement and proved that dynamic stretching showed a better outcome in jumping performance however, there is no comparison between the effect of cyclic stretching and ballistic stretching in jumping performance.

1.2.7 Cyclic and ballistic stretching

There are long-duration (static) stretch and short-duration (dynamic) stretch. “Static, sustained, hold” are used to interpret long-duration stretch which is used for release tension while “cyclic, ballistic, intermittent” are used for short-duration stretch and for warm up. Static stretching involved holding at the end range of stretch and it is advised to hold for 20 to 45 seconds whereas dynamic stretching involved active movement through a full range of motion of stretch. However, there are arguments that dynamic stretching is more likely to cause trauma and injury to the stretched tissue. Thus, proper stretching techniques are needed to be enhanced in all forms of exercise. According to Kisner and Lynn Allen Colby (2012), there are two forms of dynamic stretching. Cyclic stretching is a gradual intermittent stretch where it is repeatedly applied and released and the end range stretch is given at controlled with slow velocity and gentle intensity, whereas ballistic stretching is a forceful intermittent stretch applied rapidly and at high velocity and intensity. Cyclic stretching is proposed to hold between 5 to 10 seconds (Starring et al., 1988). However, there are arguments that stretching that is held for 5 to 10 seconds should consider as static stretching (Kisner & Lynn Allen Colby, 2012). Nevertheless, most therapists agree that cyclic stretching is considered more comfortable for patients and more effective than static stretching. The quick bouncing movement used in ballistic stretching is the main difference between cyclic stretching and ballistic stretching. Therefore, this research is aimed to compare the effect of lower limb cyclic stretching and ballistic stretching jn sports performance. This can be achieved by comparing the effectiveness of lower limb cyclic stretching and ballistic stretching in the jumping distance among undergraduate students.

1.2.8 Importance and relevance

As sports are becoming an important event or activity around the world as well as the physical status of the future leaders of the society which are the university students is being sought after, thus, physical activity should be applied correctly, safely and PA performance should be paid solicitude of. Hadala and Barrios (2009) showed that pre-participation stretching does appear to lower the incidence of muscular strains according to certain research and calls for further research to be done on this aspect. Moreover, Hough et al. (2009) showed that vertical jump performance is negatively impacted by static stretching but positively impacted by dynamic stretching. There were various stretching techniques have been implemented in sports performance. However, there is a lack of study on comparing cyclic stretching and ballistic stretching in physical performance using standing broad jump. Thus, this study offers some physiological support for the inclusion of DS and the exclusion of SS physical activities that call for jumping performance.

1.2.9 Concluding Remarks

This research will be conducted to compare the effect of lower limb cyclic stretching and ballistic stretching in sports performance by comparing the effect of lower limb cyclic stretching and ballistic stretching in the jumping distance among undergraduate students. The jumping distance will also be assessed through the outcome measure standing broad jump test. Thus, this research is intended to encourage the implementation of the correct and appropriate stretching method into sports performance with the positive result obtained.

1.3 Research question

Is there any difference between the effects of lower limb cyclic stretching and ballistic stretching in the jumping distance among undergraduate students using the standing broad jump test?

1.4 Problem statement

Jumping may be improved by stretching before activities (McMillian et al., 2006). There were various stretching techniques that have been implemented to improve sports performance. However, there is a lack of evidence showing the most effective stretching to improve sport performance in terms of jumping distance. Cyclic and ballistic stretching techniques are commonly used, and it would be beneficial to be able to find out the effects of cyclic stretching and ballistic stretching in improving jumping performance. This will add to the information that athletes, coaches and / or physiotherapists can use to improve sports performance in terms of jumping. Thus, the effects of the two types of lower limb dynamic stretching techniques; cyclic stretching and ballistic stretching in jumping distance will be compared in this research using the standing broad jump test.

1.5 Research objectives

1. To determine the effect of lower limb cyclic stretching in the jumping distance among undergraduate students using the standing broad jump test.
2. To determine the effect of lower limb ballistic stretching in the jumping distance among undergraduate students using the standing broad jump test.
3. To determine the difference between the effects of lower limb cyclic stretching and ballistic stretching in the jumping distance among undergraduate students using the standing broad jump test.

1.6 Hypothesis

H0) There is no significant difference between the effect of lower limb cyclic stretching and ballistic stretching in jumping distance.

H1) There is a significant difference between the effect of lower limb cyclic stretching and ballistic stretching in jumping distance.

1.7 Operational definition

a) Cyclic stretching is a stretch method that targets the quadriceps, iliopsoas, gluteus muscle, hamstring muscles, and gastrocnemius which is performed slowly at first for five times then quickly for 10 times without bouncing and repeat for two sets.

b) Ballistic stretching is a stretch method that targets the quadriceps, iliopsoas, gluteus muscle, hamstring muscles, and gastrocnemius which is performed by bouncing rapidly for 30 seconds and repeat for two sets.
c) Undergraduate students refer to academically active UTAR students who are currently in year one to year four Degree programs.
d) Jumping distance will be the distance of landing of the heels from the starting point using the standing broad jump test.
e) Physical performance improvement will be the difference between the jumping distance during the pre-stretching and post-stretching.

1.8 Structure of research project

In this research paper, an introduction to the background of the study which comprises of the research questions, research objectives, importance and relevance will be discussed in Chapter 1. The literature review on pertinent topics from prior studies is then included in Chapter 2. The methodology for this study is covered in Chapter 3, which also covers the research design, sample design, research instrument, and data collecting process. The findings from the data gathered after descriptive and inferential analysis as well as the hypothesis testing will be presented in Chapter 4. Chapter 5 will finish with a review of the study's findings, its limitations, and recommendations for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 Chapter overview

This chapter outlines the different topics through past journals and literature which provides the blueprints for the research project.

2.2 Jumping distance as a predictor of physical performance

In the paper of Zhou et al. (2020), the standing broad jump was accepted as a test for leg power and are common fundamental position in many sports. Ngetich & Rintaugu (2013) sought to ascertain if certain physical fitness traits, including coordination, speed, strength, cardiovascular endurance, and flexibility, might be used to predict long jump success. Measurements were taken from 50 randomly chosen long jumpers. Shuttle run, 50-meter sprint, standing broad jump, 12-minute walk/run (cooper test), and sit-and-reach were among the tests. Results revealed no significant variations in arm or shoulder endurance and a strong association between running broad jump and cardiovascular endurance, coordinative ability, explosive leg strength, and speed. It was determined that running broad jump performance is correlated with aerobic endurance, coordination, explosive leg strength, speed, and flexibility. Similarly, Kasović et al. (2021) studied on health related physical fitness among males and females. The physical fitness performance were standing broad jump which is used as an indicator of lower body power, polygon backwards which is used to measure agility and flexibility test such as sit and reach test. These studies suggest that long jump training regimens should be methodical and scientific in the development of physical fitness components.

Furthermore, Chaouachi et al. (2009) studied on a few characteristics in 21 elite handball players which include anthropometric, physiological measures and physical performance. Of the physical performance, the single leg jumping test was found to be a particular standardized predictor for elite handball players to determine sprinting ability. In addition, Maulder et al. (2006) studied on vertical jump and horizontal jump as a predictor of sprint performance in ten track sprinters as well as Bret et al. (2002) studied on the relationships between leg power and sprint ability using vertical and horizontal jump tests. Similarly, these studies had shown that horizontal jump has stronger correlations with sprint performance. Thus, horizontal jumping distance is a good predictor in predicting physical performance such as sprinting.

Moreover, in the study of Faigenbaum et al. (2006), the acute effects of four protocols and a weighted vest on anaerobic performance were done. The protocols were five static stretches, nine moderate to high-intensity dynamic exercises, nine dynamic exercises with a 2% of body mass weighted vest, and dynamic exercise with a 6% of body mass weighted vest and their effects on vertical jump, long jump, seated medicine ball toss, and 10-yard sprint have been assessed. They indicated that dynamic protocols were effective in the vertical jump and long jump only, thus, they concluded that the vertical jump and long jump are able to assess the effect of dynamic protocol on anaerobic performance. Thus, jumping distance will be used in predicting the effect of lower limb stretching in physical performance as it was proven to be a good predictor of physical performance.

2.3 Effectiveness of dynamic stretching in jumping performance

According to Yamaguchi and Ishii (2014), dynamic stretching has been shown to increase explosive performance in previous research therefore, it is currently integrated into training and preparatory routines just before physical activities. This is because dynamic stretching not only increases core body temperature but also excites the motor unit and enhances fundamental movement skills (Faigenbaum et al., 2006).

Holt and Lambourne (2008) showed that dynamic stretching has a positive outcome on jump performance. In their study, warm up with static stretching, warm up with dynamic stretching, warm up with dynamic flexibility and warm up only were used as interventions. In the results, dynamic warm up conditions were having a significant increase in vertical jump performance. Turki et al. (2011) used five protocols to asses jump performance which include concentric exercise, eccentric exercise, isometric exercise, plyometric exercise and dynamic stretching. They showed that the potentiation of vertical jump characteristics was able to be achieved with only 10 minutes of dynamic stretching whereas other protocols triggered fatigue that prevent further potentiation. Similarly, Fletcher and Monte-Colombo (2010) compared the effect of static stretching and dynamic stretching as a warm up protocol in countermovement jump and drop jump performance. The static stretches were hamstrings, quadriceps, abductors, adductors, gluteus maximus and calf muscle stretch for 15s hold. Whereas the dynamic stretches were heel flicks, high knees, high rolls, calf raises, straight leg skipping and lunging for 12 repetitions. In their result, dynamic stretching was having higher significance in countermovement jump and drop jump height than static stretching.

In addition, Hsu et al. (2020) compared the acute effects of dynamic stretching, static stretching as well as self-myofascial release technique on sit and reach test (flexibility), board jump test (power) and Edgren side step test (agility) in table tennis players. It is shown that dynamic stretching significantly improved in sit and reach test and board jump test. Smith et al. (2018) also studied on the effects of dynamic stretching and foam rolling self-myofascial release of hip flexors, adductors, hamstrings and calf muscles in the vertical jump. The vertical jump height was examined following treatment at 5-minute intervals for 20 minutes. They found that dynamic stretching was effective in jump height performance. However, the effect was acute and lasts not longer than five minutes.

Dynamic stretching indeed facilitates jumping which requires lower limb power and this can be done as dynamic stretching enhances physical performance on jumping. The gap in these studies is that they only proved that dynamic stretching has a positive outcome in jump height but a lack of studies emphasizes on the effect of dynamic stretching in jumping distance using standing broad jump. Therefore, the effect of dynamic stretching in jumping distance will be done using the standing broad jump in this research.

2.4 Jumping distance and standing broad jump

Jumping is a crucial movement ability in many sports that call for fast muscular contractions. To execute well, jumping requires intricate motor coordination of the upper and lower limbs. The standing broad jump (SBJ), which is a double-leg leap with the highest horizontal range, is a useful, practical and scaleable indicator of functional explosive strength for clinical and community screening and surveillance. The SBJ is continuously correlated with levels of objectively assessed physical activity in children and adolescents and is significantly connected to health (Tomkinson et al., 2020).

The standing broad jump (SBJ), which exhibits strong relationships with isokinetic measurements of lower extremity force, is regarded as an excellent predictor of sprint and jump performance. The SBJ test will be used to measure the jumping distance in this research as it measures the take-off distance, which is the horizontal distance between the jumper's center of mass and the starting line at the moment of take-off, the flight distance, or the horizontal distance the center of mass travels while in flight; and the landing distance, or the distance between the center of mass and the heels of the feet at the moment of landing (Krishnan et al., 2017). In addition to having a significant relationship with other field-based tests of explosive strength regardless of age, sex, or body size, SBJ has moderate to high construct validity with recognised measures of both lower and upper-body strength. The SBJ has a very high test-retest reliability with very little learning and fatigue effects on test-retest performance and is typically safe. Ortega et al. (2008) and Committee on Fitness Measures and Health Outcomes in Youth et al. (2012) have also approved it for its predictive value and suggested using it for fitness assessment in schools.

In general, SBJ demands the jumper to begin in an upright standing stance, perform a preliminary downward movement, and then instantly jump off the ground. Tendons store elastic energy when stretched like a spring, and when the spring is released, it snaps back quickly to its original position using the elastic energy it stores. To begin the leap in a forward and upward trajectory of 40-45 degrees, both feet must leave the ground at the same moment, causing complete extension of the ankle, knee, and hip, known as a triple extension in order to utilize all elastic energy from these joints. When landing, the stresses were absorbed gradually through the feet, ankles, knees, hips, and back. The gastrocnemius is largely responsible for leaping, whereas the soleus aids in ankle plantarflexion. The quadriceps femoris stretches the knee joint somewhat, whereas the gluteus maximus extends the hip joint slightly. The hip flexors flex the hip and elevate the knee; the iliopsoas is the agonist, and the rectus femoris, sartorius, and tensor fascia lata are the synergists. Therefore, stretching on the quadriceps, iliopsoas, gluteus maximus, hamstring and gastrocnemius will be implemented in this research and using SBJ as an outcome measure.

2.5 BMI affects jumping

Issues concerning large numbers of overweight and obese people were originally solely of concern to the world's wealthier nations; however, the World Health Organization (WHO) reports that similar concerns are increasingly becoming more frequent in poorer countries. In 2016, the WHO estimated that 340 million children aged 5 to 19 were overweight or obese; meanwhile, the rate of overweight adults over the age of 18 was reported to be 39 percent, with 13 percent classified as obese (World Health Organization, 2021). According to the international classification of Body Mass Index (BMI) by WHO, BMI can be calculated with the formula of weight in kg divided by height in meters squared, and overweight among adults is when the BMI is 25kg/m^2 or above while obese among adults is when the BMI is 30kg/m^2 or above.

Ding & Jiang (2020) stated when a population lacks regular high-intensity physical exercise, BMI is a good predictor of health, physical fitness, and activity level. It has been demonstrated that among young people with high BMI scores, there is frequently a decline in motor abilities and a poorer level of general physical fitness. Obesity or being overweight can frequently make it difficult to do fitness activities that call for the body to be projected through space and moved, such as running, jumping, and lifting or supporting the body off the ground. Additionally, there is an inverse relationship between an individual's level of physical fitness and their level of obesity. As a result, persons who are overweight or obese have lower levels of physical fitness than the general population.

Moreover, in the study of Okely et al. (2004), overweight boys and girls in all grades were more likely to have low levels of fundamental movement skills (FMS) than those who were not overweight, and they were less likely to have high levels of FMS. Non-overweight boys and girls in each grade were twice as likely to have more advanced locomotor skills than overweight boys and girls when FMS were divided into locomotor and object-control skills. They concluded that performance of locomotor abilities and weight status appear to have large and relevant relationships in children and adolescents. Additionally, Nikolaidis Pantelis et al. (2015) studied the relationship between the BMI status of young male basketball players and their running and jumping performances. In comparison to normal-weight players, overweight athletes performed worse in running (sprint and endurance) and jumping. Furthermore, Fogelholm et al. (2007) studied on the associations of overweight and physical activity with physical fitness. The outcome measures were sit-ups, sit and reach, five jump, back and forth jumping, ball skills, coordination and endurance shuttle run tests. They found that apart from sit and reach test, the effect of being overweight was significant for all the outcome measures. In addition, all test results were significantly worse in participants with overweight compared to participants with normal weight. Therefore, participants with a BMI of 25kg/m^2 or above which is considered overweight or obese will be excluded from this research as people with overweight and obese might have poor physical performance. This might affect the effect of lower limb stretching on the jumping distance among them.

Therefore, this research is aimed to compare the effect of lower limb cyclic stretching and ballistic stretching in the performance of jumping distance. In addition, the data presented is aimed to encourage the implementation of the correct and appropriate stretching method in sports performance. Thus, the standing broad jump test will be used to assess the jumping distance among undergraduate students. Moreover, participants who are overweight or obese will be excluded.

CHAPTER 3

METHODS

3.1 Chapter overview

This chapter will cover the research methodology used, including the research design, sampling design, research instrument and procedure of the experiment in detail.

3.2 Research design

This was a quasi-trial as no control group is involved, a two-armed, parallel-group experimental study. Randomization was included to allocate participants into two intervention groups using computer at a 1:1 allocation rate. The participants and researcher were unblinded as it is pragmatic while statistical analysis was blinded (Salkind, 2010). Sites of recruiting participants were at the KA block and KB block of UTAR, Sungai Long campus in Cheras, Malaysia. The recruitment was done in a face-to-face method and the whole recruitment duration was one week. The experiment was conducted in the Physiotherapy Center of KA block in UTAR Sungai Long campus. The experiment was done in a duration of two weeks after recruiting all the eligible participants.

3.3 Ethical approval

All participants were required to sign and read the consent form and provided demographic data after being thoroughly explained the study procedures. The results and data were computerized and recorded in Microsoft

Excel. This study was performed after obtaining the ethical approval by the Scientific and Ethical Review Committee (SERC) of Universiti Tunku Abdul Rahman (refer to Appendix A).

3.4 Sampling Design

The targeted participants were undergraduate students in UTAR, Sungai Long Campus. Using G*power 3.1.9.4 software with inserting mixed method analysis of variance (ANOVA) with an alpha of 5% and 80% power, a total number of 34 participants would be required to complete the study (refer to Appendix G). When considering a 20% dropout rate, the study would need to recruit 42 participants. However, the actual study was able to recruit 44 participants. When allocating the participants into two groups randomly, the cyclic group consisted of 22 participants and the ballistic group consisted of 22 participants. The sampling method used was convenience sampling method where all the participants were readily available at UTAR Sungai Long campus. It is a fast, inexpensive, and easy sampling method due to the time restriction of this research study (Etikan & Bala, 2017).

The inclusion criteria of the participants for this study were a) UTAR undergraduate students in the Sungai Long campus, b) male and female students and c) physically active students who were considered as minimally active or HEPA active using IPAQ-SF (IPAQ, 2004). Whereas the exclusion criteria would be a) recent fracture of 6-8 weeks (Santos, 2022), b) any lower limb and spine musculoskeletal condition in the past 6 months, c) cardiovascular disease and d) overweight or obese with BMI ≥ $25\text{kg}/m^2$ (Ding & Jiang, 2020). Exclusion criteria a and b are considered as contraindications for stretching and subjects with cardiovascular disease are excluded as jumping might be a precaution for it (Kisner & Lynn Allen Colby, 2012).

3.5 Research instrument

The instrument used contained of five components, which were consent form (refer to Appendix B), demographic data and screening form (refer to Appendix C), Personal Data Protection notice (refer to Appendix D), International Physical Activity Questionnaire (IPAQ-SF) (refer to Appendix E) and instruments for the experiment.

The inform consent form (refer to Appendix B) contains a brief introduction and description on the purpose, procedure, duration as well as benefits and risks of the study. The researcher's contact information was provided if there is any clarification about the study required. The last section of the consent form required the participants to indicate their participation in the study by providing their personal identification.

In the demographic data and screening form (refer to Appendix C) collected questions such as Name, Age, Gender, Race, Year of study and Contact number as well as a screening of exclusion criteria such as height, weight, recent fracture of 6-8 weeks, lower limb or spine muscles, joints and ligaments condition in the past six months and cardiovascular disease.

The Personal Data Protection notice (refer to Appendix D) required the participants to indicate their acknowledgment of the notice by agreed, consent and understood on the notice.

Self-reported physical activity questionnaires have been the main instrument for monitoring physical activity in population groups and in epidemiological research since they are reasonably inexpensive and simple to administer. The International Physical Activity Questionnaire short form (IPAQ-SF) (refer to Appendix E) was used to assess the physical activity level of the participants as mentioned in the inclusion criteria where only physically active students were eligible to participate in this study. The questionnaire included seven questions about the frequency and duration of various physical activities during a one-week period, which would designate the subjects as inactive, minimally active, or HEPA groups. Craig et al. (2003) evaluated IPAQ-SF to have objective capabilities comparable to other self-administered reports and they encourage it for use in measuring the physical activity level of 18-65-year-old individuals. IPAQ-SF had a correlation coefficient of 0.75, indicating that it is a good indicator of physical activity. Eligible participants in this study were physically active groups, which were minimally active and HEPA students who were screened through IPAQ SF. Individuals meeting i) 3 or more days of vigorous activity of at least 20 minutes per day OR ii) 5 or more days of moderate-intensity activity or walking of at least 30 minutes per day OR iii) 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of at least 600 MET-min/week were considered as minimally active. Whereas individuals meeting i) vigorous-intensity activity on at least 3 days achieving at least 1500 MET-min/week OR ii) 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving at least 3000 MET-min/week were considered as HEPA active.

The instruments used for the experiment were a) measuring tape used to measure the jumping distance in cm, b) tape which used to keep the measuring tape in place and as a marker on the starting point, c) a stopwatch used to calculate the time for the participants doing ballistic stretching for 30 seconds, d) chalk powder used to make a mark on the landing distance from the heels to the starting point, f) yoga mat used for stretching and g) heart rate and respiratory rate monitor.

3.6 Procedure

After recruiting participants, they are required to fill up the demographic data and screening form (refer to Appendix C) and IPAQ SF (refer to Appendix E). When ethical approval by the UTAR Scientific and Ethical Review Committee was received, the eligible participants were allocated into two intervention groups randomly. The eligible participants were contacted. They visited the UTAR physiotherapy center according to their available time slot. They were required to sign and read the consent form (refer to Appendix B) as well as the Personal Data Protection notice (refer to Appendix D) after thoroughly explaining the study procedures, possible risks, and benefits of the study.

The heart rate and respiratory rate of the participants were obtained to make sure it is in resting condition, otherwise, they were required to rest until their heart rate and respiratory rate returned to resting condition. The participants were advised to wear proper sports attire and sports footwear. Then, they warmed up by jogging for 5 minutes before performing the pre-test.

The two intervention groups were cyclic stretching (CS) – three stretches for lower limbs for two sets and ballistic stretching (BS) - three stretches for lower limbs for two sets. Each participant was assessed in 1 day from pre-test to post-test. The difference between the jumping distance during the pre-stretching and post-stretching was then calculated.

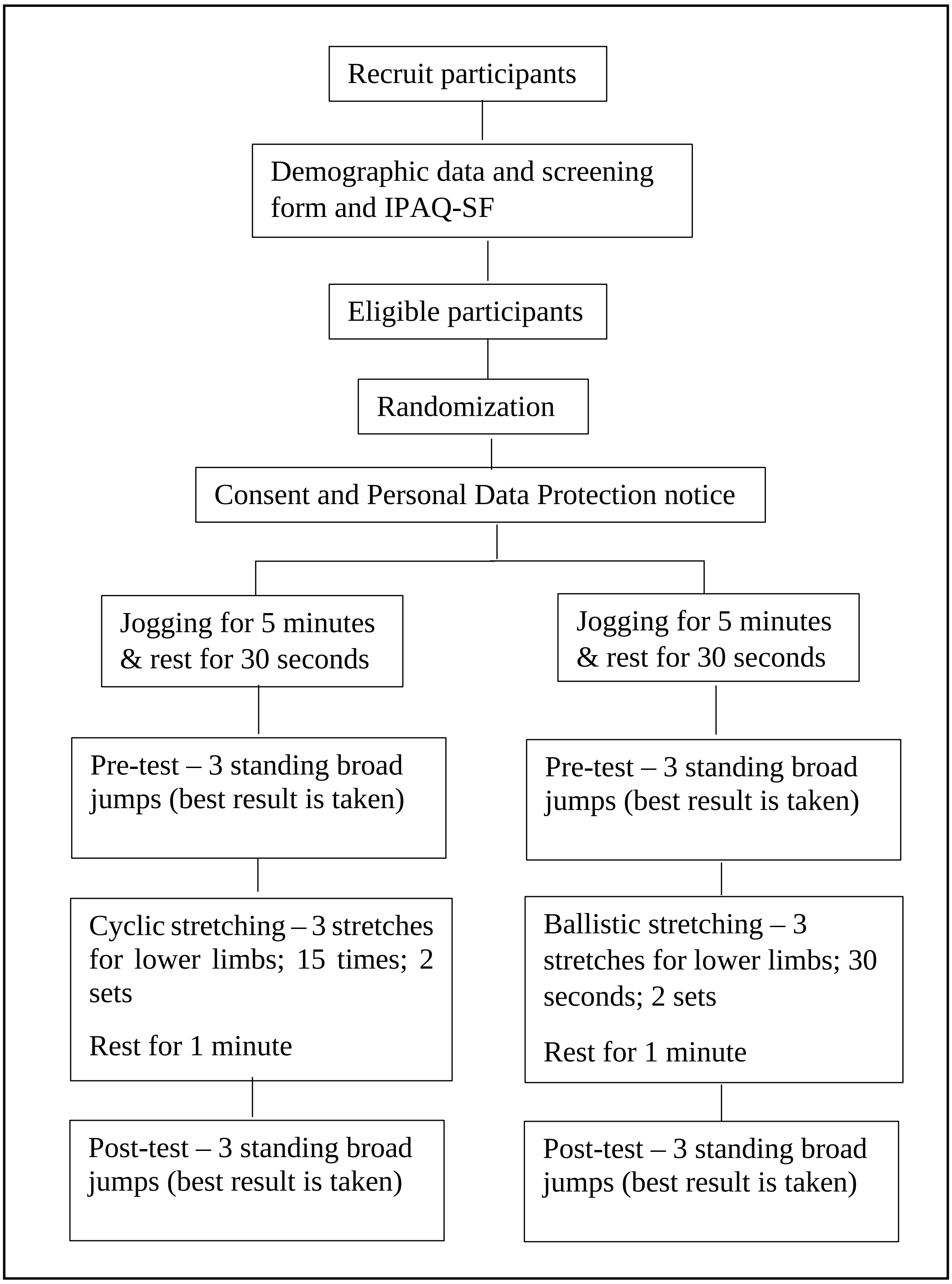

Figure 3.1: Study procedure

There were two interventions in this study which are two dynamic stretching protocols, cyclic stretching and ballistic stretching. With reference to the study of Jaggers et al. (2008), both stretching protocols consist of three lower limb stretches which are mainly for the quadriceps, iliopsoas, gluteus muscle, hamstring muscles, and gastrocnemius.

Cyclic stretching (refer to Appendix F)

In the CS group, each participant was instructed to perform each stretch slowly at first for five times then quickly for 10 times without bouncing, and repeat for two sets; 30 seconds rest between sets.

Quadriceps and Iliopsoas – standing kick back

1. Stand with one leg; mildly apart and in front of a wall.
2. Place both hands on the wall to gain balance.
3. Raise another leg slightly off the floor with the knee flexed.
4. Kick the leg behind the body by fully extending the hip.
5. Repeat for the other leg.

Gluteus maximus and Hamstring muscles – standing leg raise

1. Stand with both legs slightly apart and firmly on the floor.
2. Place both hands on the hips
3. Raise one leg, keep the knee straight and bring the thigh as high as possible.
4. Repeat for the other leg.

Gastrocnemius – calf raise

1. Position in a high push-up with the feet slightly apart.
2. Push one heel toward the ground. Next, back onto the ball of the foot to stretch the calf.
3. Repeat and alternate between legs

Ballistic stretching (refer to Appendix F)

In the BS group, each participant was instructed to perform each stretch by bouncing rapidly for 30 seconds and repeat for two sets; 30 seconds rest between sets.

Quadriceps and Iliopsoas – forward lunges

1. One leg takes a long step forward with the knee flexed and over the foot, keeping the foot flat on the floor.
2. The other leg remains at the back in straight and the foot pointing toward the front foot, the heel is not necessary to be on the floor.
3. Keep the trunk in an upright position and both hands on the hips or on the thigh of the front leg.
4. Bounce the hips in a forward and downward motion as much as possible.
5. Repeat for another leg.

Gluteus maximus and Hamstring muscles – supine leg stretch

1. Lie on the back with four limbs by side.
2. Straighten the knee and flex the hip of one leg, place both hands under the thigh, and bring the thigh toward the chest at a rapid and bouncing pace.
3. Repeat for another leg.

Gastrocnemius – sitting toe touch

1. Sit in a long sitting position.
2. Lean the body forward to touch the toes or ankles as much as possible, bounce the hip, and keep the arms and elbow extended.

The standing broad jump (SBJ) (refer to Appendix F) was used to assess the jumping distance. The measuring tape was to measure the jumping distance in cm. The participants were instructed to stand on both feet behind a marker which is placed on the 0cm of the measuring tape, where white chalk powder will be placed on the heels of the participants before jumping. The participants swing both arms and bend the knees, then take two feet off together and jump as far as possible and land on both feet without falling. The distance of landing was measured from the heels to the starting point. The best result of three trials was taken. Wearing appropriate sport shoes were compulsory for the participants during the jumping and no obstacles were kept along the jump rail as safety precautions when performing the SBJ test. SBJ is valid and reliable in measuring lower body strength (Castro-Piñero et al., 2010). It is a highly reliable field test for collegiate test and field athletes with interclass r = 0.99 and intraclass r = 0.99 (Reid et al., 2017).

3.7 Data analysis

Data analysis was done using IBM SPSS software statistics version 28. Paired sample t-test has been carried out to assess the difference in the mean score of the pre-stretching and post-stretching jumping distance in the cyclic group and ballistic group. An Independent t-test was carried out to compare the effects of the cyclic group and ballistic group in jumping distance improvement as well as to assess the effect of demographic characteristic has in the jumping distance among undergraduate students.

CHAPTER 4

RESULTS

4.1 Chapter overview

The following chapter will be presenting the findings from the data collection process for this research project. The demographic information of the participants is provided first. The outcomes of the inferential tests are next discussed, followed by hypothesis testing. The findings are provided in the order of the relevant graphs, if any, a brief discussion, and finally the tabulation at the conclusion of that component.

There were 44 data collected and all 44 participants were given consent to process the data.

4.2 Demographic of population

This section shows the demographic characteristics of the participants through graphs, descriptions, and a table that summarises the whole section.

4.2.1 Age

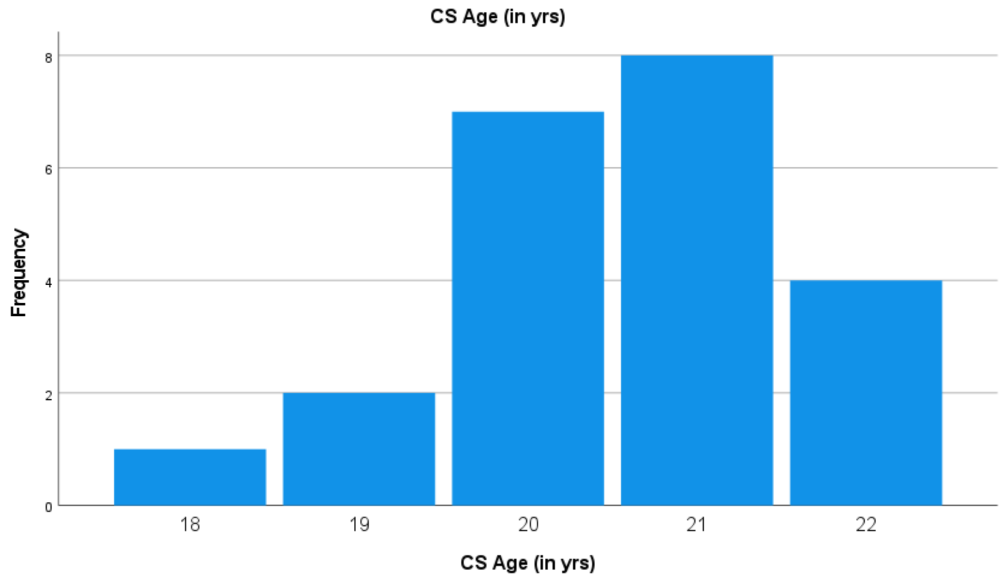

Figure 4.1: Age of participants in CS.

Figure 4.1 depicts the age distribution of the participants in the CS group in this study, which has a mean and standard deviation of 20.55 and 1.06 years, respectively (Table 4.1). The age range in this study only falls from 18 to 22 years old. The youngest participants are 18 years old, accounting for 4.5% or 1 person. There were 2 or 9.1% of 19-year-olds, 7 or 31.8% of 20-year-olds, and 8 or 36.4% of all students recruited were 21-year-olds. The 22-year-old age group has 4 participants or 18.2% which is the oldest age group in this study. (Table 4.1).

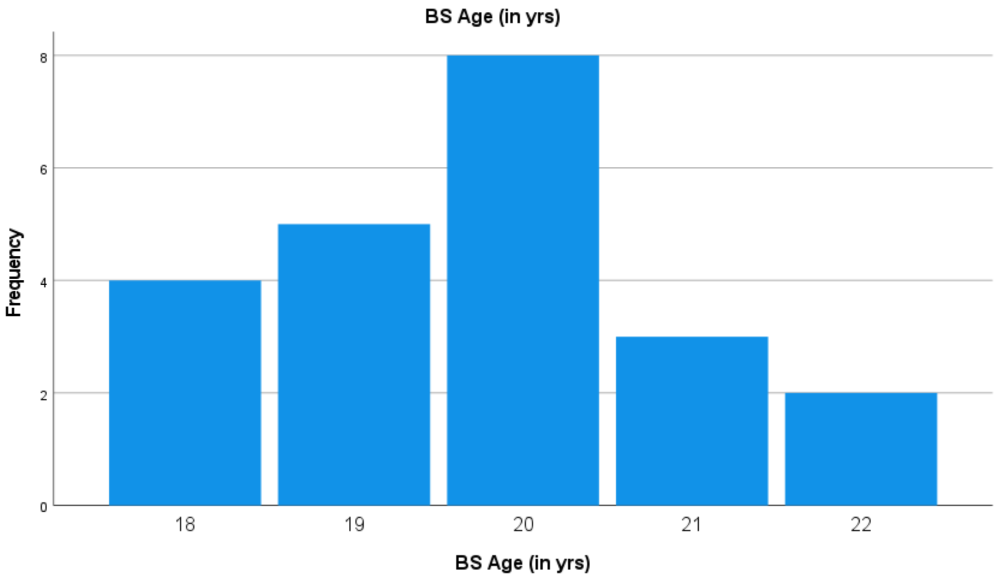

Figure 4.2: Age of participants in BS.

Figure 4.2 depicts the age distribution of the participants in the BS group in this study, which has a mean and standard deviation of 19.73 and 1.20 years, respectively (Table 4.1). The youngest participants are 18 years old, accounting for 18.2% or 4 persons. There were 5 or 22.7% of 19-year-olds, 8 or 36.4% of 20-year-olds, and 3 or 13.6% of all students recruited were 21-year-olds. The 22-year-old age group has 2 participants or 9.1% which is the least in this group. (Table 4.1).

4.2.2 Gender

The gender distribution of this study is equally distributed in both groups as shown in Table 4.1. There are 18 male students which are 81.8% of the participation pool and 4 female students or 18.2% in each intervention group (Table 4.1).

4.2.3 Race

Table 4.1 displays the racial distribution of the participants, and it is clear that the plurality of the participants is Chinese, accounting for 22 or 100% in the CS group and 21 or 95.5% in the BS group. Only one Indian student accounts for the remaining 4.5% in the BS group (Table 4.1).

4.2.4 BMI

Table 4.1 shows the BMI of the participants in this study. The mean BMI is 21.63kg/m^2 (SD=2.14kg/m^2) in the CS group and 21.68kg/m^2 (SD=2.04kg/m^2) in the BS group respectively (Table 4.1).

4.2.5 Year of study

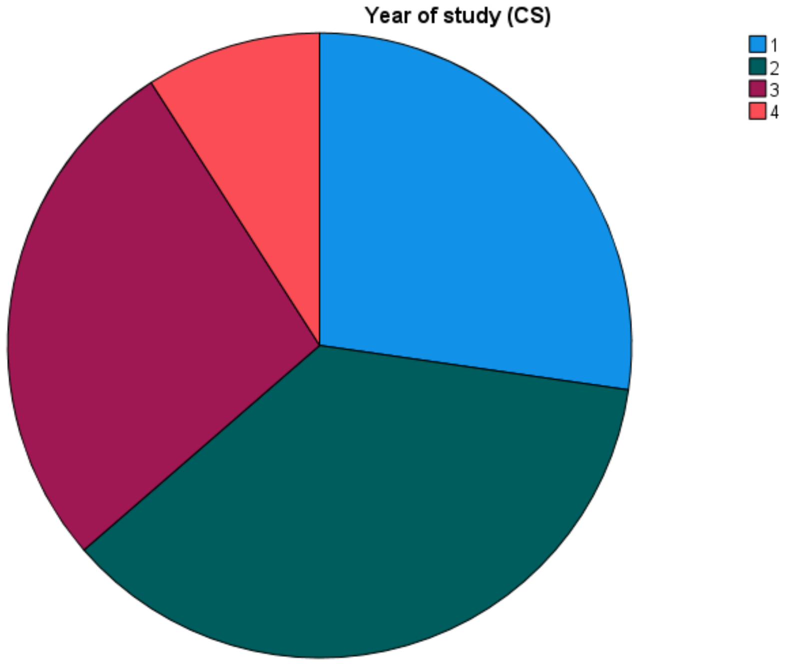

Figure 4.3: Year of study of participants in CS.

The distribution of the year of study of the participants in the CS group is displayed in Figure 4.3. Year 2 undergraduate students make up the majority of the participants, which is 8 or 36.4%. There are same amount of year 1 and year 3 undergraduate students which is 6 or 27.3%. Year 4 undergraduate students are the least which is 2 or 9.1% of all participants in the CS group (Table 4.1).

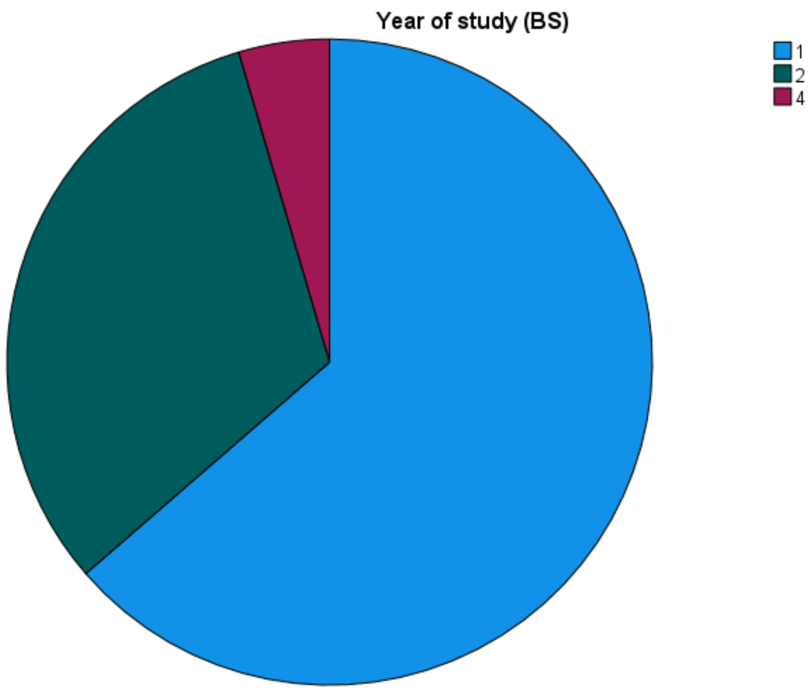

Figure 4.4: Year of study of participants in BS.

The distribution of the year of study of the participants in the BS group is displayed in Figure 4.4. Year 1 undergraduate students make up the majority of the participants, which is 14 or 63.6%. There are 7 or 31.8% of year 2 undergraduate students and only 1 or 4.5% of year 4 undergraduate students in the BS group (Table 4.1).

Demographic data		Cyclic stretching (CS) Frequency (%)	M (SD)	Ballistic stretching (BS) Frequency (%)	M (SD)
Age			20.55 (1.06)		19.73 (1.20)
	18	1 (4.5)		4 (18.2)	
	19	2 (9.1)		5 (22.7)	
	20	7 (31.8)		8 (36.4)	
	21	8 (36.4)		3 (13.6)	
	22	4 (18.2)		2 (9.1)	
Gender					
	Male	18 (81.8)		18 (81.8)	
	Female	4 (18.2)		4 (18.2)	
Race					
	Chinese	22 (100)		21 (95.5)	
	Indian	-		1 (4.5)	
BMI			21.63 (2.14)		21.68 (2.04)
Year of study					
	1	6 (27.3)		14 (63.6)	
	2	8 (36.4)		7 (31.8)	
	3	6 (27.3)		-	
	4	2 (9.1)		1 (4.5)	

Table 4.1: Demographic data of participants.

4.3 Inferential analysis

This part will go through the inferential analysis that was done for the research project, which includes the Paired sample t-test and the Independent t-test to assess the objectives and hypotheses. Each section will begin with a brief description of the test utilised, followed by the test's findings and a tabulation of results. For the analysis, IBM SPSS Statistics version 28 was employed.

4.3.1 Paired sample t-test

The Shapiro-Wilk Tests of Normality showed a significance value of $p>0.05$ for the jumping distance in the pre-stretching and post-stretching in both intervention groups. This indicates that the results of the jumping distance in the pre-stretching and post-stretching in both intervention groups were normally distributed. Therefore, paired sample t-test is conducted to test for the difference in the mean score in jumping distance during the pre-stretching and post-stretching for the same group of participants in the outcome measure.

From Table 4.2, the mean pre-stretching SBJ distance in the CS group is 200.70cm (SD= 40.09cm) and the mean post-stretching SBJ distance in the CS group is 199.49cm (SD= 41.21cm). There is no significant difference ($p>0.05$) between the pre-stretching and post-stretching jumping distance in the CS group. The 95% confidence interval (CI) of the difference is being between -5.26 and 7.69. Whereas the mean pre-stretching SBJ distance in the BS group is 197.45cm (SD= 42.12cm) and the mean post-stretching SBJ distance in the BS group is 197.39cm (SD= 40.16cm). Similarly, there is no significant difference ($p>0.05$)

between the pre-stretching and post-stretching jumping distance in the BS group. The 95% confidence interval (CI) of the difference is being between -4.87 and 4.98.

From the results of paired sample t-test, it is possible to deduce that both stretches have no significant effect in the jumping distance as the difference in the outcome measure is not statistically significant ($p>0.05$) which will be further discussed in hypothesis testing.

	Standing Broad jump			
	Pre-stretching M (SD)	**Post-stretching M (SD)**	**Diff (Post-stretching – Pre-stretching)**	**Sig (P value)**
CS	200.70cm (40.09cm)	199.49cm (41.21cm)	-1.22cm	0.35
BS	197.45cm (42.12cm)	197.39cm (40.16cm)	-0.06cm	0.49

Table 4.2: Results of Paired sample t-test.

4.3.2 Independent t-test

Following the paired sample t-test findings, the independent t-test is used to compare the difference in the jumping distance between both intervention groups as well as the difference in the mean scores of the binary outcome independent variable which is the Gender of the participants. The goal of this test is to determine if this variable will be affecting the participants in the domains being assessed. Each result will be described in detail, with a summary table at the conclusion of each section and a closing summary for the significant independent t-test findings.

The first Independent t-test was conducted to test for the significant difference between the effect of lower limb CS and BS in jumping distance. The mean difference will be the difference in the jumping distance between pre-stretching and post-stretching. As presented in Table 4.3, the mean difference in the jumping distance between the pre-stretching and post-stretching in the CS group is -1.22cm with SD=14.97cm and the mean difference in the jumping distance between the pre-stretching and post-stretching in the BS group is -0.06cm with SD=11.11cm. There is no significant difference ($p>0.05$) between the effect of lower limb cyclic stretching (CS) and ballistic stretching (BS) in jumping distance.

	CS difference M (SD)	BS difference M (SD)	Diff	t	Sig (P value)
CS and BS difference	-1.22cm (14.97cm)	-0.06cm (11.11cm)	- 1.16cm	- 0.294	0.770

Table 4.3: Results of Independent t-test between CS and BS mean difference.

The next Independent t-test was carried out to test for the effect of Gender in the jumping distance in both intervention groups. The mean difference will be the difference in the jumping distance between pre-stretching and post-stretching. From Table 4.4, the mean difference in the jumping distance among males in the CS group is 0.44cm with SD=15.85cm and the mean difference in the jumping distance among females in the CS group is -8.65cm with SD=11.39cm. There is no significant difference (p>0.05) on the effect of gender in jumping distance in the CS group. The 95% confidence interval (CI) of the difference is being between -8.51 to 26.69. Furthermore, the mean difference in the jumping distance among males in the BS group is -0.17cm with SD=10.92cm and the mean difference in the jumping distance among females in the BS group is 0.43cm with SD= 13.70cm. Similarly, there is no significant difference (p>0.05) on the effect of gender in jumping distance in the BS group. The 95% confidence interval (CI) of the difference is being between -13.71 to 12.53.

	Mean Difference (SD)		Diff	t	Sig (P value)
	Gender				
	Males	**Females**			
CS	0.44cm (15.85cm)	-8.65cm (11.39cm)	9.09cm	1.077	0.294
BS	-0.17cm (10.92cm)	0.43cm (13.70cm)	-0.59cm	-0.094	0.926

Table 4.4: Results of Independent t-test for Gender.

4.4 Hypothesis Testing

The sentences below showed the null hypothesis and alternate hypothesis for the first research objective.

H0i) Lower limb cyclic stretching has no significant effect in the jumping distance among undergraduate students using the standing broad jump test.

H1i) Lower limb cyclic stretching has a significant effect in the jumping distance among undergraduate students using the standing broad jump test.

The paired sample t-test was conducted to determine the significant effect of lower limb cyclic stretching in the jumping distance. The confidence level was set at $\alpha=0.05$. If the P value is <0.05, the null hypothesis will be rejected; if the P value is >0.05, the null hypothesis will be accepted. The results showed a t value of 0.39 and a P value of 0.35 which is >0.05, thus, the null hypothesis is accepted. In conclusion, the lower limb cyclic stretching has no significant effect in the jumping distance among undergraduate students using the standing broad jump test.

The sentences below showed the null hypothesis and alternate hypothesis for the second research objective.

H0ii) Lower limb ballistic stretching has no significant effect in the jumping distance among undergraduate students using the standing broad jump test.

H1ii) Lower limb ballistic stretching has a significant effect in the jumping distance among undergraduate students using the standing broad jump test.

The paired sample t-test was conducted to determine the significant effect of lower limb ballistic stretching in the jumping distance. The confidence level was set at α=0.05. If the P value is <0.05, the null hypothesis will be rejected; if the P value is >0.05, the null hypothesis will be accepted. The results showed a t value of 0.025 and a P value of 0.49 which is >0.05, thus, the null hypothesis is accepted. In conclusion, the lower limb ballistic stretching has no significant effect in the jumping distance among undergraduate students using the standing broad jump test.

The sentences below showed the null hypothesis and alternate hypothesis for the third research objective.

H0iii) There is no significant difference between the effect of lower limb cyclic stretching and ballistic stretching in jumping distance.

H1iii) There is a significant difference between the effect of lower limb cyclic stretching and ballistic stretching in jumping distance.

The significant difference between the effect of lower limb cyclic stretching and ballistic stretching was determined using an Independent t-test. The confidence level was set at α=0.05. If the P value is <0.05, the null hypothesis will be rejected; if the P value is >0.05, the null hypothesis will be accepted. Based on the significant value of 0.288 of Levene's Test for Equality of Variances, equal variances were assumed. The results showed a t value of -0.294 and a P value of 0.770 which is >0.05, thus, the null hypothesis is accepted.

In conclusion, there is no significant difference between the effect of lower limb cyclic stretching and ballistic stretching in jumping distance.

CHAPTER 5

DISCUSSION

5.1 Chapter overview

This chapter will provide an overview of the discussion of the key results in light of the research objectives, followed by a discussion of the study's limitations, recommendations for future studies and the study's conclusion.

5.2 Discussion

5.2.1 Effect of lower limb CS in jumping distance

The mean jumping distance in the cyclic stretching (CS) group has decreased from pre-stretching to post-stretching as analysed in the results with a mean difference of -1.22cm and a P value of >0.05. This difference is not statistically significant and lower limb CS showed no significant effect in the jumping distance.

As strength and power have been shown to be a crucial component in horizontal jump, there were a few studies which also addressed in the use of CS in strength and power performance, however, no study had been done using horizontal jumping distance test. One study had shown that CS has no effect in strength performance which is Herda et al. (2008) who also used 30s of stretching found that although EMG amplitude rose, CS did not increase muscular strength. This might instead be explained by the fact that CS had a potentiating impact on muscle activation. Thus, the study result might be explained by Herda et al (2008). However, there were three studies that showed that CS has detrimental effects in strength and power performance. Fowles et al. (2000) used 30 minutes of cyclic passive stretching and measured on strength by measuring maximal voluntary contraction with EMG and twitch characteristics showed reduced strength for up to 1 hour. Similarly, Nelson et al. (2001) who studied on the effect of 10 minutes of stretching on maximal voluntary isometric torque measurement also showed a decrease in peak torque. Moreover, Avela et al. (1999) carried out an experiment to test the effect of repeated passive stretching on reflex sensitivity using maximal voluntary contraction also showed deterioration results. There were a few studies experimented in cyclic stretching and showed no effect or detrimental effect in strength and power performance, however, lack of study experimented in cyclic stretching and horizontal jumping distance. The mechanisms of detrimental effects in strength and power performance will be discussed in the following paragraph.

These studies have the same concept in explaining the results. To justify the stretch-induced loss of strength, two main theories have been put forth which are mechanical mechanisms involving the viscoelastic characteristics of the muscle and neurological mechanisms involving decreased motor control or reflex sensitivity.

According to Rubini et al. (2007) the increased muscle compliance may affect the muscle length-tension relationship, thereby this muscle permits less resistance to stretching and increasing its capacity to extend, increase sarcomere shortening distance and velocity and decrease force production due to the force-velocity relationship. This can be described as a "stress relaxation" phenomenon where there is a decrease in tension that happens when the muscle is stretched with a constant length. It also happens regardless of any electromyographic changes that have been noticed. Stretching-induced muscle compliance is therefore put out as one possible mechanism causing the decline in muscular function. And were the main mechanical mechanism underlying the stretching-induced decreases in force.

Whereas the neurological mechanism involved the autogenic inhibition of the Golgi tendon reflex, mechanoreceptor and nociceptor afferent inhibition and fatigue-induced inhibition. The Golgi tendon reflex is triggered when strong force and muscle lengthening are detected by the Golgi tendon organs, which are found at myotendon junctions. The input from the Golgi tendon organs prevents agonist activation, which lowers force output and lessens the risk of damaging strain on the muscle. The decline in activation occurred at time points following the conclusion of the stretch eliminating Golgi tendon organ feedback as the most plausible reason for decreased voluntary activation in these experiments. In addition, the central drive may be lessened by mechanoreceptor and nociceptor pain feedback input. The sense of stretch and discomfort as a reason for momentary activation failure would have to be fleeting because no discomfort nor pain sensations were noticed after the stretch. Muscle contraction may also be reduced by a reduction in the H reflex or "spindle support" brought on by stretching. However, this impact is more pronounced during stretching and recovers soon.

Nevertheless, there were studies which showed that cyclic stretching had a positive effect in jumping performance but with the use of vertical jump (Hough et al., 2009; Pearce et al., 2008). Therefore, future studies can study on comparison of the effects of cyclic stretching in horizontal jump and vertical jump.

5.2.2 Effect of lower limb BS in jumping distance

The mean jumping distance in the ballistic stretching (BS) group has also decreased from pre-stretching to post-stretching as analysed in the results with a mean difference of -0.06cm and a P value of >0.05. Similarly, this difference is not statistically significant and lower limb BS showed no significant effect in the jumping distance.

Similarly, there were a few studies experimented in ballistic stretching and showed no effect or detrimental effect in vertical jump, strength and power performance, however, lack of study experimented in ballistic stretching and horizontal jumping distance. There were two studies which also showed no significant effect of BS in vertical jumping performance. Covert et al. (2010) and Woolstenhulme et al. (2006) used 30 seconds of BS as protocol and assessed on physical performance including jumping and flexibility. Both reviewed no significant difference between ballistic stretching and physical performance in jumping when the effect of stretches is only examined acutely with 30 seconds of stretching. However, there were three studies found negative effects of BS in jumping or strength performance. Bacurau et al. (2009) showed reduced in lower limb maximal strength after the 30s of ballistic stretching session using a leg press test. Moreover, Bradley et al. (2007) used 10 minutes ballistic stretching protocol and Nelson and Kokkonen (2001) used 20 minutes ballistic stretching protocol which also showed negative results in vertical jump performance. The added value of this study is that by using 1 minute of ballistic stretching with 2 sets of the 30s is also not significant in jumping distance. Therefore, there is currently no data in the literature that points to the ideal ballistic stretching parameters and more studies should be done on this. However, more studies should be done on this using horizontal jump as an outcome measure.

Similarly in the CS, there are discussion on why BS showed detrimental effect in jumping and strength and power performance. BS was proven to improve flexibility through the neurological mechanism; however, it was neglected that it will reduce muscle strength by inhibiting Golgi Tendon Organ thus, reducing spindle sensitivity as in CS. This was proven by Guissard and Duchateau (2006) and Weerapong et al. (2004) where BS increase in range of motion but shows reduce in EMG and a decrease in H-reflex. This reduction of the amplitude of H-reflex implies that motor neuron excitability is also decreased. In another word, the synaptic transmission from Ia afferents to the motor neuron pool is reduced after a session of stretching.

Nevertheless, there were studies which showed that ballistic stretching had a positive effect in jumping performance but with the use of vertical jump (Behm et al., 2011; Fletcher & Monte-Colombo, 2010). Therefore, future studies can study on comparison of the effects of cyclic stretching in horizontal jump and vertical jump.

5.2.3 Comparison between effects of lower limb CS and BS in jumping distance

In this study, it was concluded that there is no significant difference ($p>0.05$) between the effect of lower limb cyclic stretching (CS) and ballistic stretching (BS) in jumping distance. Similarly, Little and Williams (2006) in their study reported no significant difference between a set of dynamic stretches and jumping but there were significant increases in speed and agility performance. In explaining the improvement in speed and agility performance but not jumping performance, Little and Williams (2006) explained that this is due to the jumping test was performed first immediately after the stretching protocols. Due to the fact that they discovered substantial gains in all other performance indicators, they draw the conclusion that the acutely detrimental effects of dynamic stretching may diminish with time. This finding is similar to the study of Jaggers et al. (2008) in which the vertical jump test was also performed immediately after the stretching protocol as well as SBJ was also performed immediately after the stretching protocol in this current study. However, Bradley et al. (2007) proved that jumping performance will be restored when the jumping is done after 15 minutes of stretching. Thus, future studies should study the best interim to perform jumping after a session of stretching.

Moreover, there are several factors or methods that act as confounders in influencing jumping performance. One of that is the external focus of attention and the internal focus of attention. This related to the discussion in this current study. During the experiment, some of the participants were given motivation by asking them to jump further which is focus in the external focus of attention while some were given attention on the biomechanics during their jumps which is focus in the internal focus of attention and this might influence the distance of jumping during the pre-stretching and post-stretching and affect the accuracy of the results. According to Ducharme et al. (2016), when a person concentrates on the action's outcome rather than the action itself, this is known as an external focus of attention; whereas an internal focus of attention, by contrast, focuses on the specifics of movement production such as the body segments or musculature engaged as well as the kinematics of movement. Ducharme et al. (2016) studied on the effects of an external focus of attention and an internal focus of attention on jumping distance and effective projection angle using standing broad jump. He concluded that the jumping distance was significantly farther in the external focus of attention group compared to an internal focus of attention group as well as the projection angle was significantly effective in the external focus of attention group. Therefore, the motivation script given to the participants should be standardised in future studies.

Zhou et al. (2020) had outlined a few criteria to improve SBJ and these may infer that only stretching was not enough to make a significant difference in jumping distance, future studies may study the combination of these criteria with stretching on SBJ. According to Zhou et al. (2020), the take-off angle during jumping makes a difference in the jumping distance. As a result, it is determined that choosing the right projection angle is essential for creating a perfect performance. However, the biomechanical justifications for this projection angle option are not well understood. Wakai and Linthorne (2005) concluded that the take-off distance and landing distance progressively reduced with increasing take-off angle and the flight distance was greatly influenced by a drop in the jumper's take-off speed with increasing take-off angle. The angle at which the distance of these three components combined to generate the longest jump distance was the ideal take-off angle for the jumper. Despite the fact that the predicted optimal take-off angles (19–27°) were less than the jumpers' chosen take-off angles (31–39°), the distance lost by utilising a sub-optimum take-off angle was only marginal. Thus, future studies may study on the combination of take-off angle and stretching on SBJ.

Zhou et al. (2020) also suggested that the standing postures of the participants might affect the jumping distance by affecting the coordination. The standing posture which is the preparation posture before the participants jump off is particularly studied on the parallel and straddle position on the quality of SBJ. The feet must be at least shoulder width apart and parallel to the starting line for the parallel posture. In contrast, the straddle posture entails placing one foot in front of the other in a self-chosen straddle posture between 30 cm and 40 cm. Mackala et al. (2013) studied the effect of parallel and straddle feet placement in SBJ on the differences in kinematics and kinetics views. Electromyography (EMG) was used in their investigation to assess the activity of three associated muscle groups in these two-foot positioning groups. According to the findings, the average distance may be increased in the straddle position compared to the parallel position by 5.18%. More precisely, the straddle posture was found to cause greater flexion angles at the knee, hip, and trunk joints. In comparison to placing the feet parallel, the straddle posture was also associated with larger peak joint moments and the entire body of the participants was more likely to lean forward and create a lower centre of mass, which can provide a greater momentum in the forward and upward motions and improve performance. Moreover, greater muscular activation was seen in the gluteus maximus, biceps femoris and lower limb extensors during the push-off phase in the straddle feet placement than in parallel. Thus, the standing posture of the participants should be made consistent in the study.

In addition, Dodd and Alvar (2007) had proven that acute explosive training would improve SBJ by improving lower body power as performing SBJ required lower body strength and power. This includes high velocity or plyometric training, heavy resistance training and complex training which involves performing heavy resistance movement before a high velocity or plyometric movement. These high velocity or plyometric training drills aim to promote the ability to use maximal force as quickly as possible, enabling more work to be done in less time by training the muscles to quickly switch from eccentric to concentric movements and shortening the amortisation phase between these movements; whereas the heavy resistance training strengthening the muscles' capacity to exert a lot of power; and the complex training is the combination of these two by using 80% 1RM of the heavy resistance lift followed by 30% 1RM of the high-velocity movement. Dodd and Alvar concluded that these three methods improved SBJ but complex training showed the greatest percent change. This study showed that in order to make a significant improvement in SBJ, explosive training is needed as it boosts power output which is required for SBJ, thus, future studies may consider studying the effect of the combination of stretching and explosive training on SBJ.

Moreover, Ho et al. (2019) believed that the types of feet and the use of foot orthoses would affect jumping performance. Therefore, they experimented on normal foot arched and flat foot in jumping performance using countermovement jump (CMJ) and standing broad jump. Their participants were classified into a normal-arched group or flat-footed group with the assessment of Chippaux-Smirak index, navicular drop test and resting calcaneal angle measurement and jump both with and without precast foot orthoses. From their results, in comparison to those with normal arches, those with flat feet showed reduced ankle plantarflexion and hip joint power in CMJ performance. In SBJ, the flat-footed group generated lower horizontal ground reaction force and had lower peak hip angular velocities than the normal-arched group. Whereas foot orthoses reduced frontal plane ankle moment, peak horizontal ground reaction force and ankle eversion. They concluded that the types of feet affected the jumping mechanics and the use of orthoses does not enhance jumping performance. Thus, future studies should emphasize on the types of feet and the use of orthoses when performing the jumping test.

In addition, study showed that people inherently or initially with higher joint flexibility have lesser improvement in range of motion (ROM) from the baseline following stretching compared to people with lesser flexibility (Donti et al., 2014). Moreover, Donti et al. (2014) showed that ROM and vertical jump improved after 30s of dynamic stretching and Badar Habib et al. (2018) showed that joint flexibility has significant effect in SBJ but with the used of eight weeks of stretching. Thus, joint flexibility has an impact in stretch performance and joint flexibility has an impact in jumping performance. Therefore, researchers should consider assessing the joint flexibility of the participants as a sampling criteria.

Last but not least, the result of no significant difference between both stretching protocols might be due to the physical status of the participants. As most of the participants were HEPA active as screened through IPQA-SF and they were participated in powerlifting as the researcher recruited the participants who went to the gym, stretching alone might not be enough to make a difference in SBJ in these participants who engaged in squats and deadlifts which trained on strength and power.

5.2.4 Effect of demographic characteristic in jumping distance

The effect of gender on the outcome was assessed and the results of our test showed statistically insignificant for both males and females. This result occurred might be due to the small females sample size compared to the males which are only 8 females compared to 36 males. In the study of Rahman (2021), there were 30 males and 30 females were assessed on the validity and reliability of the SBJ test. The results showed a high degree of reliability between male and female inter rates for SBJ. Therefore, more females should be recruited in order to obtain a reliable study result. Nevertheless, this gap in the number of males and females is due to the fact that males are more physically active than females. Cai Lian et al. (2016) proved that males are more physically active in terms of moderate and vigorous intensity exercises in Malaysia as well as Guthold et al. (2018) showed that females have a higher prevalence of physical insufficiency over 146 countries. Moreover, Miles (2007) in this study showed that this level of physical activity was being met by 24% of females and 35% of males. Age-related declines in physical activity levels were seen and across all age categories, males were more active than females. The best age groups for males and females to meet the physical activity guideline were 16–24 years old for males and 35–44 years old for females. Therefore, physically active females are lesser and more difficult to be recruited in this study.

This study does not show the significance of gender on the effect of stretching, nevertheless, gender does affect the effect of stretching and males and females need different types of stretching in improving physical performance. This is proven by Troumbley (2010) who showed a significant difference between 24 males and 10 females in agility performance using dynamic stretching and males showed higher significance to dynamic stretching. This is due to the fact that females have greater flexibility than males and females preserve a higher degree of joint mobility. Therefore, females may have had higher initial flexibility, thus, the shift in males after the intervention may have been larger. Moreover, males may maintain more type II muscle fiber, keeping more neural association (Feland et al., 2001).

The effect of age on the outcome was not assessed in this study as the results of jumping distance in pre-stretching and post-stretching were normally distributed with the Shapiro-Wilk Tests of Normality. Moreover, Štefan et al. (2020) showed that the normative values of SBJ are 210cm in males and 165cm in females among 19-28 years old and Ikeda et al. (2018) showed 217cm (SD= 120cm) among 18-22 years old. The results of SBJ in this study were within the normative values as shown, thus, the effect of age might not be a factor affecting the results in this study.

Furthermore, the effect of BMI on the outcome was not able to be assessed as people with overweight or obese have been excluded from this study and the BMI distribution in both intervention groups were similar. However, there were two studies showed that BMI actually affects jumping performance. According to Cowley et al. (2019), BMI had a significant negative correlation with vertical jump performance where underweight people obtained better results compared to normal weight and overweight and overweight people failed to achieve correct jumping mechanics. Similarly, Sacchetti et al. (2012) found a significant negative correlation between BMI and standing broad jump in which the distance of jumping decreased with an increase in BMI. Therefore, future studies should involve only participants within one BMI category to avoid any confounding factors.

5.3 Limitation of study

In this study, only physically active students were recruited; only participants who went to the gym were recruited. Most of the participants were powerlifters and basketball players, and even though they were considered as physically active according to IPAQ-SF, the results obtained will not be able to be generalized and applied to other athletes in other sports. In addition, powerlifters and basketball players, may have specific patters of muscle or joint tightness and flexibility, which was not assessed and measured in this study. Future studies should take this into account.

Moreover, another limitation of the study is the recall bias that was present. In determining the physical status of the participants, they were given IPAQ-SF to fill up. It was obvious that recall bias would exist due to the way the questions were framed and designed. As the questions were based on the "last seven days" fashion, recalling of events might not be accurate and the physical status of the participants in the "last seven days" might be affected by the semester break or their time compared to usual.

The next limitation is existed during the performance of the outcome measure which is the standing broad jump test. As the test required the participants to land on both feet firmly and securely and jump for three trials, however, some of the participants were not able to obtain results in three jumps as they lost balance. Thus, they might be tiring and the results they obtained might not be consistent and accurate. In addition, during the experiment, some of the participants were given motivation in the external focus of attention while some were given attention in the internal focus of attention and this might influence the distance of jumping during the pre-stretching and post-stretching and affect the accuracy of the results.

In addition, the limitation that occurred was due to the small sample size. Independent sample t-test was failed to analyse the effect of Race and the effect of BMI in jumping distance due to small racial distribution and BMI distribution in both intervention groups which is only one participant of Indian race and two participants with underweight in this study.

Last but not least, it is significant to notice that Chinese students make up the bulk of the study's sample of students at UTAR. This is also clear from the current study, where 99% of the sample is Chinese. Malaysia is a mixed nation, hence this study's conclusions may not apply there because the other races are grossly underrepresented there. Furthermore, this study only applied to undergraduate students and this is clear from the demographic of participants where the age range was 18-22 years old. The result might not be significant to other age groups. Additionally, the study was only conducted at one institution, this should be changed in subsequent studies.

5.4 Recommendation for future research

For the recommendation for future research, to allow for better generalizability of the results, researchers should include people of differing activity level, physical body structures, and from various sport fields. Other physical assessments can also be considered such as strength and flexibility

For researchers using the SBJ test in the future, it is recommended that a standardised method of measuring the jumping distance can be utilised, for example with the use of a camera to capture the distance of landing and a demonstration video of the test can be sent to the participants and encourage them to practice beforehand. This is to make sure that during the test, only three trials will be done to ensure the consistency and accuracy of the test result. In addition, a standardised motivation should be given to the participants as external focus of attention and internal focus of attention contribute different effects in jumping performance.

Next, for greater representation of the entire population, the sample size should be increased to cover a wider range of participants. For instance, this study addresses the racial distribution, gender, BMI and number of students in the inactive category. This might result in the under or overrepresentation of particular student groups relative to other groups, which would bias the study's findings. Future studies can be done on wider age range groups and at several other universities to address this problem, which would enhance the representation of the whole student population.

5.5 Conclusion

In summary, this study detected no significant difference between pre-stretching and post-stretching jumping distance in the cyclic stretching group with $p>0.05$. This indicates that the lower limb cyclic stretching has no significant effect in the jumping distance among undergraduate students using the standing broad jump test.

Moreover, there was also no significant difference between pre-stretching and post-stretching jumping distance in the ballistic stretching group with $p>0.05$. This indicates that the lower limb ballistic stretching has no significant effect in the jumping distance among undergraduate students using the standing broad jump test.

When comparing the significant difference between the effect of lower limb cyclic stretching and ballistic stretching in jumping distance, the results showed $p>0.05$ which also indicates that there is no significant difference between the effect of lower limb cyclic stretching and ballistic stretching in jumping distance.

The difference in the mean scores of the binary outcome independent variable in both groups which is the Gender of the participants has been assessed. The goal of this test is to determine if this variable will be affecting the participants in the domains being assessed. The results again detected no significant difference between the mean difference in the gender of participants in both groups on the outcome measure.

These results might be expanded upon in a future study by increasing the sample size, increasing the age range of the participants and addressing the determinant variables that might be affecting the results for greater representation of the entire population. The findings from this study suggested that more studies should be done to develop the appropriate protocol, duration or intervention in improving physical performance with the use of stretching.

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APPENDIX A – ETHICAL APPROVAL FORM

UNIVERSITI TUNKU ABDUL RAHMAN

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Re: U/SERC/224/2022

4 November 2022

Mr Muhammad Noh Zulfikri Bin Mohd Jamali
Head, Department of Physiotherapy
M. Kandiah Faculty of Medicine and Health Sciences
Universiti Tunku Abdul Rahman
Jalan Sungai Long
Bandar Sungai Long
43000 Kajang, Selangor

Dear Mr Muhammad Noh,

Ethical Approval For Research Project/Protocol

We refer to your application for ethical approval for your students' research project from Bachelor of Physiotherapy (Honours) programme enrolled in course UMFD3026. We are pleased to inform you that the application has been approved under Expedited Review.

The details of the research projects are as follows:

No	Research Title	Student's Name	Supervisor's Name	Approval Validity
31.	Association of Postural Awareness with Sedentary Behavior and Back Pain During the Hybrid Study Among Undergraduate Students	Low Xin Yuen	Mr Martin Ebenezer Chellappan	4 November 2022 – 3 November 2023
32.	Impact of Social Media Addiction on Physical Activity Among Undergraduate Students	Mak Kai Nan		
33.	Tibial Torsion and Leg Length Discrepancy in Idiopathic Scoliosis Among UTAR Students	Khoo Wan Qi	Pn Nadia Safirah Binti Rusli	
34.	Prevalence of Patellofemoral Pain Among University Students	Khoo Wen Han		
35.	Prevalence of Varicose Veins Among Fast Food Employees in Cheras, Selangor: A Cross Sectional Study	Ropheca Phuah Su Hui		
36.	The Effect of Unstable Modified Wall Squat on Dynamic Balance Among Recreational Athletes	Chu Sin Jiet	Mr Sathish Kumar Sadagobane	
37.	Knowledge, Perception, and Attitude Towards Breast Cancer and Breast Self-Examination (BSE) Among Non-medical Private University Students	Foo Jes Mynn		
38.	Perception, Knowledge and Attitude Towards the Impact of Daytime Nap on the Risk of Stroke Among Non-Healthcare Undergraduate Students: A Cross-Sectional Study	Chan Chi Kuan	Mr Tarun Amalnerkar Co-Supervisor: Ms Swapneela Jacob	
39.	Awareness, Knowledge and Attitude Toward Orthostatic Hypotension Among Elderlies	Ch'ng Hui Kee		
40.	Effect of TikTok on Student Learning Among Physiotherapy Students	Tan Eng Jing	Mr Avanianban Chakkarapani	
41.	Awareness Towards Tourette Syndrome Among Health Science and Non-health Science Students in A Private University, Malaysia	Tan Kai Xuan		
42.	Effect of Scapular Retraction Exercise on Forward Head Posture Among University Students	Tay Kai Wei	Ms Mahadevi A/P Muthurethina Barathi	
43.	Comparison Between Effect of Lower Limb Cyclic Stretching and Ballistic Stretching on Jumping Distance Among Undergraduate Students: A Comparative Study	Ng Zi Ru		
44.	Relationship of Physical Activity with Anxiety and Depression Among University Students	Ong Aiwei		

The conduct of this research is subject to the following:

(1) The participants' informed consent be obtained prior to the commencement of the research;

(2) Confidentiality of participants' personal data must be maintained; and

(3) Compliance with procedures set out in related policies of UTAR such as the UTAR Research Ethics and Code of Conduct, Code of Practice for Research Involving Humans and other related policies/guidelines.

(4) Written consent be obtained from the institution(s)/company(ies) in which the physical or/and online survey will be carried out, prior to the commencement of the research.

Kampar Campus : Jalan Universiti, Bandar Barat, 31900 Kampar, Perak Darul Ridzuan, Malaysia
Tel: (605) 468 8888 **Fax**: (605) 466 1313
Sungai Long Campus : Jalan Sungai Long, Bandar Sungai Long, Cheras, 43000 Kajang, Selangor Darul Ehsan, Malaysia
Tel: (603) 9086 0288 **Fax**: (603) 9019 8868
Website: www.utar.edu.my

Should the students collect personal data of participants in their studies, please have the participants sign the attached Personal Data Protection Statement for records.

Thank you.

Yours sincerely,

Professor Ts Dr Faidz bin Abd Rahman
Chairman
UTAR Scientific and Ethical Review Committee

c.c Dean, M. Kandiah Faculty of Medicine and Health Sciences
Director, Institute of Postgraduate Studies and Research

APPENDIX B – INFORMED CONSENT FORM

Research Participant Information Sheet

Universiti Tunku Abdul Rahman
Faculty of Medicine and Health Sciences
Department of Physiotherapy
Bachelor of Physiotherapy (Honours)

Information Sheet to Participate in the Study
COMPARISON BETWEEN EFFECT OF LOWER LIMB CYCLIC STRETCHING AND BALLISTIC STRETCHING ON JUMPING DISTANCE AMONG UNDERGRADUATE STUDENTS: A COMPARATIVE STUDY

Student Investigator: Ng Zi Ru
Department: Bachelor of Physiotherapy (Honours)
Course Name and Course Code: UMFD3026 Research Project
Year and Semester: Y3S2
Course Coordinator: Mr Avanianban Chakkarapani

You are being asked to volunteer for this research study that is being conducted as part of the requirement to complete the above mentioned Course.

Please read this information sheet and contact me to ask any questions that you may have before agreeing to take part in this study.

Purpose of the Research Study
The purpose of this study is to compare the effectiveness of lower limb Cyclic Stretching and Ballistic Stretching on jumping performance among UTAR students.

Approximately 42 UTAR students will participate in this study.

Procedures
If you agree to be in this study, you will be allocated to either one of the intervention groups and will be visiting the physiotherapy center again to complete the pre-test, intervention (cyclic stretching or ballistic stretching), and post-test and will be assessed in one day from pre-test to post-test. The difference between the jumping distance during pre-test and post-test will then be calculated to determine the physical performance improvement.

Length of Participation
1 hour

Risks and Benefits
By the end of the study, you will improve flexibility and strength in the lower limbs as an acute effect. If there is an inappropriately perform of the stretches and SBJ, strain and sprain might be happened. In case of any injury, you will receive treatment and care which will be provided at the expense of the researcher.

Confidentiality

No information that will make it possible to identify you, will be included in any reports to the University or in any publications.
Research records will be stored securely and only approved researchers will have access to the records.

Voluntary Nature of the Study
Participation in this study is voluntary. If you withdraw or decline participation, you will not be penalized or lose benefits or services unrelated to the study. If you decide to participate, you may decline to answer any question and may choose to withdraw at any time.

Contacts and Questions
If you have any questions, clarifications, concerns or complaints, about the research, the researcher conducting this study can be contacted at 019-4808832 or email at ziru0814@gmail.com

The Course Coordinator can be contacted at Mr Avanianban Chakkarapani, avanianban@utar.edu.my if there is any concerns, or complaints about the research and wish to talk to someone other than individuals on the research team

Please keep this information sheet for your records.

Research Participant Consent Form

Universiti Tunku Abdul Rahman
Faculty of Medicine and Health Sciences
Department of Physiotherapy
Bachelor of Physiotherapy (Honours)

<u>Consent Form to Participate in the Study</u>
COMPARISON BETWEEN EFFECT OF LOWER LIMB CYCLIC STRETCHING AND BALLISTIC STRETCHING ON JUMPING DISTANCE AMONG UNDERGRADUATE STUDENTS: A COMPARATIVE STUDY

Student Investigator: Ng Zi Ru
Department: Bachelor of Physiotherapy (Honours)
Course Name and Course Code: UMFD3026 Research Project
Year and Semester: Y3S2
Course Coordinator: Mr Avanianban Chakkarapani

I have read the provided information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have, has been answered to my satisfaction. I understand that I will be given a copy of this form, and the researcher will keep another copy on file. I consent voluntarily to be a participant in this study.

Name of Participant: ________________________________

IC No: ______________________ Date: ___________

APPENDIX C – DEMOGRAPHIC DATA AND SCREENING FORM

DEMOGRAPHIC DATA AND SCREENING FORM

1. Name: Contact number:

2. Age:

3. Gender:

☐ Male

☐ Female

4. Race:

5. Year of Study:

☐ Year 1 undergraduate

☐ Year 2 undergraduate

☐ Year 3 undergraduate

☐ Year 4 undergraduate

6. Height: _______cm

7. Weight: _______kg

8. Do you have any of the conditions:

☐ Recent fracture of 6-8 weeks

☐ Lower limb or spine muscles, joints and ligaments condition in the past 6 months

☐ Cardiovascular disease (heart and lungs problem)

APPENDIX D – PERSONAL DATA PROTECTION NOTICE

PERSONAL DATA PROTECTION NOTICE

Please be informed that in accordance with Personal Data Protection Act 2010 ("PDPA") which came into force on 15 November 2013, Universiti Tunku Abdul Rahman ("UTAR") is hereby bound to make notice and require consent in relation to collection, recording, storage, usage and retention of personal information.

1. Personal data refers to any information which may directly or indirectly identify a person which could include sensitive personal data and expression of opinion. Among others it includes:

   a) Name
   b) Identity card
   c) Place of Birth
   d) Address
   e) Education History
   f) Employment History
   g) Medical History
   h) Blood type
   i) Race
   j) Religion
   k) Photo
   l) Personal Information and Associated Research Data

2. The purposes for which your personal data may be used are inclusive but not limited to:

   a) For assessment of any application to UTAR
   b) For processing any benefits and services
   c) For communication purposes
   d) For advertorial and news
   e) For general administration and record purposes
   f) For enhancing the value of education
   g) For educational and related purposes consequential to UTAR
   h) For replying any responds to complaints and enquiries
   i) For the purpose of our corporate governance
   j) For the purposes of conducting research/ collaboration

3. Your personal data may be transferred and/or disclosed to third party and/or UTAR collaborative partners including but not limited to the respective and appointed outsourcing agents for purpose of fulfilling our obligations to you in respect of the purposes and all such other purposes that are related to the purposes and also in providing integrated services, maintaining and storing records. Your data may be shared when required by laws and when disclosure is necessary to comply with applicable laws.

4. Any personal information retained by UTAR shall be destroyed and/or deleted in accordance with our retention policy applicable for us in the event such information is no longer required.

5. UTAR is committed in ensuring the confidentiality, protection, security and accuracy of your personal information made available to us and it has been our ongoing strict policy to ensure that your personal information is accurate, complete, not misleading and updated. UTAR would also ensure that your personal data shall not be used for political and commercial purposes.

Consent:

6. By submitting or providing your personal data to UTAR, you had consented and agreed for your personal data to be used in accordance to the terms and conditions in the Notice and our relevant policy.

7. If you do not consent or subsequently withdraw your consent to the processing and disclosure of your personal data, UTAR will not be able to fulfill our obligations or to contact you or to assist you in respect of the purposes and/or for any other purposes related to the purpose.

8. You may access and update your personal data by writing to us at_______________.

Acknowledgment of Notice

[ ] I have been notified and that I hereby understood, consented and agreed per UTAR above notice.

[ ] I disagree, my personal data will not be processed.

....
Name:
Date:

APPENDIX E – IPAQ-SF

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE
(August 2002)

SHORT LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health–related physical activity.

Background on IPAQ
The development of an international measure for physical activity commenced in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ
Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation
Translation from English is supported to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Further Developments of IPAQ
International collaboration on IPAQ is on-going and an ***International Physical Activity Prevalence Study*** is in progress. For further information see the IPAQ website.

More Information
More detailed information on the IPAQ process and the research methods used in the development of IPAQ instruments is available at www.ipaq.ki.se and Booth, M.L. (2000). *Assessment of Physical Activity: An International Perspective*. Research Quarterly for Exercise and Sport, 71 (2): s114-20. Other scientific publications and presentations on the use of IPAQ are summarized on the website.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

    _____ **days per week**

    ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

    _____ **hours per day**

    _____ **minutes per day**

    ☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

    _____ **days per week**

    ☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

    _____ **hours per day**

    _____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

APPENDIX F – DIAGRAMS OF SBJ AND STRETCHES

The standing broad jump test (SBJ)

CS (standing kick back)

CS (standing leg raise)

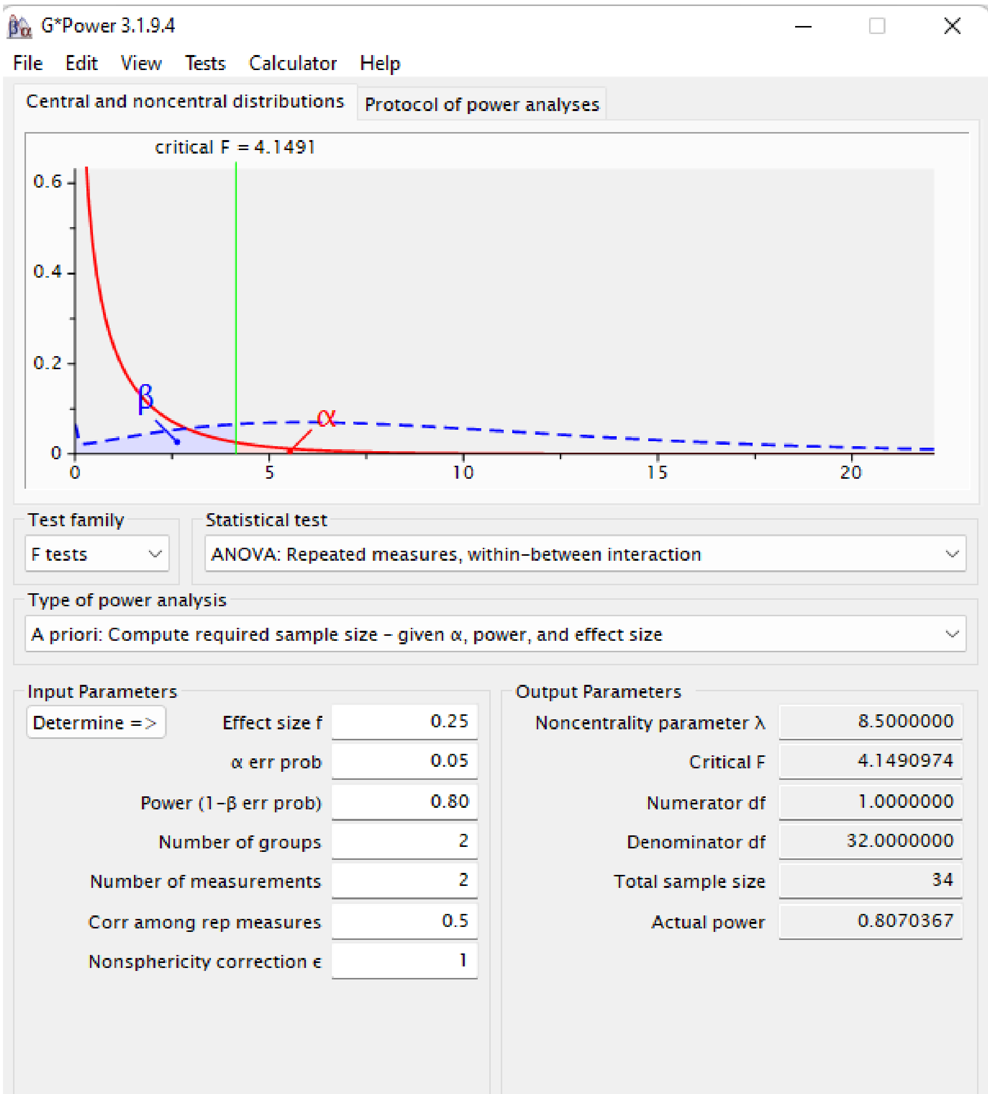
CS (calf raise)

BS (forward lunges)

BS (supine leg stretch)

BS (sitting toe touch)

APPENDIX G – G*POWER SAMPLING SIZE



APPENDIX H – TURNITIN REPORT

Turnitin

ORIGINALITY REPORT

17 %	10 %	10 %	9 %
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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11	Fang-Yu Hsu, Kuei-Lan Tsai, Chia-Lun Lee, Wen-Dien Chang, Nai-Jen Chang. "Effects of Dynamic Stretching Combined With Static Stretching, Foam Rolling, or Vibration Rolling as a Warm-Up Exercise on Athletic Performance in Elite Table Tennis Players", Journal of Sport Rehabilitation, 2021 Publication	<1 %
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