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Effectiveness of Multi-angle Isometric Exercises on Quadriceps strength and Functional status for patients with Knee Osteoarthritis

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DECLARATION

This work has not previously been accepted in substance for any degree and isn't concurrently submitted in candidature for any degree.

This dissertation is being submitted in partial fulfillment of the requirements for the degree of M.Sc. in Physiotherapy.

This dissertation is the result of my own independent work/investigation, except where otherwise stated. Other sources are acknowledged by giving explicit references. A Bibliography is appended.

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In case of dissemination the finding of this project for future publication, research supervisor will highly concern and it will be duly acknowledged as graduate thesis.

Signature.....

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Date.....13.06.23.....

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Acronyms

BHPI	Bangladesh Health Professions Institute
BMRC	Bangladesh Medical Research Council
CRP	Centre for the Rehabilitation of the Paralysed
DU	University of Dhaka
IRB	Institution Review Board
NPRS	Numerical pain rating scale
OA	Osteoarthritis
ROM	Range of motion
SPSS	Statistical Package for the Social Sciences
WHO	World Health Organization
WOMAC	The Western Ontario and MacMaster Universities

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Abstract

Background: Osteoarthritis is a developing non inflammatory disease of the movable joints and the knee is the most common site for osteoarthritis. Multiple angle isometric of quadriceps muscle is a strength training at a specific joint angle, muscle force production tends to improve most at or around the joint angles adopted during the training, although increases in force are purported to occur across a broader range of motion after training at longer muscle lengths. ***Study design:*** Assessor blinded randomized control trial (RCT) design. ***Method:*** 40 subjects with Knee Osteoarthritis were randomly allocated to two groups. The control group or standard physiotherapy group (EX; N=20) received conventional physiotherapy for four weeks (4 days/week). The experimental group or multiangle isometric quadriceps exercise group (N=20) received multi angle isometric exercise at 30, 45 and 60 degree (4days/week) for 4 weeks. Pre-tests was performed at baseline and post-test was performed after sixteen sessions (4 weeks) of the intervention. The patients were evaluated before and after treatment by using NPRS scale for pain measurement, goniometer for ROM measurement, muscle strength measurement by Oxford grade scale and WOMAC (Western Ontario and McMaster Universities) for functional status and quality of life. ***Results:*** A significant difference was found in the NPRS and WOMAC scores of both groups in group comparisons ($p < 0.05$) and showed significant improvement pain, ROM and functional activity. ***Conclusion:*** The findings from this study may contribute to understanding the effectiveness of multi angle exercise in patients with knee osteoarthritis. It has been effective in reducing pain, ROM and function. Moreover, multi angle exercise along with usual physical therapy enhances the effectiveness of physiotherapy and helps to decrease pain, increase flexibility and quadriceps strength, ROM and disability.

Key words: Knee OA, Multi angle exercise, Functional status, Quadriceps strengthening.

CHAPTER-I INTRODUCTION

1.1 Background

The most significant rheumatic illness, osteoarthritis, causes a great deal of physical pain and incapacity (Vericco et al., 2022). The disease of hip and knee arthritis is mostly to blame for its negative social effects. For osteoarthritis of the knee, a wide range of therapies are available, including education, hydrotherapy, footwear and walking aids, additional rehabilitation measures, physical therapy (SWD, UST, TENS, galvanic current, exercises, etc.), systemic drug therapy, intra-articular drug therapy, and surgery. Isometric resistance training has recently been demonstrated to improve functional ability and lessen knee joint discomfort in those with knee osteoarthritis. However, it is unclear how certain exercises, such as multi-angle isometric exercise, and physical therapy relate to the management of osteoarthritis of the knee joint (Kangeswari, Murali, & Arulappan, 2022).

Knee osteoarthritis (OA) is a very serious public health exposure which leads chronic pain, instability, decreases range of motion (ROM), impairs physical function and minimizes quality of life (Olagbegi, Adegoke & Odole, 2016). Clinically the disease is characterized by arthralgia, stiffness, restricted movement, sometimes with exudation and varying degrees of local inflammation. Arthritis pain is often associated with activity. Regular ache occurs in late stage (Pereira, Ramos & Branco, 2015).

Knee osteoarthritis (KOA) is a prevalent chronic condition, present with pain, causing disability, psychological distress, and reduced quality of life (Bennell et al., 2016). Knee OA is a progressive degenerative condition of joint which present with loss of articular cartilage and alteration of subchondral bone (Dor & Kalichman, 2017). Globally, more than 250 million individuals were suffering from knee OA, and have significant effect on health care and society (e Silva, de Andrade Alexandre & Silva., 2018). Most frequently Knee OA present with pain and others features are joint stiffness, functional impairment, even disability (Li, Hu, Di & Jiao., 2022; Mahmooda et al., 2020). The global prevalence for symptomatic knee OA over the age of 60 years is 9.6% and 18% in men and women respectfully (Haider et al., 2022). Different cross sectional study stated the incidence of

knee OA in India 10.20% and 5.78% in Bangladesh (Samal, Panchbudhe, Samal, Dixit & Gawande., 2021). Even if, the incidence rate for knee OA in Bangladesh and India relatively low but in Pakistan is two to three times higher, this is 28% of the metropolitan population and 25% of the rural population (Samal, Panchbudhe, Samal, Dixit & Gawande., 2021)

Bossmann et al. (2011) stated that, patients often experience physical limitations, their ability to care for themselves, their ability to wok and even face difficulties in supporting their families. Understanding the functioning and health of sufferers with osteoarthritis is essential for optimizing interventions to maintain function and disability. Physical exercise can alleviate pain, improve functional ability and promote psychosocial state in knee OA patients (Walsh & Hurley, 2009). Exercise therapy is still one of the first choices to prevent or reduce osteoarthritis (Saccomanno et al., 2015). Such interventions include exercise, electrotherapy, hydrotherapy, mobilization and manipulation, assistive equipment etc. The main evidence on the effectiveness of rehabilitation interventions for knee osteoarthritis shows that they provide moderate pain relief, less disability and better function (Anwer, Alghadir & Brismee, 2016).

"Isotonic, isokinetic, and isometric exercise" are three different types of essential therapeutic exercise. Given that it requires little to no equipment and is easy for patients to understand, isometric exercise may be performed at home. The least amount of bone loss and intraarticular pressure, inflammation, and pressure are caused by isometric exercise. The workouts known as "isometric exercises" are easy and inexpensive to perform, yet they build strength quickly (Chen, Rokito & Pitman, 2000). When a muscle contracts and generates force during an isometric workout, there is no visible change in the length of the muscle or clear joint motion. (Anwer, Alghadir & Brismee, 2016).

Multiple-angle isometrics. This term alludes to a framework of isometric work out in which resistance is connected, physically ormechanically,at different jointpositions inside the accessible ROM. This approach is utilized when the objective of work out is to progress quality all through the ROM when joint movement is reasonable but energetic resistance work out is excruciating or ill advice (Kisner, Colby & Borstad, 2017). Therefore, this study was designed to see the effects of multi angle exercise therapy on osteoarthritis of the knee to improve the patient’s condition.

1.2 Rationale

The prime purpose of this study is to find out the effectiveness of multi-angle isometric exercise on quadriceps strength and functional status for patients with knee Osteoarthritis. Knee osteoarthritis is increasingly a common condition throughout the country. This condition affects both men and women equally, and they are familiar with it because it is the most common and is related with aging. Three significant physical issues, including knee pain, stiffness, and diminished quadriceps strength, are strongly connected with knee OA and are thought to have a role in physical disability and the development of the condition. One of the intrinsic elements that affects how the knee joint works is the isometric strengthening of the quadriceps muscle. "Isometric exercises" are simple and affordable, but they swiftly increase strength. It is important to determine the effectiveness of different-angle isometric strengthening compared to merely conventional isometric exercise because multi-angle exercise can be administered throughout the ROM when joint mobility is conceivable but intense resistance training is exceedingly uncomfortable or not advised. Quadriceps strength at various angles must be taken into account in the research of knee OA because increased or uncontrolled stress on the joint increases the risk of disease development or progression.

Some studies are conducted about isometric exercise in others country of the world helps us to know about the isometric exercise broadly and its efficacy; however there is no available published study about multi-angle isometric exercise in perspective of Bangladesh.

As knee OA is non curable condition; I strongly believe this study finding had made a best solution for physiotherapist in management of knee OA patient in our country as well as world.

1.3 Hypothesis of the study

1.3.1 Null Hypothesis:

Null Hypothesis $H0 = \mu1 - \mu2 = 0$ or $\mu1 = \mu2$, where the post test and pretest initial and the final mean difference is the same that meant outcome of multi-angle isometric exercises along with usual therapy are no more effective for improving quadriceps strength for patients with Knee osteoarthritis.

1.3.2 Alternative Hypothesis:

Alternative Hypothesis $H\alpha = \mu1 - \mu2 \neq 0$ or $\mu1 \neq \mu2$, where the post test and pretest initial and the final mean difference is not the same that meant outcome of multi-angle isometric exercises along with usual therapy are more effective than only usual therapy for improving quadriceps strength for patients with Knee osteoarthritis.

Where,

Ho= Null hypothesis Hα = Alternative hypothesis

μ1 = Mean difference in initial assessment

μ2 = Mean difference in final assessment

1. Aim and Objectives

1.4.1 General Objective

The aim of the study was to evaluate the effectiveness of multi angle isometric exercise on quadriceps strength for patient with knee Osteoarthritis at specialized hospital in Bangladesh

1.4.2 Specific Objectives

1. To explore the demographic status of the people with knee osteoarthritis.
2. To compare the effectiveness of isometric exercise and conventional physiotherapy for a knee osteoarthritis patient.
3. To find out the effect of multi angle isometric exercise on pain.
4. To find out the effect of multi angle isometric exercise on ROM.
5. To find out the effect of multi angle isometric exercise on functional status.

1.5 Conceptual framework

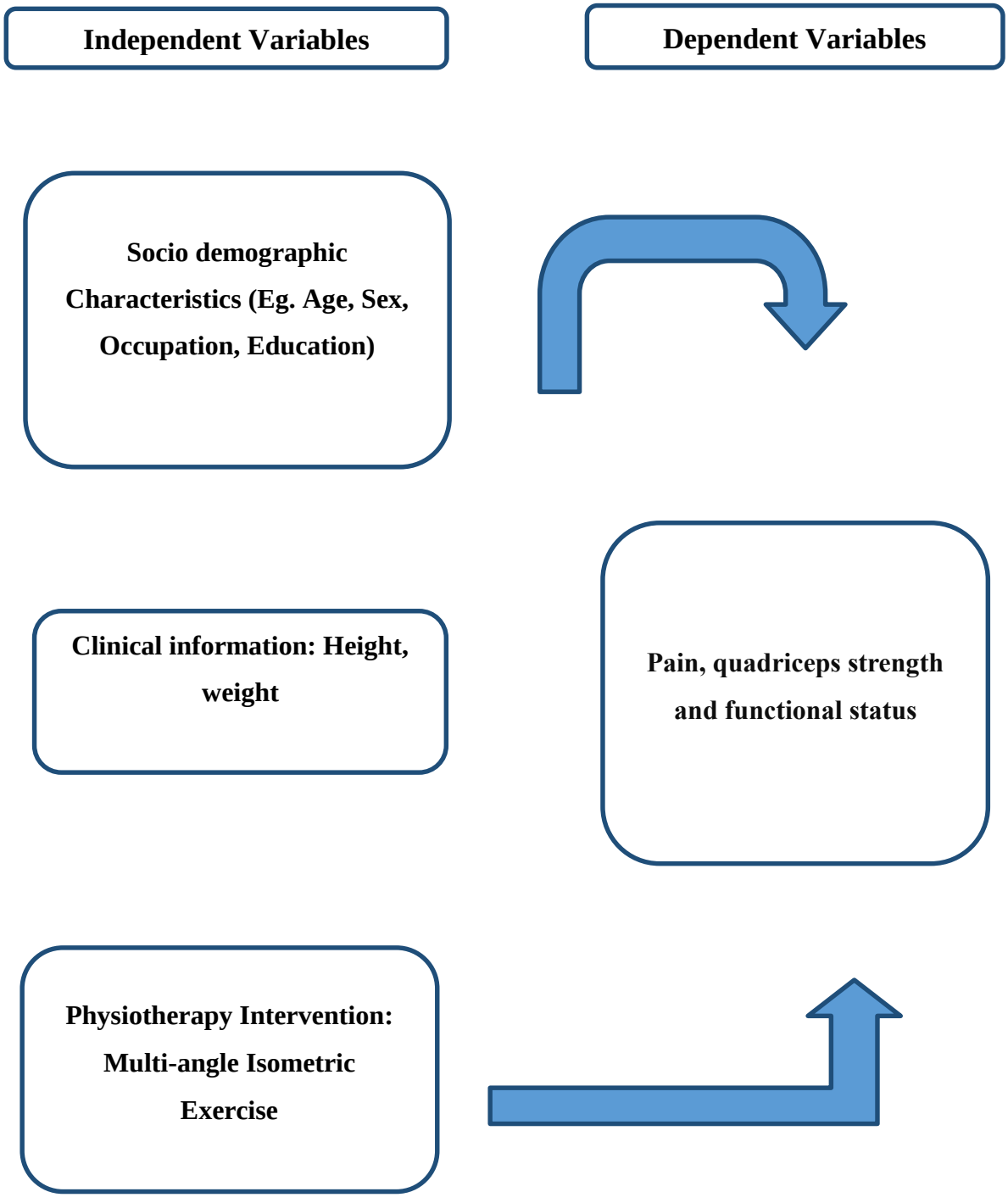


Figure 1: Conceptual framework

1.7 Operational Definition

Osteoarthritis

Osteoarthritis is one of the serious joint disease that results to a reduced quality of life A protective oily substance called synovial fluid is also contained within the joint, helping to ease movement. When these protective coverings break down, the bones begin to rub together during movement. This can cause pain, and the process itself can lead to more damage in the remaining cartilage and the bones themselves (Neogi, 2013)

Knee osteoarthritis

Knee osteoarthritis (knee OA) is a progressive disease caused by inflammation and degeneration of the knee joint that worsens over time. It affects the entire joint, including bone, cartilage, ligaments, and muscles. Its progression is influenced by age, body mass index (BMI), bone structure, genetics, muscular strength, and activity level. Knee OA also may develop as a secondary condition following a traumatic knee injury. Knee osteoarthritis is clinically characterized by usage-related pain and/or functional limitation. It is a common complex joint disorder showing focal cartilage loss, new bone formation and involvement of all joint tissues. Structural tissue changes are mirrored in classical radiographic features (Hunter & Ryan, 2022).

Knee joint

Knee joint is one kind of complex joint which is formed by 4 bones like lower end of femur, upper end of tibia and fibula and one sesamoid bone patella .Tendons connect the knee bones to the leg muscle and helps to move the knee joint. Ligaments join the knee bones and provide stability to the knee. The anterior cruciate ligament prevents the femur sliding backward on the tibia and posterior cruciate ligaments prevents the femur from sliding forward on the tibia. Medial and lateral collateral ligaments prevents the femur from sliding side to side. There are two “C” shape piece of cartilage which is called medial and lateral menisci is acts as a shock absorbers between the femur and tibia (Meyler, 2018).

Physiotherapy

Physiotherapy prevents diagnoses and treats physical impairments, limitations, and pain. Physiotherapists treat musculoskeletal injuries, neurological diseases, and chronic ailments including arthritis and pain in people of all ages (Mehta, 2022).

Isometric exercise: Isometric exercises are exercises that involve the contraction of muscles without any movement in the surrounding joints. The constant tension on the muscles may help improve muscle endurance and support dynamic exercises (Jennifer & Jimmy, 2008).

Multi-angle isometric: Multiple angle isometric of quadriceps muscle is a strength training at a specific joint angle, muscle force production tends to improve most at or around the joint angles adopted during the training, although increases in force are purported to occur across a broader range of motion after training at longer muscle lengths (More, Prachi & Joshi, 2022),

Rehabilitation

Rehabilitation improves physical, psychological, and social function after an illness, injury, or handicap. Physical, occupational, speech, and cognitive therapies are used in rehabilitation (Mills, Marks, Reynolds & Cieza, 2018)

Pain

Pain is an unpleasant sensory or emotional experience associated with actual or potential tissue damage, or described in terms of such damage (Raja et al., 2020)

Range of Motion (ROM)

Range of motion (ROM) defines the amount of movement possible at a particular joint. It plays an important role for physical function and necessary for accomplishing daily tasks including reaching, bending, and walking (Hudson, 2009).

CHAPTER-II LITERATURE REVIEW

In the year 2020, the prevalence of knee OA in people over the age of 15 was 16%, and it was 22.9% in people over the age of 40. Accordingly, by 2020, 654 million people globally (aged 40 and over) had knee OA. According to the systematic study, among people aged 20 and older, the global incidence of knee OA was 203 per 10,000 persons. Accordingly, 86.7 million people (20 years and older) had the occurrence of knee OA worldwide in 2020. The prevalence and incidence rates were 1.69 for males and females, respectively (Cui, Mubaric, Li & Yu, 2020).

One of the most common age-related health issues is knee osteoarthritis (KOA), which is characterized by functional impairment, cartilage loss, discomfort, disability, and a poor quality of life. In a semi-experimental trial, patients received daily, one-on-one instruction in isometric exercises for 40 minutes over the course of six days. For a 12-week period, all participants were urged to continue performing isometric exercises at home three times per day. According to the findings, both pain and functionality have significantly decreased (Kangeswari, Murali, & Arulappan, 2021).

Since muscle weakness is linked to pain and functional limitations, it affects how OA progresses (Fitzgerald, 2005). Patients with knee OA frequently experience diminished muscle strength, especially in the quadriceps. According to the literature, strengthening activities in particular can help persons with knee OA improve their physical function and strength (McAlindon et al., 2014).

Studies have demonstrated that compared to no therapy, an isometric training program, or an aerobic program, an isokinetic exercise program increases muscle strength. (2017) Coudeyre et al. After eight weeks and a year of the exercise regimen, this improvement materialized (Huang, Lin, Yang, & Lee, 2003).

Patient education is crucial for helping people with knee OA make decisions, manage their condition, and take their medications as prescribed. It is crucial for healthcare professionals to gain a thorough awareness of the illness in order to guide patients toward reliable health

resources. To educate people with knee OA, it is important to first comprehend how they are affected by the condition. Patients who cut back on physical activities and adopt a restricted lifestyle with less spontaneity due to false beliefs that OA is an incurable, progressive disease linked to specific causal factors are more likely to feel lonely and isolated as a result of a decline in social connections (Maly & Krupa, 2009).

Forty knee osteoarthritis patients received ten weeks of dynamic balancing training in a single-blind randomized controlled trial research to help them overcome their fear of mobility. With this intervention, knee pain, physical function, and fear of mobility were significantly improved. However, the dynamic balance as measured by the CB&M remained unchanged (Takacs et al., 2017).

According to Ayanniyi, Egwu & Adeniyi (2017), the most common cause of knee OA patients seeking medical care is pain, which if not well managed can result in loss of physical capacity and independence. The majority of guidelines strongly recommend ground-based exercises (strengthening and aerobic exercises), hydrotherapy (aquatic exercises), and transcutaneous electrical nerve stimulation (TENS). Transcutaneous electrical nerve stimulation (TENS) appears to reduce pain and improve short-term function in some cases, and other patients may last longer than 4 weeks (Hochberg et al.).

The research study also found that a typical regimen of strengthening exercises, ultrasound, pulsed electromagnetic field, and stretching exercises revealed significant variations in the knee's functional improvement, isometric quadriceps strength, and pain intensity, with the amount of change in the moderate pain group being noticeably greater than in the mild and severe pain groups (Abdel-Aziem et al., 2018).

Muscle strength, especially in the quadriceps, has a significant impact on physical function because quadriceps, hamstrings, and hip muscles are significantly impaired during knee OA. Research has found that exercise therapy, including general and targeted strength training, significantly reduces pain and improves function in people with knee OA (Alnahdi, Zeni & Snyder-Mackler, 2012).

When the knee joint is inactive and underused, the cartilage softens the number of

glycosaminoglycan drops, and the flexibility and mechanics of the joint are compromised, all of which hasten cartilage degeneration. Light-to-moderate exercise improves mechanical and functional abilities as well as mood and self-efficacy. It also reduces the risk of diabetes, cardiovascular disease, falls, and disability (Mora, Przkora & Almeida, 2018).

Stair climbing, cycling, and walking. They can lessen joint sensitivity while enhancing respiratory function and functional status. Patients are drawn to cycling because of its low effect profile. According to one study, knee pain, and physical disability questionnaire, scores decreased by 10-12% (Esser and Bailey, 2011).

It has been highlighted that losing weight has been shown to enhance the benefits of exercise, making weight loss an important component of symptom management.16 Patients who are obese are more likely to develop knee OA because obesity has detrimental molecular and mechanical effects. An important source of inflammatory agents is adipose tissue itself. Obese patients have higher levels of the cytokines adipokine, IL6, TNF alpha, and C-reactive protein, which have been linked to cartilage degradation and homeostasis changes. (Ayhan, Kesmezacar and Akgun, 2014).

Only the participants with a more neutral alignment saw a substantial reduction in knee discomfort, according to a single-blind, randomized controlled trial. Both with and without adjusting for covariates, there was a substantial main impact for strengthening and a significant interaction effect. When compared to control participants, strengthening participants in the more neutral group felt much less discomfort. The more misaligned group did not experience any discernible relief from pain. Although alignment had a significant impact on raw WOMAC physical function scores, this impact disappeared once variables were taken into account (Lim et al., 2008).

It was discovered that the quadriceps muscle's maximum voluntary isometric contraction (MVIC) in patients with knee OA was less than the muscle's MVIC in a healthy individual. For the treatment of OA patients, isometric exercise with biofeedback has just been proposed. An elderly women's knee osteoarthritis clinical research that was prospective,

randomized, and single-blind was conducted. The research showed a considerable When compared to the control group, the VAS score for the isometric training revealed a statistically significant decrease (Choi et al., 2015).

Subjects with knee discomfort have weak quadriceps, which is connected with impairment. Due to the critical role the quadriceps mechanism plays in walking, standing, and using stairs, muscle weakening may be a direct contributor to function impairment. It might also explain why those with extremely weak muscles have far higher odds of being disabled. According to Johani et al. (2014), there is a connection between quadriceps strength and pain and impairment in the general population.

According to data from 9825 patients with hip or knee OA, a 6-week combination intervention consisting of 12 sessions of neuromuscular exercise delivered twice weekly and three sessions of patient education delivered over the course of two weeks had positive effects on OA symptoms, physical function, medication intake, and sick leave time.

Weight loss (for those who are overweight or obese) and education and self-management are recommended as the first-line therapy for knee OA. Since these methods have been demonstrated to considerably reduce pain, improve general joint function, and improve patient quality of life, they ought to be the cornerstone of knee OA therapy. In people whose knee OA considerably impairs ambulation or joint stability or whose pain is severe, several recommendations strongly urge the use of tibiofemoral knee braces, canes or walkers, orthopedic footwear, and other assistive devices (Dantas, Salvini & McAlindon, 2020).

According to research, people with previous knee OA can benefit from 150 minutes per week of moderate-intensity aerobic exercise or two days per week of strenuous physical activity. If we convert these two activities into step counts, then aerobic exercise would require about 7500 steps per day, while moderate-to-vigorous physical activity would require about 5750 steps per day. Additionally, quadriceps-specific exercises have been shown to reduce pain more effectively than general lower-limb workouts when they are conducted under supervision at least three times per week (Dantas, Salvini, & McAlindon,

2020).

The Osteoarthritis Research Society International (OARSI) suggests either (1) mind-body exercises like Tai Chi or Yoga, or (2) planned land-based exercise regimens of one of two sorts, comprising strengthening, cardio, balance training, and neuromuscular exercise. Intra-articular corticosteroids (IACS) are under certain conditions advised for relieving short-term (4-6 weeks) and acute (1-2 weeks) pain. Since intra-articular hyaluronic acid (IAHA) was linked to symptom relief after 12 weeks and displayed a satisfactory safety profile, it is conditionally advised for longer-term therapy effects. It is unlikely that dietary weight management, whether it includes exercise or not, will significantly improve the symptoms of hip OA. For some patients, such as those who present with a body mass index below 30 kg/m2, dietary weight management may be advised as a part of a healthy lifestyle regimen (Bannuru et al., 2019).

In addition to topical, oral, and intra-articular drugs, a comprehensive plan for the care of OA in a specific patient may include educational, behavioral, psychological, and physical interventions. Recommendations presuppose that physical, psychological, and/or pharmaceutical therapy will be properly administered by a qualified provider. Resistance, aquatic, and/or aerobic workouts are advised by the American College of Rheumatology (ACR) (Kolasinski et al., 2020).

For older women with knee osteoarthritis, the Ottawa Panel suggests an eight-week Hatha Yoga program (60-minute sessions once a week plus a 30-minute at-home program four times a week) to manage their pain. Measures are advised after the conclusion of the eight-week therapy period. It is advised to complete an eight-week Tai Chi Qigong program (60-minute lessons twice a week) for the treatment of knee osteoarthritis in order to improve quality of life. For the treatment of knee osteoarthritis, a 12-week Sun-style Tai Chi training program (60-minute lessons once a week) is advised for increased physical function at the conclusion of the program (Brosseau et al., 2017).

The European League Against Rheumatism (EULAR) recommends activity pacing and general exercise for the therapy of knee OA. The quadriceps and proximal hip girdle

muscles in both legs should be strengthened (via continuous isometric exercise), regardless of where or how many main joints are impacted. All individuals with knee OA should be provided with an individualized management plan (a package of care) that incorporates the main non-pharmacological approaches, in particular: education and information about OA, addressing maintenance and pacing of activity, addressing a regular, individualized exercise regimen, focusing on weight loss if overweight or obese, reducing harmful mechanical factors (such as wearing appropriate footwear), and taking walking aids and assistive devices into consideration. Walking aids, assistive technologies, and modifications at home or at work should all be taken into consideration to lessen pain and promote involvement. Using a walking stick on the opposite side, using walking frames and wheeled "walkers," raising chairs, beds, and toilet seats, adding handrails to stairs, switching from a bath to a walk-in shower, and switching to a car with a high seat level, easy access, and automatic gear change are a few examples (Fernandes et al., 2014).

In lieu of prescribing a particular course of treatment for a patient, the American College of Rheumatology (ACR) has released a variety of suggestions and guidelines. For people with knee OA, exercise is highly recommended. Balance exercises are those that assist people with OA in controlling and stabilizing their body position and reducing their risk of falling. Changes in clinical and mechanistic outcomes can be correlated with weight loss of less than 5% of body weight. The utilization of a concurrent exercise program improves the effectiveness of weight loss for the management of OA symptoms. Traditional Chinese mind-body exercise known as tai chi mixes deep breathing, relaxation, and meditation with slow, graceful motions. The effectiveness of tai chi may be a result of the totality of this mind-body exercise's effects on self-esteem, depression, strength, balance, and fall prevention. A brace, which keeps the joint in a fixed position and is only conditionally advised for knee OA, prevents the range of motion in the joint to which it is applied. Kinesiotaping, in contrast, allows the joint to move while it is being taped. (Kolasinski et al., 2020).

Regular exercise can enhance functional independence in OA patients by enhancing controlling pain, proprioception, strength, instability, and endurance. Exercise is a crucial non-pharmacological strategy that has been taken into consideration by treatment

guidelines for osteoarthritis of the knee. Additionally, electrical stimulation (ES) is said to strengthen muscles. By impacting muscle fibers and the capillary system, ES strengthens muscles. Additionally, ES stops muscular atrophy that are brought on by prolonged immobility. The benefits of electrical stimulation combined with continuous passive motion (CPM-ES) therapy along with traditional physical therapy methods on knee OA were investigated in a randomized control study. The results of this study show that isometric exercise therapy or CPM-ES combination therapy can help knee OA patients improve their balance function in static and dynamic settings. The enhancement could decrease patients' risk of falling while engaging in physical activity and boost their sense of security (Tok et al., 2009).

There are several successful exercise regimens for managing pain and maintaining function, though their results can vary greatly. several guidelines encourage exercising in the early stages of the condition to avoid the potential side effects of pharmacological treatment. Improving strength, especially in the quadriceps muscle group, is of particular relevance in relation to knee OA. Exercises to this end include isometric, isotonic, and isokinetic techniques. When the range of motion is limited by discomfort in the early phases of knee rehabilitation, isometric exercises, which are types of strength training in which the joint angle and muscle length do not alter during contraction, can be helpful. The degree to which muscular strength increases depends on the isometric training angle. In a randomized controlled experiment, the efficacy of multiple-angle isometric exercises and isokinetic workouts for knee osteoarthritis was assessed. The severity of knee OA was evaluated using the Lequesne Index, an 11-item questionnaire that addresses pain/discomfort, maximal walking distance, and daily living activities. For both groups, the WOMAC score dramatically decreased. 2019 (Kilinca, Kabayelb, & Ozdemir).

Therapeutic exercise is an effective method for treating OA, especially when it combines both a strengthening component and specialized, supervised exercise teaching (Hernandez-Molina et al., 2009). At 12 months, there were considerably greater improvements in walking pain and locomotor function when a home exercise program was supplemented for 8 weeks. The number of sessions that are individually overseen by a trainer may also have an impact on how much therapy works (McCarthy et al., 2004).

Among people with knee OA, complementary and alternative medicine is frequently utilized to treat joint and arthritis pain. The evidence-based effectiveness of acupuncture for OA in lowering pain has been mentioned in earlier reviews. The same acupuncture points, also known as trigger or active points, are used in both acupuncture and acupressure, but acupuncture uses needles, whereas acupressure uses the fingers to press acupoints on the skin's surface to stimulate the body's natural healing processes. No significant differences were found between the acupressure, isometric, and control groups in a quasi-experimental pre-post test research, however all the groups displayed a considerable improvement in pain, stiffness, and physical functioning. According to Sour, Ayoub & Aziz (2014), the WOMAC scores of all the groups increased.

The origins and progression of knee OA are multidimensional, according to a systematic review of available research, with quadriceps weakness being one of the primary factors that can be changed by resistance training. It seems that all types of resistance training can help knee OA patients become stronger. The average increase in muscle strength after resisted isometric training is 17.4%. 56 percent of the studies analyzed stated that the training intervention improved self-reported measures of pain and physical incapacity/mobility. Since walking and other lifestyle activities can be replaced by systematic aerobic exercise, persons with muscle weakness or mobility issues caused by OA or other conditions may be able to enhance their total activity level through gradual resistance training. The maximum speed of gait greatly increased after resistance training. After resistance training, static balance significantly improved for the eyes-closed double-leg stance condition and tended to improve for the eyes-open single-leg stance condition. Resistance training was more cost-effective than aerobic training for enhancing self-reported disability and several other noticeable physical function outcomes when compared to health education (Lange, Vanwanseele and Singh, 2008).

Strength training with isometric contractions results in significant and powerful angle-specific changes. The strength improvements brought on by isometric training at four joint angles compared to conventional dynamic training were assessed using an intra-individual design. As a result, the significant angle specificity impact was diminished while comparing the contractile modes of isometric and dynamic training. For isometric exercise,

a typical variable resistance leg extension machine (Cybex VR2) was adjusted. Using a variable resistance leg extension machine (Cybex, VR2), weights were raised and dropped for four sets of ten repetitions. Each leg's maximum quadriceps strength was evaluated before and after training. The dynamometer was also used to assess the isometric strength at four different knee flexion angles: 0.87, 1.22, 1.57, and 1.92 rad. At three different velocities= 0.79, 2.62, and 5.24 $rads^{-1}$ the strength of knee extension was measured. The subjects completed three practice trials before three maximal efforts at each velocity were recorded. Between each speed, there was a 30-second break, and the highest peak torque out of the three trials was noted. Whatever the form, strength training greatly improved the participants' isometric strength at a variety of angles. Additionally, the isometrically trained leg experienced more considerable relative increases in isometric strength than the dynamically trained leg. Isometric and isokinetic strength significantly increased with both types of resistance training (Folland et al., 2007).

Isometric exercises result in no change in muscle length and limited joint movement. Each exercise should be performed at a variety of angles for the joint since the angle at which an isometric exercise is performed determines the strength growth. With isokinetic training sessions, the movement's speed may be managed, and maximum contraction can be attained at a constant speed along the movement's length. The effects of isokinetic and isometric exercises on pain, function, and muscle strength in women with knee osteoarthritis were examined in an experimental study to establish whether one type of exercise was superior to the other. Clinical evaluations included a thorough medical evaluation covering a person's and their family's medical history, a physical examination, a questionnaire on demographics, health practices, blood chemistry, hematological tests, blood pressure measurement, length of pain, body mass index, and the dominant leg. A visual analog scale was used to measure the intensity of both activity and resting discomfort. In the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), functional performance tests such as the 15-meter walk, 30-second sit-stand, ascend/descend the stair, and standing-up were the dependent variables. Isokinetic tests were also included. In this study, it was demonstrated that the effects of isokinetic and isometric exercises on physical function, disease-specific quality of life, and concentric

flexor and extensor strength at all test velocities were similar in females with Grade II and Grade III knee osteoarthritis. Improvement was seen with both types of exercise (Çakır, Toraman, Uçkun & Yalçın, 2016).

It is well known that there is a link between obesity and knee osteoarthritis, and that obesity itself is a risk factor for the condition. Blagojevic et al. (2010) conducted a comprehensive review and meta-analysis of 36 papers reporting BMI and discovered that all studies showed obesity and being overweight to be risk factors for knee osteoarthritis. An extensive population-based prospective study that followed 823 participants for 22 years discovered no effect of age or gender on the association between BMI and the likelihood of developing osteoarthritis of the knee. The two main explanations put out to explain the link between obesity and knee osteoarthritis are biomechanical and metabolic factors. The two main explanations put out to explain the link between obesity and knee osteoarthritis are biomechanical and metabolic factors. According to the biomechanical mechanism, obesity increases the strain and impact placed on the knee's articular cartilage, which encourages the fibrillation and deterioration processes (Lee and Kean, 2012).

The linked occupational risk factors of developing knee osteoarthritis were identified by a meta-analysis. The research examined 51 studies on knee OA, 12 studies on knee pain, and 3 studies on the development of knee OA. 18 studies in total reported several occupational exposures, frequently including a combination of kneeling, lifting, carrying, squatting, or other knee-bending tasks. The risks resulting from these many exposures were combined to provide a single overall risk. The others were reports analyzing risks specific to a given job description, such as employment requiring knee-stretching activities, heavy/arduous/manual employment, or elite athletics. In studies where data were published, the mean age of study participants ranged from 38 to 79 years, with the mean being 60.2 years (McWilliams et al., 2011).

Exercise is a broad concept that might involve aerobic exercise, weight training, and range of motion activities. A common component of exercise intervention is education and home workouts. To treat deficits relating to joint function, physiotherapists and manual therapists typically mix exercise therapy with passive manual mobilization. Soft-tissue mobilization

and oscillations are examples of passive manual mobilization, which aims to increase joint mobility and stability while reducing pain. In patients with osteoarthritis, restricted joint mobility, particularly in terms of knee flexion, appears to be a significant predictor of disability. The systematic review demonstrates that each of the three types of interventions was successful in reducing pain and enhancing physical function. Strength training (0.38) and exercise treatment alone (0.34) both had mild effects on pain, compared to exercise with extra manual mobilization, which has a substantial effect size of 0.69. Exercise therapy combined with additional manual mobilization had a bigger impact on pain than exercise therapy alone. Physiotherapists or manual therapists may think about incorporating manual mobilization to enhance supervised physical exercise programs in order to better relieve pain in individuals with knee osteoarthritis. To better understand how adding passive manual mobilization affects patients in subgroups who experience more pain, greater loss of mobility, or both, more research is required (Jansen et al., 2011).

Self-management (SM) is regarded as an effective strategy for treating chronic illnesses like OA. A randomized control trial was conducted to determine whether the Osteoarthritis of the Knee Self-Management Program (OAK), a disease-specific self-management program for primary care patients with OA of the knee, would result in and maintain clinically significant improvements in health-related outcomes when compared to a control group. The OAK group completed their six-week self-management training satisfactorily. The control group had a 6-month waiting period before starting the OAK treatment. At the beginning, at eight weeks, and at six months, assessments were completed. The Western Ontario and McMaster Universities Arthritis Index (WOMAC), which is a component of the Short Form 36 version 1 questionnaire (SF-36), was used to measure the primary outcomes. Secondary outcomes were knee range of motion, quadriceps and hamstring strength during isometric contraction, and the Timed Up & Go Test (TUG). In the OAK group, VAS pain decreased from week 8 to the baseline. Comparing the OAK group to the control group revealed significant increases in the SF-36 Physical Function, Role Physical, Body Pain, Vitality, and Social Functioning categories, as well as hamstring strength in both legs. In compared to the control group, the TUG Test, range of motion extension, and left-knee flexion all improved throughout the same time frame; however,

these changes had little clinical value (Coleman et al., 2012).

With no ionizing radiation and the capacity to image in many planes, magnetic resonance imaging offers improved contrast between the tissues of the joint.As a result, it has become more widely used in recent years to evaluate OA and the effects of exercise on cartilage. The effects of isokinetic, isometric, and aerobic exercise regimes on pain, disability, physical function, and articular cartilage in osteoarthritis were examined in an experimental investigation. Nonsteroidal anti-inflammatory medications (NSAIDs) were forbidden for the duration of the trial for all participants. Only paracetamol was permitted as an emergency painkiller; however, taking paracetamol within 24 hours after the assessment was prohibited. Transcutaneous electrical stimulation (TENS) and a cold pack were delivered to both knees of each patient in each of the three intervention groups for 20 minutes following the therapies. The reductions seen following isokinetic training were not significant enough to reach morphological measures of femoral and patellar cartilage using MRI. Although no statistical significance was established, the aerobic group showed increases rather than decreases in both cartilage volumes. Fascinatingly, the femoral cartilage volumes remained the same while the patellar cartilage volumes dramatically increased in the isometric group (Küçük, Taşkıran, Tokgöz & Meray 2018).

Using isokinetic measures and ultrasound, a randomized control trial showed the benefits of various strength training (isometric, isotonic, and isokinetic) on muscle strength and architecture in individuals with knee OA. The patients in each group underwent a 3-week (5 days/week) program to strengthen their knee extensions, with half of the patients in each group receiving only training on their right knees and the other half receiving only training on their left knees. To assess the impact of ipsilateral and contralateral strengthening, a unilateral strengthening program was used. With the exception of joint stiffness in the isokinetic group, VAS ratings and all WOMAC criteria considerably improved. After strengthening, the single-leg stance and 50-step walking tests produced better outcomes, with the isometric group's results being the most notable. All groups showed a gain in extensor muscular strength, however, only the isometric group saw a statistically significant change (for both the strengthened and the contralateral side). Except for the contralateral side in the isometric group, muscle thickness values developed significantly

in all 3 groups (Malas et al., 2013).

Alterations in proprioception, muscular weakness and atrophy, discomfort, stiffness, and restrictions on daily activities and social interaction are only a few of the clinical signs and symptoms of osteoarthritis. Osteoarthritis symptoms might include pain, soreness, stiffness, locking, and occasionally effusion in the joints. The bone may be exposed and harmed when the cartilage covering the bone surfaces declines. Regional muscles may shrink and ligaments may loosen as a result of decreased movement brought on by pain. Many people have more discomfort in cold and humid weather. Quadriceps weakness predicts radiographic progression and pain in people with osteoarthritis who do not experience any joint pain. a single-blind randomized control experiment with two groups: proprioceptive and isometric. For a period of six weeks, each patient received treatment twice each week. Prior to and following each therapy session, the patients' physical difficulty, joint stiffness, and pain severity were evaluated using the WOMAC scale. Infrared radiation was administered to the subjects in the two groups while Group A underwent proprioceptive exercises and Group B underwent isometric exercises. The findings showed that there was no significant difference between the two groups pre-treatment pain severity, joint stiffness, or physical challenges. By the sixth week, Group A had significantly less physical difficulty and pain than Group B (Ojoawo et al. 2016).

Because of decreased daily physical activity and greater pain perception, sensory-motor abilities like proprioception, static and dynamic balance, and neuromuscular control deteriorate as osteoarthritis worsens. As a result, programs that incorporate balance, coordination, and agility (sensory-motor training) may be successful by exposing these people to potentially unstable loads. This enables the neuromuscular system to adjust to circumstances that can cause knee instability during daily activity. The effectiveness of resistance training (RT) versus sensory-motor training (SMT) for reducing pain and enhancing function in a group of people with knee osteoarthritis was examined in a randomized control study. Participants were assessed at baseline and after the 16-week intervention. The outcome of pain was reduced more in the RT group. The outcome of isometric strength improved more in the SMT group. Better mobility and quality of life improvements were seen in the RT group. (Gomiero et al., 2018).

Exercises involving kinesthesia, balance, and agility (KBA) are frequently utilized to treat lower extremity injuries. KBA approaches use a variety of physical exercises that test a participant's capacity to maintain balance and coordination while also improving dynamic joint stability. KBA is most frequently used by athletes to treat and prevent ankle sprains and ruptures of the anterior cruciate ligament. The rehabilitation of a 10-year-old child with bilateral knee juvenile rheumatoid arthritis has also been successful when KBA training has been used. Programs to reduce falls among elderly people commonly employ KBA training approaches, particularly balance training. KBA training has been used as a knee OA remedy in recent years. In order to compare the isolated effectiveness of KBA with strength training (ST), randomized controlled research was conducted. The WOMAC scale indicated an improvement in physical function under the KBA group (Rogers et al., 2011).

Physically restricted exercise programs have only slightly to moderately improved pain management and functioning capacities in people with knee osteoarthritis (OA). Individuals with knee OA who did not complain of knee instability are exposed to additional challenges of motor function (such as quick stops, turns, and changes in direction; challenges to balance; navigating obstacles) that may be encountered during daily functional activities using agility and perturbation training techniques. In randomized controlled research, the advantages of including agility and perturbation training in an exercise therapy program were compared to the benefits of the same program without agility and perturbation training for those with knee OA. There were no appreciable differences between the intervention groups. Even while a significant interaction revealed that the agility and perturbation group improved marginally more quickly than the usual exercise group at early time points (Fitzgerald et al., 2011).

CHAPTER-III METHODOLOGY

3.1. Study Design

The study was a single blinded where data assessor was masked. There was two parallel groups. One arm received multi-angle isometric exercise along with usual physiotherapy entitled as experimental group and another arm received only usual physiotherapy which is entitled as control group.

The design could be shown as follow:

r o x o (experimental group)

r o o (control group)

Classic experimental research finding out the causal relationship between independent and dependent variables and infer the findings for generalization (Stangor, & Walinga, 2019). Randomized control trail design is a method of testing hypothesis by which cause and effect can be established.

3.2 Study Area

The study was conducted in single center. The setting was outdoor Musculoskeletal unit of CRP, Savar.

3.3 Study population

The study population was the patients with knee OA attended at the outdoor department of musculoskeletal unit CRP from September 30, 2022 to April 30, 2023

3.4 Sample size calculation

A power analysis to determine sample size with 5.78% prevalence of Knee OA in Bangladesh (Samal, Panchbudhe, Samal, Dixit & Gawande., 2021) where a 5% type – I error (α), 90% power (1 – type II error/β) and a clinically acceptable margin, $\delta = 0.1$, then

according to Zhong (2009).

Here,

$$N = 2 \times \left(\frac{z_{1-\alpha} + z_{1-\beta}}{\delta} \right)^2 \times p \times (1-p)$$

$$= 39.66 \approx 24$$

Allowing a dropout rate of 20%, we recruit 40 participants (20 participants for each group).

3.5 Duration of Study

7 months: September 1, 2022 to April 30, 2023

3.6 Sampling Scheme

All of the patients with knee OA and having an evident medical record of knee OA attended at CRP Physiotherapy outdoor have been chosen as subject. From the subjects, screening procedure has been performed by qualified Physiotherapist to examine the inclusion and exclusion criteria. From the eligible respondents, consecutive 40 patients have been taken as a sample by hospital randomized sampling. The setting was CRP- Savar. The setting in CRP-Savar has a connectivity and access to patients from all over the country. From this setting, as these patients attained in these CRP randomly without the choice of CRP authority or the researcher‘s choice, so they may be considered as a random sample entitled as hospital randomization.

3.7 Sampling technique

Computerized Random sampling technique was used in this study. A single blinded (assessor) randomized clinical trial with pre-measurements and post-measurements were conducted. Participants were measured by a blinded assessor once before randomization and intervention and again once 4 weeks after randomization and getting intervention. The assessor were responsible for conducting the baseline assessments had checked that each

participant meets the inclusion criteria and had collected demographic information including date of birth, sex. A secure random allocation schedule had been generated prior to commencement of the trial by an independent person. The randomization schedule had blocked (1:1) to ensure equal numbers of participants are randomised to the treatment and control group.

3.8 Eligibility Criteria of participant of RCT:

The trial had broad inclusion criteria in keeping with a pragmatic approach.

3.8.1 Inclusion Criteria:

A person was eligible to participate if they have:

1. Patients who already diagnosed as Knee OA through guideline of American College of Rheumatology (Gomaa & Zaky, 2015; 2016)
2. Patients with 1st and 2nd degree osteoarthritis diagnosed by physician.
3. Age range 28 to 77 years.
4. Both male and female gender (Tripathi & Hande,2017).
5. Both unilateral and bilateral knee OA (Tripathi & Hande,2017).
6. Subjects who signed consent form willingly.

3.8.2 Exclusion Criteria:

1. Neuropathy of Stage 3 or the patients indicated for arthoplasty.
2. Cardiovascular disease
3. Any recent trauma and injuries
4. Disability of language and cognition .
5. Did not agree to participate.
6. Subjects with any diagnosed of psychiatric illness.
7. Subjects with diagnosed congenital skeletal deformities.
8. Any history of rheumatic diseases such as rheumatoid arthritis or systemic lupus erythematous, recent operation or fracture of lower extremities or pathological conditions such as malignancy, heart disease etc. (Gomaa & Zaky, 2015; 2016).
9. Incomplete or unclear documents (Tripathi & Hande, 2017)

10. Patient got surgery for knee OA (Tripathi & Hande, 2017).
11. Patient taking steroid injection (Tripathi & Hande, 2017).

3.9 Informed Consent Process:

Potential and eligible participants were encouraged to listen the participant information sheet which was provided to the patient's caregiver for reading and if caregiver is illiterate then person who are responsible for screenings read the consent form in favor of patient/ caregiver.

3.10 Enrolment

Total enrolment procedure of the participants has been disclosed in Figure-1. An assessor (clinical physiotherapist) was responsible for conducting the baseline assessments who had checked that each participant meets the inclusion criteria. Information about each potential participant was collected from the medical records including date of birth, sex, duration of OA and classification of OA.

3.11 Randomisation procedures:

Subjects with knee OA who met the inclusion criteria were chosen at random from the CRP, Savar, outdoor musculoskeletal physiotherapy unit, and their assignments were made using a straightforward randomization technique. The study only used one blind. For this randomized clinical trial study, internal validity of the experimental research was increased by using computer-generated random numbers in Microsoft Office Excel 2013. For the Multi-angle exercise group, the samples were assigned the numbers E1, E2, E3, etc., and for the Control group, the numbers C1, C2, C3, etc.

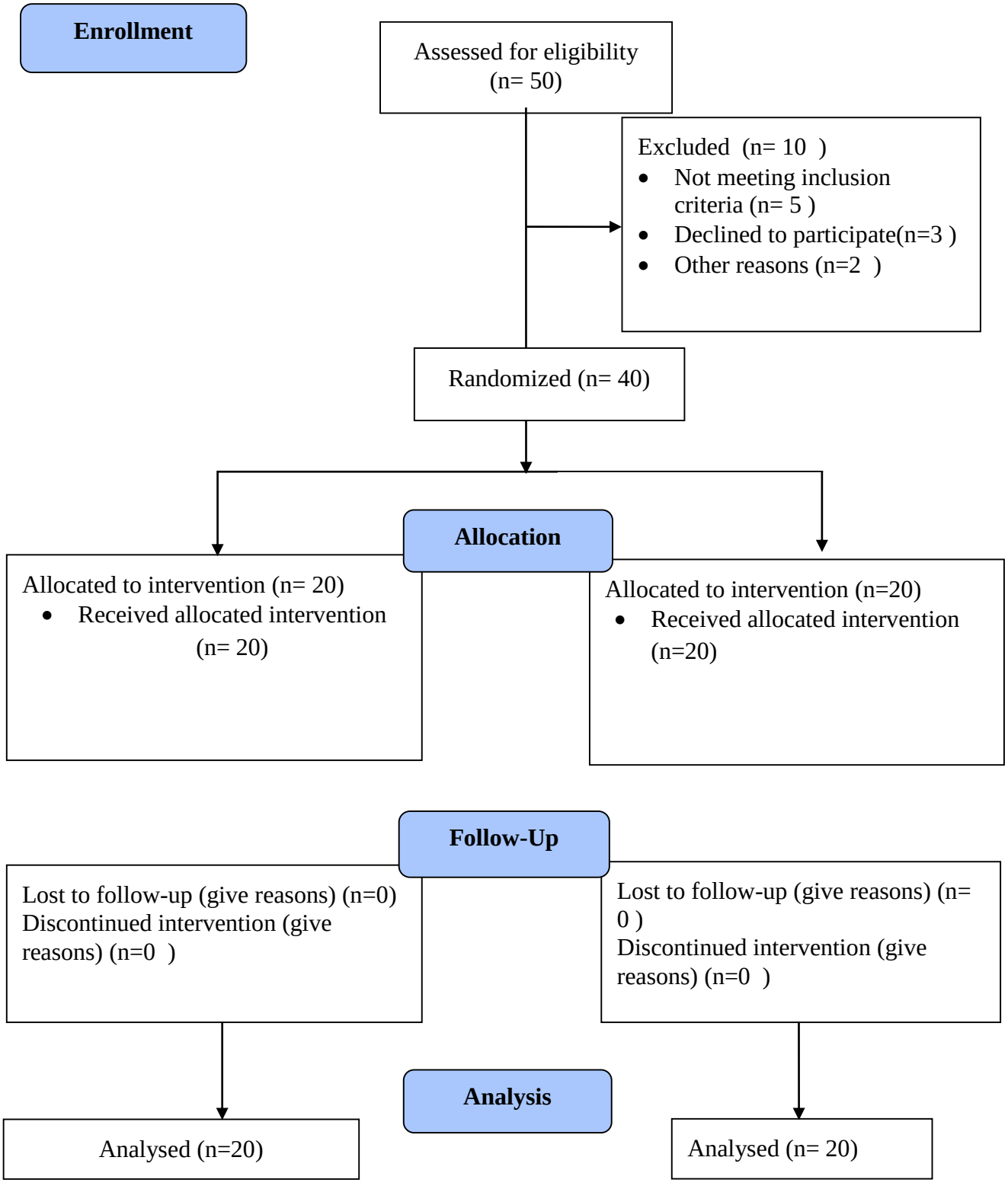


Figure 2: Consort diagram of the phases of randomized controlled trial

3.12 Interventions of the study:

Intervention Group:

Experimental group received multi angle isometric quadriceps strengthening exercise with conventional physiotherapy which included, supine hamstring stretch, quadriceps stretch prone, calf stretch. Multi-angle quadriceps strengthening exercise was given at the following dose:

Dose: 10 repetitions with 10 sec hold and 2 sec of rest in between the repetitions. Each session consisted of 3 sets and 1 minute rest was given between each set. 10 seconds hold was done in supine and sitting position in the angle of 30, 45 and 60 degrees.

The intervention was given at the frequency of 4 working sessions per week and continued to 4 weeks (More, Shah & Joshi, 2022).

Control group:

Control group received the standard physiotherapy.

A standard intervention program was carried out for both groups as usual care that consists of-

Stretching: Sustained manual stretches of 15–30s duration with 3-5 repetition to reduce muscle tightness (Gomaa and Zaky, 2016)

Muscle strengthening such as static quad sets in knee extension, straight leg raises(supine,prone), side abduction, wall squats, sit to stand chair supported : Hold each contraction for 10 sec with 2 sec rest between repetitions for 10 repetitions (Mahmooda et al. 2020).

Manual therapy technique: Mobilization grades I, II for pain and III and IV for ROM for 10 repetitions (Samal, Panchbudhe, Samal, Dixit & Gawande., 2021). Patient's education and home advice was given

Dose: Usual therapy was given at the frequency of 4 working sessions per week and continued to 4 weeks.

Isometric strengthening at 30 degree

Isometric strengthening at 45 degree

Isometric strengthening at 60 degree

Figure 3: Isometric exercises in different angles

Table 1: Treatment protocol for Usual Care

Treatment Options	Duration/Repetitions
Sustain Manual Stretching	15-35 sec hold with 3-5 repetitions
Static quad sets in Knee extension	10 sec contraction with 10 repetitions
Maitland mobilization	Grade I, II, III,,IV for 10 repetitions
Patellar mobilization	3 minutes
Soft tissue release technique	3-5 minutes
Ice/ IRR/ UST	7 minutes/10 minutes /5 minutes
Knee gaping	10 repetition
Movement with mobilization	10 repetition
Progressive strengthening exercise	10 repetition

3.13 Outcome measurements tools

The interviewer was asked from the structured questionnaire which was designed to collect information on related. However, the questionnaire was comprised of socio demographic characteristics and background information like- name, sex, age, educational qualification, monthly family income etc. Next section included items on The Western Ontario and MacMaster Universities Osteoarthritis Index (WOMAC SCORE), Numeric pain rating scale (NPRS). Final section included items on range of motion (ROM).

3.13.1 Numeric pain rating scale (NPRS):

McCaffery & Pasero (1999) used a numeric scale to rate the pain status practiced by patients. It is recognized as Numeric Pain Rating Scale. The scale is a 10 cm long scale ranging from 0-10. Here a zero (0) means no pain, 1-3 specifies mild pain, 4-6 specifies that pain is in moderate state and 7-10 is severe pain feeling experienced by patients.

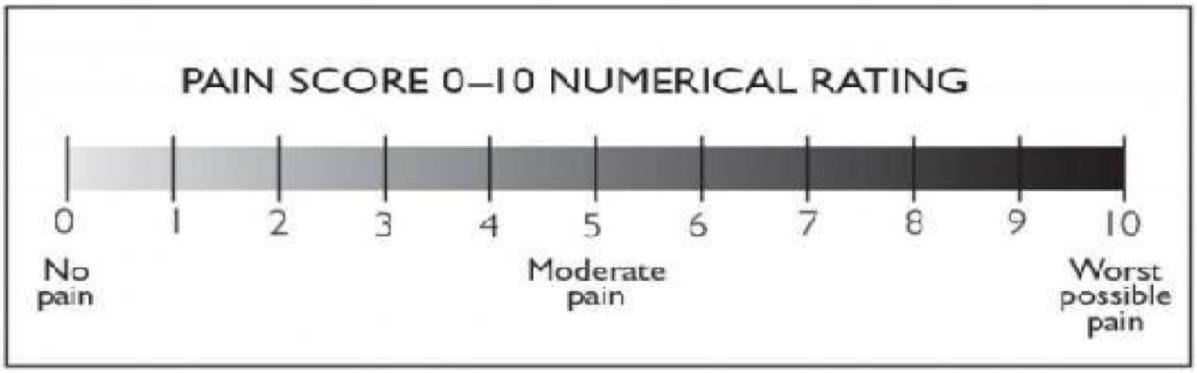


Figure 4: Numeric pain rating scale (NPRS)

3.13.2 The Western Ontario and McMaster Universities Arthritis Index (WOMAC):

The Western Ontario and McMaster Universities Arthritis Index (WOMAC) is a set of standardized questionnaires consisting of 24 items (5 items asking pain at activity or rest, the stiffness dimension includes 2 questions and the function dimension explores the degree of difficulty in 17 activities) divided into 3 subscales is widely used to evaluate the pain, stiffness, and physical functioning of the Hip and Knee joint osteoarthritis where the patients were questioned on their pain, stiffness, dysfunction (disability) in following descriptions for all items: none, mild, moderate, severe and extreme and these correspond to an ordinal scale of 0-4 (Salaffi et al., 2003).

3.13.3 Goniometer

Here, researcher used Goniometer for measuring joint range of motion and most commonly used Double-armed Goniometer, with one arm stationary and another arm is movable. The pin or axis of the movable arm is positioned directly over the center of the joint. The stationary arm is held in the line with the stationary segment of joint. Then the movement should perform. At the completion of movement the indicator show the number of degree through which the segment has moved.

Figure 5: Goniometer

3.13.4 Manual Muscle Testing Scale:

Manual muscle testing was used to evaluate contractile units, including muscles and tendons, and their ability to generate forces. When used as part of rehabilitation, muscle testing is an important evaluative tool to assess impairments and deficits in muscle performance, including strength, power, or endurance. In this study Manual Muscle Testing Scale was used to evaluate how much muscle power is present in knee. Here, 0 indicates no visible or palpable contraction , 1 indicates visible or palpable contraction,2 indicates partial ROM with gravity eliminated, 3 indicates full ROM with gravity eliminated, 4 indicates gravity eliminated with slight resistance or less than half range against gravity, 5 indicates more than half but less than full ROM against gravity , 6 indicates full ROM against gravity , 7 indicates full range of motion against gravity with slight resistance, 8 indicates full ROM against gravity with mild resistance, 9 indicates full ROM against gravity with moderate resistance , 10 indicates full ROM against gravity with almost full resistance ,11 indicates normal ROM with maximal resistance**.**

3.14 Data storage

All information collected from this study at the case report form (CRF) was kept confidential and secure in a locked cupboard. All files containing participant's personal details remained at the site where the data are collected. The original files was stored at the office of physiotherapy musculoskeletal unit in a locked drawer on completion of the study and only contained participant's ID codes. Electronically transcribed data and copy of the CRF was stored in the data base of the BHPI department. Access to data was only be granted to the Principal Investigator (PI) and other Research staff directly involved in the study.

3.15 Data Confidentiality

All information was re-identifiable which is necessitate for measuring the authenticity of data mining and further communication with the participants. Collected data was measured at utmost priority and unable to access by unauthorized person. Consent forms and all files containing participant's personal details remained at the site where participant was recruited. The data was kept in the password protected computer of Principle investigator. In case of further study with this collected data, it must be enforced to appeal to the data management committee for approval.

3.16 Statistical analysis

The between group analysis of disability, pain and range of motion (ROM) of the participants was analyzed by Mann-Whitney U-test. The within group analysis of disability, pain and range of motion (ROM) of the participants was done by Wilcoxon singed rank test. Parametric test was used to do analyzed interval/ ratio data and non-parametric test used to analyze the nominal/ordinal data. Also normality of data was checked. Normality of data was tested by Kolmogorov-Smirnov test. As the value of Kolmogorov-Smirnov test is less than .05, which indicate that the data distribution is not normal. The Kolmogorov-Smirnov test was used to determine normal distribution of The Western Ontario and McMaster Universities Arthritis Index (WOMAC) and Numeric pain

rating scale (NPRS) data.

Mann-Whitney U test is a non-parametric test that is simply compares the result obtained from each group to see if they differ significantly. This test can only be used with ordinal or interval/ ratio data. Mann-Whitney U test is one kind of non-parametric test which simply compares the result that is measured from the each group to see if they differ significantly.

Assumption

i. All the observations from both experimental and control groups are independent of each other.

ii. The responses are ordinal

iii. Under the null hypothesis Ho, the distribution of both populations are similar.

The formula of Mann-Whitney U-test:

$$U = n_1 n_{2+} \frac{nx(nx+1)}{2} - T_x$$

n_1= The number of the subjects in trail group

n_2= The number of the subject in control group

n_x= The number of the subjects of the group with larger rank total

T_x= The larger rank total

Accordingly Mann Whitney U test formula here researcher need the value of Tx that means researcher need the value of larger rank total in post-test pain in between group.so researcher found Tx in this following way.

The formula of Wilcoxon signed rank test:-

$$Z = \frac{W_S - \frac{(n+1)}{4}}{\sqrt{\frac{n(n+1)(2n+1)}{24}}}$$

Here,

n=Number of pairs where difference is not 0

W_s=Smallest of absolute values of the sum

3. 17: Level of Significance

To find out the significance of the study, the "p" value was calculated. The p values refer to the probability of the results for experimental study. The word probability refers to the accuracy of the findings. The level of significant was set at 95% ($p<0.05$). A p value is called level of significance for an experiment and a p value of <0.05 was accepted as significant result for health service research. If the p value is equal or smaller than the significant level, the results are said to be significant (De Poy and Gitlin, 2013).

3.18 Ethical consideration

This study has the ethical permission from CRP ethics Committee [CRP-R&E-0401-0401]. The study must follow the Helsinki declaration as per ethical guidelines. The participation is voluntary, and participants had have the right to withdraw from the trial anytime during the trial.

CHAPTER IV RESULTS

Table: 2- Baseline characteristics of the participants

Variable	Trial group (n=20)	Control group (n=20)
Mean age, mean(SD)	54.10±10.70	57.20±11.60
Gender	Male: 08 (30.4); Female 12 (43.5)	Male 10(43.5); Female 10 (43.5)
Education	No formal education: 3(13%), primary: 6(26%), SSC: 4(17%), HSC: 7(30%)	No formal education: 3(13%), SSC: 5(22%), HSC: 5(22%), Bachelor: 7(30%)

Table 2 compares the baseline characteristics of participants between trial and control group. In addition, two groups did not show significant differences at baseline regarding demographic characteristics and disease-related parameters. In trial group, the mean age (± SD) of the participants was 54.10 (± 10.70) years and in control group 57.20 (± 11.60) years. In trial group the number of male was 07(30.4%) and female ratio was 1(43.5%) and in control group the man ratio was 10(43.5%) and female was 10(43.5%). Maximum number of educated participants were at trial group 7(30%) and it was HSC passed and whereas maximum number of bachelor degree passed 7(30%) in control group.

4.1.1 Age range of the participants

Among total forty (n=40) participants, experimental group (n=20) age range was between '30-40' years, it was 9%(n=2) where the majority of the participants 26% (n=6) were in '41-50' years followed by 26% (n=6) were in '51-60' years and the control group (n=2) age range was '30-40' years, where the majority of the participants 26% (n=6) were in '41-50' years of age followed by 22% (n=5) were in '51-60' years, 26% (n=6) were in '61-70' years and 4%(n=1) were in 71-80 years of age range group. Moreover, the mean age range of experimental group is 54.10±10.70 years and the mean age range of control group is 57.20±11.60 years.

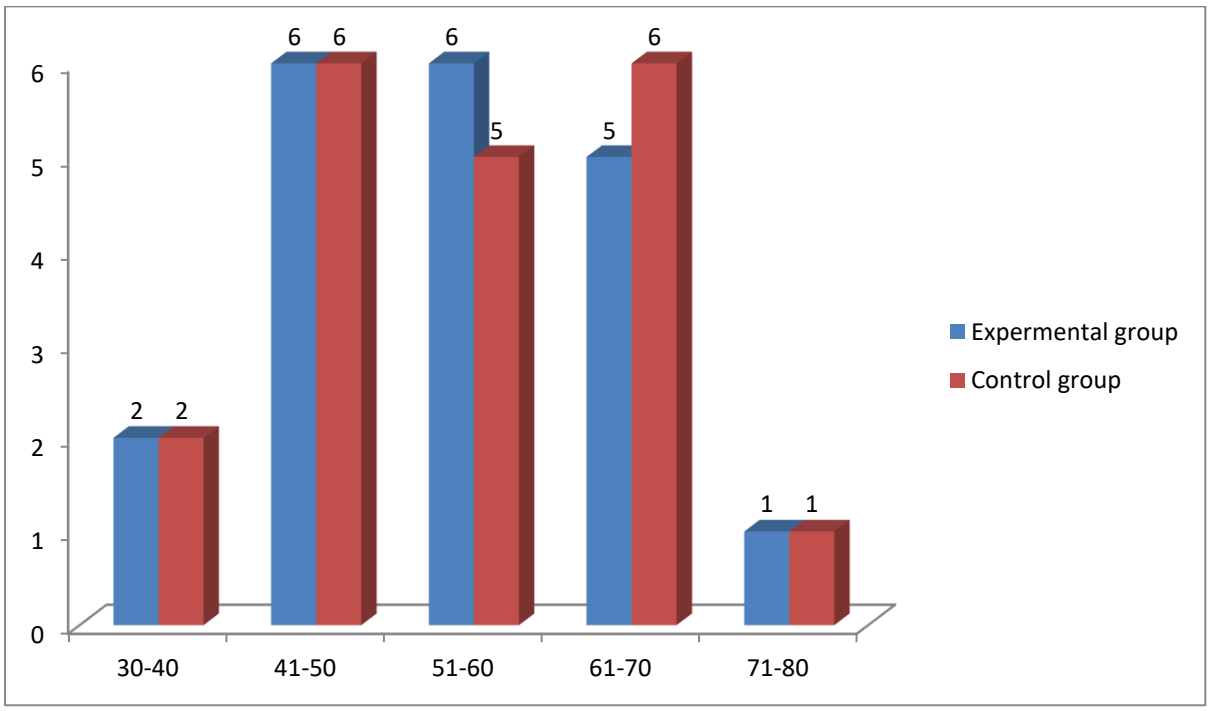


Figure 6: Age range of the participant

4.2 Pain Status

4.2.1 Comparison of pain in general

Table 03: Comparisons of changes of pain on Numeric pain rating scale (NPRS) between experimental and control group

	Experimental Group		Control Group		
	Pain_intensity_NPRS_baseline	Pain_intensity_NPRS_post test	Pain_intensity_NPRS_baseline	Pain_intensity_NPRS_post test	P value
Mean	3.30	1.50	3.05	1.80	0.021*
Std. Deviation	.657	.607	.759	.768	

From the table no 03, the post- test mean of the NPRS scale in the experimental group was 1.50±0.607 where post-test mean of NPRS scale in the control group was 1.80±0.768. In intergroup analysis between both groups had also significant improvement ($p<0.05$) in pain intensity. This mean values explained that the experimental group participant's pain intensity has reduced more effectively rather than the control group.

4.3 Knee extension in active ROM

4.3.1 Comparison of knee extension in active ROM

Table 04: Comparisons of changes of ROM on knee extension between experimental and control group

	Experimental Group		Control Group	
	Knee extension active ROM_pretest	Knee extension acive ROM_post test	Knee extension active ROM_pretest	Knee extension acive ROM_post test
Mean	0.25	0.01	0.30	.01
Std. Deviation	.550	.001	0.470	.001

From the table no 04, the post- test mean of the knee extension active ROM in the experimental group was 0.00±0.000 where post test mean of knee extension active ROM in the control group was .30±0.669. This mean values explained that the experimental group participant's knee active ROM has improved more effectively rather than in the control group.

4.4 Knee flexion in active ROM

4.4.1 Comparison of knee flexion in active ROM

Table 05: Comparisons of changes of ROM on knee flexion between experimental and control group

	Experimental Group		Control Group		P value
	Knee flexion active ROM_pretest	Knee flexion acive ROM_post test	Knee flexion active ROM_pretest	Knee flexion acive ROM_post test	.001*
Mean	2.50	0.40	2.80	0.75	
Std. Deviation	.513	.681	0.410	0.910	

From the table no 05, the post- test mean of the knee flexion active ROM in the experimental group was 0.40±0.681 where post test mean of knee flexion active ROM in the control group was .75±0.910. This mean values explained that there have no posttest changes because of new treatment.

4.5 Knee extension in active ROM

4.5.1 Comparison of knee extension in active ROM

Table 06: Comparisons of changes of Knee Flexor Hamstring muscle strength between experimental and control group

	Experimental Group		Control Group		P value
	Knee flexor hamstring muscle strength _pretest	Knee flexor hamstring muscle strength _post test	Knee flexor hamstring muscle strength _pretest	Knee flexor hamstring muscle strength _post test	
Mean	7.00	11.15	7.10	9.05	.001*
Std. Deviation	.918	.745	0.553	.945	

From the table no 06, the post- test mean of the knee flexor hamstring muscle strength in the experimental group was 11.15±0.745 where post test mean of knee flexor hamstring muscle strength in the control group was 9.05±0.945. . In intergroup analysis between both groups had also significant improvement ($p<0.05$) in ROM. This mean values explained that the experimental group participant's knee hamstring muscle strength has improved more effectively rather than in the control group.

4.6 Knee extensor quadriceps muscle strength

4.6.1 Comparison of knee extensor quadriceps muscle strength

Table 07: Comparisons of changes of Knee Extensor Quadriceps muscle strength between experimental and control group

	Experimental Group		Control Group	
	Knee extensor quadriceps muscle strength _pretest	Knee extensor quadriceps muscle strength _post test	Knee extensor quadriceps muscle strength _pretest	Knee extensor quadriceps muscle strength _post test
Mean	7.65	11.50	7.30	10.30
Std. Deviation	.671	.761	0.733	1.174

From the table no 07, the post- test mean of the knee extensor quadriceps muscle strength in the experimental group was 11.50±0.761 where posttest mean of knee extensor quadriceps muscle strength in the control group was 10.30±1.174. This mean values explained that the experimental group participant's knee extensor quadriceps muscle strength has improved more effectively rather than in the control group.

4.7 WOMAC total score

4.7.1 Comparison of WOMAC total score

Table 8: Comparisons of changes of WOMAC total score between experimental and control group

	Experimental Group		Control Group	
	WOMAC total score _pretest	WOMAC total score _post test	WOMAC total score _pretest	WOMAC total score _post test
Mean	74.30	11.50	74.40	37.30
Std. Deviation	8.266	.761	8.127	5.564

From the table no 8, the post- test mean of the WOMAC total score in the experimental group was 11.50±8.959 where post test mean of WOMAC total score in the control group was 37.30±5.564. This mean values explained that the experimental group participant's knee extensor quadriceps muscle strength has improved more effectively rather than in the control group.

4.8 Mann Whitney U test

Table 09: Mann Whitney U test for between group analysis for total WOMAC score post test

Difference between WOMAC Scale	Category of participants	N	Mean of posttest WOMAC	Mean rank	z	p
	Experimental	20	11.50	10.50	5.434	0.001
	Control	20	37.30	30.50		
	Total	**40**				

Table 09 showed that the calculated value of z is 5.434 for WOMAC scale. From the critical value of z for 95% confidence interval, 1.96 which is smaller than calculated value. So, it was clear that Z value between experimental and control groups had an associated probability. The level of significance is 0.000 which is less than 0.05. Therefore, the result is significant for two tailed hypothesis. Since the p value is less than 0.05, the result is significant and the null hypothesis (no relationship) is rejected and the alternative hypothesis is accepted. So, it can conclude that multi angle isometric exercise on quadriceps strength along with usual knee OA. Physiotherapy is more effective than only usual therapy to improve functional status for the patients with knee OA.

4.9 Within group analysis

Table 10: Within group analysis by wilcoxon sign rank test for individual variable of WOMAC

Variables	Mean of Post-test	SD	Wilcoxon Sign rank test Z	P value
WOMAC test difference within control group	37.30	5.564	3.92	0.001
WOMAC test difference within experimental group	11.50	8.959	3.92	0.001

This study found that in WOMAC score test observed value was 3.92 in the control group at two tailed Wilcoxon sign rank test while this same variable for experimental group observed value was 3.92. At 95% confidence level the critical value of z is 1.96 which is smaller than the observed z value of both groups. That means null hypothesis was rejected and alternative hypothesis was accepted, that indicated that multi angle isometric exercise on quadriceps muscle was effective for the patients with knee OA. The observed value in control group was greater than the critical z value that means null hypothesis was accepted and alternative hypothesis was rejected. Table showed that within group analysis of multi angle isometric exercise on quadriceps muscle had highly significant improvement in functional status test in trial group (p= 0.001).

CHAPTER V DISCUSSION

The present study is a randomized controlled trial. The purpose of this study was to evaluate effectiveness of multiple angle isometrics on quadriceps strength in individual with osteoarthritis knee. And we obtained successful outcomes as measured by reduction in the WOMAC and improvement in ROM scores. But multiple angle isometrics of quadriceps along with conventional physiotherapy is more effective for reducing pain and improving function and strength after 4 weeks of intervention in subject with osteoarthritis of knee. The pre- and post-intervention mean difference of WOMAC is shown in Table 10.

The findings of this study revealed that among the 40 knee OA participants, the experimental group included 10 patients who were male (43.5%) and 10 patients who were female (43.5%) whereas, 35% (n=08) participants were male and 52% (n=12) were female in Control Group. Moreover, the mean age range of the experimental group was 54.10±10.70 years and the control group was 57.20±11.60 years. In contrast, Rahbar et al. (2013) examined the effectiveness of multi-angle quadriceps isometric strengthening exercise where in the experimental group, 83.3% of patients (25 patients) were female and 16.7% (5 patients) were male, similarly, in the control group, 80% of patients (n = 24) were female and 20% (6 cases) were male. The mean ages of the control and intervention groups, respectively, were 59.13 ± 0.30 and 56 ± 5.44 (Rahbar, Toopchizadeh, Eftekharsadat & Ganjeifar, 2013).

The current study's findings indicate that various angle isometrics of the quadriceps, in addition to conventional physiotherapy and conventional physiotherapy both are effective in pain, knee function and strength. But multiple angle isometrics of quadriceps along with conventional physiotherapy is more effective for reducing pain and improving function and strength after 3 weeks of intervention in subject with osteoarthritis of knee. Joshi et al. (2018) found that hamstring flexibility improved after the therapist gave interventions (p 0.05) in all three groups (Group A (n=19) received static stretching, Group B (n=20) received remote Multi-angle isometric, and Group C (n=19) received both SS and remote

multi-angle isometric whereas, additional benefits which are related to the significant level of hamstring muscle power of this study. This study reveals that the pain reduction score on the Numerical Pain Rating Scale (NPRS) in the experimental group was statistically significantly higher than the control group at a 5% level of significance which is similar to Rahbar et al.'s study that found different types of Multi-angle quadriceps isometric strengthening exercise that have the effectiveness to decrease pain ($p< 0.001$ in both groups) in osteoarthritis patients and which is also found to be similar with Paul & Selvabharathi's study where showed significant improvement during functional activities ($p< 0.001$) increased by 10 degrees after applying multi angle isometric exercise. However, the Multi-angle quadriceps isometric strengthening exercise has been demonstrated to be effective to improve pain ($P < 0.001$) and respectively, 72.4% and7.4% reduction in pain and functional disability in week 4 which is common with this study. Arun (2014) showed that in a similar approach, based on the results of this study, the following application of various multi-angle quadriceps isometric strengthening exercise, the final assessment pain, ROM and functional status has been significantly improved in both groups.

CHAPTER V LIMITATIONS

The study has several limitations. The sample size was very small, so the result is difficult to generalize among whole population. Researcher has taken help from one assessor for data collection purpose, it may vary result. Data was collected one clinical setting CRP Savar, it can influence the result. Sometimes treatment sessions were interrupted due to public holiday mistaken in appointment schedule may interrupt the result. The participants who were illiterate may give false data. Therefore, the duration of the effect after the experimental intervention is unknown. Also, further research is needed to confirm the effectiveness of multi angle isometric quadriceps strengthening conventional physiotherapy for patients with knee OA. The rehabilitation period was small only 4 weeks for a total of 16 sessions of intervention for the two groups that experimental group and control group. Similar studies with longer intervention time are required for conclusive results. However, the present study is meaningful because it suggests that multi angle exercise at 30, 45 and 60 degree can improve knee functions, ROM, reduce pain in patients with knee OA. Owing to limitations of the present study further studies are needed.

CHAPTER VII CONCLUSIONS

Multi-angle quadriceps isometric strengthening exercise is a new treatment approach which is evidenced based. In patients with knee osteoarthritis, conventional care alone has been effective in reducing pain and enhancing the motion and function of the joint range. The addition of multi-angle quadriceps isometric exercise enhances the effectiveness of physiotherapy and helps to decrease pain and disability and improve range of motion, muscle power, and physical performance even more. Though within-group analysis showed a relevant significant improvement, between groups' analysis findings gave a clear idea that multi-angle quadriceps isometric strengthening exercise along with conventional care is a more effective therapeutic approach for patients with knee OA than only conventional care. For knee OA patients, there are so many effective approaches are used worldwide. This new treatment approach encouraged the patients to willing participate in the treatment session and dramatically outcome can be observed. The result of the study has shown that the effectiveness after sixteen sessions of treatment for patients with knee OA. Considering the final assessment pain, ROM and functional status has been improved in both groups. Improvement of knee function will reduce the burden of knee OA patients as well as their families. Hopefully this research will update and include a new dimension in the rehabilitation process of knee OA patients in Bangladesh.

Recommendations

- The sample size should be increased since, while it is sufficient for the purposes intended, there is room for improvement in terms of statistical power and generalizability.
- The current strategy calls for a 4-week intervention time, however a longer treatment term would be preferable. However, better results could be achieved by continuing treatment for a longer period of time.
- To learn how multi-angle exercise can be given in the long run, it's important to do follow-up examinations after the intervention period has ended.
- In order to better understand how successful multi angle isometric strengthening is, it can be compared to other procedures used in the rehabilitation of knee OA.
- Increasing the study's external validity requires recruiting individuals from a wide range of demographics and knee OA patients.

CHAPTER-VIII REFERENCE

Abdel-Aziem, A. A., Soliman, E. S., Mosaad, D. M., & Draz, A. H. (2018). Effect of a physiotherapy rehabilitation program on knee osteoarthritis in patients with different pain intensities. *Journal of physical therapy science*, *30*(2), 307-312.

Adegoke, B., Sanya, A., Ogunlade, S., & Olagbegi, O., (2019). The effectiveness of open versus closed kinetic chain exercises on pain, function and range of motion in patients with knee osteoarthritis. Baltic Journal of Health and Physical Activity, 11(3), 39-52. doi: 10.29359/bjhpa.11.3.05

Al-Johani, A. H., Kachanathu, S. J., Ramadan Hafez, A., Al-Ahaideb, A., Algarni, A. D., Meshari Alroumi, A., & Alanezi, A. M. (2014). Comparative study of hamstring and quadriceps strengthening treatments in the management of knee osteoarthritis. Journal of physical therapy science, 26(6), 817–820. https://doi.org/10.1589/jpts.26.817

Alnahdi, A.H., Zeni, J.A. and Snyder-Mackler, L., 2012. Muscle impairments in patients with knee osteoarthritis. Sports health, 4(4), pp.284-292.

Anwer, S., Alghadir, A., Brismeé, J.M., 2016. Effect of Home Exercise Program in Patients with Knee Osteoarthritis: A Systematic Review and Meta-analysis. J. Geriatr. Phys. Ther. 39, 38–48.

Ayhan, E., Kesmezacar, H. and Akgun, I., 2014. Intraarticular injections (corticosteroid, hyaluronic acid, platelet rich plasma) for the knee osteoarthritis. World journal of orthopedics, 5(3), p.351.

Bannuru, R.R., Osani, M.C., Vaysbrot, E.E., Arden, N.K., Bennell, K., Bierma-Zeinstra, S.M.A., Kraus, V.B., Lohmander, L.S., Abbott, J.H., Bhandari, M. and Blanco, F.J., 2019. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. Osteoarthritis and cartilage, 27(11), pp.1578-1589.

Bennell, K. L., Hall, M., & Hinman, R. S. (2016). Osteoarthritis year in review 2015: rehabilitation and outcomes. *Osteoarthritis and Cartilage*, *24*(1), 58-70.

Brosseau, L., Taki, J., Desjardins, B., Thevenot, O., Fransen, M., Wells, G.A., Imoto, A.M., Toupin-April, K., Westby, M., Gallardo, I.C.Á. and Gifford, W., 2017. The

Ottawa panel clinical practice guidelines for the management of knee osteoarthritis. Part one: introduction, and mind-body exercise programs. Clinical rehabilitation, 31(5), pp.582-595.

Çakır, T., Toraman, N.F., Uçkun, A. and Yalçın, Ü., 2016. Isokinetic exercise improves concentric knee flexion torque better than isometric exercise in patients with advanced osteoarthritis. Isokinetics and Exercise Science, 24(1), pp.7-15.

Choi, Y.L., Kim, B.K., Hwang, Y.P., Moon, O.K. and Choi, W.S., 2015. Effects of isometric exercise using biofeedback on maximum voluntary isometric contraction, pain, and muscle thickness in patients with knee osteoarthritis. Journal of physical therapy science, 27(1), pp.149-153.

Kisner, C., Colby, L. A., & Borstad, J. (2017). *Therapeutic exercise: foundations and techniques*. Fa Davis.

Coleman, S., Briffa, N.K., Carroll, G., Inderjeeth, C., Cook, N. and McQuade, J., 2012. A randomised controlled trial of a self-management education program for osteoarthritis of the knee delivered by health care professionals. Arthritis research & therapy, 14(1), pp.1-14.

Cui, Y., Mubarik, S., Li, R. and Yu, C., 2021. Trend dynamics of thyroid cancer incidence among China and the US adult population from 1990 to 2017: a joinpoint and age-period-cohort analysis. BMC Public Health, 21(1), pp.1-13.

Cuthbert SC, Goodheart GJ. On the reliability and validity of manual muscle testing: a literature review. Chiropractic & osteopathy. 2007;15(1):1-23.

Dantas, L.O., de Fátima Salvini, T. and McAlindon, T.E., 2021. Knee osteoarthritis: key treatments and implications for physical therapy. Brazilian journal of physical therapy, 25(2), pp.135-146.

Dor, A., & Kalichman, L. (2017). A myofascial component of pain in knee osteoarthritis. *Journal of bodywork and movement therapies*, *21*(3), 642-647.

Esser, S. and Bailey, A., 2011. Effects of exercise and physical activity on knee osteoarthritis. Current pain and headache reports, 15, pp.423-430.

Fernandes, L., Hagen, K.B., Bijlsma, J.W., Andreassen, O., Christensen, P.,

Conaghan, P.G., Doherty, M., Geenen, R., Hammond, A., Kjeken, I. and Lohmander, L.S., 2013. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. Annals of the rheumatic diseases, 72(7), pp.1125-1135.

Fitzgerald, G.K., 2005. Therapeutic exercise for knee osteoarthritis: considering factors that may influence outcome. Europa medicophysica, 41(2), p.163.

Fitzgerald, G.K., Piva, S.R., Gil, A.B., Wisniewski, S.R., Oddis, C.V. and Irrgang, J.J., 2011. Agility and perturbation training techniques in exercise therapy for reducing pain and improving function in people with knee osteoarthritis: a randomized clinical trial. Physical therapy, 91(4), pp.452-469.

Folland, J.P., Hawker, K., Leach, B., Little, T. and Jones, D.A., 2005. Strength training: Isometric training at a range of joint angles versus dynamic training. Journal of sports sciences, 23(8), pp.817-824.

Gomiero, A.B., Kayo, A., Abraão, M., Peccin, M.S., Grande, A.J. and Trevisani, V.F., 2017. Sensory-motor training versus resistance training among patients with knee osteoarthritis: randomized single-blind controlled trial. Sao Paulo Medical Journal, 136, pp.44-50.

Haider, M. Z., Bhuiyan, R., Ahmed, S., Zahid-Al-Quadir, A., Choudhury, M. R., Haq, S. A., & Zaman, M. M. (2022). Risk factors of knee osteoarthritis in Bangladeshi adults: a national survey. *BMC Musculoskeletal Disorders*, *23*(1), 1-9.

Hochberg, M.C., Altman, R.D., April, K.T., Benkhalti, M., Guyatt, G., McGowan, J., Towheed, T., Welch, V., Wells, G. and Tugwell, P., 2012. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. Arthritis care & research, 64(4), pp.465-474.

Hurley MV, Scott DL. Improvements in quadriceps sensorimotor function and disability of patients with knee osteoarthritis following a classically practicable exercise regime. Br J Rheumatol. 1998; 37: 1181-87.

Jansen, M. J., Viechtbauer, W., Lenssen, A. F., Hendriks, E. J., & de Bie, R. A. (2011). Strength training alone, exercise therapy alone, and exercise therapy with passive

manual mobilisation each reduce pain and disability in people with knee osteoarthritis: a systematic review. Journal of physiotherapy, 57(1), 11–20. https://doi.org/10.1016/S1836-9553(11)70002-9

Kangeswari, P., Murali, K. and Arulappan, J., 2021. Effectiveness of isometric exercise and counseling on level of pain among patients with knee osteoarthritis. SAGE Open Nursing, 7, p.2377960821993515.

Kolasinski, S.L., Neogi, T., Hochberg, M.C., Oatis, C., Guyatt, G., Block, J., Callahan, L., Copenhaver, C., Dodge, C., Felson, D. and Gellar, K., 2020. 2019 American College of Rheumatology/Arthritis Foundation guideline for the management of osteoarthritis of the hand, hip, and knee. Arthritis & Rheumatology, 72(2), pp.220-233.

Kolasinski, S.L., Neogi, T., Hochberg, M.C., Oatis, C., Guyatt, G., Block, J., Callahan, L., Copenhaver, C., Dodge, C., Felson, D. and Gellar, K., 2020. 2019 American College of Rheumatology/Arthritis Foundation guideline for the management of osteoarthritis of the hand, hip, and knee. Arthritis & Rheumatology, 72(2), pp.220-233.

Küçük, E.B., Taşkıran, O.O., Tokgöz, N. and Meray, J., 2018. Effects of isokinetic, isometric, and aerobic exercises on clinical variables and knee cartilage volume using magnetic resonance imaging in patients with osteoarthritis. Turkish journal of physical medicine and rehabilitation, 64(1), p.8.

Lange, A. K., Vanwanseele, B., & Fiatarone Singh, M. A. (2008). Strength training for treatment of osteoarthritis of the knee: a systematic review. Arthritis and rheumatism, 59(10), 1488–1494. https://doi.org/10.1002/art.24118

Lee, R., & Kean, W. F. (2012). Obesity and knee osteoarthritis. Inflammo pharmacology, 20(2), 53–58. https://doi.org/10.1007/s10787-011-0118-0

Lim, B.W., Hinman, R.S., Wrigley, T.V., Sharma, L. and Bennell, K.L., 2008. Does knee malalignment mediate the effects of quadriceps strengthening on knee adduction moment, pain, and function in medial knee osteoarthritis? A randomized controlled trial. Arthritis Care & Research: Official Journal of the American College of Rheumatology, 59(7), pp.943-951.

Malas, F.Ü., Özçakar, L., Kaymak, B., Ulaşlı, A., Güner, S., Kara, M. and Akıncı,

A., 2013. Effects of different strength training on muscle architecture: clinical and ultrasonographic evaluation in knee osteoarthritis. PM&R, 5(8), pp.655-662.

McAlindon, T.E., Bannuru, R., Sullivan, M.C., Arden, N.K., Berenbaum, F., Bierma-Zeinstra, S.M., Hawker, G.A., Henrotin, Y., Hunter, D.J., Kawaguchi, H. and Kwoh, K., 2014. OARSI guidelines for the non-surgical management of knee osteoarthritis. Osteoarthritis and cartilage, 22(3), pp.363-388.

McCarthy, C. J., Mills, P. M., Pullen, R., Roberts, C., Silman, A., & Oldham, J. A. (2004). Supplementing a home exercise programme with a class-based exercise programme is more effective than home exercise alone in the treatment of knee osteoarthritis. Rheumatology (Oxford, England), 43(7), 880–886. https://doi.org/10.1093/rheumatology/keh188

Mora, J.C., Przkora, R. and Cruz-Almeida, Y., 2018. Knee osteoarthritis: pathophyMalassiology and current treatment modalities. Journal of pain research, pp.2189-2196.

Neogi, T. (2013). The epidemiology and impact of pain in osteoarthritis. *Osteoarthritis and cartilage*, *21*(9), 1145-1153.

Ojoawo, A.O., Olaogun, M.O. and Hassan, M.A., 2016. Comparative effects of proprioceptive and isometric exercises on pain intensity and difficulty in patients with knee osteoarthritis: a randomized control study. Technology and Health Care, 24(6), pp.853-863.

Olagbegi, O. M., Adegoke, B. O. A., & Odole, A. C. (2016). Effectiveness of combined chain exercises on pain and function in patients with knee osteoarthritis. *Bangladesh Journal of Medical Science*, *15*(2), 178-188.

Pereira, D., Severo, M., Santos, R. A., Barros, H., Branco, J., Lucas, R., ... & Ramos, E. (2016). Knee and hip radiographic osteoarthritis features: differences on pain, function and quality of life. *Clinical rheumatology*, *35*, 1555-1564.

Rahbar M, Toopchizadeh V, Eftekharsadat B, Ganjeifar V. Therapeutic efficacy of myofascial trigger point therapy in patients with bilateral knee osteosrthritis: a randomized clinicel trial. Life Sci. J.. 2013;10(6):472-8. [DOI:10.7537/marslsj1006s13.72]

Rogers, M.W., Tamulevicius, N., Coetsee, M.F., Curry, B.F. and Semple, S.J., 2011. Knee osteoarthritis and the efficacy of kinesthesia, balance & agility exercise training: a pilot study. International journal of exercise science, 4(2), p.124.

Rosa, U. H., Velásquez Tlapanco, J., Lara Maya, C., Villarreal Ríos, E., Martínez González, L., Vargas Daza, E. R., & Galicia Rodríguez, L. (2012). Comparación de la eficacia ejercicio terapéutico isocinético vs isométrico en pacientes con artrosis de rodilla [Comparison of the effectiveness of isokinetic vs isometric therapeutic exercise in patients with osteoarthritis of knee]. Reumatologia clinica, 8(1), 10–14.

Samal, S., Panchbudhe, S., Samal, S., Dixit, M., & Gawande, V. (2021). Efficacy of Maitland mobilization and conventional treatment in patients of osteoarthritis of knee. *IJCRR*, *13*, 132-7.

Saccomanno, M.F., Donati, F., Careri, S., Bartoli, M., Severini, G., Milano, G., 2015. Efficacy of intra-articular hyaluronic acid injections and exercise-based rehabilitation programme, administered as isolated or integrated therapeutic regimens for the treatment of knee.

Verrico, C. D., Wesson, S., Konduri, V., Hofferek, C. J., Vazquez-Perez, J., Blair, E., ... & Halpert, M. M. (2020). A randomized, double-blind, placebo-controlled study of daily cannabidiol for the treatment of canine osteoarthritis pain. *Pain*, *161*(9), 2191.

Walsh, N. E., & Hurley, M. V. (2009). Evidence based guidelines and current practice for physiotherapy management of knee osteoarthritis. *Musculoskeletal Care*, *7*(1), 45-56.

Appendix-I

Informed Consent

Assalamu Alaikum,

I am Rabeya Rokshana Roli, student of M.Sc. in Physiotherapy , Bangladesh Health Professions Institute (BHPI), faculty of medicine under the University of Dhaka. For the partial fulfillment of my Master degree, I have to conduct a research project and it is a part of my study. My Research title is "**Effectiveness of Multi-angle Isometric Exercise on quadriceps strength and functional status for patients with knee Osteoarthritis.** Now I want to ask you some questions those are mentioned in this form. The conversation time will be 20-30 minutes.

I would like to inform you that this is a purely academic study and will not be used for any other purposes. I assure you that all the data will be kept confidential. Your participation will be voluntary. You may have the rights to withdraw your consent and discontinue from the study. You also have the right not to answer any other question that you don't like of this questionnaire. If you have any query about the study, you may contact with me or my supervisor Prof. Dr. Md. Sohrab Hossain**,** Professor, Department of Physiotherapy, BHPI and executive director (ED), CRP, Savar, Dhaka-1343.

Signature of the participant……..Date…..…….……

Signature of the witness…….....Date…...…….……..……

Signature of the researcher……...Date.……..…….……...…

Appendix-II

Research Title: Effectiveness of Multi-angle Isometric Exercise on quadriceps strength and functional status for patients with knee Osteoarthritis Questionnaire (English)

Part-I: Socio-demographic information

Patient Id No: **Code No:**

1.Name of patient	
2.Age	
3.Sex	Male ☐ Female☐
4.Address	Village/Area: P/O: P/S: District:
5.Contact no	
6.Weight	.....Kg
7.Height	……Cm
8. Dominant side	Right☐ Left☐
9.Affected side	Right☐ Left☐
10.Education	
11.Occupation	
12.Start time of intervention	
13.End time of intervention	
14.Concent taken	Yes ☐ No☐

Pre-Test Data

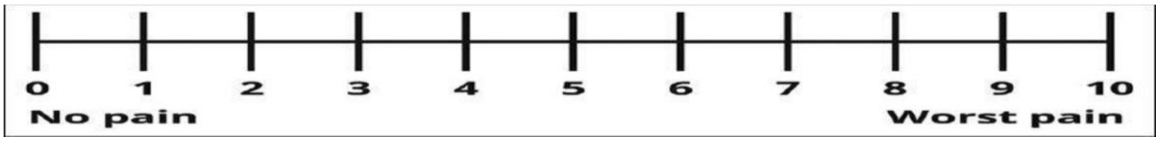
Part-I: Pain Intensity

Please mark the scale below to show how intense your pain is.

Instructions:

0=No pain 1-3=Mild pain 4-6=Moderate pain 7-10=Severe pain

How intense is your pain now?



Part-II: Estimate the Range Of Motion

This part of questionnaire is designed for knee range of motion measurement.

Goniometer is used for taking measurement.

Instructions:

0=Normal 1=Mild loss 2=Moderate loss 3=Severe loss

Movement	Range of Motion
Knee Flexion (active)	
Knee Extension (active)	
Knee Flexion (Passive)	
Knee Extension (Passive)	

Part-III: Estimate Muscle Power

According to Manual Muscle Testing Scale how much muscle power in knee will be measured

Instructions:

	Code	Grade	Points
0	0	No visible or palpable contraction	
1	1	Visible or palpable contraction	
2	2-	Partial ROM, gravity eliminated	
3	2	Full ROM, gravity eliminated	
4	2+	Gravity eliminated /slight resistance or <1/2 range against gravity	
5	3-	>1/2 but <Full ROM, against gravity	
6	3	Full ROM against gravity	
7	3+	Full range of motion against gravity, slight resistance	
8	4-	Full ROM against gravity, mild resistance	
9	4	Full ROM against gravity, moderate resistance	
10	4+	Full ROM against gravity, almost full resistance	
11	5	Normal, maximal resistance	

Name of muscle	Action \movement	Muscle power
Quadriceps	Knee_extension	
Hamstring	Knee_flexion	

Dorsi flexor muscle	Dorsi_flexion of foot	
Planter flexor muscle	Planter flexion of foot	

Part-IV: Physical disability questionnaire

This questionnaire is developed according to, "The Western Ontario and MacMaster Universities Osteoarthritis Index (WOMAC SCORE)" for measuring the pain and disability of the patient with knee osteoarthritis.

Each question has 4 score. Total questions are 24. Total number is 96.

Pre - test score of the patient is _____ / 96.

Instructions: Please rate the activities in each category according to the following scale of difficulty:

0 = None

1 = Slight

2 = Moderate

3 = Very

4 = Extremely

Circle one number for each activity

A) Pain:

1. How much pain do you feel during walking?	0	1	2	3	4

2. How much pain do you feel during stair climbing?	0	1	2	3	4
3. How much pain do you feel during sleeping at night?	0	1	2	3	4
4. How much pain do you feel during resting time?	0	1	2	3	4
5. How much pain do you feel during weight bearing?	0	1	2	3	4

B) Stiffness:

1. How much stiffness do you feel in knee joint in the morning?	0	1	2	3	4
2. How much stiffness do you feel in knee joint later in the day	0	1	2	3	4

C) Physical Function:

1. How much problem do you feel during descending stairs?	0	1	2	3	4
2. How much problem do you feel during ascending stairs?	0	1	2	3	4
3. How much problem do you feel during rising from sitting?	0	1	2	3	4
4. How much problem do you feel during standing?	0	1	2	3	4
5. How much problem do you feel during bending to floor?	0	1	2	3	4
6. How much problem do you feel during walking on flat surface?	0	1	2	3	4
7. How much problem do you feel during getting in/ out of car?	0	1	2	3	4
8. How much problem do you feel during going shopping?	0	1	2	3	4
9. How much problem do you feel during putting on socks?	0	1	2	3	4
10. How much problem do you feel during lying in bed?	0	1	2	3	4

11. How much problem do you feel during taking off socks?	0	1	2	3	4
12. How much problem do you feel during rising from bed?	0	1	2	3	4
13. How much problem do you feel during getting in/ out of bath?	0	1	2	3	4
14. How much problem do you feel during sitting?	0	1	2	3	4
15. How much problem do you feel during getting on/ off toilet ?	0	1	2	3	4
16. How much problem do you feel during doing heavy domestic duties?	0	1	2	3	4
17. How much problem do you feel during doing light domestic duties?	0	1	2	3	4

Result of patient before taken treatment _____ /96

Post-Test Data

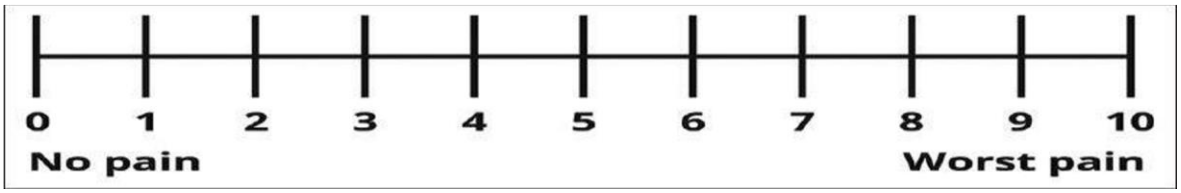
Part-I: Pain Intensity

Please mark the scale below to show how intense your pain is.

Instructions:

0=No pain 1-3=Mild pain 4-6=Moderate pain 7-10=Severe pain

How intense is your pain now?



Part-II: Estimate the Range Of Motion

This part of questionnaire is designed for knee range of motion measurement.

Goniometer is used for taking measurement.

Instructions:

0=Normal 1=Mild loss 2=Moderate loss 3=Severe loss

Movement	Range of Motion
Knee Flexion (active)	
Knee Extension (active)	
Knee Flexion (Passive)	
Knee Extension (Passive)	

Part-III: Estimate Muscle Power

According to Manual Muscle Testing Scale how much muscle power in knee manu be measured

Instructions:

Code	Grade	Points
0	0	No visible or palpable contraction

1	1	Visible or palpable contraction
2	2-	Partial ROM, gravity eliminated
3	2	Full ROM, gravity eliminated
4	2+	Gravity eliminated /slight resistance or <1/2 range against gravity
5	3-	>1/2 but <Full ROM, against gravity
6	3	Full ROM against gravity
7	3+	Full range of motion against gravity, slight resistance
8	4-	Full ROM against gravity, mild resistance
9	4	Full ROM against gravity, moderate resistance
10	4+	Full ROM against gravity, almost full resistance
11	5	Normal, maximal resistance

Name of muscle	**Action / movement**	**Muscle power**
Quadriceps	Knee extension	
Hamstring	Knee flexion	
Dorsi flexor muscle	Dorsi flexion	
Planter flexor muscle	Planter flexion of foot	

Part-IV: Physical disability questionnaire

This questionnaire is developed according to, "The Western Ontario and MacMaster Universities

Osteoarthritis Index (WOMAC SCORE)" for measuring the pain and disability of the patient with knee osteoarthritis.

Each question has 4 score. Total questions are 24. Total number is 96.

Post - test score of the patient is _____ / 96.

Instructions: Please rate the activities in each category according to the following scale of difficulty:

5 = None

6 = Slight

7 = Moderate

8 = Very

9 = Extremely

Circle one number for activity
A) Pain:

1. How much pain do you feel during walking?	0	1	2	3	4
2. How much pain do you feel during stair climbing?	0	1	2	3	4
3. How much pain do you feel during sleeping at night?	0	1	2	3	4
4. How much pain do you feel during resting time?	0	1	2	3	4
5. How much pain do you feel during weight bearing?	0	1	2	3	4

B) Stiffness:

1. How much stiffness do you feel in knee joint in the morning?	0	1	2	3	4
2. How much stiffness do you feel in knee joint later in the day	0	1	2	3	4

C) Physical Function:

1. How much problem do you feel during descending stairs?	0	1	2	3	4

2. How much problem do you feel during ascending stairs?	0	1	2	3	4
3. How much problem do you feel during rising from sitting?	0	1	2	3	4
4. How much problem do you feel during standing?	0	1	2	3	4
5. How much problem do you feel during bending to floor?	0	1	2	3	4
6. How much problem do you feel during walking on flat surface?	0	1	2	3	4
7. How much problem do you feel during getting in/ out of car?	0	1	2	3	4
8. How much problem do you feel during going shopping?	0	1	2	3	4
9. How much problem do you feel during putting on socks?	0	1	2	3	4
10. How much problem do you feel during lying in bed?	0	1	2	3	4
11. How much problem do you feel during taking off socks?	0	1	2	3	4
12. How much problem do you feel during rising from bed?	0	1	2	3	4
13. How much problem do you feel during getting in/ out of bath?	0	1	2	3	4
14. How much problem do you feel during sitting?	0	1	2	3	4
15. How much problem do you feel during getting on/ off toilet?	0	1	2	3	4
16. How much problem do you feel during doing heavy domestic duties?	0	1	2	3	4
17. How much problem do you feel during doing light domestic duties?	0	1	2	3	4

Result of patient after taken treatment _____ /96

Appendix-III

গবেষণার শিরোনাম: হাঁটুর অস্টিওআর্থারাইটিস রোগীদের ব্যথা এবং জয়েন্ট রেঞ্জ অফ মুশন পরিসরে কোয়াড্রিসেপস পেশী এবং ইলিওটিবিয়াল ব্যান্ডের ফিজিও গান রিলিজ বনাম মায়োফেসিয়াল রিলিজের চিকিৎসাবিদ্যাগত কার্যকারিতা

প্রশ্নপত্র (বাংলা)

পার্ট-১: সামাজিক প্রেক্ষাপট সংক্রান্ত তথ্য

কোড নং:

রোগীর আইডি নম্বর:

অংশগ্রহণকারীর নাম:	
বয়স:	
লিঙ্গ:	
ঠিকানা:	গ্রাম/এলাকা: ডাকঘর: থানা: জেলা:
যোগাযোগের নম্বর:	
শিক্ষাগত যোগ্যতা:	
চিকিৎসা শুরুর তারিখ:	
চিকিৎসা শেষ তারিখ:	

চিকিৎসার পূর্ববর্তি তথ্য

পার্ট-২: শারীরিক অক্ষমতা প্রশ্নাবলী

হাঁটুর অস্টিওআর্থারাইটিসে আক্রান্ত রোগীর ব্যথা এবং অক্ষমতা পরিমাপের জন্য এই প্রশ্নপত্রটি "দ্য ওয়েস্টার্ন অন্টারিও এবং ম্যাকমাস্টার ইউনিভার্সিটিজ অস্টিওআর্থারাইটিস ইনডেক্স (WOMAC SCORE)" অনুসারে তৈরি করা হয়েছে

প্রতিটি প্রশ্নের ৪ স্কোর আছে, মোট প্রশ্ন ২৪, মোট নম্বর ৯৬

চিকিৎসার পূর্ববর্তি স্কোর _____/৯৬

নির্দেশাবলী: অনুগ্রহ করে প্রতেক ধরনের কাজকে কাঠিন্য মাপকাঠি অনুযায়ী নির্ধারণ করুন

০ = নাই; ১ = অল্প; ২ = মাঝারি; ৩ = অনেক; ৪ = সর্বাধিক

প্রতিটি কার্যকলাপের জন্য একটি সংখ্যা বৃত্ত

ক) ব্যথা

১. হাঁটার সময় আপনি কতটা ব্যথা অনুভব করেন?	০	১	২	৩	৪
২. সিঁড়িতে ওঠা নামার সময় আপনি কতটা ব্যথা অনুভব করেন?	০	১	২	৩	৪
৩. রাতে ঘুমানোর সময় আপনি কতটা ব্যথা অনুভব করেন?	০	১	২	৩	৪
৪. বিশ্রাম নেওয়ার সময় আপনি কতটা ব্যথা অনুভব করেন?	০	১	২	৩	৪

৫. ওজন বহন করার সময় আপনি কতটা ব্যথা অনুভব করেন?	০	১	২	৩	৪

খ) শক্ত হয়ে যাওয়া

১. দিনের বেলায় আপনার পায়ের মাংসপেশী শক্ত হয়ে যাওয়ার ধরন কেমন হয়?	০	১	২	৩	৪
২. রাতের বেলায় আপনার পায়ের মাংসপেশী শক্ত হয়ে যাওয়ার ধরন কেমন হয়?	০	১	২	৩	৪

গ) শারীরিক কাজ:

১. সিঁড়ি দিয়ে নামার সময় কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
২. সিঁড়ি বেয়ে ওঠার সময় আপনি কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
৩. বসা থেকে ওঠার সময় কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
৪. কিছুক্ষন দাঁড়িয়ে থাকলে আপনি কি ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪

৫. মেঝের দিকে ঝুকলে আপনি কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
৬. সমতল মেঝেতে হাঁটার সময় আপনি কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
৭. গাড়িতে উঠতে বা নামতে আপনি কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
৮. কেনাকাটা করতে গেলে আপনি কি ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
৯. মোজা পরার সময় আপনি কি ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
১০. বিছানায় শুয়ে থাকার সময় আপনি কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
১১. মোজা খোলার সময় আপনি কি ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
১২. শুয়া থেকে ওঠার সময় আপনি কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
১৩. গোসলে যাওয়া/ বের হওয়ার সময় কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
১৪. কিছুক্ষণ বসে থাকলে কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪

১৫. টয়লেট যাওয়া/আসার করার সময় আপনি কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
১৬. ভারী গৃহস্থালীর কাজের সময় (আসবাবপত্র নড়াচড়া) আপনি কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪
১৭. হালকা গৃহস্থালীর কাজের সময় আপনি কী ধরনের সমস্যা অনুভব করেন?	০	১	২	৩	৪

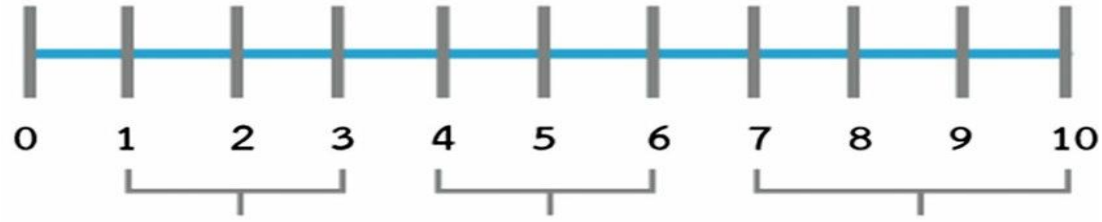
পার্ট-৩: ব্যথার তীব্রতা

আপনার ব্যথা কতটা তীব্র তা দেখানোর জন্য অনুগ্রহ করে নিচের স্কেলটি চিহ্নিত করুন

নির্দেশাবলী:

০ = ব্যথা নেই; ১-৩ = অল্প ব্যথা; ৪-৬ = মাঝারি ব্যথা; ৭-১০ = তীব্র ব্যথা

আপনার ব্যথা এখন কতটা তীব্র?



ব্যথা নেই অল্প ব্যথা মাঝারি ব্যথা তীব্র ব্যথা

পার্ট-৪: হাটুর জয়েন্ট রেঞ্জ অফ মুশন নির্ধারণ

প্রশ্নাবলীর এই অংশটি হাঁটুর জয়েন্ট রেঞ্জ অফ মুশন নির্ধারণ করার জন্য

পরিমাপক যন্ত্র হিসেবে গনিওমিটার ব্যবহার করা হয়

নির্দেশাবলী:

0 = স্বাভাবিক; ১= অল্প হ্রাস পেয়েছে; ২ = মাঝারি অল্প হ্রাস পেয়েছে; ৩ = অনেকখানী অল্প হ্রাস পেয়েছে

নড়াচড়া	**জয়েন্ট রেঞ্জ অফ মুশনের পরিসীমা**
হাঁটু সংকোচন (সক্রিয়)	
হাঁটু প্রসারণ (সক্রিয়)	
হাঁটু সংকোচন (পরোক্ষ)	
হাঁটু প্রসারণ (পরোক্ষ)	

Appendix-IV

Permission Letter

Date: 31 October, 2022

To
Head of Physiotherapy Department,
Centre for the Rehabilitation of the Paralysed (CRP),
CRP-Chapain, Savar, Dhaka-1343.
Through: Head of the Department of Physiotherapy, BHPI.

Subject: Prayer for seeking permission to collect data for conducting research project.

Dear Sir,

With due respect and humble submission to state that I am Rabeya Rokshana Roli, student of M.Sc. in Physiotherapy (Part-II) at Bangladesh Health Professions Institute (BHPI). The Ethical committee has approved my research project entitled: **"Effectiveness of Multi-angle Isometrics Exercise on Quadriceps Strength and Functional Status for Patients with Knee Osteoarthritis."** under the supervision of Prof. Dr. Md. Sohrab Hossain (PhD), Professor, Department of Physiotherapy, BHPI & Executive Director (ED), Centre for the Rehabilitation of the Paralysed (CRP). I want to collect data for my research project from the outpatient department, Musculoskeletal Unit, Department of Physiotherapy at CRP. So, I need permission for data collection from the honorable Head, Department of Physiotherapy, CRP, Savar. I would like to assure that anything of the study will not be harmful for the participants.

I, therefore pray and hope that your honor would be kind enough to grant my application and give me permission for data collection and oblige thereby.

Yours Obediently,

Rabeya Rokshana Roli
M.Sc. in Physiotherapy (Part-II)
Reg. No: 3467
Session: 2020-21
Bangladesh Health Professions Institute (BHPI)
CRP-Chapain, Savar, Dhaka-1343.

Forwarded & Recommended
Shofiq
31.10.2022

Head of PT
For necessary support.
Approved,

Approved
31/10/22

Appendix-V

বাংলাদেশ হেল্‌থ প্রফেশন্স ইনস্টিটিউট (বিএইচপিআই)
Bangladesh Health Professions Institute (BHPI)
(The Academic Institute of CRP)

Ref: CRP/BHPI/IRB/10/2022/667

Date: 25/10/2022

To
Rabeya Rokshana Roli
M. Sc. in Physiotherapy
Session: 2020-2021, Reg. No.: 3467
BHPI, CRP, Savar, Dhaka 1343, Bangladesh

Subject: Approval of the thesis proposal **"Effectiveness of Multi Angle Isometric Exercise on Quadriceps Strength for Patients with Knee Osteoarthritis."** by ethics committee.

Dear Rabeya Rokshana Roli,

Congratulations.
The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application to conduct the above-mentioned dissertation, with yourself, as the principal investigator. The Following documents have been reviewed and approved:

Sr. No.	Name of the Documents
1	Dissertation Proposal
2	Consent form
3	Research questionnaire

The Purpose of the study is to illustrate the effectiveness of multi angle isometric exercise on quadriceps strength for knee osteoarthritis patients. Should there any interpretation, type, spelling and grammatical mistake in the title, it is the responsibility of investigator. Since the study involve questionnaire that may take 25 to 30 minutes and have no likelihood of any harm to the participants. Data collector will receive informed consents from all participants; the members of the Ethics committee approved the study to be conducted in the presented form at the 33rd meeting held at 09.00 AM on 24th September 2022 at BHPI.

The institutional Ethics committee expects to be informed about the progress of the study, any changes occurring during the study, any revision in the protocol and patient information or informed consent and ask to be provided a copy of the final report. This Ethics committee is working accordance to Nuremberg Code 1947, World Medical Association Declaration of Helsinki, 1964 - 2013 and other applicable regulation.

Best regards,

Muhammad Millat Hossain
Associate Professor, Dept. of Rehabilitation Science
Member Secretary, Institutional Review Board (IRB)
BHPI, CRP, Savar, Dhaka-1343, Bangladesh
The Chairman,

CRP-Chapain, Savar, Dhaka-1343, Tel : 7745464-5, 7741404
E-mail : principal-bhpi@crp-bangladesh.org, Web: bhpi.edu.bd, www.crp-bangladesh.org