EFFECTIVENESS OF GLUTEUS MEDIUS STRENGTHENING TO REDUCE LOW BACK PAIN IN THE ELITE ROWERS - A RANDOMIZED CONTROLLED TRIAL

By

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Under The Guidance of

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2023

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled “**Effectiveness Of Gluteus Medius Strengthening To Reduce Low Back Pain In The Elite Rowers - A Randomized Controlled Trial”** is a bonafide and genuine research work carried out by me under the guidance of Prof**. Asifuzzaman Shahriyar Ahmed**

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LIST OF ABBREVIATIONS

ANOVA – Analysis Of Variance

BMI – Body Mass Index

CON – Control

Gmed - Gluteus Medius

LBP - Low Back Pain

MCID- Minimal Clinically Important Differences

MYAS – Ministry of Youth Affairs and Sports

RMQ – Roland Morris Back Pain Questionnarie

SD- Standard Deviation

SPSS – Statistical package for social science

TOPS – Target Olympic Podium Scheme

VAS - Visual Analogue Scale

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ABSTRACT

Effectiveness Of Gluteus Medius Strengthening To Reduce Low Back Pain In The Elite Rowers – A Randomized Controlled Trail

Background: Rowing is an Olympic sport and was launched in 1896. Rowing is one of the physically demanding sports and is associated with intensive and long-term training programs. The main objective of rowing is to push the boat using an oar as a fixed lever in flat water. Like other sports athletes, rowers risk getting both short-term and long-term musculoskeletal injuries. 63% of players are more prone to get Low Back Pain compared to other types of injuries in 12 months of training. The main aim of this study is to see the effectiveness of Gluteus Medius Strengthening whether it reduces or not the Low Back Pain in the Rowers.

Methods: 40 elite Rowers with ages between 18-30 years were assigned randomly into two groups that are Group A the experimental group and received various types of Gluteus Medius Strengthening Exercises(n=20) and Group B is Control group got conventional physiotherapy treatment(n=20). Each session was one hour including 10 minutes of warm-up and cool-down for 5 minutes. The outcomes were VAS for pain and Handheld Dynamometer for strength measurement. Outcomes have been checked before and after 6 weeks of intervention.

Results: The results of this study showed significant differences between the experimental and control groups in pain reduction and strength improvement ($P < 0.05$).

Interpretation And Conclusion: The results of this support that the reduction of Low Back Pain in rowers occurred by the Gluteus Medius Strengthening. The results showed significant improvement in the experimental group than the control group.

Keywords: Low Back Pain; Rowing; Gluteus Medius weakness; Gmed Strengthening; Conventional physiotherapy.

INTRODUCTION

Rowing is an Olympic sport and was launched in 1896(Hofmijster et al., 2008; Hosea and Hannafin, 2012)[1,2]. Rowing has a long history of competition and has gained much popularity in recent decades. The first rowing competitions took place about 300 years ago in England on the River Thames. At the collegiate and club level, rowing competitions have existed for more than 100 years, and this game was one of the first to be added to the modern Olympic Games(Rumball et al., 2005)[3].

The excitement for rowing is increasing among Indian athletes. Indian rowers have been an integral part of the team in the last 5 Olympics since the 2000 Sydney Olympics. India is 5th overall in the Asian Games with 23 medals so far. The Indian government has included Rowing into the Khelo-India program, which provides extensive support to young potential athletes in residential academies so that they can excel in their chosen sport at the international level.

There will be a total of 27 categories in the Khelo India Youth Games, the first time water sports were added to this sport and which will be the first history. Different types of water sports include Canoe Slalom, Kayaking, Canoeing, and Rowing. Since India recently won the 2023 Junior Asian Medals, every year India aims to qualify for the Olympics, and Khelo India is given priority, water sports in India are becoming more and more popular. Target Olympic Podium Scheme (TOPS) Development athletes competed at the Khelo India Youth Games in Madhya Pradesh on January 30. This increases the importance of the games since the TOPS athletes, who are already experienced on the international stage, will motivate athletes at younger ages to compete strongly.

The Ministry of Youth Affairs and Sports (MYAS), Government of India, created the Target Olympic Podium Scheme in 2014 as a professional structure that provides all athletes full assistance. The program offers athletes individual coaching help from the best international coaches, global training sessions, assistance with getting visas, and excellent research support to monitor opponent performances. The program's main goal is to give athletes financial support and other types of aid as they compete for medals at the Olympics and other major international sporting events. The TOPS Development, which targets kids as young as 10 to 12 years old, was also introduced in 2020 to produce Olympic champions in 2028[4].

Rowing is one of the physically demanding sports and is associated with intensive and long-term training programs. The main objective of rowing is to push the boat using an oar as a fixed lever in flat water. Rowing is categorized into two types: Sculling and Sweep. In sculling rower uses two oars, and in the sweep, where the rower only uses one oar, either on the left or right side. Furthermore, Rowing Can be done by an individual or by a group of Two, Four, or Eight persons(Heyneke and Green, 2021)[5].

Although Rowing competitions are further divided into two categories: Heavy/Open Weight Category and Lightweight Category Under the lightweight category men's weight should be for individuals less than70 kg, Crew Average less than 72 kg, for women should be individuals less than 59 kg, Crew Average less than 57 kg (Hofmijster et al., 2008; Hosea and Hannafin, 2012). Para-Rowing, for athletes with a physical disability, is divided into three Paralympic classifications based on the extent of actual ability: Legs, Trunk, and Arms (LTA), Trunk and Arms (TA), and Arms and Shoulders (AS).

Although race distances may vary, the Olympic distance is 2000 m, and for masters and para rowers, it is 1000 m(Thornton et al., 2017)[6]. The goal is for the boat to get to the finish line as quickly as possible. High levels of physical and mental stamina, particularly cardiovascular endurance, are necessary for this(Hofmijster et al., 2008; Hosea and Hannafin, 2012).

Rowing is a high-performance sport that is played in major contests(Yusof et al., 2022)[7]. The rowing stroke is made up of a continuous series of repetitive motions which is divided into four phases shown in Fig 1

1. Catch/Preparation Phase
2. Drive Phase
3. Finish/Release Phase
4. Recovery Phase(Heyneke and Green, 2021).

During the Catch phase, the oars will be going placed into the water with full flexion position of the hips and knees. Much potential energy is stored in the legs, back, and arms in this compressed position to prepare for the stroke's drive phase. The Legs then push the body back towards the boat's bow while the Back, Shoulders, and Arms act as a balanced platform to transmit the force created by the Legs to the oars. The Drive phase is going to end with the Finish with the position legs fully extended and elbows going fully flexed position with the body. The Recovery phase starts with the hands moving away from the body, then the hips flexing forward and the spine moving forward, which causes the body to move back toward the Catch position. This same cycle is repeated for the race or training period (fig: 1.1)(Hofmijster et al., 2008; Hosea and Hannafin, 2012).

1. Catch Phase

2. Drive Phase

3. Finish Phase

4. Recovery Phase

Figure: 1.1 Phases of Rowing (Hofmijster et al., 2008; Hosea and Hannafin, 2012).

Like other sports athletes, rowers risk getting both short-term and long-term musculoskeletal injuries(Heyneke and Green, 2021), conditions for eg, Low Back Pain, Rib Stress Fractures, Shoulder Impingement Syndrome, Iliotibial Friction Syndrome, De Quervains Tenosynovitis, etc(Hofmijster et al., 2008; Hosea and Hannafin, 2012). Based on some recent studies Low Back Pain is reported as a common site for Injury compared to all injuries, and the most prevalent site of injury in rowers competing at all levels(Heyneke and Green, 2021). Low back pain (LBP) is a musculoskeletal condition that affects a large percentage of the population, and is one of the most prevalent health issues in the world; 80% of adults have LBP at some point in their lives. LBP is also a significant clinical and social burden because, according to the Global Burden of Disease 2017 report, it is the primary cause of Years Lived with Disability.

Similarly, a large proportion of athletes suffer from LBP. According to one systematic review, the prevalence of back pain in sports is 42%, Lifetime prevalence is 63%, and 12-month prevalence is 51%.particularly in rowing 61% of rowers have been experiencing low back pain in 12 months period(Wilson et al., 2021)[8]. Compared to non-athlete populations, some sports disciplines, such as skiing, rowing, golf, volleyball, track and field, swimming, and running, carry a higher risk of LBP. Low back pain experienced by athletes would involve reducing athletic performance. Additionally, many athletes who experience low back pain might run into marked disability when they retire from sports(Maselli et al., 2021)[9].

Rowing is a cyclical endurance sport that frequently requires intensive training. Rowers train for more than 13 hours (or 11 sessions) a week, from the junior to the international levels. Continues training programs take large demand on lumber spine so LBP is more common in rowers. Specifically, in the sport of rowing, 61% of individual rowers reported having LBP within the previous 12 months on average(Casey et al., 2022) [10] with an incidence of 1.5–3.7 per 1000 h of rowing and associated training(Newlands et al., 2015; Ng et al., 2014)[11,12]. There isn't yet agreement on how to describe LBP in athletes; it can be thought of as a symptom, not an illness, that may be brought on by several distinct or undiagnosed abnormalities or disorders. It is further distinguished by the area of pain, which is commonly between the lower rib and buttock creases. Studies that examined biomechanical changes of rowers with LBP had more flexion range of motion from the lumbar region followed by less range from the hip and pelvis(Nugent et al., 2021)[13].

The kinematics of the rowing stroke has been the focus of several investigations. Few studies have looked at the kinematics of bilateral asymmetry of the lower limbs, (Buckeridge et al., 2012)[14]. Poor hip range of motion and lower limb strength asymmetries can be predisposing factors for LBP(Nugent et al., 2020)[15]. Even though rowing is done while seated with one's weight supported, there is evidence to indicate that pelvic asymmetry can affect the dynamics of trunk motion while doing so. This could lead to increased stress on the lumbar spine(Buckeridge et al., 2012). According to (Davis and Finnoff, 2003) most elite rowers have poor inflexibility Gluteal, Hamstrings, Quadriceps, Iliopsoas, and tensor fascia lata muscles, along with thoracolumbar rotational flexibility deficits.

Similarly, many rowers with thoracolumbar injuries will not pass or perform badly on clinical tests meant to measure their strength and muscle recruitment patterns. A study has been done by (Davis and Finnoff, 2003)[16], according to their study they have been checked different strength tests for each muscle of the hip and pelvic region but coming to hip abductors showed weakness by the corkscrew test, in this test athlete has to stand on a single leg squat if the abductors are weak then it will go for adduction and internal rotation. And there was some lateral bending of the side of the hip due to abductor weakness this is called as Trendelenburg sign, and if away from the leg called as Compensatory Trendelenburg sign. Poor abduction strength of the hip is a core deficit in lower lumbar injuries. Screening of hip abduction is an important assessment tool for this

The Gluteus Medius is a primary muscle for hip abduction and provides stability to the pelvis during walking and other activities in the frontal plane of the femur and hip joint. This stability is important to control excessive movements and reduces forces on the lower back. Gluteus medius weakness leads to loss of the pelvis's dynamic stability, and lower back leads to increased lateral trunk flexion and subsequent intervertebral disc compression. The majority of studies revealed that a reduction in gluteus medius strength consequently impacts the development of LBP due to biomechanical changes in the Lumbopelvic-Hip complex and Lower Limbs. The gluteus medius helps control the hip joint's transverse plane rotation and frontal plane position during normal walking. Weakening of the gluteus medius leads to several biomechanical alterations in the pelvis and may subsequently contribute to the LBP(Sadler et al., 2019)[17].

A prolonged sitting position may contribute to the lack of pelvic stability and develops the posterior pelvic tilt in a sitting position due to abnormal lumbar flexion in the sitting position. So this sitting position can lead to getting imbalances and weakness in the gluteus muscle and may develop a flattened or weekend gluteus due to lack of activation. In rowing, the gluteus medius plays a crucial role in stabilizing the pelvis and maintaining proper posture throughout the stroke. It works synergistically with other muscles to provide stability and power generation. During the drive phase, the gluteus medius engages to prevent excessive hip drop on the side opposite to the rowing side, helping to maintain a level pelvis and efficient transfer of force from the legs to the oar. Strengthening this muscle group can enhance rowing performance and reduce the risk of low back pain by promoting optimal biomechanics and posture.(Beach et al., 2008; Waongenngarm et al., 2015)[18,19].

According to (Buckeridge et al., 2012) during rowing, contact forces occur between the rower and equipment and act on feet, seat, and oar. The drive is initially started by the legs through rapid knee extension, then the torso leans back to maintain power through the trunk, and lastly, the stroke is finished by drawing the hands towards the body. Improper rowing techniques can decrease power transmission due to the result of lower limb asymmetries in the sitting position. This study aims to see the effectiveness of gluteus medius strengthening and whether it reduces low back pain or not because no study has been done on elite rowers to reduce low back pain by using deferent gluteus medius strengthening.

NEED OF THE STUDY

- No studies have been done yet on rowers to reduce low back pain by using gluteus medius strengthening. Many studies say that rowers are more prone to lower back pain than all injuries. It has a high prevalence rate due to continuous flexion and extension movements in the lumbopelvic region and asymmetry in the lower limbs in the sitting position. And these asymmetries can lead to muscular imbalances in the pelvic region. As rowers continuously sit and row long distances, they must prevent low back pain to win race pain freely.
- Many other studies also reviewed that low back pain can occur due to gluteus medius weakness.
- So it is essential to know the effectiveness of gluteus medius strengthening to reduce low back pain in rowers.

AIM OF THE STUDY

- To see the effectiveness of gluteus medius strengthening on reducing low back pain in the rowers.

OBJECTIVES OF THE STUDY

- To see the effectiveness of gluteus medius strengthening to reduce low back pain in the rowers.
- Evaluate the gluteus medius strength by using Dynamometer whether it increased or not and how it is correlated pain.
- To see the pain levels between the control and experimental groups by using VAS and whether it reduced or not by strength.

Hypothesis

Null Hypothesis

There will be no significant difference between the Gluteus Medius Strengthening group and Control group to reduce Low Back Pain in the Elite Rowers.

Alternative Hypothesis

There will be a significant difference between the Gluteus Medius Strengthening group and Control group to reduce Low Back Pain in the Rowers.

REVIEW OF LITERATURE

Rowing Injuries

(Heyneke and Green, 2021) Done a study on "The prevalence and severity of lower back pain in South African university rowers" to evaluate the severity, prevalence, and disabilities among the university level rowers and concluded that no differences were found between the sexes and moderate severity. And age is correlated with ADI and disability percentage. Finally, they recommended further studies needed to know the risk factors and causes of low back pain in rowers.

(Nugent et al., 2021) They have done a study of "The relationship between rowing related low back pain and rowing biomechanics: a systematic review" In this study they have taken data from different data sources of both experimental and non-experimental 21 studies and they used kinematics and muscle activity and Modified Quality Index (QI) outcome measures. Results showed that safe and effective rowing biomechanics can reduce low back pain incidence.

(Newlands et al., 2015) "The prevalence, incidence, and severity of low back pain among international-level rowers" This study was a prospective cohort study and the collected data from 76 New Zealand including both women and men rowers. The total study duration was 12 months to investigate prevalence, severity, and incidence among international-level rowers. The results of this data found the prevalence of low back pain is high and is correlated with rowing training. The previous history of LBP and age are risk factors to develop LBP in the future.

(Hosea and Hannafin, 2012) The “Rowing Injuries” this review describes the biomechanics of rowing and rowing-related injuries. They took data from the PubMe database and rowing coaching manuals. The result of this study was rowing is an overuse injury and it affects mostly the lumbar spine, knee, and ribs. The incidence of injury is directly related to the volume of training.

(Davis and Finnoff, 2003) They did a study on “Diagnosis and Management of Thoracic and Rib Pain in Rowers” and did different types of strength and flexibility evaluation tests in the core and pelvic region. These findings revealed that thoracolumbar injuries take a major percentage to restrict the competition level of the rowers. And the prevalence of low back pain has increased among rowers.

Gluteus Medius Dysfunction In LBP

(Cooper et al., 2016) “Prevalence of gluteus medius weakness in people with chronic low back pain compared to healthy controls” clinical observation was conducted on a matched group of 75 of each group that is control and experimental groups from 150 patients with chronic nonspecific LBP were enlisted. A standardized back and hip physical examination were done, and the results showed that those with LBP had weaker gluteus medius muscles than the controls. Focusing on the evaluation and treatment of gluteus medius muscle dysfunction may improve clinical judgment and the effectiveness of treatment for LBP patients.

(Sadler et al., 2019) “Gluteus medius muscle function in people with and without low back pain: a systematic review” This review took 24 articles involving 1088 participants with LBP and 998 without LBP from different databases until December 2018. The result of this study was gluteus medius muscle function with LBP participants revealed that reduced strength and more trigger points compared to gluteus medius function without LBP

(Pooja Nair et al.,2018) “Is there the presence of gluteal muscle weakness in individuals with chronic low back pain as compared to healthy individuals? This study was a cross-sectional observational study. In this study, these authors have taken experimental and control groups of 50 individuals with chronic low back pain. The outcomes were a hand-held dynamometer for the r strength of the gluteus maximus and medius and the Trendelenburg test has been used. Results showed Strength in the gluteus medius was found to be a more reliable indicator of the development or incidence of LBP than the gluteus maximus.

(Penney et al., 2014) “Determining the activation of gluteus medius and the validity of the single leg stance test in chronic, nonspecific low back pain” this study aimed to examine the relationship between the clinical rating of the single leg stance (SLS) and chronic low back pain (CLBP) and gluteus medius weakening. To compare the gluteus medius activation in people with chronic, nonspecific low back pain to that in control patients. The gluteus medius muscles of people with chronic low back pain were weaker than those of control patients who had no back pain.

(Kendall et al., 2010) this is a study of “The relationship between hip abductor strength and the magnitude of the pelvic drop in patients with low back pain”

The aim of this study was to determine the relationship between hip abductor strength and magnitude of pelvic drop during static Trendelenburg test. And the second aim was to see the three weeks of hip abductor strengthening in non-specific low back pain. Hip abductor strength is poorly correlated with the magnitude of pelvic drop. But after three weeks of strengthening, pain decreased in the low back pain.

Gluteus Medius Strengthening

(Famude Samuel Olawale et al., 2020a) conducted a study on the “Effect of gluteus medius strengthening on pain perception, functional disability and quality of life in patients with non-specific chronic low back pain” In this study, they choose 50 non-specific chronic low back pain and allocated them into two groups. Group one got stabilization exercises and group two got gluteus medius strengthening with stabilization exercises. Protocol was 4 weeks at the end of this study and showed better results in gluteus medius strengthening with stabilization exercises.

(Jeong et al., 2015) these authors conducted a study on “The effects of gluteus muscle strengthening exercise and lumbar stabilization exercise on lumbar muscle strength and balance in chronic low back pain patients” 40 patients were randomly allocated into two equal groups. The results of this study showed a greater decrease in pain in the lower back.

Outcomes

(Escalona-Marfil et al., 2020) conducted a study on “Validation of an Electronic Visual Analog Scale mHealth Tool for Acute Pain Assessment: Prospective Cross-Sectional Study” They compared traditional paper methods and clinical apps and have taken 102 subjects aged between 18 to 65. And measured by 10 cm line on paper and mobile app. Intramethod reliability estimated by ICC was 0.86 with a 95% confidence interval of 0.81 to 0.90, indicating good reliability. The conclusion was the mobile app was highly valid than the paper method and useful for clinical practice.

(Mst. Rabea Begum et al., 2019) did a study on “Validity And Reliability Of Visual Analogue Scale (Vas) For Pain Measurement” In this study authors done a critical review of ten studies. The majority of research used Spearman correlation in their analysis to determine the study's overall strength. The participants were older than 18 years old. Most studies have used a pain measuring scale to assess post-operative discomfort. The scales that were employed were the visual analog scale, the numerical rating scale, the color analog scale, and the facial pain scale. The results of this study showed VAS showed high reliability for pain measurement.

(Alghadir et al., 2018) Concluded a study on “Test–retest reliability, validity, and minimum detectable change of visual analog, numerical rating, and verbal rating scales for measurement of osteoarthritic knee pain.” 121 participants with OA of the knee were enrolled in the study (65 women and 56 men, ages 40 to 80). During two consecutive visits separated by 24 hours, the test-retest reliability of the VAS, NRS, and VRS was evaluated. The VAS, NRS, and VRS had intraclass correlation values of 0.97, 0.95, and 0.93, respectively. All three scales showed excellent test-retest reliability. But VAS scales were considered stable with the smallest error in the OA Knee.

(Olds et al., 2023) did a study on “Validity and Reliability of the KINVENT Handheld dynamometer in the athletic shoulder test” In this study they have taken 27 athletes without any injury to the shoulder. And they checked shoulder abduction 3 times against the force plates, which measure in kilograms. The study results showed that KINVENT HHD is valid and more reliable than force plates.

(Soomro et al., 2022) have done a study on “Reliability of hand-held dynamometer in measuring gluteus medius isometric muscle strength in healthy population” This study aimed to determine the isometric strength of gluteus medius by using a handheld dynamometer. The strength of the unilateral side was measured on the same day and one week later. Using reliability analysis, the intraclass correlation was determined using a 95% confidence interval and standard error of measurements. A portable dynamometer has demonstrated great inter-rater and intra-rater reliability when evaluating the Gluteus Medius muscle's isometric strength in a healthy population. It is practical to use in clinical settings and may be a helpful outcome tool to evaluate the effectiveness of interventional research.

(González-Rosalén et al., 2021) conducted a study on “Intra- and Inter-Rater Reliability of Strength Measurements Using a Pull Hand-Held Dynamometer Fixed to the Examiner’s Body and Comparison with Push Dynamometry” In this study authors included 40 subjects and 15 isometric strengths were conducted in two sessions with a one-week interval. The intra-class correlation (ICC) and standard error of measurement were used to investigate reliability. With the help of paired t-tests, rater reliability was investigated. The pull HHD tests' intra- and inter-rater reliability displayed good results, with ICCs ranging from 0.991 to 0.998.

METHODOLOGY

Methods

Study Design

Randomized Controlled Trial

Study Population

Rowers With Low Back Pain

Sample Size

40

The sample size was calculated by using the formula – $2K \times sd^2 / d^2$

Sampling Technique

Purposive Sampling

Study Setting

Different Rowing Academies And Clubs all over India

Study Duration

6 Months

Selection Criteria

Inclusion Criteria

- Elite Rower With Low Back Pain.
- Both female and male
- Age between 18-30(Babiarz et al., 2022)[20].
- Trendelenburg Sign Positive(Davis and Finnoff, 2003)
- VAS score should be above 5 CM(Delgado et al., 2018)[21].

EXCLUSION CRITERIA

- Subjects with a history of musculoskeletal disorders in the upper and lower extremities.
- Being unable to perform any of the required tests.
- Subjects with surgical history before 12 months.
- Leg Length Discrepancy
- Any recent injuries to the ankle, knee, and hip

Outcome Measures

Visual Analog Scale (VAS): For measurement of Pain Intensity

Handheld Dynamometer: For measurement of the strength of Gluteus Medius

Instruments And Tools

- KINVENT Handheld Dynamometer
- KFORCE App
- Thera Bands
- Weight Cuffs
- Yoga Mat

PROCEDURE

After the Ethical Clearance from the Ethical Clearance Committee of ABSMARI, players were selected for the study from different rowing academies and clubs in India. In this study, a total of 47 rowers has been selected by purposive sampling method and included after obtaining consent from them. All players have been screened for inclusion and exclusion criteria by pre-participation evaluation form for elite athletes (Ionescu et al., 2021)[22] in which demographics, health status (family medical history, personal medical), training history, and health condition checked. based on inclusion criteria, 44 players have been included. Based on exclusion criteria 3 players were excluded due to one player having a recent knee injury and two players not passing the screening method. For the Back Pain assessment, all players The Oswestry Disability Index (ODI), a patient-completed questionnaire, provides a subjective percentage score of a patient's level of function (disability) in daily life activities while they are recovering from low back pain(Yates and Shastri-Hurst, 2017)[23.]

Of the remaining 44 players, 2 players dropped from the study during the study period. And one player has been excluded by us player wasn't attending during study time. While the period of strengthening, one player got a fracture during her training sessions, so she also dropped from the study. After all the criteria, 40 players were selected and randomly allocated into two groups the mean age was 18 to 30 years, and each group contains 20 subjects. Group A was experimental with a Gluteus Medius Strengthening group and Group B was a Control Group with Conventional physiotherapy treatment.

After group allocation players were monitored for pre-test. For back pain, we have given a self-report questionnaire that is a Roland Morris disability questionnaire for low back pain in which 24 back pain function restriction-related questions will be there(Stratford and Riddle, 2016)[24]. For the pre-test in this study, we have used two outcome measures: KINVENT Handheld Dynamometer for the strength measurement (Olds et al., 2023)[25] and the Visual Analog Scale for checking the Pain. Pre-tests are performed before the study and post-test results have been taken after 6 weeks of the study.

Handheld Dynamometer

The hand-held dynamometer is a portable device that can easily fit in the hand and is used to measure strength through manual muscle testing (MMT). The device can be externally fixed at the testing area, and the tester asks the individual to push against it as hard as possible and ask the player to push against the device as much as he can. The results of the test are displayed in a mobile app called KFORCE PRO App, which is connected to the dynamometer via Bluetooth(fig:5.1).

In the KFORCE PRO App, we have to enter the player's details such as name, age, gender, height, and weight. The app provides various assessment options, and for strength measurement, you would select the muscle controller. Once you've selected the muscle controller, the app displays the areas to be tested. Based on the specific test being performed, you can choose the relevant areas for assessment.

The app can also assist in measuring pain using the Visual Analog Scale (VAS). The VAS is a subjective measurement tool where individuals rate their pain level on a scale, typically ranging from 0 to 10, with 0 being no pain and 10 being the worst possible pain. The app likely provides a user-friendly interface to record and track pain levels using the VAS(Lesnak et al., 2019; Martins et al., 2017; Olds et al., 2023)[25,26,27].

This study aimed to assess hip abduction strength in both the supine and side-lying positions. The participants were instructed to perform hip abduction movements against the hand-held dynamometer device. During the trials, the KFORCE PRO App displayed the strength of the hip abductors in kilograms (Kgs). After completing the three trials, the best score out of the three measurements was selected for analysis[27.]

Figure: 5.1 Handheld Dynamometer

Visual Analog Scale

The Visual Analog Scale (VAS) is a commonly used method for assessing the severity of pain symptoms in children, adults, and adolescents. It is a subjective measure that allows individuals to rate their pain level on a continuum or a scale(Hersh et al., 2016)[28]. The VAS typically consists of a straight line that ranges from one extreme (e.g., "no pain") to the other extreme (e.g., "worst possible pain"). The individual is asked to mark or indicate their level of pain intensity on the line, usually by making a vertical mark or placing a cross. The distance from the starting point of the line to the individual's mark is then measured, providing a numerical value that represents the pain severity(Delgado et al., 2018)[29].

In this study, we have used the Kforce Pro app to measure pain using the Visual Analog Scale (VAS). The participants were asked to touch or indicate their pain level on a line that ranged from 0 to 10 centimeters within the app. The values indicating the distance from the starting point of the line to the participant's touch were then noted.

Using a digital app like Kforce Pro can provide a convenient and standardized way to administer and record VAS scores. It eliminates the need for physical paper scales and allows for easier data collection and analysis. The app likely provided a visual representation of the VAS line, allowing participants to interact with it digitally(fig:5.2)[30,31].

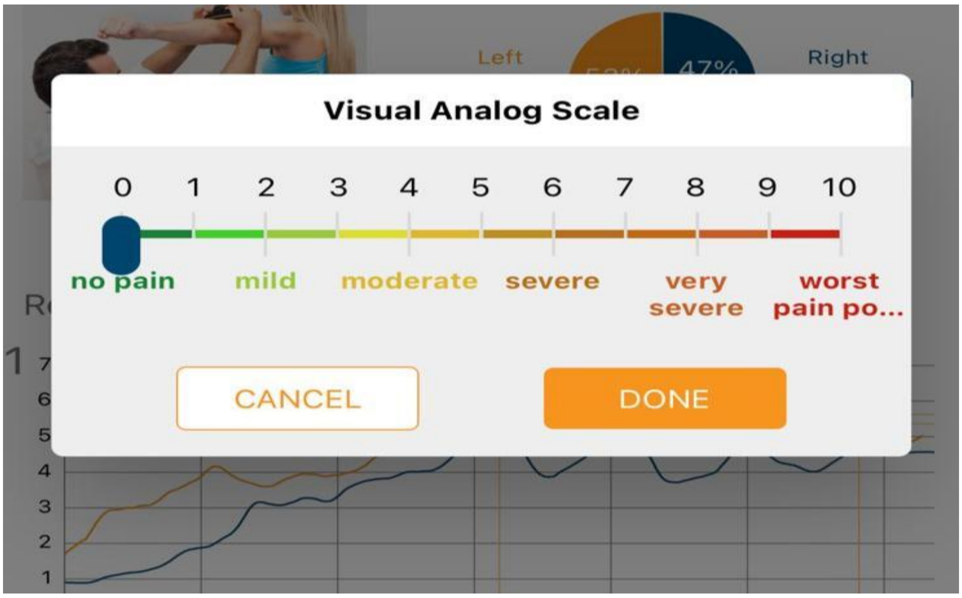


Figure: 5.2 Digital Visual Analogue Scale

All groups took intervention for a total of 60 minutes from which 15 minutes are for Warm-up and cool-down and 45 minutes for the intervention. Group A got Gluteus Medius Strengthening and Group B got Conventional treatment.

Warm-Up Exercise: 10 Minutes

Dynamic Stretching (3 minutes):

Arm Circles: During arm circles subject stand with feet hip-width apart and then we instructed to extend the arms out to the sides and make small circles forward for 30 seconds, then backward for another 30 seconds and every one done accordingly.

Leg Swings: For leg swings subjects were standing and holding onto a wall for support, we instructed them to gently swing one leg forth and backward to increase the range of motion. On each leg, they each completed ten swings.

Torso Twists: Subjects have been placed their hands on their hips, then rotated their pelvis to the right and left, and performed the same thing again for one minute

Hip Circles: Hip circles have done in the standing position, in this each have rotated their hips in clockwise and anticlockwise direction and performed for 30 sec[32].

Jogging (7 minutes):

For the first minute, players should lightly jog in place to raise their heart rates. Start jogging and keep up a steady speed for three minutes. Ensure that they are jogging with good form, making gentle foot landings, and naturally swinging their arms. Jog backward for 2 minutes after the first 3 minutes of forward motion. Watch your surrounds and make sure the space is free of obstructions. Finish with one more minute of stationary jogging while progressively lowering your speed[33].

Cool Down: 5 minutes

Static Stretching (3 minutes):

Hamstring Stretch: Player feet hip-width apart while standing. One leg should be extended forward with the heel resting on a surface that is slightly raised, such a step or bench. Bend forward from the hips while maintaining a straight back until player feel a little stretch at the back of your thigh. Hold for 30 seconds, then done the same for to other leg.

Quadriceps Stretch: Player grabs the ankle with their right hand while standing. Feel a stretch in the front of the thigh as they slowly draw their heel towards their glutes. Hold for 30 seconds, then done this alternate legs.

Chest Stretch: Subject stands with their feet separated by their shoulders. They elevate their arms upward and connected their fingers behind their backs, squeezing their shoulder blades together. 30 seconds of holding.

Triceps Stretch: We instructed the participants to raise one arm above, bend it at the elbow, and bring the palm of their hand to the middle of their back. To intensify the stretch in your triceps, softly press on their bent elbow with the other hand. Hold for 30 seconds, then done this for opposite arm.[34].

Walking (2 minutes):

After static stretching, we made them to start walking at a slow pace. we focused on them to take deep breaths and allowing them to bring heart rate to gradually return to normal. Continue walking for 2 minutes, gradually slowing down them pace until they feel completely relaxed(Olsen et al., 2012)[35,36].

Gluteus Medius Strengthening

Gluteus Medius exercises have been given 2 times a day for 3 days per week for 6 weeks, repetitions will be increased for every week. The Gluteus Medius strengthening exercises consist of various types those are clamshell exercises, hip abduction side lying exercises, and hip abduction side lying with weight, lunges, and steps ups have been used. In this study, We have used different types of weight cuffs and resistance bands to improve Gluteus Medius Strength in different positions.

Clamshell exercises: This exercise is typically performed while player was lying on one side with the knees bent and stacked on top of each other. Keeping the feet together, and we instructed to slowly lift the top knee while keeping the feet in contact with each other, resembling the opening of a clamshell. This movement targets the gluteus medius and helps improve hip stability (fig: 5.3).

Hip abduction side lying exercises: For these exercises, we had our participants lie on their side with their legs extended, and we gave them instructions to raise the upper leg straight up. The hip abductor muscles that pull the leg away from the body's midline are strengthened by this motion, which isolates the gluteus medius. (fig: 5.5).

Hip abduction side lying with weight exercises: In this we instructed each subject to perform hip abduction movement in different positions like standing, side lying and supine lying with use of Therabands to improve gluteus medius strengthening(Famude Samuel Olawale et al., 2020a)[37](fig: 5.5)

Bilateral squats: In this exercise, participants stood with their feet shoulder-width apart and sat back into a chair-like position by bending their knees and hips. after go back up to the starting position, pay attention to maintaining their knees in line with your toes and pushing through your heels. The gluteus maximus is the muscle that is largely used during bilateral squats, however the gluteus medius is also involved for stability. (fig: 5.4).

Lunges: Lunges involve moving one leg forward or backward while keeping the other one still. asked for participants to bend their knees slightly forward, both knees should be about 90 degrees. Lunges can be performed in the forward and side directions. Lunges work the gluteus medius in addition to the quadriceps and hamstrings to regulate movement and stabilize the pelvis. (fig: 5.4).

Step-ups: For this exercise, we used a step or elevated platform. We made player to step up onto the platform with one foot and drive through the heel to lift subjects body until the front leg is straight and we used some weights like dumbles. Step down and repeated with the opposite leg. Step-ups engage the gluteus medius to stabilize the pelvis and control hip movement(Stastny et al., 2016)[38](fig:5.6).

These exercises aim to target and strengthen the gluteus medius, which is an important muscle involved in hip stabilization, pelvic alignment, and lower limb function. By incorporating these exercises into the intervention, the study likely aimed to improve the strength and function of the gluteus medius in the respective groups(Famude Samuel Olawale et al., 2020b; Stastny et al., 2016).

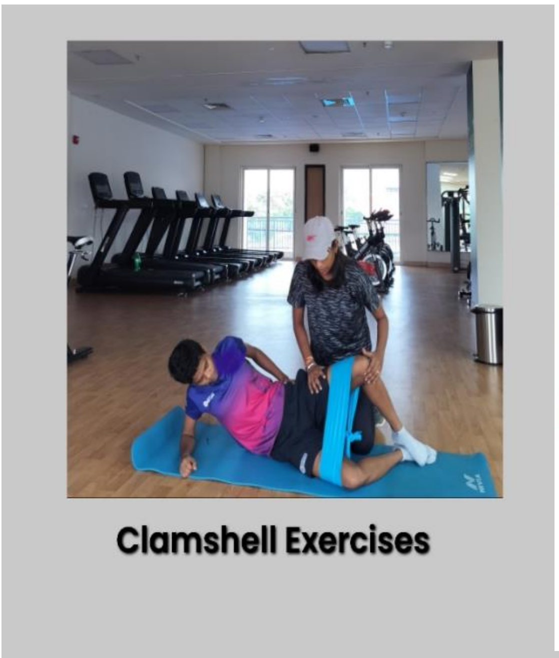


Figure: 5.3 Clamshell Exercises. Figure: 5.4 Lunges And Squats with Resistance

Figure: 5.5 Theraband Exercises.

Figure: 5.6 Step Ups

Conventional Treatment

Hot Pack: We told to each subject to apply the hot pack for 10 minutes helps to improve blood flow, relax muscles, and reduce pain and stiffness in the lower back(Freiwald et al., 2021)[39].

Pelvic Bridging: This exercise targets the muscles in the hips, buttocks, and lower back. We instructed the subject to lie on their back with knees bent and feet flat on the floor. Asked them to lift hips off the ground, keeping shoulders and feet on the floor. Hold for a few seconds, then lower your hips back down. Repeated this exercise for 10 repetitions (fig:5.7).

Pelvic Tilt Exercises: Subjects lied on back with knees bent and feet flat on the floor. Instructed to gently tilt pelvis backward by pressing their lower back into the floor. Hold for a few seconds, then release. Repeated for 10 repetitions.

This exercise helps improve pelvic stability and strengthens the abdominal muscles(Bi et al., 2013; Minicozzi et al., 2016)[40,41](Fig: 5.9).

Back Extension Exercises: Player was on their stomach, their hands lying on the ground close to their shoulders. Lift their upper body off the ground while maintaining their legs and pelvis on it. Hold for a few moment, then bring yourself back down. 10 times in total were repeated. Lower back muscles can be strengthened using back extension exercises.(Yaprak, 2013)[42] (fig:5.9).

Static Abdominal Exercises: Subjects lied on their backs, knees lower, feet flat on the ground. Advised them to place their hands on their stomachs, tighten their cores by pulling their belly buttons towards their spines. Hold for a few seconds until relaxing. 10 times in total were repeated. The lower back is supported and core stability is improved with static abdominal workouts.(Shri Jagdishprasad Jhabarmal Tibrewala University, Rajasthan-333001. and Makke, 2019)[43].

Knee-to-Chest Exercises: In order to participate in this exercise, participants lied on their backs with their feet flat on the ground and their knees bent. We also told them to carefully take the knee close to the chest and hold it there for a brief period of time using their hands. The operation is then repeated on the other limb. Stretch your buttocks and lower back muscles with this workout. (fig: 5.7).

Cat-Camel Stretch: The person is positioned on their hands and knees with their back straight. Slowly lower your head while arching your back upward (cat stretch). After just a few seconds of holding, reverse the motion by lowering yourself back down and elevating your head (camel stretch). Everyone had performed the cat-camel stretch ten times. This exercise increases the spine's flexibility and mobility. (fig: 5.10).

Curl-Up Exercises: Player lays on back, knees bent, feet flat on ground. The player was instructed to cross their arms over their chests. And making sure that they keep their lower back in contact with the ground, slowly elevate their head, shoulders, and upper back off the ground. Hold for a few while, then lower back down. 10 times were repeated. Curl-up workouts strengthen the core by focusing on the abdominal muscles. (fig:5.9).

These all exercises have been given 2 times a day for 4 days for 6 weeks(Shipton, 2018)[44].

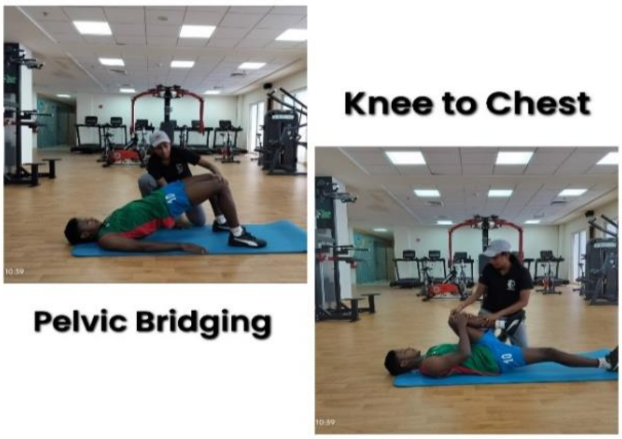


Figure: 5.7 Pelvic Bridging And Knee to Chest.

Figure: 5.8 Back Extension Exercises

Abdominal Curls

Pelvic Tilt And Static Abdominal Exercises

Figure: 5.9 Abdominal Curls and pelvic tilts

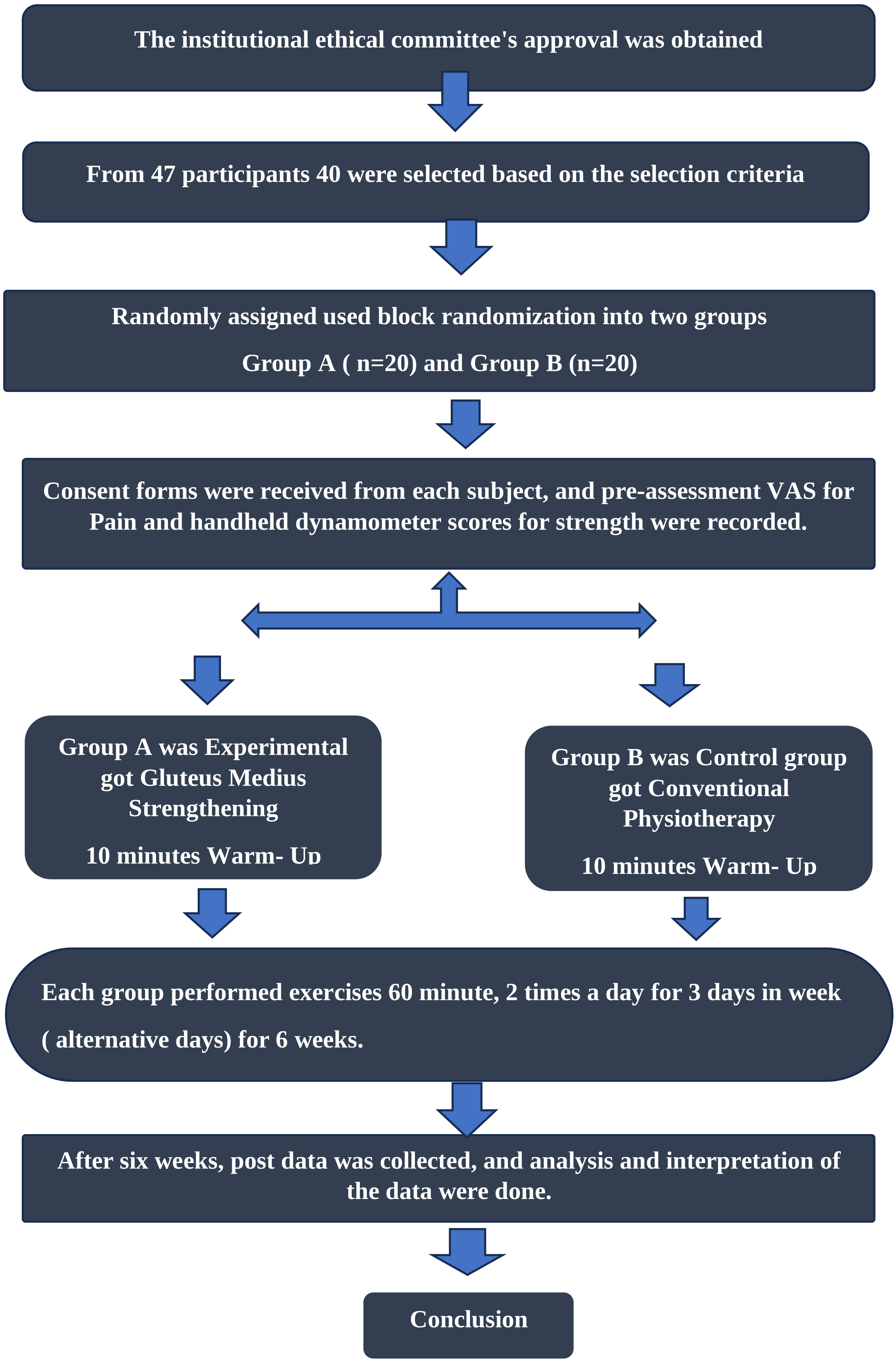
Cat And Camel Exercises

Figure: 5.10 Cat And Camel Exercises

Exercise	Weeks	Repetitions	Sets	Rest Interval
Hip Abduction in side lying with weight cuffs	1-2	6-8	3	2-3
	3-4	10-12		
	5-6	12-15		
Hip Abduction in supine lying with weights	1-2	6-8	3	2-3
	3-4	10-12		
	5-6	12-15		
Clamshell Exercises	1-2	6-8	3	2-3
	3-4	10-12		
	5-6	12-15		
Bilateral Squats	1-2	6-8	3	2-3
	3-4	8-10		
	5-6	12-15		
Lunges	1-2	6-8	3	2-3
	3-4	10-12		
	5-6	12-15		
Step Ups	1-2	6-8	3	2-3
	3-4	8-10		
	5-6	12-15		

Table 5.1: Gluteus Medius Strengthening Repetitions

Methodology Flow Chart



SAMPLE SIZE ESTIMATION

Sample size calculation was done by using the formula for experimental studies

(Outcome – Modified T-test)

$$n=2k\ SD^2 / d^2$$

Where,

n= Number of samples

k= Power

SD=Standard Deviation

d = MCID Value

K =10.5

SD= 2.2

d(MCID value)=1.8

$n= 2k * SD^2/d^2$

$2x10.5 \text{ x } (2.2)^2/(1.8)^2$

=21x1.49=21.49

=21.49~22 + 15% drop outs= 23.3~24

=24 per group (2 groups are there so total of 48 subjects)

STATISTICAL ANALYSIS

Statistics were performed by using SPSS 13. Results were calculated by using a 0.05 level of significance.

Using the statistical formula for the mean, for a given number of subjects, the mean of different variables was calculated by

$$\bar{X} = \frac{\sum X}{N}$$

Where,

N = Number of subjects X = the value of each subject

Standard Deviation (σ)

$$s = \sqrt{\frac{\sum x^2}{N}}$$

x = deviation of score from mean

N = Number of subjects

t-test of independent means

The formula for the independent t-test is

$$t = \frac{X_1 - X_2}{\sqrt{\left(\frac{SS_1 + SS_2}{n_1 + n_2 - 2}\right)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}},$$

where

X_1 is the mean for group 1, X_2 is the mean for group 2,

SS_1 is the **sum of squares** for group 1, SS_2 is the **sum of squares** for group 2,

$\mathbf{n_1}$ is the number of subjects in Group 1, and $\mathbf{n_2}$ is the number of subjects in Group 2.

t-test of dependent means

The formula for the dependent t is:

$$t = \frac{\sum D}{\sqrt{\frac{n\sum D^2 - \left(\sum D\right)^2}{n-1}}}$$

Where D is the difference between pairs of scores,

$$D = X_2 - X_1$$

df = n – 1 and **n** is the number of pairs of subjects in the study.

Group Description

Total Subjects → **40**

Group A → **20**

Males → **11**

Females → **09**

Group B → **20**

Males → **10**

Females → **10**

Level Of Significance → **95%**

P < 0.05 → Significant

P > 0.05 → Not Significant

Demographic	Group A		Group B	
	Mean	SD	Mean	SD
AGE	20.45	2.09	20.05	1.82
HEIGHT	160.35	11.53	160.20	11.63
WEIGHT	56.50	8.26	55.75	7.27
BMI	22.02	1.77	21.71	1.54

Table 6.1: Mean and SD of AGE, HEIGHT, WEIGHT & BMI for the subjects of Group A and Group B.

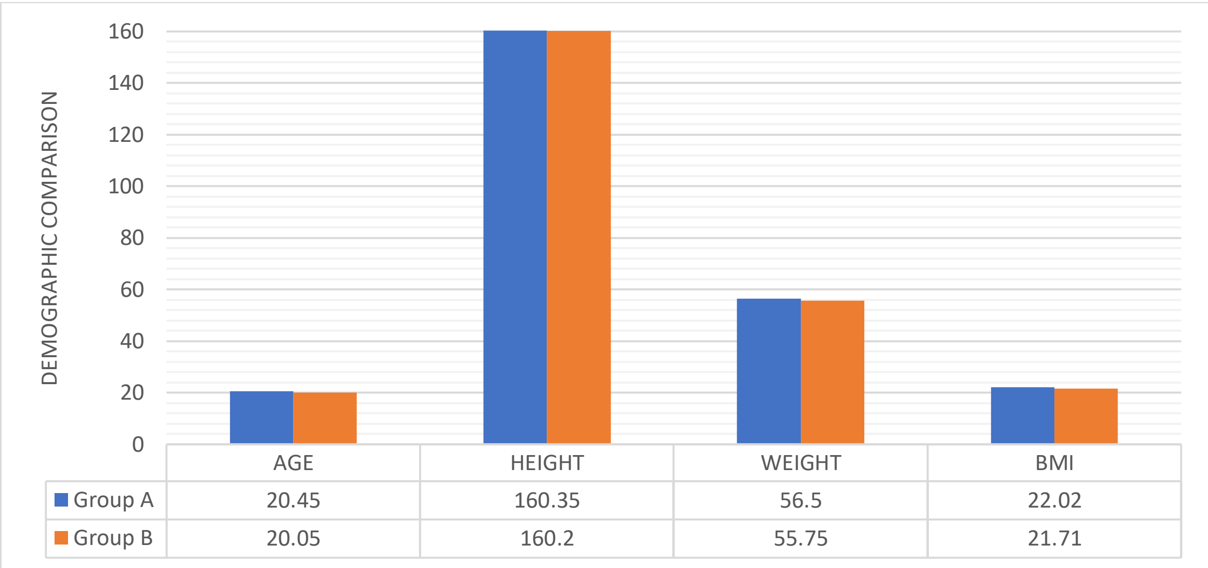


Figure: 6.1 Graphical Presentation Of Descriptive Statistics

VAS	Group A		Group B	
	Mean	SD	Mean	SD
PRE	8.44	1.21	8.64	1.07
POST	0.53	0.65	5.80	1.10
MD (PRE – POST)	7.91	0.90	2.83	1.05

Table 6.2: VAS within Group Analysis

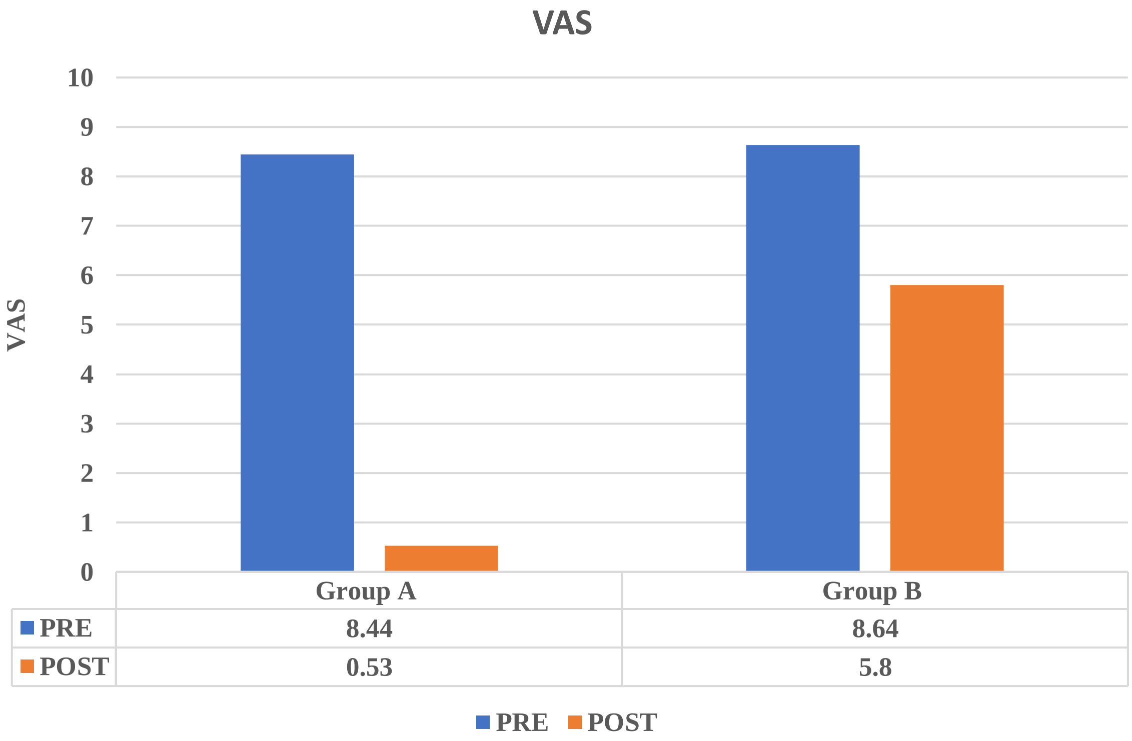


Figure: 6.2 Graphical Presentation Of VAS within Group Analysis

Dynamometer (Right)	Group A		Group B	
	Mean	SD	Mean	SD
PRE	13.15	2.51	12.14	2.45
POST	15.49	2.59	11.99	2.48
MD (PRE – POST)	2.34	0.671	0.15	0.26

Table 6.3: Dynamometer Right Within Group Analysis

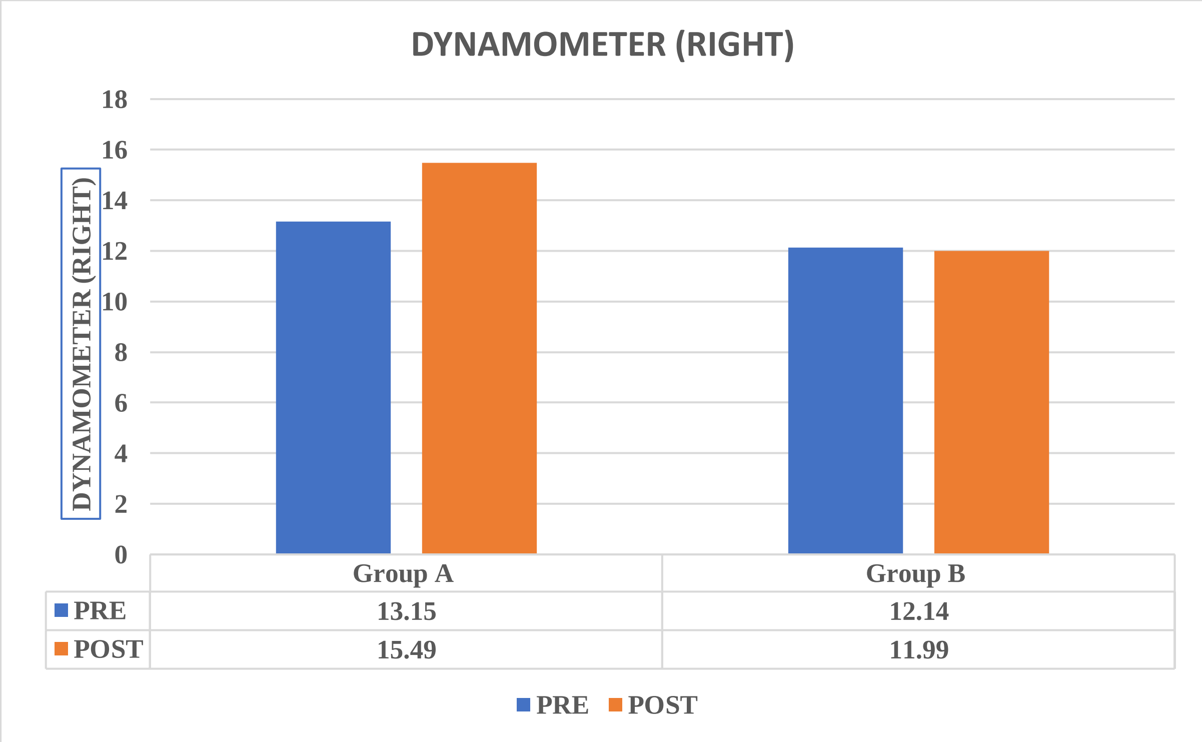


Figure: 6.3 Graphical Presentation Of Dynamometer Right Within Group Analysis

Dynamometer (Left)	Group A		Group B	
	Mean	**SD**	**Mean**	**SD**
PRE	12.44	2.55	11.30	2.46
POST	14.74	2.89	10.89	2.48
MD (PRE – POST)	2.30	0.82	0.41	0.21

Table 6.4 Handheld Dynamometer Left Within Group Analysis

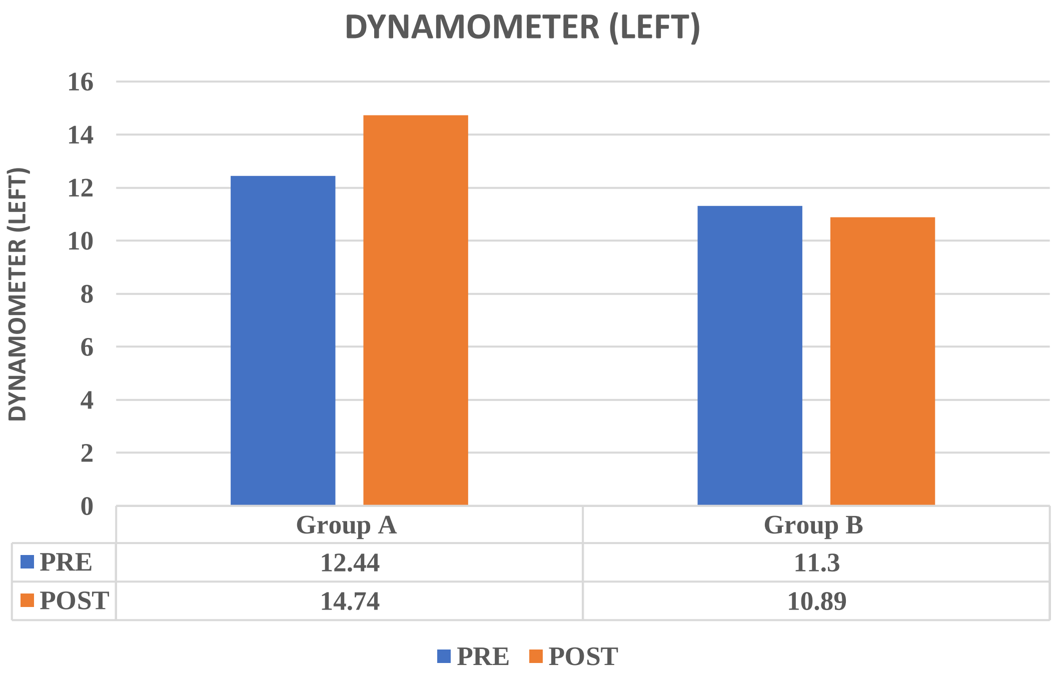


Figure: 6.4 Graphical Presentation Of Handheld Dynamometer Left Within Group Analysis

VAS	Group A Vs Group B	
	t value	**P value**
PRE	-0.539	P > 0.05
POST	-18.358	**P < 0.05**
MD (PRE – POST)	16.370	**P < 0.05**

Table 6.5: Of VAS Between Group Analysis

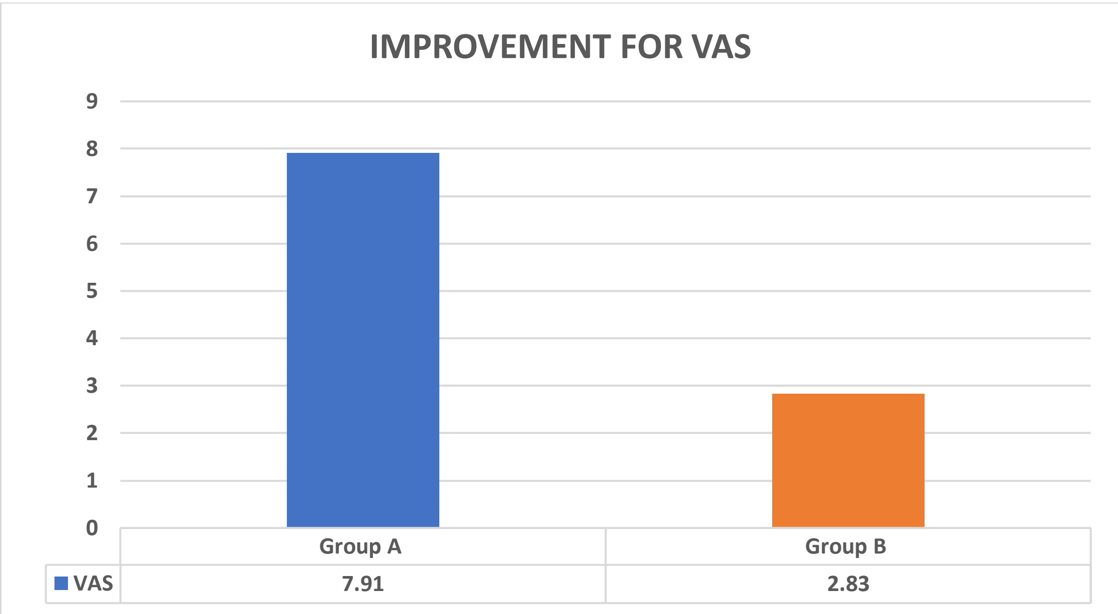


Figure: 6.5 Graphical Presentation Of VAS Between Group Analysis

Dynamometer (Right)	Group A Vs Group B	
	t value	**P value**
PRE	1.285	P > 0.05
POST	4.362	**P < 0.05**
MD (PRE – POST)	-15.460	**P < 0.05**

Table 6.6: Dynamometer Right Between Group Analysis

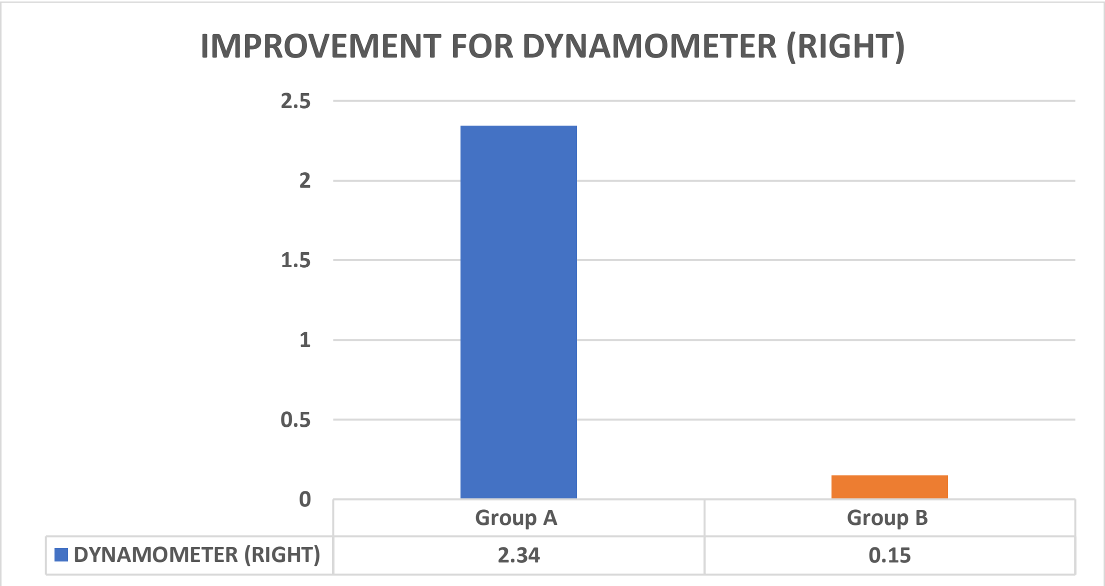


Figure: 6.6 Graphical Presentation Of Dynamometer Right Between Group Analysis

Dynamometer (Left)	Group A Vs Group B	
	t value	P value
PRE	1.436	P > 0.05
POST	4.508	**P < 0.05**
MD (PRE – POST)	-14.150	**P < 0.05**

Table 6.7: Dynamometer Left Between Group Analysis

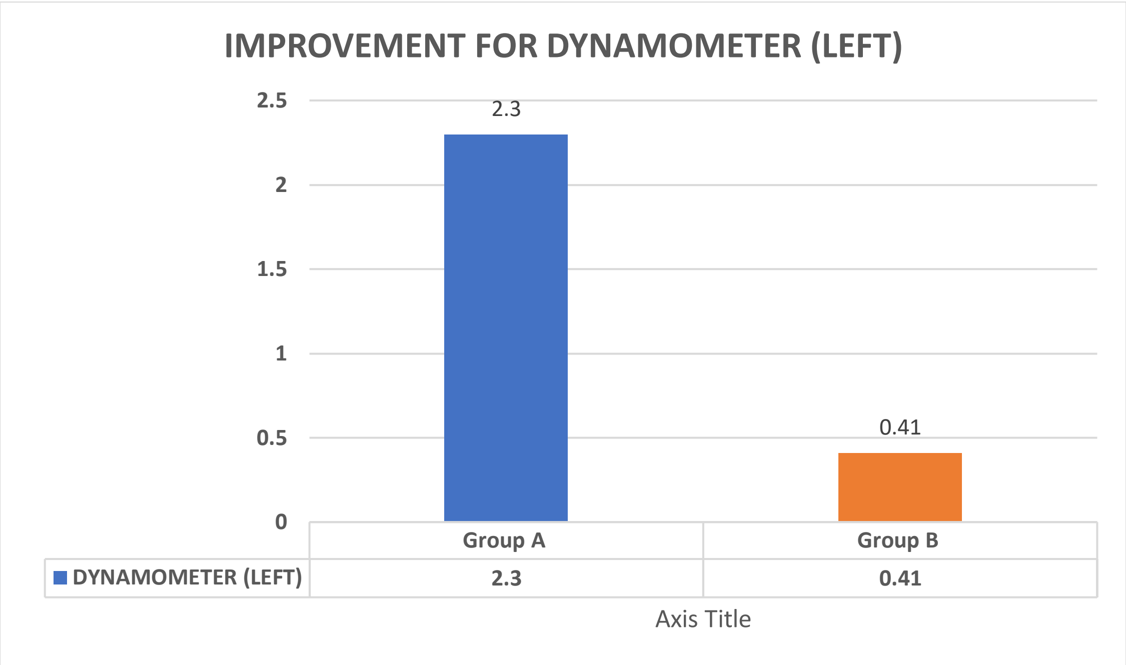


Figure: 6.7 Graphical Presentation Of Dynamometer Left Between Group Analysis

RESULTS

This study aimed to investigate the effectiveness of Gluteus Medius strengthening to reduce Low Back Pain in Elite Rowers. A total of 40 participants were enrolled in the study and randomly assigned to two groups: Group A Expiremental (n=20) and Group B Control (n=20). The demographic variables, including age, height, weight, and BMI, were compared between the groups. Primary outcome Visual Analog Scale (VAS) scores and Secondary outcome Dynamometer measurements (for both right and left lower limbs) were assessed at pre- and post-intervention intervals to evaluate any changes. The analyses were conducted at a significance level of 0.05 (95% confidence level).

Demographic Variables

Age: The mean age of subjects in Group A was 20.45 ± 2.09, while in Group B, it was 20.05 ± 1.82. The t-test comparing the mean age between the two groups showed a t-value of 0.646, which was not statistically significant (P > 0.05).Height: There was no significant difference in height between the two groups, as indicated by a t-value of 0.041 (P > 0.05).Weight: The t-test for weight also showed no significant difference between the groups, with a t-value of 0.305 (P > 0.05).BMI: The comparison of BMI between Group A and Group B resulted in a t-value of 0.590 (P > 0.05), indicating no significant difference.

VAS

VAS is a self-report pain assessment tool that measures pain intensity on a continuous scale from 0 to 10, with 0 representing "no pain" and 10 representing "worst possible pain. VAS scores were recorded before and after the intervention for both Group A and B.

Within-Group Comparison:

Group A: The mean pain intensity decreased significantly from PRE (8.44 ± 1.21) to POST (0.53 ± 0.65) intervention ($t = 39.143$, $P < 0.05$). Group B: The mean pain intensity also decreased significantly from PRE (8.64 ± 1.07) to POST (5.80 ± 1.10) intervention ($t = 12.058$, $P < 0.05$). Both groups experienced a statistically significant reduction in pain intensity after the intervention.

Between-Group Comparison:

Post-Intervention Pain Levels: The mean pain intensity at POST intervention was significantly lower in Group A (0.53) compared to Group B (5.80) ($t = -18.358$, $P < 0.05$). This indicates that after the intervention, participants in Group A reported significantly lower pain levels than those in Group B. Pain Reduction (MD - PRE-POST): The difference in pain reduction (MD - PRE-POST) was significantly larger in Group A (7.91) compared to Group B (2.83) ($t = 16.370$, $P < 0.05$). This indicates that the intervention resulted in a more substantial pain reduction in Group A compared to Group B.

Dynamometer

Dynamometer tests were conducted to assess the hip abductor strength of participants in both Group A and Group B before and after the intervention.

Within-Group Comparison:

Right Hip Abductor Strength:

Before the intervention, Group A had a mean right hip abductor strength of 13.15 (± 2.51), and Group B had a mean of 12.14 (± 2.45). After the intervention, Group A's right hip abductor strength increased to 15.49 (± 2.59), and Group B's increased to 11.99 (± 2.48). Both Group A and Group B showed a significant increase in left and right hip abductor strength after the intervention. (Group A: $P < 0.05$, Group B: $P < 0.05$)

Left Hip Abductor Strength:

Before the intervention, Group A had a mean left hip abductor strength of 12.44 (± 2.55), and Group B had a mean of 11.30 (± 2.46). After the intervention, Group A's left hip abductor strength increased to 14.74 (± 2.89), and Group B's increased to 10.89 (± 2.48).

Between-Group Comparison:

Group A showed a larger improvement in right hip abductor strength (MD = 2.34, SD = 0.671) compared to Group B (MD = 0.15, SD = 0.26)and in left hip abductor strength (MD = 2.30, SD = 0.82) compared to Group B (MD = 0.41, SD = 0.21). Before the intervention, there were no significant differences in hip abductor strength between Group A and Group B. ($P > 0.05$) After the intervention, Group A had significantly higher hip abductor strength compared to Group B for both left and right sides. (Left: $P < 0.05$, Right: $P < 0.05$).

Based on the results, both Groups A and B's hip abductor strength considerably increased following the intervention. However, improvements were larger in Group A compared to Group B for both sides, suggesting that Group A's hip abductor strength was improved more significantly as a result of the intervention, and improvement in strength had reduced VAS score.

DISCUSSION

The purpose of the study is to see the effectiveness of Gluteus Medius strengthening exercises to reduce low back pain in elite rowers. The results of the study revealed that group A, who received Gluteus Medius Strengthening for six weeks, experienced significantly less discomfort than group B that received conventional physiotherapy. This gives support to the hypothesis that Gluteus Medius strengthening helps reduce Low Back Pain in rowers. The 40 players had been divided into two groups of 20, each of which received while Group A underwent experimental Gluteus Medius Strengthening and conventional physiotherapy as the control group, We used a handheld dynamometer to assess strength and VAS to measure pain. Upon completing the 6-week strengthening phase, both measures increased.

Back pain (LBP) is a common issue and a major cause of disability. In rowing, around 61% of adult rowers get back pain in a year(Casey et al., 2022; Wilson et al., 2021)[8,10]. Veronica **Athy's study** says that rowers often have back pain due to long ergometer training. Rowing involves tough training, over 13 hours a week, leading to back strain and common LBP(Athy et al., 2023; Nugent et al., 2021)[13,45].

Based on previous studies we have selected an age group between 18-30 years, because in our early adult years, roughly between 18 - 30, we usually achieve our highest muscle strength(Bosco and Komi, 1980)[46]. After that, starting around age 40 due to the physiological changes in the body(Babiarz et al., 2022; Kallman et al., 1990; Leblanc et al., 2015)[20,47,48].

In athletic populations, exercises like squats, clamshells, step-ups, and other types of exercises are single-joint rehabilitation exercises because they can gradually increase exercise intensity, increase the hormonal response (Kraemer and Ratamess, 2005)[49], and cause satellite cell proliferation. So these studies suggest that resistance exercises help to increase cell proliferation in the muscle as well as stability in the hip by Gluteus Medius activation (Kadi et al., 2004; Vierck et al., 2000)[50,51].

Recent studies have proven that people with back pain have Gluteus Medius weakness. Weakness leads to a decrease in pelvis stability which further put impact the lumber region(Beach et al., 2008; Sadler et al., 2019; Waongenngarm et al., 2015)[17,18,19]. Studies have proven that implementing exercise to strengthen the Gluteus Medius has resulted in a considerable improvement in the stability of the pelvic area and the hip joint. This positive impact leads to a considerable increase in lumbar segmental stability(Famude Samuel Olawale et al., 2020b; Jeong et al., 2015; Kendall, 2013)[37,52,53]. **Lorah Heald et., al** stated that Addressing the gluteus medius and hip abductors through specific interventions holds the potential to alleviate low back pain among middle-aged individuals.

Strengthening the gluteus medius has a big impact on pelvic stabilization and posture, which helps to reduce low back discomfort. A major hip abductor muscle, the gluteus medius, helps in maintaining good pelvic alignment while moving. When it is weak, it can cause altered biomechanics, pelvic tilt, unequal weight distribution, and pelvic tilt, which puts too much strain on the lower back muscles[54].

Mendis and Hides noted the existence of lumbar-pelvic muscular abnormalities in people with low back pain (LBP). They observed an interesting increase in the size of the gluteus medius muscles as a result of the use of motor training interventions during the treatment of LBP in both non-weight-bearing and weight-bearing situations leading to this significant result.

Motor training of gluteus medius focuses on pelvis stability. Different types of strengthening exercises can activate the gluteus medius muscle fibers, leading to increased recruitment and subsequent strengthening. The gluteus medius grows as a result of motor training, becoming stronger for improved pelvic stability during movement(Hides et al., 2016; Müller et al., 2015)[55,56].

Previous research has shown that persons with low back pain may benefit from strengthening the gluteus medius (Gmed) muscle in terms of reducing pain and enhancing mobility patterns. Exercises that are specially meant to activate and strengthen the Gmed muscle can help to improve the stability and function of the pelvis and lower back, which can reduce pain and enhance overall movement mechanics(Cooper et al., 2016)[57].

Studies support that Gluteus Medius helps to maintain appropriate alignment and minimizes the excessive load on the lumbar spine by the stabilizing pelvis. By strengthening the Gmed, individuals with low back pain may experience improved pelvic stability, which in turn could alleviate discomfort and enhance functional movement(Kang and Oh, 2021; Lee et al., 2014)[58,59].

There are many sitting sports athletes who are prone to get back pain due to long periods of sitting that can weaken the gluteus muscles, cause pelvic instability, and affect posture. Strong gluteus medius aid in stabilizing the pelvis and improve performance when rowing. For healthy posture and less back discomfort, strengthening is essential(Beach et al., 2008; Waongenngarm et al., 2015)[18,19].

The intratester reliability of side-lying hip abduction using a dynamometer was reported to range between 0.76 to 0.98 in prior research, and the ICCs reported in the previous study. Previous studies confirmed that the side-lying position, used with the subjects in the current study, was the optimal position to achieve the most hip abduction force(Aramaki et al., 2016; Bazett-Jones and Squier, 2020; Florencio et al., 2019)[60,61,62].

Another study was supporting that dynamometry has been recognized as the gold standard for measuring muscle strength, we think it is insufficient for testing hip abduction in the standing position in older people with less strength and balance. Their investigation has demonstrated that this novel technique for stabilizing the contralateral side yields remarkably accurate findings when used in the supine position using a handheld dynamometer(Awwad et al., 2017)[63].

Studies have shown that exercise stimulates endogenous opioid synthesis, producing immediate anti-nociception in both humans and animals. Repeated exercise additionally produces long-lasting anti-nociception in animals who would not otherwise get medication(Stagg et al., 2011)[64].

Alternatively, through increased strength supporting movement around a joint, resistance exercise or other types of strength training could enhance the individual's ability to support bone and cartilage, possibly decreasing stiffness and providing some discomfort (Mayer 2008)(Mayer et al., 2008)[65].

According to the mechanistic model, exercise causes behavioural or clinical change by influencing a variety of physiological levels, including molecular, cellular, and structural/functional in the body. Exercise triggers an elevated level of substances that result in beneficial cellular changes, such as the growth of new neurons (also known as neurogenesis and gliogenesis), connections between neurons (also known as synaptogenesis), and the production of blood cells. Increased gray and white matter volume, which affects receptor activity and blood flow, results from the growth of new cells with more synapses(El-Sayes et al., 2019)[66].

Exercise has been shown to decrease levels of pro-inflammatory molecules within the nervous system and increase levels of anti-inflammatory molecules. This can contribute to reducing inflammation and pain sensitivity, leading to an overall improvement in pain management. Certainly, strengthening bones, muscles, tendons, and ligaments through activities like resistance training target the underlying causes of pain. These exercises enhance balance, flexibility, and overall physical resilience, potentially reducing strain on affected areas and providing relief from discomfort(Palmer et al., 2023)[67].

The results of this study suggest the significance of Gluteus Medius training is for reducing low back pain in competition rowers. Especially for athletes who perform sitting-intensive sports like rowing, the findings give useful insights for creating therapies that improve overall movement mechanics, enhance pelvic stability as well as improve lumbar stabilization, and reduce low back pain.

CONCLUSION

In this study, Gluteus Medius strengthening was investigated for its impact on reducing Low Back Pain (LBP) in elite rowers. Both Group A (Experimental) and Group B (Control) showed significant decreases in pain and improvements in hip abductor strength following the intervention, with Group A experiencing greater benefits. These findings suggest that Gluteus Medius exercises can effectively alleviate LBP and enhance hip abductor strength among elite rowers. However, the study's limitations, including a small sample size and a narrow focus on elite rowers, indicate the need for further research to confirm these outcomes across broader populations and for longer durations.

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ANNEXURE – 1

CONSENT FORM

CONSENT FORM

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE UTKAL UNIVERSITY

I ____________________________ agree to take part in the research study conducted by Tara Revati postgraduate student (MPT, Sports Medicine), Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, affiliated to the Utkal University, entitled **"Effectiveness Of Gluteus Medius Strengthening To Reduce Low Back Pain In The Elite Rowers - A Randomized Controlled Trial".**

I have been informed about the purpose and procedure; measurement of the research and my queries about the research have been clarified.

I provide consent to the researcher to use the information for research and educational purpose only.

I understand that my participation is voluntary and I can withdraw at any stage of the research project.

I understand that no monetary benefit will be given for participation in this research study.

Name of the Participant: ………………………………

Signature:

Signature of the researcher:

Date:

ANNEXURE – 2

ABHINAV BINDRA
Sports Medicine & Research Institute
A Unit of the Abhinav Bindra Foundation Trust
Recognised by DMET, Health & FW Dept., Govt. of Odisha, Affiliated to Utkal University
Recognised by Odisha State Council for Occupational Therapy and Physiotherapy

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Reference No. – ABSMARI/IRB/07/2023
Date: 22nd June 2023

INSTITUTIONAL REVIEW BOARD

To
Ms Tara Revati,
Post Graduate student, Department of Physiotherapy,
Abhinav Bindra Sports Medicine and Research Institute (ABSMARI).

This is to certify that your proposal for the study titled "**Effectiveness of Gluteus Medius Strengthening to Reduce Low Back Pain in the Elite Rowers – A Randomized Controlled Trail**" has been taken for discussion in the meeting held on 20th May 2023. Following the meeting, the committee approves the proposal and it has no objection on the study being carried out.

You are advised to familiarize yourself with the ICMR guidelines on biomedical research in human subjects and also adhere to the principles of Good Clinical Practice. You are hereby directed to submit the final report to the committee, on completion of the study. Any case of adverse reactions should be informed to this ethics committee and action will be taken thereafter.
Any such adverse reactions during the course of the study are the sole responsibility of the Principal Investigator and there is no onus on the Ethical Committee members resulting thereof.
We wish you all the best for your study.

Member Secretary **Chair Person**

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE ★ ABSMARI BHUBANESWAR

2023.08.21 15:59

Utkal Signature, Plot No 273, NH-5, Pahal, Bhubaneswar, 752101
Phone: 6370703650, 6370703651

ANNEXURE – 3

ASSESSMENT FORM

DEMOGRAPHIC DATA

Name –

Age –

Gender –

Phone Number –

Height –

Weight –

Date Of Examination :

- Pre Test
- Post Test

COMPONENT	PRE INTERVENTION SCORE	POST INTERVENTION SCORE
VAS		
HANDHELD DYNAMOMETER		

ANNEXURE – 4

MASTER CHART

S.NO	AGE	GENDER	HEIGHT	WEIGHT	BMI	PRE VALUES OF VAS	POST VALUES OF VAS		PRE VALUES OF DYNAMOMETER		POST VALUES OF DYNAMOMETER		RIGHT	LEFT	group
									RIGHT	LEFT	RIGHT	LEFT			1
1	19	2	159 CM	49 KG	19.4	10	1	9	8.5	7.9	11.9	9.3	-3.4	-1.4	1
2	18	1	149 CM	54 KG	24.3	10	1	9	13.7	14	16.2	16.9	-2.5	-2.9	1
3	20	1	168 CM	62 KG	22	8.1	0	8.1	14.3	13.8	18	17.8	-3.7	-4	1
4	18	1	155 CM	50 KG	20.8	7	0	7	13.5	13	15.5	15.1	-2	-2.1	1
5	18	2	143 CM	48 KG	23.5	9.3	1	8.3	9.7	9	11.4	10.5	-1.7	-1.5	1
6	21	1	165 CM	64 KG	23.5	8	0	8	14.7	14.2	16.2	15.6	-1.5	-1.4	1
7	23	2	164 CM	56 KG	20.8	7.2	1	6.2	13.3	12.7	14.7	13.3	-1.4	-0.6	1
8	22	2	160 CM	50 KG	19.5	10	1.7	8.3	12.6	11.5	15.3	14.3	-2.7	-2.8	1
9	20	1	169 CM	68 KG	23.8	9	0	9	15.3	14.4	17.3	16.5	-2	-2.1	1
10	23	2	163 CM	66 KG	24.8	7	0	7	12.3	11.8	15	14.7	-2.7	-2.9	1
11	22	1	175 CM	68 KG	22.2	7	0	7	15.6	14.8	18.4	17.6	-2.8	-2.8	1
12	20	1	169 CM	57 KG	19.6	7	0	7	15.2	14.4	17.8	16.7	-2.6	-2.3	1
13	19	2	147 CM	48 KG	22.2	8	1	7	8.9	8	10.3	9.8	-1.4	-1.8	1
14	18	2	140 CM	47 KG	24	10	1	9	10.5	9.7	13.7	12.5	-3.2	-2.8	1
15	20	2	158 CM	51 KG	20.4	9.6	2	7.6	10.9	9.6	13.7	12.9	-2.8	-3.3	1
16	18	1	147 CM	50 KG	23.1	7	0	7	13.9	12.3	15.6	14.7	-1.7	-2.4	1
17	22	1	162 CM	51 KG	19.4	10	1	9	12.2	11.9	14.1	13.3	-1.9	-1.4	1
18	23	1	174 CM	67 KG	22.1	8	0	8	16.7	16.5	19.3	19	-2.6	-2.5	1
19	25	1	185 CM	72 KG	23.5	7.7	0	7.7	17.9	16.6	20.3	19.9	-2.4	-3.3	1
20	20	2	155 CM	52 KG	21.6	9	0	9	13.4	12.7	15.2	14.4	-1.8	-1.7	1
21	18	1	144 CM	53 KG	25.6	10	4	6	12.1	11.8	11.5	10.9	0.6	0.9	2
22	18	2	137 CM	47 KG	25	8.3	5.3	3	9.7	8.5	9.5	7.8	0.2	0.7	2
23	20	1	164 CM	54 KG	20.1	7.6	4.8	2.8	14.9	13.7	14.8	13.6	0.1	0.1	2
24	19	1	163 CM	60 KG	22.6	9	5	4	13.7	12.5	13.5	12	0.2	0.5	2
25	19	2	147 CM	51 KG	23.6	10	7	3	10.9	8.3	10.8	8	0.1	0.3	2
26	21	2	155 CM	50 KG	20.8	8	6	2	8.5	7.9	8.3	7.5	0.2	0.4	2
27	22	1	176 CM	67 KG	21.6	9	5	4	16.5	15.3	16.4	15	0.1	0.3	2
28	20	1	167 CM	57 KG	20.4	8	5	3	14.4	13.8	14.1	13.3	0.3	0.5	2
29	18	2	152 CM	49 KG	21.2	10	7	3	9.2	8.7	8.8	8.2	0.4	0.5	2
30	19	1	157 CM	56 KG	22.7	7	6	1	13.7	12.9	13.5	12.5	0.2	0.4	2
31	18	1	159 CM	55 KG	21.8	7	4	3	13.4	12.2	13.4	12	0	0.2	2
32	22	2	160 CM	53 KG	20.7	9.3	6.2	3.1	11.3	10.5	10.9	9.7	0.4	0.8	2
33	23	1	175 CM	68 KG	22.2	8	5	3	15.6	14.8	15.5	14.2	0.1	0.6	2
34	20	2	158 CM	53 KG	21.2	10	8	2	12.3	12	13.1	11.9	-0.8	0.1	2
35	19	2	155 CM	49 KG	20.4	9.4	7.3	2.1	9.6	8.6	9.5	8.4	0.1	0.2	2
36	18	2	153 CM	50 KG	21.4	10	7	3	7.8	7.3	7.7	7	0.1	0.3	2
37	24	1	185 CM	72 KG	21	8.2	6.5	1.7	12.3	11.9	12.1	11.6	0.2	0.3	2
38	21	2	162 CM	54 KG	20.6	9	6	3	12.2	11.6	12	11.2	0.2	0.4	2
39	20	2	159 CM	50 KG	19.8	7	5	2	10.3	9.7	10.2	9.3	0.1	0.4	2
40	22	1	176 CM	67 KG	21.6	8	6	2	14.5	14	14.2	13.7	0.3	0.3	2

ANNEXURE – 5

PREPARTICIPATION PHYSICAL EVALUATION

HISTORY FORM

(Note: This form is to be filled out by the patient and parent prior to seeing the physician. The physician should keep a copy of this form in the chart.)

Date of Exam ____________________

Name ____________________ Date of birth ____________________

Sex ______ Age ________ Grade __________ School ____________________ Sport(s) ____________________

Medicines and Allergies: Please list all of the prescription and over-the-counter medicines and supplements (herbal and nutritional) that you are currently taking

____

____

____

Do you have any allergies? ☐ Yes ☐ No If yes, please identify specific allergy below.
☐ Medicines ☐ Pollens ☐ Food ☐ Stinging Insects

Explain "Yes" answers below. Circle questions you don't know the answers to.

GENERAL QUESTIONS	Yes	No
1. Has a doctor ever denied or restricted your participation in sports for any reason?		
2. Do you have any ongoing medical conditions? If so, please identify below: ☐ Asthma ☐ Anemia ☐ Diabetes ☐ Infections Other: ____________		
3. Have you ever spent the night in the hospital?		
4. Have you ever had surgery?		
HEART HEALTH QUESTIONS ABOUT YOU	**Yes**	**No**
5. Have you ever passed out or nearly passed out DURING or AFTER exercise?		
6. Have you ever had discomfort, pain, tightness, or pressure in your chest during exercise?		
7. Does your heart ever race or skip beats (irregular beats) during exercise?		
8. Has a doctor ever told you that you have any heart problems? If so, check all that apply: ☐ High blood pressure ☐ A heart murmur ☐ High cholesterol ☐ A heart infection ☐ Kawasaki disease Other: ____________		
9. Has a doctor ever ordered a test for your heart? (For example, ECG/EKG, echocardiogram)		
10. Do you get lightheaded or feel more short of breath than expected during exercise?		
11. Have you ever had an unexplained seizure?		
12. Do you get more tired or short of breath more quickly than your friends during exercise?		
HEART HEALTH QUESTIONS ABOUT YOUR FAMILY	**Yes**	**No**
13. Has any family member or relative died of heart problems or had an unexpected or unexplained sudden death before age 50 (including drowning, unexplained car accident, or sudden infant death syndrome)?		
14. Does anyone in your family have hypertrophic cardiomyopathy, Marfan syndrome, arrhythmogenic right ventricular cardiomyopathy, long QT syndrome, short QT syndrome, Brugada syndrome, or catecholaminergic polymorphic ventricular tachycardia?		
15. Does anyone in your family have a heart problem, pacemaker, or implanted defibrillator?		
16. Has anyone in your family had unexplained fainting, unexplained seizures, or near drowning?		
BONE AND JOINT QUESTIONS	**Yes**	**No**
17. Have you ever had an injury to a bone, muscle, ligament, or tendon that caused you to miss a practice or a game?		
18. Have you ever had any broken or fractured bones or dislocated joints?		
19. Have you ever had an injury that required x-rays, MRI, CT scan, injections, therapy, a brace, a cast, or crutches?		
20. Have you ever had a stress fracture?		
21. Have you ever been told that you have or have you had an x-ray for neck instability or atlantoaxial instability? (Down syndrome or dwarfism)		
22. Do you regularly use a brace, orthotics, or other assistive device?		
23. Do you have a bone, muscle, or joint injury that bothers you?		
24. Do any of your joints become painful, swollen, feel warm, or look red?		
25. Do you have any history of juvenile arthritis or connective tissue disease?		

MEDICAL QUESTIONS	Yes	No
26. Do you cough, wheeze, or have difficulty breathing during or after exercise?		
27. Have you ever used an inhaler or taken asthma medicine?		
28. Is there anyone in your family who has asthma?		
29. Were you born without or are you missing a kidney, an eye, a testicle (males), your spleen, or any other organ?		
30. Do you have groin pain or a painful bulge or hernia in the groin area?		
31. Have you had infectious mononucleosis (mono) within the last month?		
32. Do you have any rashes, pressure sores, or other skin problems?		
33. Have you had a herpes or MRSA skin infection?		
34. Have you ever had a head injury or concussion?		
35. Have you ever had a hit or blow to the head that caused confusion, prolonged headache, or memory problems?		
36. Do you have a history of seizure disorder?		
37. Do you have headaches with exercise?		
38. Have you ever had numbness, tingling, or weakness in your arms or legs after being hit or falling?		
39. Have you ever been unable to move your arms or legs after being hit or falling?		
40. Have you ever become ill while exercising in the heat?		
41. Do you get frequent muscle cramps when exercising?		
42. Do you or someone in your family have sickle cell trait or disease?		
43. Have you had any problems with your eyes or vision?		
44. Have you had any eye injuries?		
45. Do you wear glasses or contact lenses?		
46. Do you wear protective eyewear, such as goggles or a face shield?		
47. Do you worry about your weight?		
48. Are you trying to or has anyone recommended that you gain or lose weight?		
49. Are you on a special diet or do you avoid certain types of foods?		
50. Have you ever had an eating disorder?		
51. Do you have any concerns that you would like to discuss with a doctor?		
FEMALES ONLY		
52. Have you ever had a menstrual period?		
53. How old were you when you had your first menstrual period?		
54. How many periods have you had in the last 12 months?		

Explain "yes" answers here

____

____

____

____

____

____

____

____

I hereby state that, to the best of my knowledge, my answers to the above questions are complete and correct.

Signature of athlete ____________ Signature of parent/guardian ____________ Date ________

ANNEXURE – 6

■ PREPARTICIPATION PHYSICAL EVALUATION (Interim Guidance)

PHYSICAL EXAMINATION FORM

Name: ____ Date of birth: ____________________

PHYSICIAN REMINDERS

1. Consider additional questions on more-sensitive issues.
   - Do you feel stressed out or under a lot of pressure?
   - Do you ever feel sad, hopeless, depressed, or anxious?
   - Do you feel safe at your home or residence?
   - Have you ever tried cigarettes, e-cigarettes, chewing tobacco, snuff, or dip?
   - During the past 30 days, did you use chewing tobacco, snuff, or dip?
   - Do you drink alcohol or use any other drugs?
   - Have you ever taken anabolic steroids or used any other performance-enhancing supplement?
   - Have you ever taken any supplements to help you gain or lose weight or improve your performance?
   - Do you wear a seat belt, use a helmet, and use condoms?
2. Consider reviewing questions on cardiovascular symptoms (Q4–Q13 of History Form).

EXAMINATION		
Height: Weight:		
BP: / (/) Pulse: Vision: R 20/ L 20/ Corrected: ☐ Y ☐ N		
COVID-19 VACCINE		
Previously received COVID-19 vaccine: ☐ Y ☐ N Administered COVID-19 vaccine at this visit: ☐ Y ☐ N If yes: ☐ First dose ☐ Second dose		
MEDICAL	**NORMAL**	**ABNORMAL FINDINGS**
Appearance • Marfan stigmata (kyphoscoliosis, high-arched palate, pectus excavatum, arachnodactyly, hyperlaxity, myopia, mitral valve prolapse [MVP], and aortic insufficiency)		
Eyes, ears, nose, and throat • Pupils equal • Hearing		
Lymph nodes		
Heart[a] • Murmurs (auscultation standing, auscultation supine, and ± Valsalva maneuver)		
Lungs		
Abdomen		
Skin • Herpes simplex virus (HSV), lesions suggestive of methicillin-resistant *Staphylococcus aureus* (MRSA), or tinea corporis		
Neurological		
MUSCULOSKELETAL	**NORMAL**	**ABNORMAL FINDINGS**
Neck		
Back		
Shoulder and arm		
Elbow and forearm		
Wrist, hand, and fingers		
Hip and thigh		
Knee		
Leg and ankle		
Foot and toes		
Functional • Double-leg squat test, single-leg squat test, and box drop or step drop test		

[a] Consider electrocardiography (ECG), echocardiography, referral to a cardiologist for abnormal cardiac history or examination findings, or a combination of those.

Name of health care professional (print or type): ______________________________ Date: ____________

Address: ____ Phone: ________________

Signature of health care professional: ____, MD, DO, NP, or PA

ANNEXURE – 7

Roland-Morris Low Back Pain and Disability Questionnaire (RMQ)

Instructions

Patient name:______________________________ File #:____________ Date:_____________

Please read instructions: When your back hurts, you may find it difficult to do some of the things you normally do. Mark only the sentences that describe you today.

- ☐ I stay at home most of the time because of my back.
- ☐ I change position frequently to try to get my back comfortable.
- ☐ I walk more slowly than usual because of my back.
- ☐ Because of my back, I am not doing any jobs that I usually do around the house.
- ☐ Because of my back, I use a handrail to get upstairs.
- ☐ Because of my back, I lie down to rest more often.
- ☐ Because of my back, I have to hold on to something to get out of an easy chair.
- ☐ Because of my back, I try to get other people to do things for me.
- ☐ I get dressed more slowly than usual because of my back.
- ☐ I only stand up for short periods of time because of my back.
- ☐ Because of my back, I try not to bend or kneel down.
- ☐ I find it difficult to get out of a chair because of my back.
- ☐ My back is painful almost all of the time.
- ☐ I find it difficult to turn over in bed because of my back.
- ☐ My appetite is not very good because of my back.
- ☐ I have trouble putting on my socks (or stockings) because of the pain in my back.
- ☐ I can only walk short distances because of my back pain.
- ☐ I sleep less well because of my back.
- ☐ Because of my back pain, I get dressed with the help of someone else.
- ☐ I sit down for most of the day because of my back.
- ☐ I avoid heavy jobs around the house because of my back.
- ☐ Because of back pain, I am more irritable and bad tempered with people than usual.
- ☐ Because of my back, I go upstairs more slowly than usual.
- ☐ I stay in bed most of the time because of my back.

ANNEXURE- 8

OSWESTRY LOW BACK DISABILITY QUESTIONNAIRE

Instructions: this questionnaire has been designed to give us information as to how your back pain has affected your ability to manage everyday life. Please answer every section and mark in each section only the ONE box which applies to you at this time. We realize you may consider 2 of the statements in any section may relate to you, but please mark the box which most closely describes your current condition.

1. PAIN INTENSITY
- ☐ I can tolerate the pain I have without having to use pain killers
- ☐ The pain is bad but I manage without taking pain killers
- ☐ Pain killers give complete relief from pain
- ☐ Pain killers give moderate relief from pain
- ☐ Pain killers give very little relief from pain
- ☐ Pain killers have no effect on the pain and I do not use them

2. PERSONAL CARE (e.g. Washing, Dressing)
- ☐ I can look after myself normally without causing extra pain
- ☐ I can look after myself normally but it causes extra pain
- ☐ It is painful to look after myself and I am slow and careful
- ☐ I need some help but manage most of my personal care
- ☐ I need help every day in most aspects of self care
- ☐ I don't get dressed, I was with difficulty and stay in bed

3. LIFTING
- ☐ I can lift heavy weights without extra pain
- ☐ I can lift heavy weights but it gives extra pain
- ☐ Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, i.e. on a table
- ☐ Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned
- ☐ I can lift very light weights
- ☐ I cannot lift or carry anything at all

4. WALKING
- ☐ Pain does not prevent me walking any distance
- ☐ Pain prevents me walking more than one mile
- ☐ Pain prevents me walking more than ½ mile
- ☐ Pain prevents me walking more than ¼ mile
- ☐ I can only walk using a stick or crutches
- ☐ I am in bed most of the time and have to crawl to the toilet

5. SITTING
- ☐ I can sit in any chair as long as I like
- ☐ I can only sit in my favorite chair as long as I like
- ☐ Pain prevents me from sitting more than one hour
- ☐ Pain prevents me from sitting more than ½ hour
- ☐ Pain prevents me from sitting more than 10 minutes
- ☐ Pain prevents me from sitting at all

6. STANDING
- ☐ I can stand as long as I want without extra pain
- ☐ I can stand as long as I want but it gives me extra pain
- ☐ Pain prevents me from standing for more than one hour
- ☐ Pain prevents me from standing for more than 30 minutes
- ☐ Pain prevents me from standing for more than 10 minutes
- ☐ Pain prevents me from standing at all

7. SLEEPING
- ☐ Pain does not prevent me from sleeping well
- ☐ I can sleep well only by using medication
- ☐ Even when I take medication, I have less than 6 hrs sleep
- ☐ Even when I take medication, I have less than 4 hrs sleep
- ☐ Even when I take medication, I have less than 2 hrs sleep
- ☐ Pain prevents me from sleeping at all

8. SOCIAL LIFE
- ☐ My social life is normal and gives me no extra pain
- ☐ My social life is normal but increases the degree of pain
- ☐ Pain has no significant effect on my social life apart from limiting my more energetic interests, i.e. dancing, etc.
- ☐ Pain has restricted my social life and I do not go out as often
- ☐ Pain has restricted my social life to my home
- ☐ I have no social life because of pain

9. TRAVELLING
- ☐ I can travel anywhere without extra pain
- ☐ I can travel anywhere but it gives me extra pain
- ☐ Pain is bad, but I manage journeys over 2 hours
- ☐ Pain restricts me to journeys of less than 1 hour
- ☐ Pain restricts me to short necessary journeys under 30 minutes
- ☐ Pain prevents me from traveling except to the doctor or hospital

10. EMPLOYMENT/ HOMEMAKING
- ☐ My normal homemaking/ job activities do not cause pain.
- ☐ My normal homemaking/ job activities increase my pain, but I can still perform all that is required of me.
- ☐ I can perform most of my homemaking/ job duties, but pain prevents me from performing more physically stressful activities (e.g. lifting, vacuuming)
- ☐ Pain prevents me from doing anything but light duties.
- ☐ Pain prevents me from doing even light duties.
- ☐ Pain prevents me from performing any job or homemaking chores.