Comparison of eccentric versus concentric strengthening exercise of hamstring muscles along with conventional physiotherapy for the patients with knee osteoarthritis

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We the undersigned certify that we have carefully read and recommended to the Faculty of Medicine, University of Dhaka, for the acceptance of this dissertation entitled

COMPARISON OF ECCENTRIC VERSUS CONCETRIC STRENGTHENING EXERCISE OF HAMSTRING MUSCLES ALONG WITH CONVENTIONAL PHYSIOTHERAPY FOR THE PATIENTS WITH KNEE OSTEOARTHRITIS

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DECLARATION

I declare that the work presented here is my own. All sources used have been cited appropriately. Any mistakes or inaccuracies are my own. I also decline that same any publication, presentation or dissemination of information of the study. I would bind to take consent from the department of Physiotherapy of Bangladesh Health Profession Institute (BHPI).

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Acronyms

&	And
CRP	Centre for the rehabilitation of the paralyzed
OA	Osteoarthritis
NPRS	Numeric pain rating scale
WOMAC	Western Ontario and McMaster University Osteoarthritis Index
NSAIDs	Non-steroidal anti-inflammatory drugs
TB	Tuberculosis
MRI	Magnetic resonance imaging
ROM	Range of motion
H: Q	Hamstring: Quadriceps

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Abstract

Purpose: To find out the effectiveness of eccentric strengthening and concentric strengthening of hamstring muscles along with conventional physiotherapy for the patients with knee osteoarthritis. **Objectives**: To assess the effect on pain and disability of knee osteoarthritis patients after applying eccentric versus concentric strengthening exercise of hamstring muscles along with conventional physiotherapy. **Methodology:** The study was a quantitative clinical trial. 60 patients were allocated based on inclusion and exclusion criteria. The age range was 32- 75 years old. They received 6 sessions of treatment for 3 weeks. Numeric pain rating scale (NPRS) & WOMAC were used in the study to see the effectiveness in the pretest and posttest values of pain and disability. **Results:** Among 60 participants with knee OA in this study, 30 participants received eccentric strengthening exercise of hamstring muscles and 30 participants received concentric strengthening exercise of hamstring muscles along with conventional physiotherapy. Each participant of both experimental and control group scored on Numeric Pain Rating Scale (NPRS) and WOMAC before and after completion of treatment. Wilcoxon Signed ranked test applied to the post-test pain score of the participants in both groups were revealed a statistically significant difference at the level of $P= 0.000$ ($P< 0.05$). Following application of treatment, the study found that the eccentric strengthening group showed a significant improvement ($p<0.05$) in some cases than the concentric strengthening group. The eccentric strengthening of hamstring muscles along with conventional physiotherapy showed better improvement than concentric strengthening of hamstring muscles along with conventional physiotherapy for the patients with knee osteoarthritis. Though both groups were effective in posttest values and their P values were significant ($P< 0.05$). The eccentric group showed more significance in 6 more points among 24 points of WOMAC index. **Conclusion:** The quantitative clinical trial showed that eccentric strengthening of hamstring muscles along with conventional physiotherapy were more effective than concentric strengthening on hamstring muscles along with conventional physiotherapy for the patients with knee osteoarthritis.

Key words: Osteoarthritis, knee OA, eccentric strengthening, concentric strengthening.

CHAPTER-I INTRODUCTION

1.1 Background

Osteoarthritis is one of the most common arthritic conditions treated medically around the world. Osteoarthritis affects about 3532 persons per 100,000 in the United States (Guermazi et al., 2012). Osteoarthritis is a form of joint disease caused by the deterioration of joint cartilage and bone beneath it (Cyrus et al., 2014). Osteoarthritis is a prominent cause of disability, affecting 10% of men and 20% of women over the age of 60, and one-fifth of people with osteoarthritis have depression and anxiety symptoms (Stubbs et al., 2016). According to Hafez et al., (2013), osteoarthritis (OA) is a serious public health problem that causes functional impairment and lowers quality of life (QOL) around the world, as documented by the World Health Organization. Osteoarthritis causes a variety of physical, psychological, and socioeconomic difficulties. Knee osteoarthritis causes significant disability, such as decreased ambulatory function and daily living tasks. Osteoarthritis typically affects the knee joint, and it is believed that 10% of adults over the age of 60 have knee osteoarthritis symptoms, resulting in significant pain and physical disability (Chang et al., 2016).

In the United States, OA is one of the most frequent joint ailments. Because of population aging and obesity, the prevalence of OA is expected to rise. It was formerly thought to be a "wear-and-tear" of articular cartilage condition caused only by aging and unrelated to inflammation (Stubbs et al., 2016).

Osteoarthritis affects 12% of the population between the ages of 25 and 74 years. We discovered radiological evidence of osteoarthritis in the minor joint of the hand in more than 80% of the population over the age of 70. Radiographic osteoarthritis of the knees affects roughly 34% of the population over 45 years old in the United Kingdom, while radiographic osteoarthritis of the hips affects 19% of the people over 55 years old. Knees with osteoarthritis, up to two-thirds of which experience symptoms of the disease (Baar et al., 2008). A joint loses cartilage in knee osteoarthritis, and the bone grows to try to repair the damage. Instead of making things better, the bone grows unnaturally, aggravating and exacerbating the individual's agony. For example, the bone can become deformed or abrasive, causing pain and instability in the joint (Fransen & McConnell, 2015). According to the Framingham Osteoarthritis Study, 10% of participants aged 63

and up experienced clinical knee osteoarthritis in addition to radiographic abnormalities (Fransen & McConnell, 2008). Women, older persons, and those who are obese or have a history of knee injuries have a moderate to considerably elevated risk of knee complaints and radiographic and symptomatic osteoarthritis, according to many osteoarthritis incidences studies (Murphy et al., 2015).

Knee osteoarthritis (OA) is the most common cause of pain and impairment in the elderly (Wylde et al., 2016). Though the pathogenesis of the illness is still unknown and under investigation, it is known that knee OA is complex in nature. Various non-modifiable and modifiable risk factors for the development of knee OA are discussed. According to Linn et al. 2012, women over 50 have a higher rate of osteoarthritis than men of the same age group. Although numerous theories have been offered, there is some evidence that sex hormones have a role in osteoarthritis development. Both diabetic mellitus (DM) and osteoarthritis ensure their mutual coexistence to increase the project, according to King et al., 2015.

According to Glyn-Jones et al., 2015, osteoarthritis is one of the leading causes of pain, disability, and socioeconomic burden in the world. Knee OA primarily affects the three compartments of the knee joint (medial, lateral, and patellofemoral joint), and it usually develops slowly over a period of 10 to 15 years, interfering with daily activities and performance.

Nonmodifiable risk factors include hereditary (genetic mutations that may predispose an individual to the development of OA of the knee) and congenital (risk factors that cannot be modified) (inherited abnormalities in the shape of the bones of the knee joint). Modifiable risk factors are those that can be targeted for treatment and so modified or altered (for example, obesity), as well as being adjustable (Lespasio et al., 2017). Obesity is typically a substantial risk factor for incident knee OA, according to Muraki et al 2013, due to probable sources of mechanical stress over the knee joint.

The primary cause of OA including age, obesity, genetics, occupation as well as prolonged standing, sports, multiple metabolic disorders (Conaghan et al., 2008). Another study shows the factors that are responsible for primary osteoarthritis are crystals presents in joint fluid or cartilage, very high bone mineral density, any trauma to the joint, peripheral neuropathy and joint hyper mobility can also be responsible (Mounach et al., 2008). The causes of secondary osteoarthritis of the knee are valgus and varus deformities of the knee, Rheumatoid arthritis, infection, TB, hyperparathyroidism, overuse of intra articular steroid therapy (Conaghan et al., 2008).

Obesity is often a substantial risk factor for incident knee OA, according to Muraki et al 2013, due to probable causes of mechanical stress over the knee joint. Because males have stronger muscle strength than women, participation of muscle strength may compensate for the mechanical stress on the joint, lowering the chance of disease incidence in men.

Knee osteoarthritis is one of the most frequent debilitating diseases in Bangladesh, affecting both adult males and females (Connor, 2007). In Bangladesh, osteoarthritis affects specific joints more than others in certain ethnic groups. In this country, the prevalence of osteoarthritis among ethnic groups is on the rise. Approximately 89.6% of participants did not have osteoarthritis, while 10.4% were identified as having osteoarthritis. Chakma, Marma, Tripura, and Tanchyanga accounted for 72.7 percent, 15.1 percent, 6.5 percent, and 5.7 percent of the participants, respectively (Islam et al., 2016).

Another study found that female gender is also a strong risk factor for knee OA, possibly because of muscular strength compensating for mechanical stress. Because males have stronger muscle strength than women, participation of muscle strength may compensate for the mechanical stress on the joint, lowering the chance of disease incidence in men. Knee osteoarthritis is one of the most frequent debilitating diseases in Bangladesh, affecting both adult males and females (Connor, 2007).

Pain is the most common symptom of osteoarthritis (Conaghan et al., 2008). The majority of OA knee pain is restricted to the anterior or medial portions of the knee and the upper tibia (Robert & Petrella, 2010). Swelling might be intermittent (effusion) or continuous (large osteophytes or capsular thickening) (Lawrence et al., 2008). After a period of rest, stiffness develops, which gradually dissipates with movement (Veerapan et al., 2007). Soft tissue compliance is reduced because of degenerative changes and subsequent inflammatory processes. Additionally, as the subchondral microfractures heal, callus forms, resulting in a loss of joint motion and stiffness. Patients generally limit their activities due to joint pain, stiffness, and potential effusion, resulting in a loss of end-of-range movement (Chapple et al., 2011). Tenderness and coarse crepitus can be elicited with minimal effort (Conaghan et al., 2008). In severe disease, crepitus can progress from modest cracking to loud noises. As a result of effusions, loss of proprioception, ligamentous control, and negative pressure inside the joint all contribute to joint instability in OA (Veerapan et al., 2007). Going up and down stairs

usually makes patella-femoral pain worse. Due to increased pressure in the subchondral bone, discomfort becomes worse at night and during rest (Robert & Petrella, 2010).

People with knee osteoarthritis (OA) seek medical help for a variety of reasons, but the causes of pain are complex, and radiographs, which are the gold standard for clinical imaging in OA, are frequently out of sync with symptoms. Many consider synovial alterations in OA to be a subsequent response to cartilage degradation, but others argue that they are a key driver of OA and may be partially responsible for pain and disease progression (Hall et al., 2014). The doctor will look for any signs and symptoms that are usually related with osteoarthritis during the physical examination. The doctor will search for swelling in the joints and discomfort in the joints. Joint range of motion is reduced, and obvious joint deterioration is seen (i.e., bony growths). X-rays are commonly utilized in imaging tests to confirm the diagnosis of osteoarthritis. Osteophytes at the joint borders, joint space constriction, and subchondral bone sclerosis can all be shown on X-rays. The layer of bone right beneath the cartilage is known as subchondral bone. While MRI (magnetic resonance imaging) is a more sensitive imaging technique, it is less common (Silverwood et al., 2015).

Chronic muscular inhibition is frequently associated to chronic pain, and it leads to muscle atrophy and weakening (Chapple et al., 2011). The quadriceps muscle, which is responsible for knee extension, is particularly weak and withering (Robert &Petrella, 2010). Muscle atrophy can make a joint appear larger (Veerapan et al., 2007).

Aerobic exercise of adequate intensity (e.g., walking, cycling) stimulates muscle oxidative enzymes and capillarization, resulting in increased peak oxygen consumption. Increased oxygen intake has an inverse relationship with morbidity and death, makes every submaximal daily work simpler (in terms of effort). As a result, increasing fitness may improve quality of life by allowing a wider range of everyday tasks to be performed, therefore enhancing physical function (Fransen et al., 2015).

Physiotherapy's main goals are to educate the patient, care givers, and relatives, to relieve symptoms including pain and stiffness, and to preserve joint motion and function by slowing disease progression (Reijman et al., 2007), Strengthen weak muscles around the arthritis joint, promote proper function, and reduce disability (Kornaat et al., 2006). Individuals with a range of diseases, such as post-operative rehab and knee osteoarthritis, may benefit from patella mobilizations (Michael et al., 2010). Knee mobilizations have been utilized to treat knee disease in several studies. To

prevent patellar tendon adhesion and increase patellofemoral joint reactivity, patella mobilization is essential (Hurst et al., 2010)

Strengthening, cardio, flexibility, and skills/balance are the four physical performance areas that most exercise therapies for OA fall under. The health advantages are, in theory, specific to the type of exercise. Strengthening primarily improves local muscle function and proprioception to improve joint stability and local biomechanical functioning, whereas aerobic activity to improve cardiorespiratory fitness can improve sleep and well-being and reduce, whereas strengthening primarily improves local muscle function and proprioception to improve joint stability and local biomechanical functioning. However, because both types of exercise have been shown to relieve pain and enhance function, they are both recommended in the most recent guidelines. Range of motion (ROM) exercise, in addition to strengthening and aerobic exercises, is thought to be effective in improving symptoms and function. This is especially effective when the periarticular soft tissue's functional and structural characteristics have been damaged due to acute knee swelling or extended joint immobilization. Other forms of exercise that include mind and body components, such as Tai Chi and Yoga, are gaining popularity due to their ability to improve symptoms and function. It's likely that they could have additional benefits in persons with OA, such as reducing central sensitization and modulating the inflammatory response (Goh et al., 2016).

According to 2010 World Health Organization research, Physical activity is "any movement produced by skeletal muscle that involves energy expenditure. An "exercise program" is defined as a planned, scheduled, and repeated physical activity over a period of time (Bouchard and colleagues, 2007). For persons with knee OA, international recommendations recommend a variety of nonpharmacological therapy, including exercise, as the first line of treatment (Fransen et al., 2015).

Knee extensor muscle weakness has been observed in people with osteoarthritis. Knee extensor muscle weakness has been identified as a risk factor for knee osteoarthritis, particularly in women, according to individual research (Iestad et al., 2014). Both the hamstring and quadriceps muscles are damaged together in knee osteoarthritis. The hamstring muscle is more impacted in both of them. For obvious reasons, hamstring strengthening exercise is included with quadriceps strengthening exercise in the physiotherapy management of knee osteoarthritis. The hamstring muscle is more affected by OA knee than the quadriceps muscle. (Adegoke and colleagues, 2007).

1.2 Rationale

Osteoarthritis (OA) is a clinical term for a group of degenerative disorders characterized by increasing articular cartilage deterioration, subchondral bone remodeling, and a restricted synovitis. The condition is referred to as an illness or as part of an age-related transformation process. It affects twice as many women as it does males, and its prevalence rises with age, with a sharp increase after 60 years. Daily functional tasks become increasingly challenging for people with progressing symptomatic knee OA. Knee OA, in fact, causes greater handicap in non-institutionalized adults aged 50 and over in terms of walking, stair climbing, and housekeeping than any other condition. The majority of the current evidence indicates that there is no effective treatment for osteoarthritis, and that recommended drugs provide little help to those with the illness. In the Centre for the Rehabilitation of the Paralyzed (CRP) of Musculoskeletal Unit, Savar, Dhaka, there are many common treatment programs for knee joint osteoarthritis, such as soft tissue mobilization technique, patellar mobilization, active free range of motion, knee gaping, Ice, UST, IRR, and so on.

Muscle weakness in the lower limbs, particularly in the quadriceps and hamstrings, is linked to femorotibial knee osteoarthritis, which leads to disease development. The hamstring muscle is more impacted than the quadriceps muscle, according to studies. When walking, especially downhill, the functional impairment caused by knee osteoarthritis presents itself most when the muscles are called upon to contract eccentrically. Many writers argue that eccentric muscle contraction is more effective than concentric muscle contraction because extending contraction is better than shortening contraction, and residual muscular exhaustion occurs after 6 seconds in eccentric contraction against 5 seconds in concentric contraction. As a result, the force exerted during eccentric contraction is greater than that exerted during concentric contraction.

Research shows that significant improvement and reduce pain and increased joint range of motion of the knee joint by strengthening exercise of knee joint muscles. (Minoonejad., 2010)

The aim of the study was to find out the effectiveness between eccentric strengthening exercise and concentric strengthening exercise of hamstring muscles along with conventional physiotherapy given worldwide among the patients with knee OA.

So, the purpose of this study is to compare between effectiveness between eccentric strengthening exercise and concentric strengthening exercise of hamstring muscles along with conventional physiotherapy and to find out which is the important intervention for this condition.

1.3 Aim

The aim of this study to compare the effectiveness between eccentric strengthening exercise of hamstring muscles and concentric strengthening exercise of hamstring muscles along with conventional physiotherapy.

1.4 Objectives

- To find out the effectiveness of eccentric versus concentric strengthening exercise of hamstring muscles along with conventional physiotherapy for the patients with knee osteoarthritis.
- To find out the socio-demographic factors affect the level of pain and functionaldisability within and between groups
- To measure pain level before and after introducing eccentric versus concentricstrengthening exercise of hamstring muscles.
- To check the strength and integrity of the muscles.
- To measure the joint range of motion.
- To compare functional disability before and after introducing eccentric versus concentricstrengthening exercise of hamstring muscles for the patients with knee osteoarthritis.

1.5 Hypothesis

Null Hypothesis

Ho:1-μ2 = 0 or μ1 ≥μ2, where the experimental group and control group mean difference is not same or control group is higher than experimental group.

Alternative Hypothesis

Ha: μ1-μ2 ≠ 0 or μ1 ≠μ2 where the experimental group and control group mean difference is not same.

Where,

Ho= Null hypothesis

Ha = Alternative hypothesis

μ1 = Mean difference in initial assessment

μ2 = Mean difference in final assessment

1.6 Operational definition

Knee Osteoarthritis: Knee Osteoarthritis is a degenerative joint disease characterized by pain atknee which is the barrier to do daily activities properly, decreased joint range of motion, difficulty to perform activity daily life (ADL).

Functional disability: Functional disability or diversity is a politically and socially correct termfor special needs, disability, impairment and handicap, which began to be used in Spain in scientific writing, at the initiative of those directly affected, in 2005. A functional disability limits a person's ability to perform physical activities, have a significant sensory impairment, need long-term care, use assistive devices, technology or exercises.

Conventional Physiotherapy

Physiotherapy interventions that are widely accepted and practiced by the mainstream medical community are called Conventional Physiotherapy.

Eccentric contraction: Eccentric movement is when the muscle lengthens while producingforce. The amount of force exerted by muscle is lower than the external force.

Concentric contraction: Concentric movement is when the muscle shortens while producing force (contracting themuscle). The amount of force exerted by muscles is greater than the external force.

CHAPTER – II LITERATURE REVIEW

Osteoarthritis (OA) of the knee is the most common cause of pain and impairment in the elderly (Wylde et al., 2016). When cartilage is lost in the knee, the bone develops to try to heal the injury. However, instead of making things better, the bone develops unnaturally and exacerbates the problem. 2008 (Fransen & McConnell). Osteoarthritis (OA) is a type of joint disease that results from breakdown of joint cartilage and underlying bone (Cyrus et al., 2014). According to Glyn-Jones et al. 2015, osteoarthritis is a major source of pain, disability, and socioeconomic burden throughout the world. The disorder's epidemiology is multifaceted and complicated, including genetic, biochemical, and biomechanical components. Joint-specific etiological variables are also present. Although joint replacement is an effective therapy for symptomatic end-stage arthritis, functional results can be poor, and prostheses have a limited lifetime. As a result, the focus is turning to disease prevention and early osteoarthritis therapy. Joint space narrowing due to articular cartilage degradation and disappearance, sharpness of articular edges and intra-articular structures e.g., tibial tubercules, bony sclerosis, osteophytes, and marginal lapping, and bony cysts are the most common alterations in knee OA (Brandt., 2001).

The genesis of OA is multifactorial, and it may be thought of as the result of a complex interaction between systemic and local variables. Age, female gender, obesity, knee injury, repetitive usage of joints, bone density, muscle weakness, and joint laxity all have a role in the development of joint osteoarthritis, especially in weight-bearing joints. Modifying these variables may help to lower the chance of osteoarthritis and the pain and impairment that comes with it (Yuqing., 2010).

According to Berenbaum 2013, osteoarthritis (OA) has long been thought to be a wear and tear disease that results in cartilage loss. OA was once thought to be the primary result of any procedure that resulted in increasing strain on a single joint or cartilage matrix instability. The patello-femoral and medial tibiofemoral compartments of the knee are the most commonly affected by OA (Robert & Petrella, 2010). Pain is the most common symptom of osteoarthritis (Conaghan et al., 2008). The majority of OA knee pain is restricted to the anterior or medial portions of the knee and the upper tibia (Robert & Petrella, 2010). Going up and down stairs generally makes patella-femoral discomfort worse. Due to increased pressure in the subchondral bone, discomfort

becomes greater at night and during rest (Robert & Petrella, 2010). The production of osteophytes at the joint borders, joint space narrowing, sub-chondral sclerosis, sub-chondral cyst formation, and chondrocalcinosis are the most common radiographic findings. It is expected that 40 percent to 80 percent of persons who have radiographic abnormalities will have symptoms. Symptomatic knee OA is common among elderly individuals globally (10% to 30%), especially in rural areas with high occupational physical demands. (Busija and colleagues, 2010)

According to the Framingham Osteoarthritis Study, 10% of participants over the age of 63 had symptomatic knee osteoarthritis with radiographic abnormalities (Fransen & McConnell, 2008). Women, older persons, and those who are obese or have a history of a knee injury have a moderate to considerably elevated risk of knee complaints, as well as radiographic and symptomatic osteoarthritis, according to osteoarthritis incidence research (Murphy et al., 2015). Chronic OA of the lower limb joints eventually leads to a loss of physical fitness, which increases the risk of cardiometabolic co-morbidity and early death (Hochberg., 2008). Osteoarthritis is the most prevalent kind of arthritis, which is a degenerative joint illness marked by cartilage loss over time (OA). In the United States, OA of the knee affects 28% of persons over the age of 45 and 37% of adults over the age of 65 (Lawrence et al., 2008).

Deep, agonizing pain is described by those with symptomatic OA of the knee. Pain is intermittent in early disease and is most typically related with joint usage. Symptomatic illness worsens in many patients, and pain becomes more chronic and might occur at rest and at night. When movement is resumed after a period of rest, the joint feels ‘stiff,' resulting in normal discomfort and difficulties. Crepitus or deep 'creaking' noises on movement are common in those with severe illness, as is a limited range of joint action. Daily functional tasks become increasingly challenging for people with progressing symptomatic knee OA. In fact, among non-institutionalized adults 50 years and older, knee OA is more responsible than any other condition for difficulty in walking, stair climbing, and housework (Davis., 2011). In severe illness, crepitus can progress from modest cracking to loud noises. As a result of effusions, loss of proprioception, ligamentous control, and negative pressure inside the joint all contribute to joint instability in OA (Veerapan et al., 2007).

Although the exact origin of OA is unknown (Mounach et al., 2008). Age, obesity, heredity, employment as well as extended standing, sports, and numerous metabolic diseases are thought to be the key causes (Conaghan et al., 2008). Secondary

osteoarthritis of the knee can be caused by valgus and varus deformities of the knee, Rheumatoid arthritis, infection, TB, hyperparathyroidism, and extensive intra-articular steroid therapy (Conaghan et al., 2008). According to Mohig et al., "The best therapy for knee osteoarthritis is prevention". When the patient's symptoms match the physical and radiological results and all other options have been tried, surgery is recommended. Especially weakness and wasting of the quadriceps muscle which is responsible for the knee extension (Robert & Petrella, 2010). Chronic oedema of synovial membrane and capsule makes the joint appear large. Muscle atrophy may also make the joint look bigger (Veerapan et al., 2007). The pain associated with OA is frequently triggered by physical exertion. Climbing stairs, getting out of a chair, and walking long distances are all painful for those with OA of the knee. The stiffness in the morning normally lasts less than 30 minutes (Zhang & Jordan, 2010). In fact, among non-institutionalized adults 50 years and older, knee OA is more responsible than any other condition for difficulty in walking, stair climbing, and housework (Lane et al., 2011).

The diagnosis of osteoarthritis is based on two main objectives. When diagnosing osteoarthritis, the doctor must first distinguish it from other kinds of arthritis. It's also crucial to figure out whether a patient has primary osteoarthritis or osteoarthritis that's caused by another disease or condition. Osteoarthritis must be diagnosed early and accurately to evaluate relevant treatment choices. The doctor will use the following tools to diagnose osteoarthritis: Past medical problems, allergies, treatments, and surgical operations, as well as current medical difficulties, will be included in the medical history (Vincent et al., 2012).

The doctor will look for any signs and symptoms that are usually related with osteoarthritis during the physical examination. The doctor will search for swelling in the joints and discomfort in the joints. Joint range of motion is reduced, and obvious joint deterioration is seen (i.e., bony growths). X-rays are commonly utilized in imaging tests to confirm the diagnosis of osteoarthritis. Osteophytes at the joint borders, joint space constriction, and subchondral bone sclerosis can all be shown on X-rays. The layer of bone right under the cartilage is known as subchondral bone. While MRI (magnetic resonance imaging) is a more sensitive imaging technique, it is less common (Silverwood et al., 2015). Muscle atrophy and weakening are common side effects of persistent muscular inhibition, which is linked to chronic pain (Chapple et al., 2011). The prevention of joint injuries would result in a 14–25% decrease in the prevalence of osteoarthritis (Takeda et al., 2011).

Most patients with osteoarthritis are handled in primary care, and the prevalence of knee osteoarthritis is high enough that modest community-based therapies are required (Andre et al., 2008). The goal of treatment is to reduce discomfort while maintaining function. The role of various types of exercise treatment in osteoarthritis is gaining popularity (O'Reilly et al., 2016). There is currently no cure for osteoarthritis. Disease-related characteristics, such as diminished muscular function and fitness, can, nevertheless, be improved by exercise. For patients with osteoarthritis, international recommendations recommend a variety of non-pharmacological therapies, including exercise, as the first line of therapy (Fransen & McConnell, 2008).

Several scientific organizations have released recommendations and guidelines for the treatment of osteoarthritis. However, most of them are generated by national organizations or are limited to the use of certain therapies, such as physical therapy or specific pharmacological classes in many cases. Many OA management recommendations across organizations, controversies persist, and they are related to the use of some non-pharmacological interventions (e.g. acupuncture, knee braces, heel wedges) and, within pharmacological treatments, the pharmacological class of symptomatic slow-acting drugs in osteoarthritis (SYSADOAs), which is primarily represented by glucosamine sulfate and chondrocyte growth factor. (Reginster et al., 2015).

Clinical trials in OA suffer from a large placebo effect, and most pharmacological treatments are shown to have a mild-to-moderate effect over oral placebo. Intra-articular hyaluronic acid emerged as the most effective treatment for knee OA pain, with an effect size in the mild-to-moderate range over oral placebo (Rieger, 2008).

There is sufficient evidence to support the use of a variety of physiotherapy techniques in the treatment of osteoarthritis of the knee joint (Arshad et al., 2015). The treatment of OA is determined by the number of joints involved, the stage of the disease, the severity of the symptoms, the patient's age, and his or her functional requirements (Lawrence et al., 2008).

According to Lyons 2017, open kinetic chain workouts improve function and decrease discomfort. Previous research has shown that these sorts of exercises isolate the quadriceps muscle, allowing it to be flexed safely and strengthened. With an exercise programed, pain is reduced, and functional capacity is improved, which is consistent across all pain measurements (O'Reilly et al., 2016). In terms of decreased knee pain, high-quality research suggests that therapeutic-based exercise gives a short-term effect

that lasts for at least two to six months after formal therapy is stopped. Another limitation identified by patients with knee OA is a lack of physical fitness. Increasing muscle oxidative capability increases physiological reserve for aerobic capacity. Increased oxygen intake has an inverse relationship with morbidity and death and makes every submaximal daily work simpler (in terms of effort). As a result, increasing fitness may improve quality of life by allowing a wider variety of everyday chores to be performed, therefore enhancing physical function (Fransen et al., 2015).

Physiotherapy's main goals are to educate the patient, care givers, and relatives, to relieve symptoms including pain and stiffness, and to preserve joint mobility and function by slowing disease progression (Reijman et al., 2007), Strengthen weak muscles around the arthritic joint, promote proper function, and reduce disability (Kornaat et al., 2006). The disuse atrophy of the quadriceps femoris muscle that accompanies knee joint discomfort demonstrates the importance of muscle in the formation and function of joints. The American Academy of Orthopedic Surgeons has identified quadriceps muscle weakness as a risk factor for structural injury to the knee joint. Muscle weakening impairs the anteroposterior stability of the knee joint, making patients feel unstable. This leads to a loss of personal confidence, as well as diminished performance and independence in everyday tasks, resulting in impairment and dysfunction in knee OA patients (2007, Adegoge et al.). According to Joshua et al. (2016), prescribing resistance training (RT) activities is an important part of managing knee osteoarthritis (OA).

Strengthening, cardio, flexibility, and skills/balance are the four physical performance areas that most exercise therapies for OA fall under. To increase joint stability and local biomechanical functioning, strengthening mostly improves local muscle function and proprioception. However, because both types of exercise have been shown to relieve pain and enhance function, they are both recommended in the most recent guidelines (Goh et al., 2016). Research by Potts et al. 2013 found recent findings that were compatible with the use of exercise and mobilization in particular. Furthermore, the Osteoarthritis Research Society International (OARSI) guidelines urge that patients be referred to physiotherapy, as well as patient education and self-management, cardiovascular and muscle strengthening activities, thermal modalities, and acupuncture.

Muscle weakness in the lower limbs, particularly in the quadriceps, is linked to knee osteoarthritis, which leads to disease development. Muscle strengthening as part of the therapeutic arsenal for the medical treatment of knee osteoarthritis is becoming increasingly popular. The eccentric contraction of the quadriceps muscles appears to play a key role in walking and other daily activities, providing regulation of knee bending (cushioning) and active joint stability. In terms of functional improvement in knee osteoarthritis, regimens for isokinetic muscle training in mixed concentric-eccentric mode have demonstrated superior outcomes than concentric mode alone (Anne et al., 2014). Although eccentric exercise may be more beneficial than splinting or other physical treatments in treating tendinosis, it was no more successful than any other treatment during a competitive sports season (Wasielewski., 2007). According to Dewey et al. 2008, therapies such as physiotherapy functional exercises after discharge from the hospital result in a short-term improvement following primary Total Knee Arthroplasty. Small to moderate effect sizes were seen, with no long-term benefit.

The hamstring muscle is more affected by knee OA than the quadriceps muscle. As a result, physiotherapists who have previously concentrated on strengthening the quadriceps muscle in knee OA patients must now incorporate hamstring strengthening into their treatment plans. The quadriceps to hamstring muscle strength ratio is critical for knee stability and protection against excessive load (Hafez et al., 2013).

Until recently, the H: Q ratio was determined by the concentric strength of these two muscle groups. Co-activation of various muscle groups has been seen, and it occurs via opposing contraction patterns. The quadriceps contract concentrically whereas the hamstrings contract eccentrically during leg extension. During leg flexion, however, the hamstrings contract concentrically and the quadriceps eccentrically (Coombs and colleagues, 2002). Various researchers have measured and reported on the strength connection between the quadriceps femoris and hamstring muscles. The quadriceps to hamstring muscle strength ratio is vital for knee stability and protection from excessive stress. For ostensibly healthy persons, the isotonic Q:H ratio is 3:2, although it is known that this ratio is lower in OA patients. (Adegoge et al., 2007) It has been shown that strengthening the hamstring muscle improves the functional capacity of a defective knee. This is likely because an increase in total hamstring and quadriceps strength, as well as an increase in the H:Q ratio, may reduce anterior-lateral tibia subluxation (P. Kannus, 1998.).

Despite the quadriceps involvement in the stability of the knee joint, only the hamstring muscles in the sample analyzed showed an inverse relationship between IL-6 plasma concentrations and muscular resistance. Because hamstring muscles govern knee flexion and hip extension, balance the head, arms, and torso over the legs, and maintain stability during mobility tasks, hamstring strength is more important than quadriceps strength in functional activities (Maly et al., 2006). The decrease in H/Q balance found might be attributable to a more pronounced fall in hamstring muscle torque in comparison to quadriceps torque. (Croce et al., 1996). The capacity of these muscles to protect the joint from mechanical overload is reduced when knee extensor and flexor strength is reduced (Teixeira and Olney, 1995). Both the hamstring and quadriceps muscles are strengthened, and muscular resistance is increased in an attempt to reestablish or enhance muscular balance, lessening the impact of OA on the older person's functioning (Slemenda et al., 1998).

CHAPTER – III METHODOLOGY

This research was clinical trial of this quantitative research design to evaluate the effectiveness of eccentric versus concentric exercises of hamstring muscles in patients with knee joint osteoarthritis.

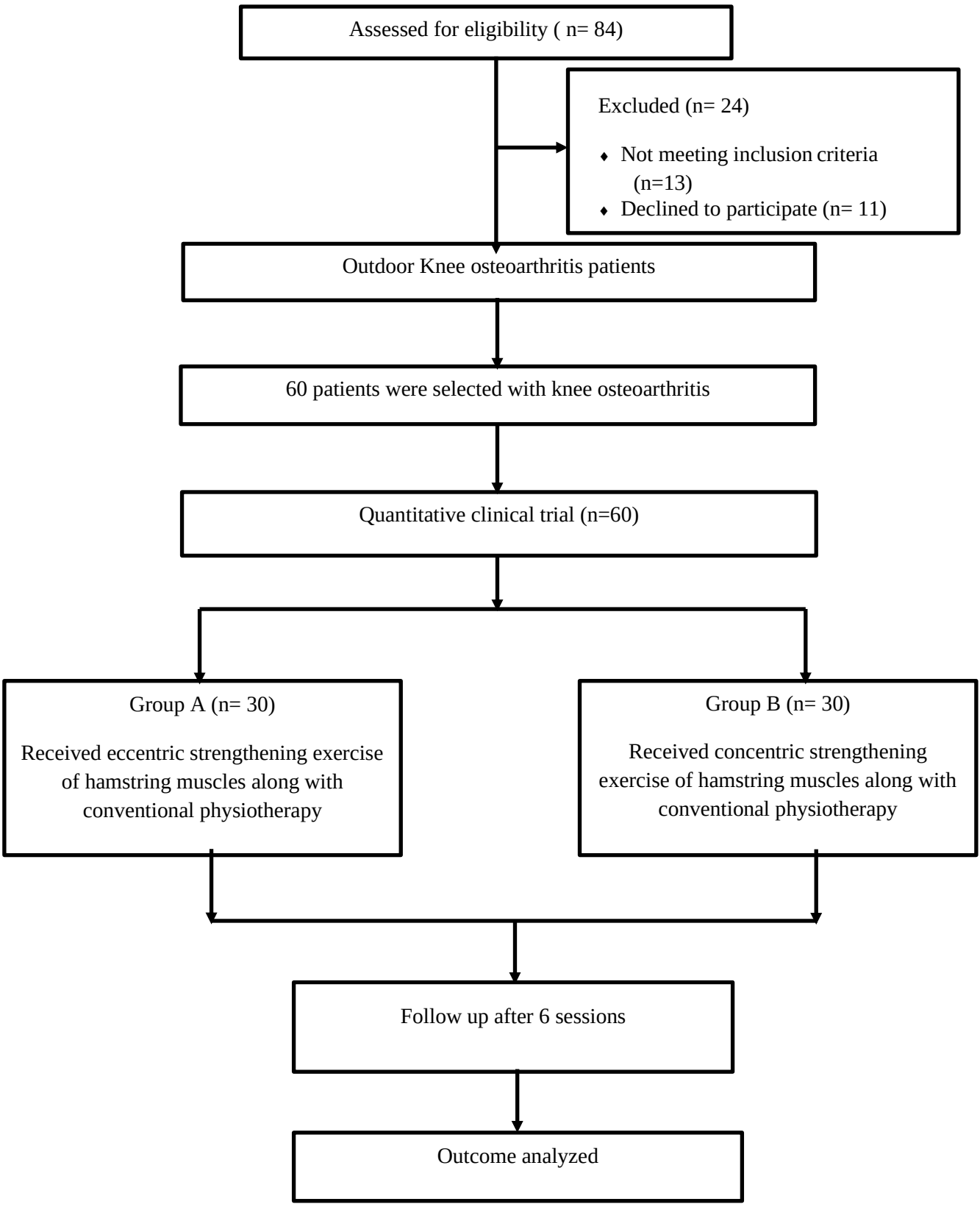
To identify the effectiveness of this treatment regime, Numeric Pain Rating Scale (NPRS) and The Western Ontario and McMaster Osteoarthritis Index (WOMAC) were used as measurement tools for measuring the pain intensity and disability caused by osteoarthritis. All patients signed an informed consent form prior to their inclusion into the study.

3.1 Study design:

The researcher chose clinical trial of this quantitative research. This study design fulfilled the aim and objectives of the research. The total number of patients could be 60 which was divided into two group. Subjects were allocated into two groups: Eccentric strengthening exercise of hamstring muscles (Group A, n= 30), Concentric strengthening exercise of hamstring muscles (Group B, n= 30).

A before exercise and after exercise program was administered with each subject of both groups to compare the pain effects, and functional ability before and after the treatment. The design could be shown by flowchart –

Flowchart of the phases of Quantitative Clinical Trial



A flowchart for a quantitative clinical trial of a treatment program including eccentric exercise along with conventional physiotherapy versus concentric exercise along with conventional physiotherapy for the patients with knee osteoarthritis.

3.2 Study area:

The study area was Musculoskeletal Outpatient Unit of Physiotherapy Department of Centre for the Rehabilitation of the Paralyzed (CRP), Savar, Dhaka.

3.3 Study population:

The study population was the patients diagnosed with knee osteoarthritis in the Musculo-skeletal Unit of Physiotherapy Department at CRP, Savar, Dhaka. The study population must fulfill the inclusion criteria of the study.

3.4 Sample size:

In this study, 60 participants were selected according to inclusion and exclusion criteria. 30 participants will in group A and 30 participants will in group B.

3.5 Sampling technique:

Simple Sampling Technique was used in this study. Subjects, who met the inclusion criteria, was taken as sample in this study. 60 patients with knee osteoarthritis was selected from outpatient musculoskeletal unit of physiotherapy department of CRP, Savar and then 30 patients was assigned to group A for the treatment approached of eccentric strengthening exercise of hamstring muscles along with conventional physiotherapy and 30 patients to the group B for the treatment approached of concentric strengthening exercise of hamstring muscles along with conventional physiotherapy treatment.

3.6 Inclusion criteria:

- Patient who was diagnosed with knee osteoarthritis by physical examination and by radiographic evidence.
- Both male and female were included.
- Subjects who willingly participated who were diagnosed with knee OA.
- Subjects whose age were less than 75 with knee OA patients were included.
- Knee OA pain in either one knee joint or both.
- Patients who were receiving to Physiotherapy from musculoskeletal unit of CRP. (Fransen & McConnell, 2015)

3.7 Exclusion criteria:

- Any history of recent surgery or fracture of femur, tibia, fibula, or foot bones.
- Any history of pathological condition (malignancy, heart disease etc.).
- Any history of osteoporosis.
- Any previous or current history of psychiatric or psychological treatment.
- Any intra-articular or epidural injection in the last 6 months.
- Patient with severe psychological problem.
- Patients age more than 75 years. (Fransen & McConnell, 2015).

3.8 Methods of data collection:

The data collection procedure was carried away by an examiner who had no connection with this research. This procedure conducted through assessing the patient based on inclusion and exclusion criteria, pretest data collection, 6 treatment sessions and final post test data collection.

After screening the patient at department and the patients were assessed and treated by the qualified physiotherapist. Sixty participants were chosen based on the inclusion criteria and they were given 6 sessions of treatments individually. Eccentric exercise (30) for the group A and concentric exercise (30) for the group B. Group A received Eccentric strengthening exercise of hamstring muscles along with conventional physiotherapy and Group B received concentric strengthening exercise of hamstring muscles along with conventional physiotherapy.

A pilot study was carried out prior to the main data collection procedure to determine the responsiveness and side effect of the exercise as it is applied to the knee osteoarthritis patients.

Data wad gathered through a selection and intervention procedure and by using a written questionnaire form which was formatted and prepared by the researcher under the supervision of the supervisor which also included the Numeric Pain Rating Scale (NPRS) to measure the general pain intensity level and the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) to measure pain and disability. Treatment procedure was performed in 6 session and gathered data before and after the treatment. The researcher gave vague instruction to the data collector how to proceed with the questionnaire and the scales used in that. A Bangla questionnaire of the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) was used as the participants are native Bangla speaker and the Bangla translation of was used with the permission from the developers of the questionnaire. The data collector collected the data from all group in presence of the qualified physiotherapist to reduce the biasness. The patient was totally blind about the procedure and the researcher had no connection with the data collection procedure. The data collector only gave the participants filled up questionnaires. At the end of the trail, specific tests were performed for statistical analysis.

3.9 Data collection tools:

In this study, a written questionnaire, pen, paper and a Numeric Pain Rating Scale and the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) were used as a data collection tools.

3.10 Questionnaire:

The questionnaire for this study was carefully developed under the constant observations, advice and permission of the supervisor following certain guidelines. There were close ended questions with Numeric Pain Rating Scale (NPRS) and the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) with some objective questions which were measured by the examiner and each question was formulated to compare the effect of eccentric strengthening exercise of hamstring muscles along with the conventional physiotherapy and concentric strengthening exercise of hamstring muscles along with the conventional physiotherapy for the treatment of knee osteoarthritis.

3.11 Measurement tools:

3.11.1 Numeric pain rating scale (NPRS)

The Numeric Pain Rating Scale (NPRS) is a segmented numeric version of the visual analog scale (VAS) in which a respondent selects a whole number (0–10 integers) that best reflects the intensity of the individual's pain (Rodriguez, 2001).

According to McCaffery et al. (1989) and later on Stevens, Lin, and Maher, (2016) the Numeric Pain Rating Scale (NPRS -11) is an 11-point scale for the patient self-reporting of pain. It is for adults and children 10 years old or older. Where 0 is the smallest value and 10 is the largest value. 0 means there is no pain, 1-3 indicates there is mild pain, 4-6 indicates there is moderate pain and 7-10 indicates severe pain level.

3.11.2 The Western Ontario and McMaster Universities Arthritis Index (WOMAC)

The Western Ontario and McMaster Universities Arthritis Index (WOMAC) is a widely used, proprietary set of standardized questionnaires used by health professionals to evaluate the condition of patients with Osteoarthritis of the knee including pain, stiffness, and physical functioning of the joints.

The WOMAC measures five items for pain (score range 0–20), two for stiffness (score range 0–8), and 17 for functional limitation (score range 0–68). Physical functioning questions cover everyday activities such as stair use, standing up from a sitting or lying position, standing, bending, walking, getting in and out of a car, shopping, putting on or taking off socks, lying in bed, getting in or out of a bath, sitting, and heavy and light household duties.

The WOMAC takes approximately 15-20 minutes to complete, and can be taken on paper, over the telephone or computer. Both the computerized and the mobile versions of the test have been found to be comparable to the paper form, with no significant difference. The test questions are scored on a scale of 0-4, which correspond to: None (0), Mild (1), Moderate (2), Severe (3), and Extreme (4).

The scores for each subscale are summed up, with a possible score range of 0-20 for Pain, 0-8 for Stiffness, and 0-68 for Physical Function. Usually, a sum of the scores for all three subscales gives a total WOMAC score, however there are other methods that have been used to combine scores.

Higher scores on the WOMAC indicate worse pain, stiffness, and functional limitations. The test-retest reliability of the WOMAC varies for the different subscales. The pain subscale has not been consistent across studies, but it generally meets the minimum standard. The physical function subscale is more consistent and has stronger test-retest reliability. The stiffness subscale has shown low test-retest reliability.

3.12 Intervention

In this study along with conventional physiotherapy, two strengthening exercises of hamstring muscles were used. Group A received eccentric strengthening exercise of hamstring muscle and group B received concentric strengthening exercise of hamstring muscles. All the participants received conventional physiotherapy twice a week with the recommended exercises for 3 weeks.

The treatment was given by the clinical physiotherapists of musculoskeletal unit of CRP, Savar. Patients were advised to follow the instructions.

3.13 Data analysis:

To ensure that the research had some values, the meaning of collected data had to be presented in ways that other research workers could understand. In other words, the researcher must made sense of the results. As the result came from an experiment in this research, data analysis was done by using the software named Statistical Package of Social Science (SPSS) version 20. Mann Whitney U test had used to analysis the collected data. All participants were code according to group to maintain participant's confidentiality and both the experiment and control group participants score their pain intensity and functional disability on the Numeric Pain Rating Scale (NPRS) and the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) prior to the trial and after the intervention sessions. Reduction of pain intensity level for both groups and improvement of functional disability should be analyzed with the help of U test. The U test was done for the analysis of the pain and disability after six session treatment of all groups. Experimental studies with the different subject design where two groups are used and each tested in two different conditions and the data was ordinal should be analyzed with Mann-Whitney U test. This test can only be used with ordinal or interval/ ratio data.

Wilcoxon matched pair signed rank test was performed for the analysis of the pain and disability within group data. when there were two measures to be compared from the same cases and the data were normally distributed, then Wilcoxon test was applied. The study had an experimental study and had unmatched groups of different participants.

3.14 Estimated predictor

Hypothesis test of mean difference between the experimental group and the control groups, within groups, unlike the t- test it does not require the assumption of normal distribution. It is nearly as efficient as the t- test on normal distributions. This test can be used to determine whether two independent samples were selected from population having the same distribution.

3.15 Hypothesis test

Mann Whitney U test

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.

Assumption

- All the observations from both groups are independent of each other.
- The responses are ordinal
- Under the null hypothesis Ho, the distribution of both populations are equal.
- The test was done for between groups.

The formula of Mann-Whitney U test:

$$\mathbf{U} = \boldsymbol{n_1 n_2} + \frac{\boldsymbol{n_x(n+1)}}{\mathbf{2}} - \boldsymbol{T_x}$$

Where,

n_1=The number of subjects in experimental group

n_2=The number of subjects in control group

T_x= The larger rank total

n_x= The number of subjects in the group with large rank total

U= ?

Calculation of Mann Whitney U is below:

$$\mathbf{U} = \boldsymbol{n_1 n_2} + \frac{\boldsymbol{n_x(n+1)}}{\mathbf{2}} - \boldsymbol{T_x} = \mathbf{U} = \mathbf{30 \times 30} + \frac{\mathbf{30(30+1)}}{\mathbf{2}} - \mathbf{975} = \mathbf{390}$$

In this way researcher had calculated paired t-value and significant level and have presented in the following tables-

Table 1: Researcher has calculated pre-treatment's value of pain intensity through Mann-Whitney U test in between eccentric and concentric group in the following table:

Numeric Pain Rating Scale	Concentric exercise (n =30) X ± SD	Eccentric exercise (n = 30) X ± SD	Z	p	U
How much pain do you feel today	1.3333±0.479	1.2000±0.406	1.158	0.247	390
How much pain did you feel after waking up from sleep	1.3667±0.49	1.1000±0.305	2.421	0.015*	330
How much pain did you feel while standing up	1.4000±0.498	1.2000±0.406	1.676	0.094	360
How much pain did you feel while rest	.3667±0.49	.3667±0.556	0.169	0.866	440.5

Wilcoxon Signed Rank Test

Experimental studies with the different subject design within one subject groups and the data is non-parametric and numerical data, which should be analyzed with "Wilcoxon Signed Rank Test:" As it was quasi-experimental and had within groups of different subjects, who were selected to eccentric strengthening exercise of hamstring muscles and concentric strengthening exercise of hamstring muscles and the measurement of the outcome came from collecting Numeric pain rating score, with considering numerical data, so the "Wilcoxon Signed Rank Test" was used in this study to calculate the level of significance. "Wilcoxon Signed Rank Test:" was calculated to test the hypothesis based on following assumptions-

- Data were numerical.
- Data were not well distributed
- Within-group comparison among subjects.

Wilcoxon sign test denoted by Z test, after the conclusion of the observed value and p-value whenever it is less than the table value of significance 0.05 level then null hypothesis was considered as rejected and alternative hypothesis considered as accepted.

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

Here, $\mathbf{W_s}$ = Smallest of absolute values of the sum

n = Total number of samples

$$\mathbf{Z} = \frac{\mathbf{W_s} - \frac{\mathbf{n(n+1)}}{\mathbf{4}}}{\sqrt{\frac{\mathbf{n(n-1)(2n+1)}}{\mathbf{24}}}} = \mathbf{Z} = \frac{\mathbf{456.992} - \frac{\mathbf{30(30+1)}}{\mathbf{4}}}{\sqrt{\frac{\mathbf{30(30-1)(2\times30+1)}}{\mathbf{24}}}} = \mathbf{4.774}$$

In this way researcher had calculated paired t-value and significant level and have presented in the following tables-

Table 2: Researcher has calculated post-treatment's value of pain intensity through Wilcoxon test within eccentric strengthening and concentric strengthening group in the following table:

Pain intensity	**Concentric exercise**		**Eccentric exercise**	
	Z	**p**	**Z**	**p**
How much pain do you feel today	4.774	0.000*	5.035	0.000*
How much pain did you feel after waking up from sleep	4.525	0.000*	4.244	0.000*
How much pain did you feel while standing up	4.597	0.000*	4.802	0.0000*
How much pain did you feel while rest	4.294	0.000*	4.226	0.000*

Paired t test

Paired t-test was used to compare difference between means of paired variables.

Selection of test of hypothesis is mean difference under t distribution.

Assumption

- Paired variables
- Variables were quantitative
- Parent population of sample observation follows normal distribution.

  Formula test statistic t is follows:

$$t = \frac{\bar{d}}{SE\,(\bar{d})} = \frac{\bar{d}}{\frac{SD}{\sqrt{n}}}$$

  Where,

  $\bar{d}$ = mean of difference (d) between paired values
  SE ($\bar{d}$)= Standard Error of the mean difference
  SD = standard deviation of the differences *d* and
  n= number of paired observations

$$t = \frac{\bar{d}}{SE\,(\bar{d})} = \frac{\bar{d}}{\frac{SD}{\sqrt{n}}} = = \frac{1.45}{\frac{1.185}{\sqrt{30}}} = 4.161$$

In this way researcher had calculated paired t-value and significant level and have presented in the following tables-

Table 3: Researcher has calculated the value of pain and disability of WOMAC questionnaire through pair-t test in between pre and post values of Concentric strengthening exercise and Eccentric strengthening exercise group in the following table:

		Concentric Strengthening			**Eccentric Strengthening**		
Serial no.	**Variables**	**t**	**df**	**Sig-2 tailed**	**t**	**df**	**Sig-2 tailed**
1	Walking	4.161	29	0.000*	12.042	29	0.000*
2	Stair climbing	5.761	29	0.000*	7.527	29	0.000*
3	Nocturnal	1.546	29	0.133	.338	29	0.738
4	Rest	1.725	29	0.095	3.120	29	0.004*
5	Weight bearing	8.449	29	0.000*	11.148	29	0.000*
6	Morning stiffness	5.722	29	0.000*	3.159	29	0.004*
7	Stiffness occurring later in the day	5.139	29	0.000*	5.406	29	0.000*
8	Descending stairs	6.298	29	0.000*	8.733	29	0.000*
9	Ascending stairs	7.718	29	0.000*	10.933	29	0.000*
10	Rising from sitting	3.597	29	0.001*	1.720	29	0.096

		Concentric Strengthening			Eccentric Strengthening		
Serial no.	**Variables**	**t**	**df**	**Sig-2 tailed**	**t**	**df**	**Sig-2 tailed**
11	standing	10.910	29	0.000*	9.642	29	0.000*
12	Bending to floor	5.065	29	0.000*	3.754	29	0.001*
13	Walking on flat surface	7.919	29	0.000*	7.644	29	0.000*
14	Getting in/ out of car	11.238	29	0.000*	9.401	29	0.000*
15	Going shopping	7.940	29	0.000*	9.950	29	0.000*
16	Putting on socks	6.911	29	0.000*	3.633	29	0.001*
17	Lying in bed	5.572	29	0.000*	6.595	29	0.000*
18	Taking off socks	7.663	29	0.000*	8.074	29	0.000*
19	Rising from bed	8.527	29	0.000*	6.817	29	0.000*
20	Getting in/ out of bath	6.656	29	0.000*	6.595	29	0.000*
21	Sitting	5.091	29	0.000*	5.610	29	0.000*

		Concentric Strengthening			Eccentric Strengthening		
Serial no.	**Variables**	**t**	**df**	**Sig-2 tailed**	**t**	**df**	**Sig-2 tailed**
22	Getting on/ off toilet	.924	29	0.363	4.709	29	0.000*
23	Heavy domestic duties	7.059	29	0.000*	10.515	29	0.000*
24	Light domestic duties	16.155	29	0.000*	9.800	29	0.000*

Unrelated t test

Unrelated t test was used to compare difference between two means of independent variables. Selection of test of hypothesis was two independent mean differences under independent t distribution.

Assumption

- Different and independent variables
- Variables were quantitative
- Normal distribution of the variables

Formula: test statistic t is follows:

$$t = \frac{\bar{x}1 - \bar{x}2}{s\sqrt{\frac{1}{n1} + \frac{1}{n2}}}$$

$\bar{x}1$ = Mean of the Experimental Group,
$\bar{x}2$ = Mean of the Control Group,
$n1$ = Number of participants in the Experimental Group,
$n2$ = Number of participants in the Control Group
S = Combined standard deviation of both groups

Calculation of unrelated t value of the respiratory rate as below-

$$\mathbf{t} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2})}} = \frac{\mathbf{1.933 - 1.133}}{\sqrt{\frac{(.90719)^2}{30} + \frac{(.77608)^2}{30}}} = 3.670$$

In this way researcher had calculated paired t-value and significant level and have presented in the following tables-

Table 4: Researcher has calculated the value of pain and disability of WOMAC questionnaire through unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group in the following table:

Variables	**Unrelated T test of between group**		
	t	**df**	**Sig-2 tailed**
Walking	3.670	58	0.001*
Stair climbing	0.955	58	0.344
Nocturnal	0.226	58	0.822
Rest	1.223	58	0.226
Weight bearing	2.834	58	0.006*
Morning stiffness	0.465	58	0.644
Stiffness occurring later in the day	2.373	58	0.021*
Descending stairs	2.705	58	0.009*
Ascending stairs	1.398	58	0.168
Rising from sitting	1.213	58	0.230

Variables	Unrelated T test of between group		
	t	**df**	**Sig-2 tailed**
standing	3.459	58	0.001*
Bending to floor	0.612	58	0.543
Walking on flat surface	1.682	58	0.098
Getting in/ out of car	0.443	58	0.659
Going shopping	1.088	58	0.281
Putting on socks	0.887	58	0.379
Lying in bed	0.579	58	0.565
Taking off socks	0.000	58	1.000
Rising from bed	0.000	58	1.000
Getting in/ out of bath	1.308	58	0.196
Sitting	1.086	58	0.282

Variables	Unrelated T test of between group		
	t	**df**	**Sig-2 tailed**
Getting on/ off toilet	0.305	58	0.761
Heavy domestic duties	3.685	58	0.001*
Light domestic duties	1.095	58	0.278

3.16 Informed Consent

It is vital to obtain consent from the subjects before doing research with them (Baily, 1997). Every participant was given a consent form for this study, and the aim of the research and consent forms were orally explained to them. Participants were totally voluntary, according to the researcher, and they had the freedom to withdraw at any moment. The researcher assured them that their privacy would be respected. Information may have been published in the form of a presentation or a written document, but it was not identified. Although the study's findings may not have any immediate implications for them, members of the physiotherapy population may benefit from it in the future. They will not feel ashamed as a result of the research. The researcher would be accessible to answer any more questions about the study at any time.

3.17 Ethical consideration

The research proposal was submitted for approval to the administrative bodies of the ethical committee of CRP and also had followed the Bangladesh Medical Research guideline (BMRC) and the World Health Organization (WHO) guideline. Again Before data collection, permission from the Ethical Committee of Bangladesh Health Professions Institute (BHPI) took and a requested letter hand over to the appropriate authority of the study area for taking permission and seeking assistance for smooth access to data collection with insurance of patient's safety. In order to eliminate ethical claims, the participants were set free to receive treatment for other purposes as usual. Each participant was informed about the study before beginning and given written consent. The researcher received verbal and signed an informed consent form to participate in this study from every subject. The participants were informed that they have the right to meet with an outdoor doctor if they think that the treatment is not enough to control the condition or if the condition becomes worse. The participants were also informed that they were completely free to decline to answer any question during the study and were free to withdraw their consent and terminate participation at any time. If the patients wanted to withdraw themself from the study, it would not affect their treatment in the physiotherapy department and they would still get the same

facilities. Every subject had the opportunity to discuss their problem with the senior authority or administration of CRP and had any questioned answer to their satisfaction.

CHAPTER – IV RESULTS

Socio-demographic Information

	Eccentric exercise		Concentric exercise	
	Mean with SD	**Min-Max**	**Mean with SD**	**Min-Max**
Age	51.63±9.36	35-74	46.63±1.104	32-75
Sex	1.53±0.507	1-2	1.80±0.406	1-2
Educational Background	2.50±1.10	1-5	2.23±0.935	1-5
Occupation	4.03±3.13	1-8	2.20±2.905	1-8
Monthly income	3.03±0.889	1-4	2.83±0.949	1-4
Family members	1.93±0.52	1-3	2.0±0.262	1-3
Marital status	1±0	1-1	1.06±0.253	1-2
Type of work	2.63±1.75	1-7	3.4±2.38	1-7
Methods of working	2.90±1.709	1-6	2.133 ± 0.73	2-6
Height	160.27±8.55	134.62-172.72	152.06±10.24	132.08-177.80
Weight	68.76±8.46	41-89	61.76±6.57	42-70
BMI	2.83±0.698	2-4	2.9±0.547	2-4
Tobacco user	6±1.05	1-8	6.1±1.8	1-8
Drug addiction	6±0	6-6	6±0	6-6
History of trauma	1.53±0.507	1-2	1.33±0.479	1-2
Chronic disease	4.34 ± 2.40	1-8	5.19±2.07	1-7

Age: The **Socio-demographic Information** table shows that among 60 participants with knee osteoarthritis the mean age of participants between eccentric strengthening exercise group and concentric strengthening exercise group were 51.63 ± 9.36 and 46.63 ± 1.104 years with a range from 32 to 75 where the minimum age of eccentric strengthening exercise group was 35 and maximum was 74 years. Again, the minimum age of concentric strengthening exercise group was 32 and maximum was 75 years old.

Sex: The mean gender of 60 participants with knee osteoarthritis with standard deviation between eccentric strengthening exercise group and concentric strengthening exercise group were 1.53 ± 0.507 and 1.80 ± 0.406 . In this study 20 males and 40 females were included and the percentage of male and female were 33.3% and 66.7%.

Educational Background: Among the participants of the study the mean with standard deviation of educational background is 2.50 ± 1.10. Among the participants 16.7% (n=10) was primary level pass, 46.7% (n=28) was SSC pass, 20% (n= 12) was HSC pass, 13.3% (n= 8) was graduate and 3.3% (n= 2) was post graduated.

Occupation: Among the participants of the study the mean with standard deviation of occupation was 4.03 ± 3.13 (eccentric group) and 2.20 ± 2.905 (concentric group). Among the 60 participants the number of housewives were 37 (61.7%), 1 laborer (1.7%), Govt. job holders were 6 (10%), Private job holders 3 persons (5%), 4 businessman (6.7%) and other occupation were 9 participants (15%).

Monthly income: Among the participants, 6.7%(n=4) of the participants have a monthly income around 0-10000 taka per month, 25% (n=15) of the participants have the monthly income around 11000-20000, 36.7% (n=22) of the participants have 21000–30000-taka monthly income and the rest 31.7% (n=19) earnt more than 30000 taka per month.

Family members: In this study, among the participants 10% (n=6) has a small family of 1-3 members, 83.3% (n=50) has a family of 4-6 members and 6.7% (n=4) has a relatively large family of 7-10 members.

Marital status: Among the participants, 96.7% (n= 58) were married and 3.3% (n=2) were unmarried.

Type of work: In this study, among the participants, 31.7% (n=19) work in prolong sitting, 13.3% (n=8) has a work type of manual labor, 33.3% (n= 20) has household type of work, 1.7% (n=1) has type of work of prolong standing, another 3.3% (n= 2) has work type of both manual labor with household work and another16.7% participants (n= 10) has work type of both prolong sitting with manual labor.

Methods of working: Among the participants, 3.3% (n= 2) work in prolong standing, 81.7% (n= 49) has a method of work in sitting, 15% (n= 8) work in both standing and sitting position.

Height: in this study, the mean height with SD of Eccentric strengthening group was 160.27±8.55 and in concentric group was 152.06±10.24 .

Where, in eccentric group has a maximum height of 172.72 CM and minimum of 134.62 CM. and in concentric group has a maximum height of 177.8 CM and minimum of 132.08 CM.

Weight: Among the participants, the mean with SD of weight of the eccentric and concentric strengthening group was 68.76±8.46 and 61.76±6.57. The minimum weight of eccentric and concentric group was 41 & 42 KG. The maximum weight of eccentric and concentric group was 89 & 70 KG.

Body mass index: Among the participants, 26.7% (n=16) participants has a normal BMI level (18.5- 24.9), 60% (n= 36) participants were overweight and BMI level were (25- 29.9) and 13.3% (n= 8) participants were obesity class 1 and BMI level were (30- 34.9).

Tobacco user: Among the participants, 61.7% (n= 37) participants did not any tobacco, cigarette smoker were 6.7% (n= 4), 25% (n= 15) used jarda and betel leaf and another 6.7% (n= 4) used jarda, gul and betel leaf.

Drug addiction: Among the participants 0% have any kind of drug addiction.

History of trauma: In this study, among the participants of eccentric group the mean with SD of trauma to lower limb was 1.53±0.507 and in concentric group the mean value with SD was 1.33±0.479. Here 56.7% (n= 34) participants has a history of trauma in the lower limb and rest 43.3% (n= 26) didn't have a history of trauma.

Chronic disease: In this study, 16.7% (n=10) participants had diabetes, 5% (n=3) participants had hypertension, 46.7% (n= 28) participants had diabetes with hypertension, 8.3% (n= 5) participants had diabetes, hypertension with heart diseases and rest 5% (n= 3) participants had other chronic diseases.

How much pain do you feel today: The study found that, the post treatment pain intensity was observed, and Z value of eccentric group was 5.035 and Z value of concentric group was 4.774. Both groups in aspect of pain intensity were significant at 0.000 Level. The test results were significant as the P value of both groups were <0.05. The U value of the test was 390.

The pretreatment pain intensity was observed in eccentric group and concentric group. Where eccentric group had a mean with SD of 1.2000±0.406 and concentric group had a mean with SD of 1.3333±0.479. The Z value of between groups were 1.158 and P value was 0.247. Since the P> 0.05, so the value was not significant and the pretest value of both groups didn't differ much.

How much pain did you feel after waking up from sleep: The study found the post treatment pain intensity after waking up from sleep and observed, the Z value of eccentric and concentric strengthening group was in order 4.244 and 4.525. Both groups in aspect of pain intensity were significant at 0.000 Level. The test results were significant as the P value of both groups were <0.05. The U value of the test was 330.

The pretreatment pain intensity was observed in eccentric group and concentric group when the participants wake up from sleep. Where eccentric and concentric group had a mean with SD of 1.1000±0.305 and 1.3667±0.49. The Z value of between groups were 2.421 and P value was 0.015. Since P<0.05 so the pain intensity of between groups were significant and they differ significantly from one another.

How much pain did you feel while standing up: The study found the post treatment pain intensity after standing up and observed it, the Z value of eccentric and concentric strengthening group was in order 4.802 and 4.597. Both groups in aspect of pain intensity were significant at 0.000 Level. The test results were significant as the P value of both groups were <0.05. The U value of the test was 330.

The pretreatment pain intensity was observed in eccentric group and concentric group during standing up. Where eccentric and concentric group had a mean with SD of 1.2000±0.406 and 1.4000±0.498. The Z value of between groups were 1.676 and P value were 0.094. Since P> 0.05, the pain intensity between groups didn't differ significantly.

How much pain did you feel while rest: The study found the post treatment pain intensity at rest and observed it, the Z value of eccentric and concentric strengthening group was in order 4.226 and 4.294. The test results were significant as the P value of both groups were <0.05. Both groups in aspect of pain intensity were significant at 0.000 Level. The U value of the test was 440.5.

The pretreatment pain intensity was observed in eccentric group and concentric group during rest. Where eccentric and concentric group had a mean with SD of .3667±0.556 and .3667±0.49. . The Z value of between groups were 0.169 and P value were 0.886. Since P> 0.05, the pain intensity between groups didn't differ significantly.

Walking: The post treatment pain intensity was observed in eccentric group and concentric group during walking. Both of the groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 12.042 & 4.161 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05. So, each group has significance in pain perception during walking.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For walking test, t value was 3.670 and df was 58. P value was 0.001 which is lesser than 0.05, which is significant. So, for walking the alternative hypothesis was accepted.

Stair climbing: The post treatment pain intensity was observed in eccentric group and concentric group during stair climbing. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 7.527 & 5.761in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05. So, each group has significance in pain perception during stair climbing.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For stair climbing, t value was 0.995 and df was 58. P value was 0.344 which is greater than 0.05, which is insignificant. So, for stair climbing the null hypothesis was accepted.

Nocturnal: The post treatment pain intensity was observed in eccentric group and concentric group of night. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 0.338 & 1.546 in order. Eccentric and concentric group had a P value of 0.738 & 0.133. As the P>0.05 so, the nocturnal pain perception is insignificant for both groups.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For night pain, t value was 0.226 and df was 58. P value was 0.822 which is greater than 0.05, which is insignificant. So, for night pain the null hypothesis was accepted.

Rest: The post treatment pain intensity was observed in eccentric group and concentric group of during rest. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 3.120 & 1.725 in order. Eccentric and concentric

group had a P value of 0.004 & 0.095 in order. So, the eccentric group is significant and concentric group is not.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For resting pain, t value was 1.223 and df was 58. P value was 0.226 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Weight bearing: The post treatment pain intensity was observed in eccentric group and concentric group of during weight bearing. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 11.148 & 8.449 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05. So, both group has significance in pain perception during weight bearing.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For weight bearing, t value was 2.834 and df was 58. P value was 0.006 which is lesser than 0.05, which is significant. So, for walking the alternative hypothesis was accepted.

Morning stiffness: The post treatment stiffness intensity was observed in eccentric group and concentric group of during morning . Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 3.159 & 5.722 in order. Eccentric and concentric group had a P value of 0.004 & 0.000 in order. So, both group has significant effect in morning stiffness as the P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For morning stiffness, t value was 0.465 and df was 58. P value was 0.644 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Stiffness occurring later in the day: The post treatment stiffness intensity was observed in eccentric group and concentric group of during rest of the day. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 5.406 & 5.139 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For stiffness occurring later in the day, t value was 2.373 and df was 58. P value was 0.021 which is lesser than 0.05, which is significant. So, for walking the alternative hypothesis was accepted.

Descending stairs: The post treatment pain intensity was observed in eccentric group and concentric group of during descending stairs. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 8.733 & 6.298 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For descending stairs, t value was 2.705 and df was 58. P value was 0.009 which is lesser than 0.05, which is significant. So, for walking the alternative hypothesis was accepted.

Ascending stairs: The post treatment pain intensity was observed in eccentric group and concentric group of during ascending stairs. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 10.933 & 7.718 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For ascending stairs, t value was 1.398 and df was 58. P value was 0.168 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Rising from sitting: The post treatment pain intensity was observed in eccentric group and concentric group of during rising from sitting. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 1.720 & 3.597 in order. eccentric and concentric group had a P value of 0.096 & 0.001 in order. So, the P value of eccentric group is insignificant as P> 0.05 and P value of concentric group is significant as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For Rising from sitting, t value was 1.213 and df was 58. P value was 0.230 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Standing: The post treatment pain intensity was observed in eccentric group and concentric group of during standing. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 9.642 & 10.910 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For standing, t value was 3.459 and df was 58. P value was 0.001 which is lesser than 0.05, which is significant. So, for walking the alternative hypothesis was accepted.

Bending to floor: The post treatment pain intensity was observed in eccentric group and concentric group of during Bending to floor. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 3.754 & 5.065 in order. eccentric and concentric group had a P value of 0.001 & 0.000 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For Bending to floor, t value was 0.612 and df was 58. P value was 0.543 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Walking on flat surface: The post treatment pain intensity was observed in eccentric group and concentric group of during walking on flat surface. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 7.644 & 7.919 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For walking on flat surface, t value was 1.682 and df was 58. P value was 0.098 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Getting in/ out of car: The post treatment pain intensity was observed in eccentric group and concentric group during getting in/ out of car. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 9.401 & 11.238 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For Getting in/ out of car, t value was 0.443 and df was 58. P value was 0.659 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Going shopping: The post treatment pain intensity was observed in eccentric group and concentric group during shopping. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 9.950 & 7.940 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For going shopping, t value was 1.088 and df was 58. P value was 0.281 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Putting on socks: The post treatment pain intensity was observed in eccentric group and concentric group of during Putting on socks. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 3.633 & 6.911 in order. eccentric and concentric group had a P value of 0.001 & 0.000 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For putting on socks, t value was 0.887 and df was 58. P value was 0.379 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Lying in bed: The post treatment pain intensity was observed in eccentric group and concentric group during shopping. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 6.595 & 5.572 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For lying in bed, t value was 0.579 and df was 58. P value was 0.565 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Taking off socks: The post treatment pain intensity was observed in eccentric group and concentric group during taking off socks. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 8.074 & 7.663 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For Taking off socks, t value was 0.000 and df was 58. P value was 1.000 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Rising from bed: The post treatment pain intensity was observed in eccentric group and concentric group during rising from bed. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 6.817 & 8.527 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For Rising from bed, t value was 0.000 and df was 58. P value was 1.000 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Getting in/ out of bath: The post treatment pain intensity was observed in eccentric group and concentric group during getting in/ out of bath. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 6.595 & 6.656 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For Getting in/ out of bath, t value was 1.308 and df was 58. P value was 0.196 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Sitting: The post treatment pain intensity was observed in eccentric group and concentric group while sitting. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 5.610 & 5.091 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For sitting, t value was 1.086 and df was 58. P value was 0.282 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Getting on/ off toilet: The post treatment pain intensity was observed in eccentric group and concentric group of getting on/ off toilet. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 4.709 & 0.924 in order. eccentric and concentric group had a P value of 0.000 & 0.363 in order. Eccentric group had a significant P value of 0.000 as P< 0.05 and concentric group had a insignificant P value of 0.363 as P> 0.05.

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For Getting on/ off toilet, t value was 0.305 and df was 58. P value was 0.761 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

Heavy domestic duties: The post treatment pain intensity was observed in eccentric group and concentric group during heavy domestic duties. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 10.15 & 7.059 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For Heavy domestic duties, t value was 3.685 and df was 58. P value was 0.001 which is lesser than 0.05, which is significant. So, for walking the alternative hypothesis was accepted.

Light domestic duties: The post treatment pain intensity was observed in eccentric group and concentric group during light domestic duties. Both groups had a degree of freedom (df) of 29. T value of eccentric and concentric group were 9.800 & 16.155 in order. Both eccentric and concentric group had a significant P value of 0.000 as P< 0.05

In the unrelated-t test in between Concentric strengthening exercise and Eccentric strengthening exercise group were shown. For Light domestic duties, t value was 1.095 and df was 58. P value was 0.278 which is greater than 0.05, which is insignificant. So, for resting pain the null hypothesis was accepted.

CHAPTER – V DISCUSSION

The researcher was intended to find out the effectiveness of eccentric and concentric strengthening exercise of hamstring muscles along with conventional physiotherapy for the patients who were suffering from pain and disability from knee osteoarthritis. The researcher then compared the result to find out the best one from the two of the exercises.

In this study, researcher took 60 participants who were affected with knee osteoarthritis. Among them 30 participants took part in eccentric strengthening group, while the rest 30 participants got the concentric strengthening along with conventional physiotherapy. Each group received 3-weeks training programs along with the conventional physiotherapy treatment. Which included 6 sessions of strengthening exercise program. The outcome was measured by using Numeric Pain Rating Scale (NPRS) for pain intensity and Western Ontario & McMaster Universities Osteoarthritis Index was used as measurement tools for measuring the level of pain, stiffness and functional activities in several functional positions.

The capacity of these muscles to protect the joint from mechanical overload is reduced when knee extensor and flexor strength is reduced (Teixeira and Olney, 1995; Slemenda et al., 1998). Both the hamstring and quadriceps muscles are strengthened and muscular resistance is increased in an attempt to reestablish or enhance muscular balance, lessening the impact of OA on the older person's functioning. That is why the effectiveness of hamstring strengthening was important to know.

The researcher found that in the study 33.3% (n=20) was male and 66.7% (n=40) was female among the 60 participants. The mean gender of 60 participants with knee osteoarthritis with standard deviation between eccentric strengthening exercise group and concentric strengthening exercise group were 1.53 ± 0.507 and 1.80 ± 0.406 .

Before starting the treatment protocol, The pain of both groups were measured and analyzed by Mann-whitney test for the NPRS. In this analysis, the mean pain value with SD of eccentric group of that day, after waking up, standing and at rest were as follows- 1.2000 ± 0.406, 1.1000 ± 0.305, 1.2000 ± 0.406 & $.3667 \pm 0.556$. While the pain value with SD of concentric group for that day, after waking up, standing and at rest were as follows- 1.3333 ± 0.479, 1.3667 ± 0.49, 1.4000 ± 0.498 & $.3667 \pm 0.49$. after a 3 weeks (6

sessions) treatment there was a significant change in pain and disability within both groups.

In Wilcoxon test, each group had a significant improvement in pain. Each pain point had a P value of less than 0.05. P= 0.00 for every point of the groups. Though there was some difference in between groups but pain perception was improved significantly in post test groups.

Other studies also support this result. Many studies have found that strengthening exercises are beneficial for improving pain and functionality for the pain of knee OA.

Patients with knee OA usually have reduced muscle strength because of reductions in physical activity and pain inhibition. Strengthening the hamstring muscle has been found to improve the functional ability of the affected knee and pain. (Highgenboten, et al., 1988). Overall increase in both the hamstring and quadriceps strength and increase in the hamstring to quadriceps ratio (H: Q), anterior-lateral subluxation of the tibia can be reduced which reduce the load on joint. (Alnahdi et al 2012) & (Hafez, et al., 2014)

Another study showed that patients with knee osteoarthritis revealed increased in hamstring muscle activation while executing activities of daily living. Altered muscle activation at the knee can interfere with normal load distribution in the knee joint and facilitate disease progression. Therapeutic interventions should focus not only on quadriceps strengthening but also on improving muscle balance at the knee. (Hortobágyi et al., 2005)

For the WOMAC index of knee OA, researcher used the paired t test to calculate the pre and post value of pain and disability of within the group. There was 29 DF for each point of the questionnaire. Most of the t values of posttest were significant within the group. The P value were less than 0.05 in both of the posttest group. So, researcher assumed that both eccentric and concentric strengthening of hamstring muscle along with conventional physiotherapy was effective to reduce pain and disability for patients with knee osteoarthritis.

After calculating and analyzing the values of each group, the researcher then compared the posttest values of each group with one another by unrelated t test. That was the actual comparison of the eccentric and concentric strengthening exercise of hamstring muscles for OA knee patients. Out of 24 points 6 points were significant in eccentric

comparison group. The pain was significantly improved in eccentric group during walking, weight bearing, Stiffness occurring later in the day, descending stairs, standing & Heavy domestic duties. For these points the P value was significant for eccentric group ($P< 0.05$).

The results of the study demonstrated that eccentric strengthening exercise of hamstring muscles is slightly better for pain and disability for the patient with knee OA patients than concentric exercise of hamstring muscles. Other studies have also found that eccentric strengthening exercise of muscles have greater role in muscle strength and improve functionality.

Strengthening exercises are frequently advised. Because of decreased physical activity and pain suppression, patients with knee OA have lower muscular strength. It has been discovered that strengthening the hamstring muscle improves the functional ability of the deficient knee and reduces discomfort (Highgenboten et al., 1988). Because of an increase in total hamstring and quadriceps strength, as well as an improvement in the hamstring to quadriceps ratio (H: Q), anterior-lateral tibia subluxation can be reduced (Alnahdi et al., 2012) & (Hafez, A.R., et al., 2014).

Strengthening the hamstrings, in addition to the quadriceps, has been demonstrated to help individuals with knee osteoarthritis improve their subjective knee pain, range of motion, and functional performance (Ashraf and colleagues, 2013).

Limitation of the Study:

- Among the vast numbers of knee osteoarthritis patients, the sample size was really very small, so the result is difficult to generalize among whole population as different people can have different lifestyles.
- Researcher took help from one assessor for data collection purpose, it may vary result and had a high chance of biasness.
- Data was collected from only one clinical setting CRP at Savar; it can be influencing the result and outcome of the results.
- Sometimes treatment sessions and exercise sessions were interrupted due to public holiday and recruit physiotherapists took leave in the data collection that may interrupt the result.
- Different participants had different capacity of exercise tolerance, but every participant took on the same exercise protocol. Exercise protocols would be better if participants were given different protocol according to their capacity.
- The mean age and gender of two groups were not same. That can affect the results.
- Clinical Physiotherapists who were providing physiotherapy treatment, they could give different treatments to different patients. That can change the result.

CHAPTER – VI CONCLUSION AND RECOMMENDATION

Conclusion

The result of this study has shown that the effectiveness of eccentric versus concentric strengthening exercise of hamstring muscles along with conventional physiotherapy for the patients with knee osteoarthritis. It was a quantitative study of clinical trial. Among 60 participants 30 participants received eccentric strengthening exercise and rest 30 participants received concentric strengthening exercise. Both groups received same conventional physiotherapy at the same time. Only difference was the strengthening exercise given by the researcher and this difference brought the difference to the results. Actually, both of the groups had significant change in pain and disability among the patients in pre and post treatment periods. After posttest, group had significant change in pain perception and functionality. Then researcher compare the results between groups, both groups had a significant change in 6 points among 24 points. where the eccentric strengthening exercise had significant change over the concentric strengthening exercise. The final result showed that the eccentric hamstring strengthening is more helpful in knee osteoarthritis patients for pain control and reduce disabilities. This study now can help the physiotherapists to rehabilitation and prevent disabilities by knee osteoarthritis even more.

Recommendation

As a consequence of this research, it is recommended to do further study including only eccentric strengthening exercise and only concentric strengthening exercise of hamstring muscles along with conventional physiotherapy for knee osteoarthritis alone to assess the effectiveness of these interventions with well blinding procedure. It is also recommended to include the functional outcome assessment of patient and to identify the average number of sessions that are needed to be discharged from treatment to validate the treatment technique.

It is also recommended to do further study on this topic with much larger population.

The researcher did not enough environment and enough equipment to complete the research. That's why researcher recommended to do further study with enough time and by maintaining available equipment to make the study more valid.

REFERENCES

Adegoke, B., Mordi, E., Akinpelu, O. and Jaiyesimi, A., 2007. Isotonic quadriceps-hamstring strength ratios of patients with knee osteoarthritis and apparently healthy controls. African Journal of Biomedical Research, 10(3).

Berenbaum, F., (2013). Osteoarthritis as an inflammatory disease (osteoarthritis is not osteoarthritis!.Osteoarthritis and Cartilage, 21:16-21.

Bouchard, C., 2007. BMI, fat mass, abdominal adiposity and visceral fat: where is the 'beef'?. International journal of obesity, 31(10), pp.1552-1553.

Bouchard, C., Blair, S.N. and Haskell, W. eds.,(2012). Physical activity and health. Human Kinetics

Brandt, K.D., (2004). Non-surgical treatment of osteoarthritis: a half century of "advances".AnnalsRhumatic Diseases,63(2): 117–122.

Busija, L.,Bridgett, L.,Williams, S.R., Osborne, R.H., Buchbinder, R., March, L., Fransen, M., (2010). Osteoarthritis. Best Practice & Research Clinical Rheumatology, 24(6):757-68.

Chapple CM, Nicholson H, Baxter GD and Abbott JH, (2011). Patient characteristics that predict progression of knee osteoarthritis: A systematic review of prognostic studies. Arthritis Care and Research, 63(8):1115-25.

Chapple CM, Nicholson H, Baxter GD and Abbott JH, (2011). Patient characteristics that predict progression of knee osteoarthritis: A systematic review of prognostic studies. Arthritis Care and Research, 63(8):1115-25.

Chotanaphuti, T., Ongnamthip, P., Songpatanasil, T., Veerapan, P. and Deeprecha, K., 2007. Risk factors of deep vein thrombosis (DVT) after total knee arthroplasty (TKA) at Phramongkutklao Hospital. JOURNAL-MEDICAL ASSOCIATION OF THAILAND, 90(3), p.485.

Conaghan PG, Dickson J and Grant RL, (2008). Care and management of osteoarthritis in adults: summary of NICE guidance. British Medical Journal, 33(6):502.

Conaghan, P.G., Dickson, J. and Grant, R.L., 2008. Care and management of osteoarthritis in adults: summary of NICE guidance. Bmj, 336(7642), pp.502-503.

Connor, M.I., (2007). Sex differences in osteoarthritis of the hip and knee. Journal of American Academy Orthopedic Surgery, 15(1):22-25.

Coombs, R. and Garbutt, G., 2002. Developments in the use of the hamstring/quadriceps ratio for the assessment of muscle balance. Journal of sports science & medicine, 1(3), p.56.

Couppé, C., Svensson, R.B., Silbernagel, K.G., Langberg, H. and Magnusson, S.P., 2015. Eccentric or concentric exercises for the treatment of tendinopathies?. journal of orthopaedic & sports physical therapy, 45(11), pp.853-863.

Croce, R.V., Pitetti, K.H., Horvat, M. and Miller, J., 1996. Peak torque, average power, and hamstring/quadriceps ratios in nondisabled adults and adults with mental retardation. Archives of physical medicine and rehabilitation, 77(4), pp.369-372.

Cyrus, C.,Kassim, J., (2014). Epidemiology of Osteoarthritis. Available: https://books.google.ca/books?id=qT1FBgAAQBAJ&pg=PA21#v=onepage&q&f=fa

Fransen, M. and McConnell, S., (2008). Exercise for osteoarthritis of the knee. The Cochrane Library.

Fransen, M. and McConnell, S., (2008). Exercise for osteoarthritis of the knee. The Cochrane Library

Fransen, M., McConnell, S., Harmer, A.R., Van der Esch, M., Simic, M. and Bennell, K.L., 2015. Exercise for osteoarthritis of the knee. Cochrane database of systematic reviews

Fransen, M., McConnell, S., Harmer, A.R., Van der Esch, M., Simic, M. and Bennell, K.L., (2015). Exercise for osteoarthritis of the knee: a Cochrane systematic review. British Journal of Sports Medicine, 49(24):1554-1557.

Glyn-Jones, S., Palmer, A.J., Agricola, R., Price, A.J., Vincent, T.L., Weinans, H., Carr, A.J., (2015).Osteoarthritis. Lancet,386: 376–87.

Goh, S.L., Persson, M.S., Bhattacharya, A., Hall, M., Doherty, M. and Zhang, W., (2016). Relative efficacy of different types of exercise for treatment of knee and hip osteoarthritis: protocol for network meta-analysis of randomised controlled trials. Systematic Reviews, 5(1):147.

Goh, S.L., Persson, M.S., Bhattacharya, A., Hall, M., Doherty, M. and Zhang, W., (2016). Relative efficacy of different types of exercise for treatment of knee and hip osteoarthritis: protocol for network meta-analysis of randomised controlled trials. Systematic Reviews, 5(1):147.

Guermazi, A., Niu, J., Hayashi, D., Roemer, F.W., Englund, M., Neogi, T., Aliabadi, P., McLennan, C.E. and Felson, D.T., 2012. Prevalence of abnormalities in knees detected by MRI in adults without knee osteoarthritis: population based observational study (Framingham Osteoarthritis Study). Bmj, 345.

Hafez, A.R., Al-Johani, A.H., Zakaria, A.R., Al-Ahaideb, A., Buragadda, S., Melam, G.R. and Kachanathu, S.J., 2013. Treatment of knee osteoarthritis in relation to hamstring and quadriceps strength. Journal of physical therapy science, 25(11), pp.1401-1405.

Hafez, A.R.,Zakaria, A.,Buragadda, S., (2012). Eccentric versus concentric contraction of quadriceps muscles in treatment of chondromalacia patellae. World Journal of Medical Sciences, 7 (3): 197-203.

Hall, M., Doherty, S., Courtney, P., Latief, K., Zhang, W. and Doherty, M., (2014). Synovial pathology detected on ultrasound correlates with the severity of radiographic knee osteoarthritis more than with symptoms. Osteoarthritis and Cartilage, 22(10):1627-1633.

Haque, M.M., 2016. Prevalence of Osteoarthritis among Ethnic Communities in Bangladesh. EC Orthopaedics, 3, pp.284-289.

Heidari, B., 2011. Knee osteoarthritis prevalence, risk factors, pathogenesis and features: Part I. Caspian journal of internal medicine, 2(2), p.205.

Hochman, J.R., Gagliese, L., Davis, A.M. and Hawker, G.A., 2011. Neuropathic pain symptoms in a community knee OA cohort. Osteoarthritis and cartilage, 19(6), pp.647-654.

Hurst, J.M., Steadman, J.R., O'Brien, L., Rodkey, W.G. and Briggs, K.K., (2010). Rehabilitation following microfracture for chondral injury in the knee. Clinics in Sports Medicine, 29(2):.257-265.

Jonhagen, S., Nemeth, G. and Eriksson, E., 1994. Hamstring injuries in sprinters: the role of concentric and eccentric hamstring muscle strength and flexibility. The American journal of sports medicine, 22(2), pp.262-266.

Joshua, N., Farr, Scott, B., Going, Patrick, E., McKnight, Kasle, S., Ellen, C.,Cussler, (2016). Progressive Resistance Training Improves Overall Physical Activity Levels in Patients With Early Osteoarthritis of the Knee: A Randomized Controlled Trial. Journal of TheAmerical Physical Therapy Association,90(3): 356–366.

Kannus, P., 1994. Isokinetic evaluation of muscular performance. International journal of sports medicine, 15(S 1), pp.S11-S18.

Kannus, P., Jozsa, L., Jarvinen, T.L., Kvist, M., Vieno, T., Jarvinen, T.A., Natri, A. and Jarvinen, M., 1998. Free mobilization and low-to high-intensity exercise in immobilization-induced muscle atrophy. Journal of Applied Physiology, 84(4), pp.1418-1424.

Kornaat PR, Bloem JL, Ceulemans RYT, Riyazi N, Rosendaal FR, Nelissen RG, Carter WO, and Kloppenburg M, (2006). Osteoarthritis of the Knee: Association Between Clinical Features and MR Imaging Findings, [Access on 10th July 2012] Available:<http://radiology.rsna.org/content/239/3/811.

Kornaat PR, Bloem JL, Ceulemans RYT, Riyazi N, Rosendaal FR, Nelissen RG, Carter WO, and Kloppenburg M, (2006). Osteoarthritis of the Knee: Association Between Clinical Features and MR Imaging Findings, [Access on 10th July 2012] Available:<http://radiology.rsna.org/content/239/3/811.

Kornaat, P.R., Bloem, J.L., Ceulemans, R.Y., Riyazi, N., Rosendaal, F.R., Nelissen, R.G., Carter, W.O., Hellio Le Graverand, M.P. and Kloppenburg, M., 2006. Osteoarthritis of the knee: association between clinical features and MR imaging findings. Radiology, 239(3), pp.811-817.

Lane, N.E., Brandt, K., Hawker, G., Peeva, E., Schreyer, E., Tsuji, W. and Hochberg, M.C., 2011. OARSI-FDA initiative: defining the disease state of osteoarthritis. Osteoarthritis and cartilage, 19(5), pp.478-482.

Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, Gabriel S, Hirsch R, Hochberg MC, Hunder GG, Jordan JM, Katz JN, Kremers HM, Wolfe F and National Arthritis Data Workgroup, (2008). Estimates of the prevalence of arthritis and other rheumatic conditions in the United States: Part II. Arthritis and Rheumatism, 58(1):26-35.

Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, Gabriel S, Hirsch R, Hochberg MC, Hunder GG, Jordan JM, Katz JN, Kremers HM, Wolfe F and National Arthritis Data Workgroup, (2008). Estimates of the prevalence of arthritis and other rheumatic conditions in the United States: Part II. Arthritis and Rheumatism, 58(1):26-35.

Lawrence, R.C., Felson, D.T., Helmick, C.G., Arnold, L.M., Choi, H., Deyo, R.A., Gabriel, S., Hirsch, R., Hochberg, M.C., Hunder, G.G. and Jordan, J.M., 2008.

Estimates of the prevalence of arthritis and other rheumatic conditions in the United States: Part II. Arthritis & Rheumatism, 58(1), pp.26-35.

Lespasio, M.J., Piuzzi, N.S., Husni, M.E., Muschler, G.F., Guarino, A.J. and Mont, M.A., 2017. Knee osteoarthritis: a primer. The Permanente Journal, 21.

lse[access date]

Maly, M.R., Costigan, P.A. and Olney, S.J., 2006. Determinants of self-report outcome measures in people with knee osteoarthritis. Archives of physical medicine and rehabilitation, 87(1), pp.96-104.

Michael, J.W., Schlüter-Brust, K.U. and Eysel, P., (2010). The epidemiology, etiology, diagnosis, and treatment of osteoarthritis of the knee. DtschArzteblInt, 107(9):152-62.

Mjølsnes, R., Arnason, A., Østhagen, T., Raastad, T. and Bahr, R., 2004. A 10-week randomized trial comparing eccentric vs. concentric hamstring strength training in well-trained soccer players. Scandinavian journal of medicine & science in sports, 14(5), pp.311-317.

Mounach, A., Nouijai, A., Ghozlani, I., (2008). Risk factors for knee osteoarthritis in Morocco: A case control study. Clinical Rheumatology, 27:323-326.

Muraki, S., Tanaka, S. and Yoshimura, N., (2013). Epidemiology of knee osteoarthritis. OA Sports Medicine Journal, 1(3):21.

Murphy, L.B., Moss, S., Do, B.T., Helmick, C.G., Schwartz, T.A., Barbour, K.E., Renner, J., Kalsbeek, W. and Jordan, J.M., (2016). Annual incidence of knee symptoms and four knee osteoarthritis outcomes in the Johnston County Osteoarthritis Project. Arthritis care & research, 68(1):55-65.

O'Reilly, S.C., Muir, K.R. and Doherty, M., (2016). Effectiveness of home exercise on pain and disability from osteoarthritis of the knee: A randomised controlled trial. Annals of the Rheumatic Diseases, 58(1):15-19.

Øiestad, B.E., Juhl, C.B., Eitzen, I. and Thorlund, J.B., 2015. Knee extensor muscle weakness is a risk factor for development of knee osteoarthritis. A systematic review and meta-analysis. Osteoarthritis and Cartilage, 23(2), pp.171-177.

Potts, A., Harrast, J.J., Harner, C.D., Miniaci, A. and Jones, M.H., 2012. Practice patterns for arthroscopy of osteoarthritis of the knee in the United States. The American journal of sports medicine, 40(6), pp.1247-1251.

Reginster, J.Y., Cooper, C., Hochberg, M., Pelletier, J.P., Rizzoli, R., Kanis, J., Abadie, E., Maheu, E., Brandi, M.L., Devogelaer, J.P. and Branco, J., (2015). Comments on the discordant recommendations for the use of symptomatic slowacting drugs in knee osteoarthritis. Current Medical Research and Opinion, 31(5):1041-1045.

Reijman M, Pols HAP, Bergink AP, Hazes JMW, Belo JN, Lievense AM and Bierma-Zeinstra SMA, (2007). Body mass index associated with onset and progression of 60 osteoarthritis of the knee but not of the hip: the Rotterdam Study. Annals of the rheumatic diseases, doi:10.1136/ard.2006.053538.

Reijman M, Pols HAP, Bergink AP, Hazes JMW, Belo JN, Lievense AM and Bierma-Zeinstra SMA, (2007). Body mass index associated with onset and progression of 60 osteoarthritis of the knee but not of the hip: the Rotterdam Study. Annals of the rheumatic diseases, doi:10.1136/ard.2006.053538.

Rieger, M.A., (2008). Individual and occupational risk factors for knee osteoarthritis. BMC Musculoskeletal Disorders, 9(26):1471-1474.

Robert J and Petrella, (2010). A qualitative study on patients with knee osteoarthritis to evaluate the influence of different pain patterns on patients quality of life and to find out patients interpretation and coping strategies for the disease. Rheumatology, doi:10.4081/rr.2011.

Saag, K.G., Teng, G.G., Patkar, N.M., Anuntiyo, J., Finney, C., Curtis, J.R., Paulus, H.E., Mudano, A., Pisu, M., Elkins-Melton, M. and Outman, R., 2008. American College of Rheumatology 2008 recommendations for the use of nonbiologic and biologic disease-modifying antirheumatic drugs in rheumatoid arthritis. Arthritis Care & Research: Official Journal of the American College of Rheumatology, 59(6), pp.762-784.

Silverwood, V., Blagojevic-Bucknall, M., Jinks, C., Jordan, J.L., Protheroe, J. and Jordan, K.P., (2015). Current evidence on risk factors for knee osteoarthritis in older adults: A systematic review and meta-analysis. Osteoarthritis and Cartilage, 23(4):507-515.

Silverwood, V., Blagojevic-Bucknall, M., Jinks, C., Jordan, J.L., Protheroe, J. and Jordan, K.P., (2015). Current evidence on risk factors for knee osteoarthritis in older adults: A systematic review and meta-analysis. Osteoarthritis and Cartilage, 23(4):507-515.

Slemenda, C., Heilman, D.K., Brandt, K.D., Katz, B.P., Mazzuca, S.A., Braunstein, E.M. and Byrd, D., 1998. Reduced quadriceps strength relative to body weight: a risk factor for knee osteoarthritis in women?. Arthritis & Rheumatism: Official Journal of the American College of Rheumatology, 41(11), pp.1951-1959.

Stanton, P. and Purdam, C., 1989. Hamstring injuries in sprinting—the role of eccentric exercise. Journal of Orthopaedic & Sports Physical Therapy, 10(9), pp.343-349.

Stubbs, B., Aluko, Y., Myint, P.K. and Smith, T.O., 2016. Prevalence of depressive symptoms and anxiety in osteoarthritis: a systematic review and meta-analysis. Age and ageing, 45(2), pp.228-235.

Takeda H, Nakagawa T, Nakamura K, and Engebretsen, L (2011). Prevention and management of knee osteoarthritis and knee cartilage injury in sports. British Journal of Sports Medicine, 45(4):304-309.

Teixeira, L.F. and Olney, S.J., 1995. Avaliação clínica, radiológica e estudo isocinético da força muscular em pacientes idosos portadores de osteoartrite (OA) do joelho. Fisioterapia e Pesquisa, 2(2), pp.5-10.

Veerapen K, Wigley RD, and Valkenburg H, (2007). Musculoskeletal pain in Malaysia: a COPCORD survey. Journal of Rheumatology, 34(1):207-13.

Vincent, K.R. and Vincent, H.K., 2012. Resistance exercise for knee osteoarthritis. Pm&r, 4(5), pp.S45-S52.

Wasielewski, N.J. and Kotsko, K.M., 2007. Does eccentric exercise reduce pain and improve strength in physically active adults with symptomatic lower extremity tendinosis? A systematic review. Journal of athletic training, 42(3), p.409.

Wylde, V., Artz, N., Marques, E., Lenguerrand, E., Dixon, S., Beswick, A.D., Zhang, Y. and Jordan, J.M. (2010). Epidemiology of osteoarthritis. Clinics in Geriatric Medicine, 26(3):.355-369.

Wylde, V., Artz, N., Marques, E., Lenguerrand, E., Dixon, S., Beswick, A.D., Zhang, Y. and Jordan, J.M. (2010). Epidemiology of osteoarthritis. Clinics in Geriatric Medicine, 26(3):.355-369.

Appendix

CONSENT FORM (ENGLISH)

Assalamu-Alaikum,

I am Asadul Islam, a student of 4th Professional, B.Sc. in Physiotherapy, Bangladesh Health Professions Institute (BHPI), University of Dhaka. To obtain my bachelor's degree, I have to conduct a research project and it is a part of my study. My research title is "**Comparison of eccentric versus concentric strengthening exercises of hamstring muscles along with conventional physiotherapy for the patients with knee osteoarthritis"** To fulfill my research project, I need some information from you to collect data. So, you can be a respected participant of this research and the conversation time will be 20-30 minutes. I would like to inform you that this is a purely academic study and will not to be used for any other purposes. I assure that all data will be kept confidential. Your participation will be voluntary. You may have the rights to withdraw consent and discontinue participation at any time of the study. You also have the right to reject a particular question that you don't like.

If you have any query about the study, you may contact with my supervisor Mohammad Anwar Hossain. Associate Professor, dept. of Physiotherapy, BHPI, CPR, Savar, Dhaka- 1343.

Do you have any questions before start this session?

So, can I proceed with the interview?

☐ yes ☐ no

Signature of the participant and Date …….

Signature of the researcher and Date …….

Signature of the Physiotherapist and Date ……

Questionnaire (English)

Comparison of eccentric versus concentric strengthening exercise of hamstring muscles along with conventional physiotherapy for the patients with knee osteoarthritis

Please give a tick (√) mark on the left side of the box of correct answer

Code: Date:

Name: Mobile:

Address: Reg no:

Part –I (Social and global information)

Serial no	Questions	Answers
1.	Age	..... Years
2.	Sex	I. Male II. Female
3.	Occupation	I. Farmer II. Job Holder III. Businessman IV. Teacher V. Student VI. Car driver VII. Housewife VIII. Rickshaw puller IX. Day labourer X. Others (.....)
4.	Monthly income	.....taka
5.	Family members	I. 2-5 II. 6-8 III. 9+
6.	Marrital status	I. Married II. Unmarried III. Widow IV. Divorced
7.	Educational status	I. Illiterate II. Primary education III. S.S.C IV. H.S.C V. Graduation VI. Post Grauation VII. Others (.....)
8.	Type of work	I. Long time sitting II. Manual labour III. Household works IV. Others (.....)

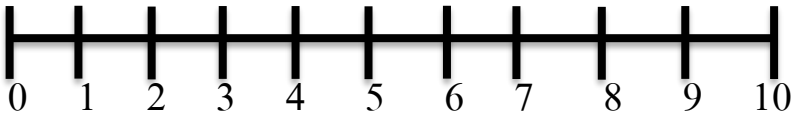
9.	Methods of working	I. Standing II. Sitting III. Walking IV. Others (.....)

Part – II (Health related information)

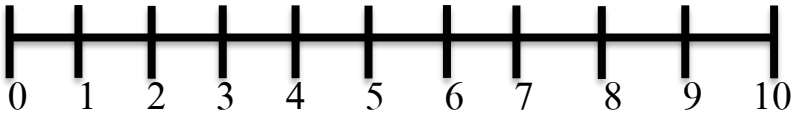
Serial no	Questions	Answers
1.	Height	..... C.M.
2	Weight	..... KG
3	BMI	
4.	Smoking Habits	I. Yes II. No III. Others.....
5.	Alchoholic	I. Yes II. No III. Others.....
6.	History of trauma to lower limb	I. Yes II. No
7.	Chronic diseases	I. Diabetes II. Hypertension III. Heart disease IV. Others.....

Part-III: Physical disability questionnaire

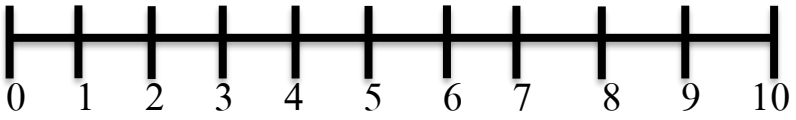
1. How much pain do you feel today?



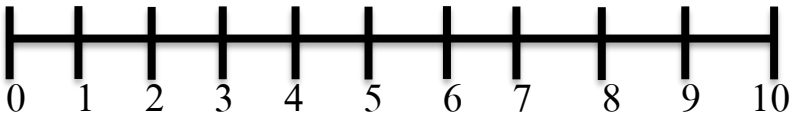
2. How much pain did you feel after waking up from sleep?



3. How much pain did you feel while standing up?



4. How much pain did you feel while rest?



Each question has 4 score. Total question are 24.Total number 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

Pain:

1. Walking	0	1	2	3	4
2. Stair climbing	0	1	2	3	4
3. Nocturnal	0	1	2	3	4
4. Rest	0	1	2	3	4
5. Weight bearing	0	1	2	3	4

Stiffness:

1. Morning stiffness	0	1	2	3	4
2. Stiffness occurring later in the day	0	1	2	3	4

Physical Function:

1. Descending stairs	0	1	2	3	4
2. Ascending stairs	0	1	2	3	4
3. Rising from sitting	0	1	2	3	4
4. standing	0	1	2	3	4
5. Bending to floor	0	1	2	3	4
6. Walking on flat surface	0	1	2	3	4

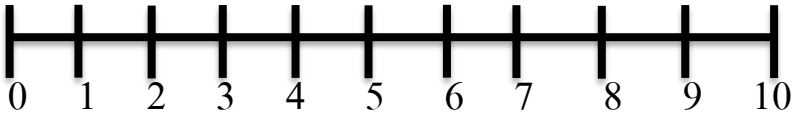
7. Getting in/ out of car	0	1	2	3	4
8. Going shopping	0	1	2	3	4
9. Putting on socks	0	1	2	3	4
10. Lying in bed	0	1	2	3	4
11. Taking off socks	0	1	2	3	4
12. Rising from bed	0	1	2	3	4
13. Getting in/ out of bath	0	1	2	3	4
14. Sitting	0	1	2	3	4
15.Getting on/ off toilet	0	1	2	3	4
16. Heavy domestic duties	0	1	2	3	4
17. Light domestic duties	0	1	2	3	4

Pretest score of the patient
is____/ 96.

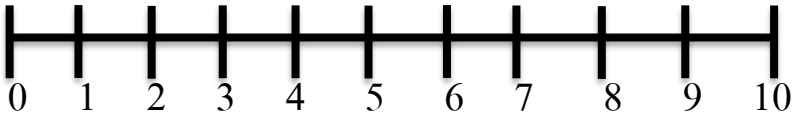
Post-test Data

Part-II: Pain Intensity

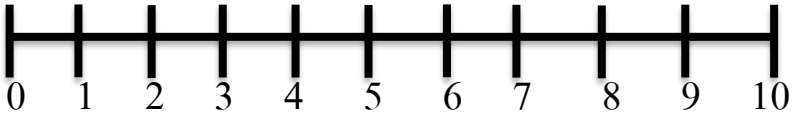
1. How much pain do you feel today?



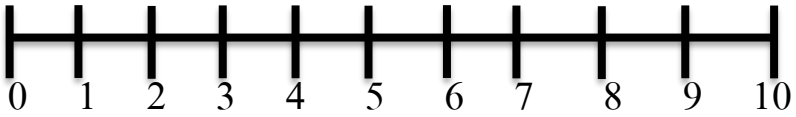
2. How much pain did you feel after waking up from sleep?



3. How much pain did you feel while standing up?



4. How much pain did you feel while rest?



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

Instructions: Please rate the activities in each category according to the following scale of difficulty: 0 = None

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6 = Moderate

7 = Very

8 = Extremely

Circle **one number** for each activity

Pain:

1. Walking	0	1	2	3	4
2. Stair climbing	0	1	2	3	4
3. Nocturnal	0	1	2	3	4
4. Rest	0	1	2	3	4
5. Weight bearing	0	1	2	3	4

Stiffness:

1. Morning stiffness	0	1	2	3	4
2. Stiffness occurring later in the day	0	1	2	3	4

Physical Function:

1. Descending stairs	0	1	2	3	4
2. Ascending stairs	0	1	2	3	4
3. Rising from sitting	0	1	2	3	4
4. standing	0	1	2	3	4
5. Bending to floor	0	1	2	3	4
6. Walking on flat surface	0	1	2	3	4
7. Getting in/ out of car	0	1	2	3	4
8. Going shopping	0	1	2	3	4
9. Putting on socks	0	1	2	3	4
10. Lying in bed	0	1	2	3	4
11. Taking off socks	0	1	2	3	4
12. Rising from bed	0	1	2	3	4
13. Getting in/ out of bath	0	1	2	3	4
14. Sitting	0	1	2	3	4

15.Getting on/ off toilet	0	1	2	3	4
16. Heavy domestic duties	0	1	2	3	4
17. Light domestic duties	0	1	2	3	4

Posttest score of the
patient is____/ 96.

সম্মতি পত্র

আসসালামু-আলাইকুম,

আমি মোঃ আসাদুল ইসলাম, ৪র্থ বর্ষের বিএসসি ইন ফিজিওথেরাপি, বাংলাদেশ হেলথ প্রফেশন্স ইন্সটিটিউট, ঢাকা বিশ্ববিদ্যালয় এর একজন ছাত্র। আমার স্নাতক ডিগ্রী পাওয়ার জন্য আমাকে একটা গবেষণা পরিচালনা করতে হবে এবং এটি আমার পড়ালেখার একটা অংশ। রিসার্চের শিরোনাম হচ্ছে "**অস্টিও আর্থ্রাইটিস রোগীদের মধ্যে প্রচলিত ফিজিওথেরাপির সাথে ইসেন্ট্রিক হ্যামসট্রিং স্ট্রেন্দেনিং বনাম কনসেন্ট্রিক হ্যামসট্রিং স্ট্রেন্দেনিং এক্সারসাইজ এর কার্যকারিতা।**"

আমার গবেষণা প্রকল্পটি সম্পন্ন করতে আমার কিছু তথ্য সংগ্রহ করা প্রয়োজন। আপনিও একজন সম্মানিত অংশগ্রহণকারী হতে পারেন এবং এজন্য এই গবেষণার জন্য অংশগ্রহণকারীর সম্মতি প্রয়োজন এবং তথ্য সংগ্রহের জন্য অংশগ্রহণকারীর কাছ থেকে ১০-২০ মিনিট সময় নেয়া. আমি আপনাকে আশ্বস্ত করছি যে ,এটি শুধু একাডেমিক গবেষণার কাজে ব্যাবহার করা হবে এবং অন্য কোনো উদ্দেশ্যে ব্যাবহার করা হবে না। আমি আপনাকে আশ্বস্ত করছি আপনার প্রদত্ত সব তথ্য গোপন রাখা হবে। আপনার অংশগ্রহণ হবে স্বেচ্ছাকৃত। অংশগ্রহণকারী যে কোনো মুহূর্তে সম্মতি প্রত্যাহার করতে পারবেন। এ ছাড়াও আপনি যে প্রশ্নটি পছন্দ করেন না সেটির উত্তর না দেওয়ার অধিকার আছে।

যদি আপনার এই গবেষণার ব্যাপারে আর কোনো প্রশ্ন থাকে , আপনি আমার সুপারভাইজর মোহাম্মদ আনোয়ার হোসেন, সহযোগী অধ্যাপক , ফিজিওথেরাপি বিভাগ, বিএইচপিআই, সিআরপি, সাভার, ঢাকা-১৩৪৩ এর সাথে যোগাযোগ করতে পারেন।

শুরু করার আগে কি আপনার কোনো প্রশ্ন আছে?

সুতরাং, আমি আপনার অনুমতিতে এই সাক্ষাতকার শুরু করতে পারি?

☐ হ্যাঁ ☐ না

অংশগ্রহণকারীর সাক্ষর ও তারিখ .....

গবেষকের সাক্ষর ও তারিখ .....

ফিজিওথেরাপিস্ট এর সাক্ষর ও তারিখ .....

প্রশ্নপত্র (বাংলা)

অস্টিও আর্থ্রাইটিস রোগীদের মধ্যে প্রচলিত ফিজিওথেরাপির সাথে ইসেন্ট্রিক হ্যামসট্রিং স্ট্রেন্দেনিং বনাম কনসেন্ট্রিক হ্যামসট্রিং স্ট্রেন্দেনিং এক্সারসাইজ এর কার্যকারিতা।

নির্দেশিকাঃ যে উত্তরটিকে আপনার সবচেয়ে সঠিক মনে হয় সেটিতে টিক (√) চিহ্ন দিন।

কোড .....

তারিখ.....

.....

নাম ..... মোবাইল .....

ঠিকানা ..... রেজিঃ নংঃ.....

পর্ব– ১ (সামাজিক এবং সাধারণ তথ্য)

ক্রমিক নং	প্রশ্নাবলী	উত্তর
১	বয়স	বছর
২	লিঙ্গ	i. পুরুষ ii. মহিলা
৩	শিক্ষাগত যোগ্যতা	
৪	পেশা	
৫	মাসিক আয়	টাকা
৬	পরিবারের সদস্য সংখ্যা	জন
৭	বৈবাহিক অবস্থা	
৮	কাজের ধরণ	i. দীর্ঘ সময় বসে ii. কায়িক শ্রম iii. গৃহস্থালি কাজ iv. দীর্ঘ্য সময় দাঁড়িয়ে v. অন্যান্য (_____)
9	কাজের পদ্ধতি	i. দাঁড়িয়ে ii. বসে iii. হেঁটে iv. অন্যান্য (_____)

পর্ব - ২ (স্বাস্থ্য সম্পর্কিত তথ্য)

ক্রমিক নং	প্রশ্নাবলী	উত্তর
১	উচ্চতা	_____সে মিঃ
২	ওজন	_____ কেজি
৩	বিএমআই	
৪	তামাক ব্যাবহার	i হ্যাঁ (যদি হ্যা হয়) ● সিগারেট ● জর্দা ● গুল ● পান ● অন্যান্য ( ) ii নেই
৫	মাদক জাতীয় দ্রব্যে নেশা	i হ্যা (যদি হ্যা হয়) ● এ্যালকোহল ● হিরোইন ● কোকেইন ● ইয়াবা ● অন্যান্য ( ) ii নেই
৬	পায়ে আঘাতের ঘটনা	i. আছে ii. নেই

৭	দীর্ঘ মেয়াদি রোগ	i. ডায়াবেটিস ii. উচ্চরক্তচাপ iii. হৃদরোগ iv. অন্যান্য……

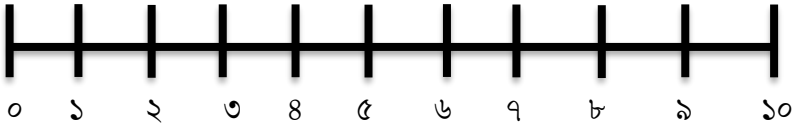
পর্ব – ৩ (শারীরিক অক্ষমতা সম্বন্ধীয় প্রশ্ন)

চিকিৎসা পূর্ববর্তী নিরীক্ষণ তথ্য

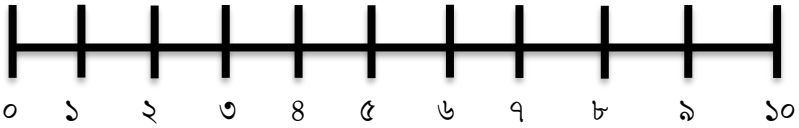
যে কোনো একটি সংখ্যায় গোল দাগ দিন।

০ = ব্যথা নেই ১০ = সর্বাধিক ব্যথা

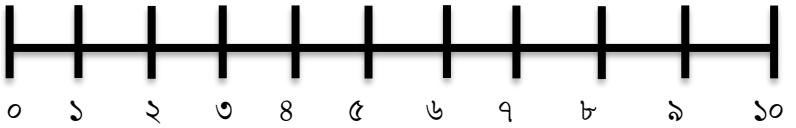
১. আজকে আপনার ব্যথা কতটুকু?



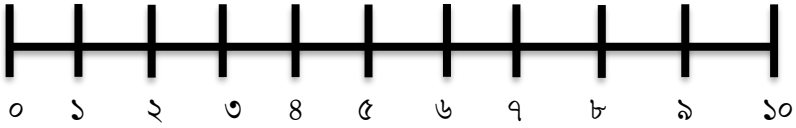
২. ঘুম থেকে উঠার পর কতটুকু ব্যথা ছিলো?



৩. দাঁড়িয়ে থাকলে কি পরিমাণ ব্যথা হয়?



৪. বিশ্রামের সময় কতটুকু ব্যথা অনুভব করেন?



ওয়েস্টার্ন অন্টারিও ও ম্যাকমাস্টার বিশ্ববিদ্যালয় অস্টিও আর্থ্রাইটিস সূচিপত্র

নির্দেশিকা – প্রত্যেক ধরণের কাজকে নিচের অসুবিধার মাপকাঠি অনুযায়ী নির্ধারণ করুন।

০ = ব্যথা নেই

১ = অল্প ব্যথা

২ = মাঝারি ব্যথা

৩ = অনেক ব্যথা

৪ = সর্বাধিক ব্যথা

ব্যথা

১. যখন হাঁটেন	০	১	২	৩	৪
২. যখন সিঁড়িতে উঠেন	০	১	২	৩	৪
৩. রাতের বেলায়	০	১	২	৩	৪
৪. বিশ্রামের সময়	০	১	২	৩	৪
৫. যখন ওজন বহন করেন	০	১	২	৩	৪

হাঁটু শক্ত হয়ে যায়

১. সকালে শক্ত হয়	০	১	২	৩	৪
২. দিনের অন্য সময় শক্ত হয়	০	১	২	৩	৪

শারীরিক কাজের সময় ব্যথা:

১. সিঁড়ি দিয়ে নামতে	০	১	২	৩	৪
২. সিঁড়ি দিয়ে উঠতে	০	১	২	৩	৪
৩. বসা থেকে উঠার সময়	০	১	২	৩	৪
৪. দাড়িয়ে থাকার সময়	০	১	২	৩	৪
৫. আসন দিয়ে বসার সময়	০	১	২	৩	৪
৬. সমতলে হাঁটার সময়	০	১	২	৩	৪
৭. যানবাহনে উঠার সময়/ নামার সময়	০	১	২	৩	৪
৮. কেনাকাটা করার সময়	০	১	২	৩	৪
৯. মোজা পড়ার সময়	০	১	২	৩	৪
১০. বিছানায় শুতে	০	১	২	৩	৪
১১. মোজা খোলার সময়	০	১	২	৩	৪
১২. শোয়া থেকে উঠার সময়	০	১	২	৩	৪
১৩. গোসলে যাওয়ার সময়	০	১	২	৩	৪
১৪. বসে থাকা অবস্থায়	০	১	২	৩	৪
১৫. টয়লেটে যাওয়ার সময়	০	১	২	৩	৪
১৬. বাসার ভারী কাজগুলো করতে	০	১	২	৩	৪
১৭. বাসার হাল্কা কাজগুলো করতে	০	১	২	৩	৪

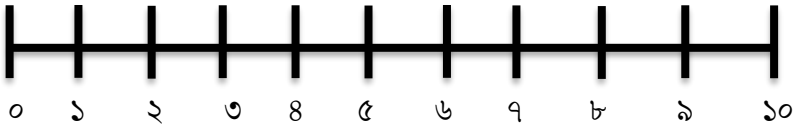
রোগীর চিকিৎসা পূর্ববর্তী নাম্বার _____/ ৯৬

চিকিৎসা পরবর্তী নিরীক্ষণ তথ্য

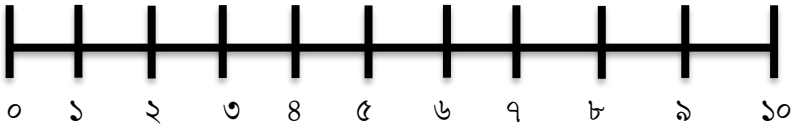
যে কোনো একটি সংখ্যায় গোল দাগ দিন।

০ = ব্যথা নেই ১০ = সর্বাধিক ব্যথা

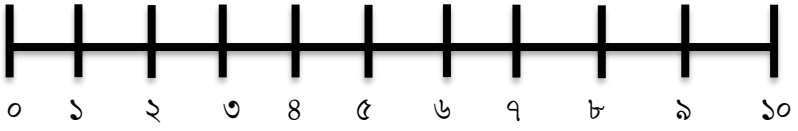
১. আজকে আপনার ব্যথা কতটুকু?



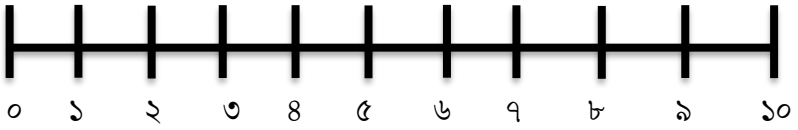
২. ঘুম থেকে উঠার পর কতটুকু ব্যথা ছিলো?



৩. দাঁড়িয়ে থাকলে কি পরিমাণ ব্যথা হয়?



৪. বিশ্রামের সময় কতটুকু ব্যথা অনুভব করেন?



(শারীরিক অক্ষমতা সম্পর্কিত তথ্য)

ওয়েস্টার্ন অন্টারিও ও ম্যাকমাস্টার বিশ্ববিদ্যালয় অস্টিও আর্থ্রাইটিস সূচিপত্র

নির্দেশিকা – প্রত্যেক ধরণের কাজকে নিচের অসুবিধার মাপকাঠি অনুযায়ী নির্ধারণ করুন।

০ = ব্যথা নেই

১ = অল্প ব্যথা

২ = মাঝারি ব্যথা

৩ = অনেক ব্যথা

৪ = সর্বাধিক ব্যথা

ব্যথা

১. যখন হাঁটেন	০	১	২	৩	৪
২. যখন সিঁড়িতে উঠেন	০	১	২	৩	৪
৩. রাতের বেলায়	০	১	২	৩	৪
৪. বিশ্রামের সময়	০	১	২	৩	৪
৫. যখন ওজন বহন করেন	০	১	২	৩	৪

হাঁটু শক্ত হয়ে যায়

১. সকালে শক্ত হয়	০	১	২	৩	৪
২. দিনের অন্য সময় শক্ত হয়	০	১	২	৩	৪

শারীরিক কাজের সময় ব্যথা:

১. সিঁড়ি দিয়ে নামতে	০	১	২	৩	৪
২. সিঁড়ি দিয়ে উঠতে	০	১	২	৩	৪
৩. বসা থেকে উঠার সময়	০	১	২	৩	৪

৪. দাড়িয়ে থাকার সময়	০	১	২	৩	৪
৫. আসন দিয়ে বসার সময়	০	১	২	৩	৪
৬. সমতলে হাঁটার সময়	০	১	২	৩	৪
৭. যানবাহনে উঠার সময়/ নামার সময়	০	১	২	৩	৪
৮. কেনাকাটা করার সময়	০	১	২	৩	৪
৯. মোজা পড়ার সময়	০	১	২	৩	৪
১০. বিছানায় শুতে	০	১	২	৩	৪
১১. মোজা খোলার সময়	০	১	২	৩	৪
১২. শোয়া থেকে উঠার সময়	০	১	২	৩	৪
১৩. গোসলে যাওয়ার সময়	০	১	২	৩	৪
১৪. বসে থাকা অবস্থায়	০	১	২	৩	৪
১৫. টয়লেটে যাওয়ার সময়	০	১	২	৩	৪
১৬. বাসার ভারী কাজগুলো করতে	০	১	২	৩	৪
১৭. বাসার হাল্কা কাজগুলো করতে	০	১	২	৩	৪

রোগীর চিকিৎসা পূর্ববর্তী নাম্বার _____/ ৯৬

INTERVENTION

Conventional Physiotherapy for knee osteoarthritis

Treatment option	**Duration/ Repetition**
Soft tissue release technique	3-5 minutes
Patellar mobilization	2 minutes
Rotation mobilization	1 minutes
Isometric strengthening exercise	3 minutes
Pendulum exercise	2-3 minutes
MWD	6 repetitions
Joint Play	10 repetitions
Knee gaping	10 repetitions
Ice	5 minutes
UST	5-7 minutes
IRR	15 minutes

Experimental Physiotherapy guideline:

Eccentric strengthening exercise:

Eccentric strength refers to tension being applied to a muscle as it lengthens. This is also when the muscle's force-producing capacity is most optimal.
During eccentric contraction, the muscle lengthens as the resistance becomes greater than the force the muscle is producing. (A.V. Hill., 1925)

Concentric Strengthening exercise:

In a concentric contraction, the muscle tension rises to meet the resistance then remains stable as the muscle shortens. (A.V. Hill., 1925)
A concentric contraction is a type of muscle contraction in which the muscles shorten while generating force, overcoming resistance.

Procedure of applying Eccentric exercise:

- At first patients should be placed on a bed in prone position.
- Place a sandbag above the ankle joint to give resistance according to tolerance.
- The patient rapidly extends the knee from 90-degree flexion and decelerates at approximately 20-30 degree via an eccentric hamstring contraction, followed by a quick concentric contraction.
- Progression is initially made by progressing from slow "catches," through medium speeds to fast catches over several training sessions.
- Once the patient experiences no discomfort during or after the fast catches, more weight is added to the foot and the patient returns to a slow catch speed before again progressing to fast catches.
- The weight is slowly progressed according to tolerance up to a point just below where a noticeable drop in catch speed is encountered. (Mjølsnes R. et al., 2003)

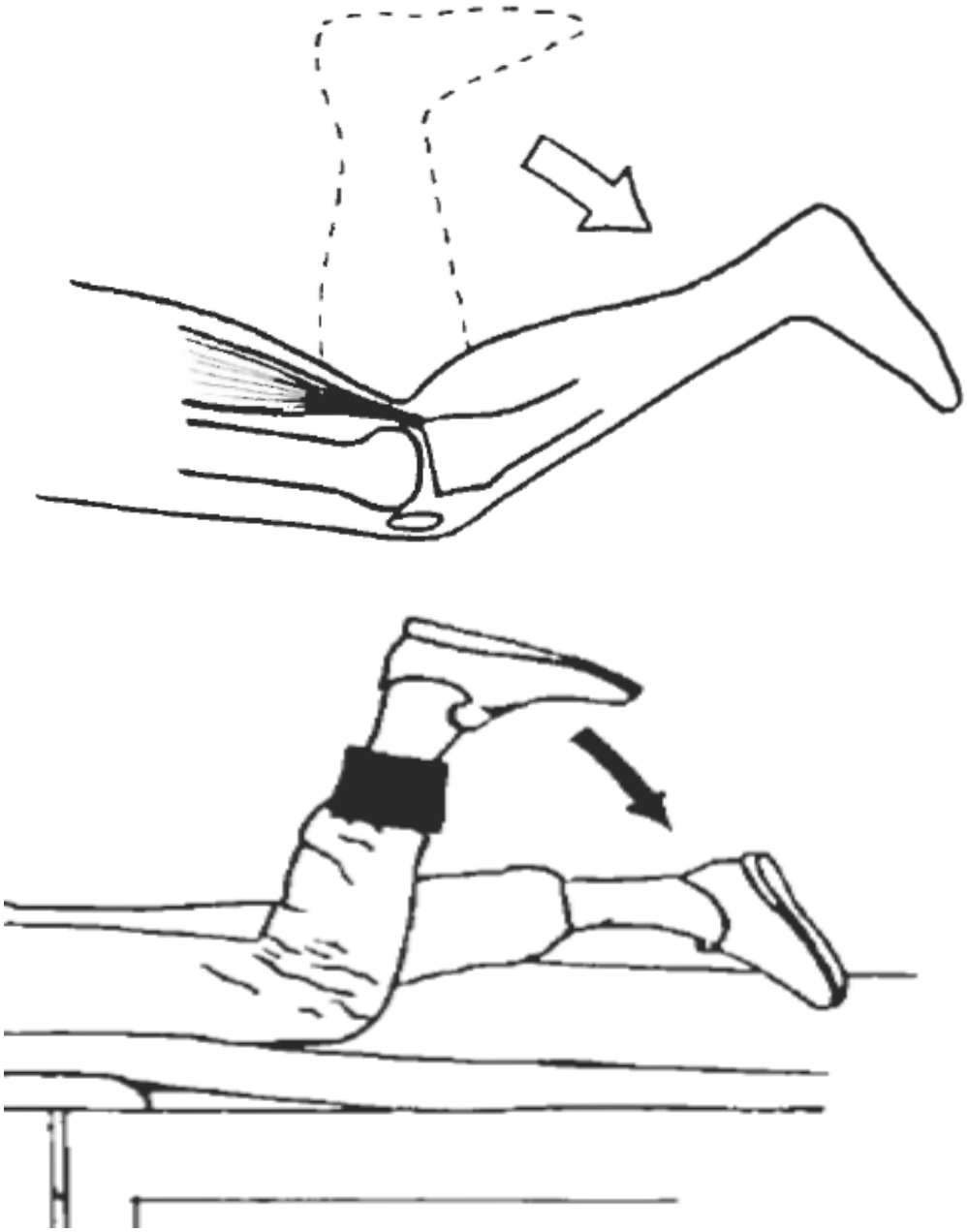


Figure 1: eccentric exercise of hamstring muscles

Procedure of applying Concentric exercise:

- Patient will go through a warmup period of 5 minutes before starting exercise.
- Then the patient will be in prone lying on a Hamstring curl machine.

- The HC exercise was performed in a traditional HC machine.
- The patients will be instructed to lie flat on the bench, stomach down, keeping their hip in a fixed position and their ankles hooked under a padded bar attached to a weight rack by a cable pulley.
- They were asked to rest their forehead on the bench, grab the handgrips, and bring their heels up towards their bottom as fast and forcefully as possible to maximize the effort during the concentric phase.
- They were instructed to return the load using as little effort as possible to minimize loading in the eccentric phase. (Mjølsnes R. et al., 2003)

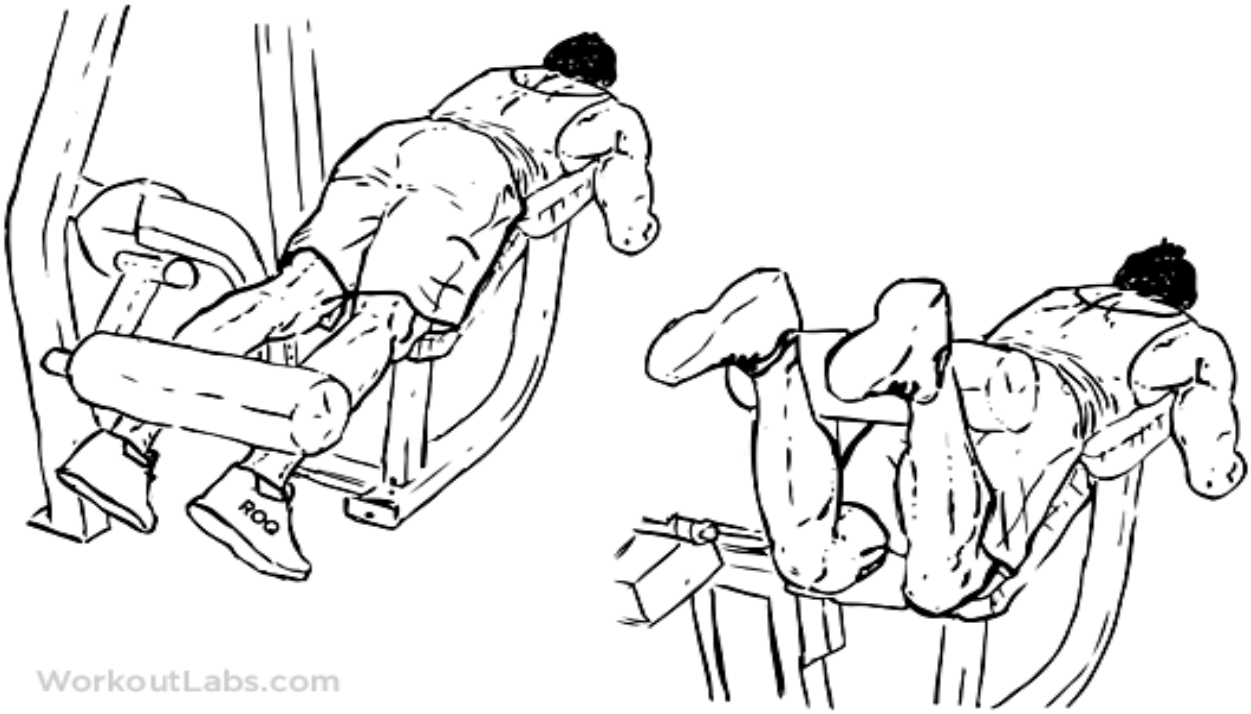


Figure 2: Concentric exercise of hamstring muscles.

Dosage and load:

After the pretesting sessions, subjects assigned to the **eccentric** and **concentric** training groups began a 3-week hamstring strength-training program. Subjects exercised **twice** each week, for a total of 6 training sessions.

Eccentric exercise:

Sets and repetitions: 3 sets of 8-12 repetitions.

Concentric exercise:

Sets and repetitions: 3 sets of 8-12 repetitions.
Progressive loading. Increase load by 2.5 kg if possible.

Effectiveness:

Eccentric exercise:

- Faster muscle gains
- Greater metabolic boosts
- More flexibility
- Reduce pain
- Lower risk of injury
- Better sports performance
- increase delayed onset muscle soreness (DOMS)
- Eccentric muscle action has been shown by many authors to be more efficient than concentric muscle action
- Eccentric muscle action can produce higher forces
- uses less oxygen than a concentric contraction of comparable muscle unit activity (Stanton P. et al., 1989)

Concentric exercise:

- Increase muscle size
- Reduce pain
- Increase strength
- Better sports performance
- Increase metabolic activity (Stanton P. et al., 1989)