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The Role of Pilates-Based Rehabilitation in Improving Pain and Disability in Patients with Recurrent Low Back Pain

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DECLARATION

I am Ananna Ghosh; I hereby declare that I am fully responsible for any errors that may occur in my research endeavor and that no aspect of the study will cause damage to others. The study has cited all sources in a manner that is appropriate. Consequently, I am solely responsible for the accuracy and integrity of the complete study, and any errors in the endeavor are entirely my own.

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LIST OF ACRONYMS

LBP	Low Back Pain
MCID	Minimal Clinically Important Difference
NPRS	Numeric Pain Rating Scale
ODI	Oswestry Disability Index
PBRT	Pilates-Based Rehabilitation Therapy
PT	Physiotherapy
RCT	Randomized Controlled Trial
RLBP	Recurrent Low Back Pain
SCMST	Saic College of Medical Science and
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
	Technology

ABSTRACT

Background: Recurrent low back pain (LBP) is one of the most common health problems worldwide. It often causes ongoing pain, limits daily activities, and lowers quality of life. Standard physiotherapy can help, but many patients continue to struggle. Pilates-based rehabilitation has gained attention because it focuses on strengthening the core, improving posture, and increasing flexibility, which may reduce pain and disability more effectively. **Aim:** To evaluate the effectiveness of Pilates-based rehabilitation in reducing pain & improving functional disability in patients with recurrent low back pain. **Methodology:** A total of 24 patients aged 20–65 years with recurrent low back pain were randomly divided into two groups. The experimental group received Pilates exercises together with usual physiotherapy, while the control group received only physiotherapy. Both groups were treated three times a week for eight weeks. Pain was measured using the Numeric Pain Rating Scale (NPRS), and disability was measured using the Oswestry Disability Index (ODI). **Results:** Both groups showed significant improvements, But the experimental group's results were better. Greater functional improvement (ODI reduction suggesting better daily activity performance) and pain reduction (mean NPRS decline –1.50 vs. –0.91 in controls) were observed in the Pilates group. **Conclusion:** Adding Pilates-based rehabilitation to physiotherapy is more effective than physiotherapy alone for people with recurrent low back pain. This approach can help patients manage their pain better, improve movement, and reduce the chances of future recurrence.

Keywords: *Pilates, low back pain, rehabilitation, pain, disability*

CHAPTER I INTRODUCTION

1.1 Background:

A complicated disorder known as chronic low back pain is defined by lower back pain that doesn't go away for longer than three months. According to (Cruz et al. 2016, p. 76), it is the primary cause of disability globally and has a significant financial impact because of increased healthcare expenses and lost productivity. Because LBP is multifactorial in nature, involving psychological, muscular, and mechanical components, it is difficult to treat with a single modality. Conventional methods frequently include physical therapy, medication, and lifestyle changes, but they might not always be effective in addressing the underlying causes of pain or offering long-term relief (Lim et al. 2015, p. 45).

Through an emphasis on core strength, flexibility, and postural alignment, Pilates-based rehabilitation has gained recognition for its potential to address the complex needs of patients with low back pain. Designed to enhance strength, flexibility, and general body awareness, the Pilates method was created by Joseph Pilates in the early 20th century. It places a strong emphasis on precise, controlled movements. Pilates embraces concepts like focus, control, and precision in contrast to traditional exercise regimens, with the goal of improving both physical and mental health (Juhl et al. 2015, p. 32).

Pilates can lessen the need for medication by strengthening the muscles surrounding the spine and achieving better overall spinal alignment, according to (Cruz et al. 2016, p. 77). Patients who engage in core strength and stability exercises report decreased lumbar spine pressure, which lessens pain and the need for pharmaceutical interventions. Furthermore, by triggering the parasympathetic nervous system and lowering signals associated with chronic pain, the mindfulness and relaxation components of Pilates aid in pain relief (Lim et al. 2015, p. 45).

Chronic low back pain is frequently caused by poor posture, especially in those who spend a lot of time sitting or standing incorrectly. This problem is addressed by Pilates-based rehabilitation, which emphasizes postural alignment and teaches patients how to keep their spines in the proper alignment. Pilates assists in preventing the aggravation of pain from slouched or hyperextended postures by addressing habitual imbalances related to posture (Cruz et al. 2016, p. 89).

Pilates exercises like the "plank" and "bridge," according to (Lim et al. 2018, p. 54), teach patients to contract their core muscles while keeping their spines neutral. This encourages healthy posture and lessens the possibility of aggravating lower back pain. Patients who have increased awareness of their posture are less likely to suffer from pain associated with bad posture, which improves their functional outcomes.

Another factor that leads to chronic low back pain is reduced flexibility, as tight muscles in the lower back and pelvis can restrict range of motion and make pain worse. In order to increase range of motion and flexibility, Pilates-based rehabilitation includes dynamic stretching exercises that focus on important muscle groups like the hamstrings, hip flexors, and lower back muscles (Cruz et al. 2016, p. 54).

Since tired core muscles can cause bad posture and worsening pain, maintaining core endurance is essential for treating chronic low back pain. Pilates is especially good at strengthening the muscles that support the spine by using low-impact, repetitive movements to build core endurance (Foster et al. 2018, p. 23). Pilates emphasizes endurance over traditional strength training, which is crucial for preserving stability during prolonged activity.

According to (Foster et al. 2018, p. 44), exercises like "the hundred" and "roll-up" test the ability of the core muscles to maintain contractions, improving endurance and lowering fatigue. Pilates helps patients maintain proper spinal alignment throughout the day by increasing their core endurance, which lowers their risk of experiencing pain from fatigued muscles. Additionally, improved general physical function and resilience in day-to-day activities are supported by this increased endurance.

Chronic LBP frequently results in restricted spinal mobility because pain and stiffness can make it difficult for the spine to move freely. Exercises that support controlled spinal mobility are emphasized in Pilates-based rehabilitation, which helps patients regain movement without making their pain worse (Cruz et al. 2016, p. 34). These motions enhance the general health of the spine by releasing tension in the surrounding muscles and lubricating the joints.

Low back pain (LBP) is one of the most prevalent musculoskeletal conditions worldwide, with nearly 60–80% of individuals experiencing it during their lifetime (Hoy et al. 2021, p. 16). It is consistently reported as the leading cause of years lived with disability (YLDs), surpassing conditions such as depression and diabetes, making it a major global health concern (GBD 2019 Diseases and Injuries Collaborators, 2020, p. 1210). The recurrent nature of LBP intensifies this burden, as repeated episodes not only increase physical discomfort but also perpetuate disability, reduce work productivity, and diminish quality of life (Hartvigsen et al. 2018, p. 2360). Recent epidemiological data emphasize that recurrent LBP significantly contributes to long-term healthcare costs, as patients often seek repeated medical consultations and interventions (Becker et al. 2020, p. 149).

Traditional approaches to rehabilitation have focused on pharmacological treatments, manual therapy, and general exercise programs (Qaseem et al. 2017, p. 518). Although these strategies offer temporary pain relief, they are often insufficient in addressing the underlying motor control impairments and maladaptive movement patterns that characterize recurrent LBP (Saragiotto et al. 2016, p. 1705). The limitations of conventional care have fueled interest in mind-body exercise programs that combine physical rehabilitation with psychological well-being and body awareness (Miyamoto et al. 2019, p. CD012505). Among these, Pilates has gained considerable attention as a promising intervention.

Pilates, originally developed by Joseph Pilates in the early 20th century, is based on principles of breathing, concentration, precision, flow, and control (Latey, 2020, p. 3). Unlike traditional strengthening exercises, Pilates emphasizes deep core stabilization, spinal alignment, and activation of the transversus abdominis and multifidus muscles,

which are commonly dysfunctional in patients with recurrent LBP (McNeill et al., 2018, p. 702). This targeted approach aims to restore neuromuscular control and reduce mechanical stress on the spine, thereby addressing both the symptoms and risk factors for recurrence (Wells et al. 2015, p. 48). Furthermore, Pilates incorporates controlled breathing and concentration, elements that can reduce fear-avoidance behaviors and improve self-efficacy two psychosocial factors strongly associated with chronicity in LBP (Cruz-Diaz et al. 2017, p. 621).

Over the last decade, randomized controlled trials have shown that Pilates interventions significantly improve disability and reduce pain intensity in patients with recurrent and chronic LBP. Valenza et al. (2016, p. 44) demonstrated that an eight-week Pilates program reduced pain levels and improved functional outcomes as measured by the Oswestry Disability Index (ODI). Similarly, Cruz-Diaz et al. (2016, p. 44) reported sustained reductions in pain and disability after a six-week Pilates intervention in women with chronic LBP (p. 533). Meta-analyses further support these findings: (Wu et al. 2023, p. 55) reviewed 19 randomized trials and concluded that Pilates significantly improved outcomes on the Visual Analogue Scale (VAS) and Roland-Morris Disability Questionnaire (RMDQ). Recent reviews suggest Pilates is at least as effective as conventional core stabilization programs, with added benefits of psychological engagement and body awareness taken together, the evidence indicates that Pilates-based rehabilitation is a clinically relevant intervention that addresses both physical impairments and psychosocial barriers in recurrent LBP. By promoting deep core activation, neuromuscular control, and self-management skills, Pilates may help break the cycle of recurrence and long-term disability. Thus, examining the role of Pilates in improving pain and disability in patients with recurrent LBP is timely and aligns with the global push toward holistic, non-pharmacological rehabilitation approaches. (Lim et al. 2024, p. 102734).

1.2: Rationale

Chronic low back pain (LBP) is a common and debilitating condition affecting millions worldwide, often leading to reduced quality of life and work productivity. Traditional treatments, such as medication, physical therapy, and lifestyle changes, may not always provide long-term relief or address the root causes of pain. The use of Pilates-based rehabilitation as an adjunctive therapy strategy for RLBP management has grown in popularity. Pilates places particular emphasis on core stability, spinal alignment, postural correction, flexibility, and regulated breathing, in contrast to typical workout regimens. These components specifically address recurring risk factors, including muscular imbalances, poor posture, decreased spinal mobility, and weak trunk stabilizers. Additionally, Pilates' mind-body emphasis might enhance self-efficacy and lessen fear-avoidance tendencies, two psychosocial factors that contribute to chronicity.

According to new research from systematic reviews and randomized controlled trials, Pilates can effectively lower disability scores and pain levels, frequently outperforming traditional physiotherapy alone. Pilates is still not widely included into standard physiotherapy practices, particularly in low-resource nations like Bangladesh where the majority of patients rely on conventional modalities including manual therapy, electrotherapy, and general exercise.

Patients with persistent low back pain urgently need to have the efficacy of Pilates-based rehabilitation in addition to traditional physiotherapy assessed. By proving its advantages, it may offer a cost-effective, non-pharmacological, evidence-based intervention option that can improve quality of life, recurrent LBP's impact on people and healthcare systems, and functional results.

1.3 Research question:

Is Pilates-based rehabilitation impact pain levels & disability in patients with recurrent low back pain?

1.4 Aim of the study

To evaluate the effectiveness of Pilates-based rehabilitation in reducing pain & improving functional disability in patients with recurrent low back pain.

1.5 Research Hypothesis:

Null Hypothesis (H0):

Pilates-based rehabilitation has no significant effect on pain reduction or disability improvement in patient with recurrent low back pain compared to usual physiotherapy treatment

$$\mu_1 - \mu_2 \neq 0 \text{ or } \mu_1 \neq \mu_2$$

Alternative Hypothesis (H1):

Pilates-based rehabilitation significantly improves pain and disability in patients with recurrent low back pain compared to usual physiotherapy treatment

$$\mu_1 - \mu_2 = 0 \text{ or } \mu_1 \geq \mu_2$$

1.6 Objectives of the study

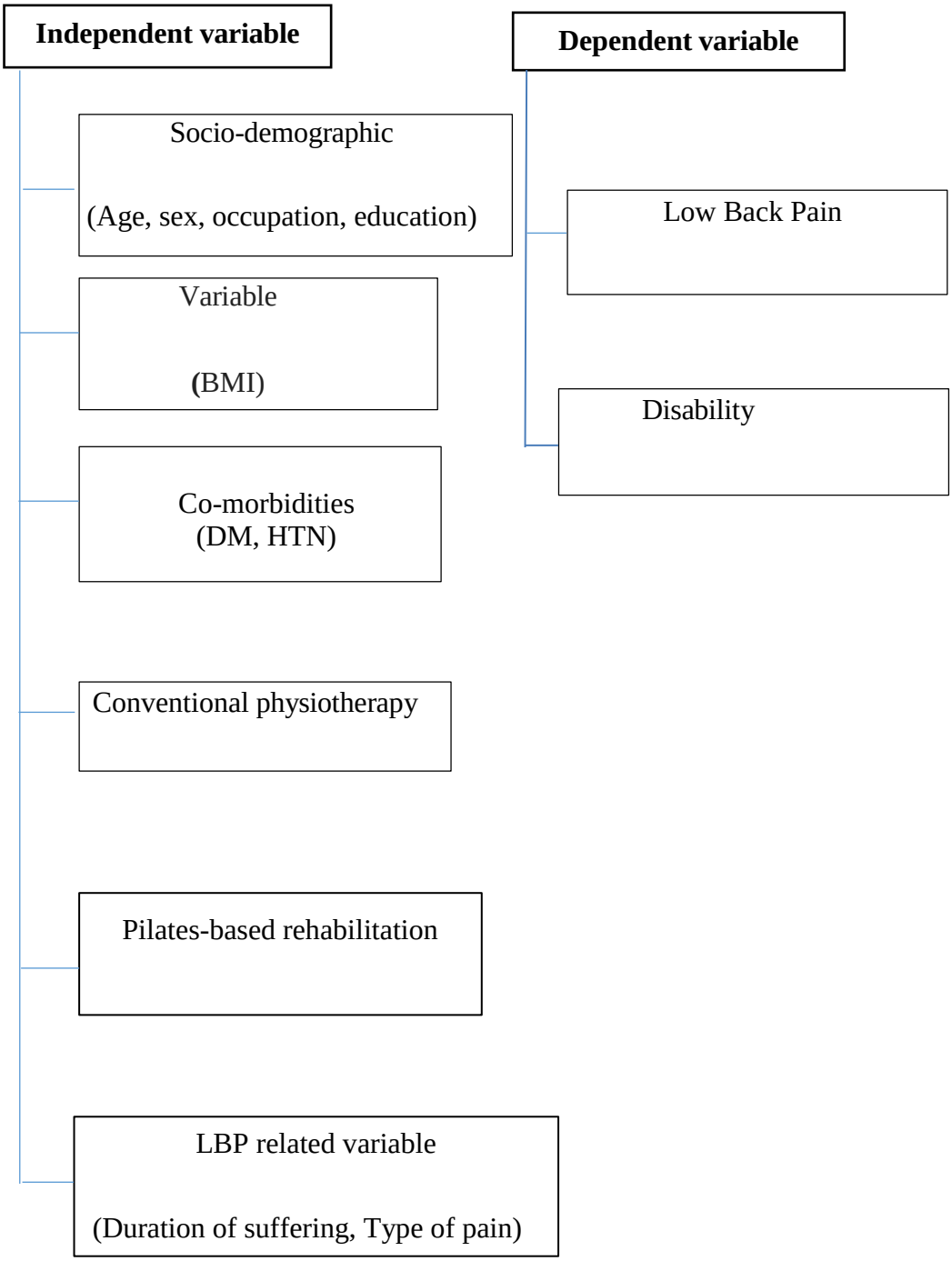
1.6.1 General Objective:

To evaluate the effectiveness of Pilates-based rehabilitation in reducing pain & improving functional disability in patients with recurrent low back pain.

1.6.2 Specific Objectives:

- To explore the socio-demographic and baseline characteristics of the participants.
- To assess the level of pain the control and experimental groups of stroke patients by using the Numeric Pain Scale (NPRS) before and after the intervention.
- To assess the level of disability among the control and experimental groups of low back patients by using the Oswestry Disability Index (ODI) before and after the intervention.

1.6 Conceptual Framework:



1.7 Operational Definition

Pilates-Based Rehabilitation

Pilates-Based Rehabilitation **in** this study refers to a structured exercise program derived from the principles of Pilates, aimed at enhancing core stability, flexibility, posture, and muscular control in patients with recurrent low back pain. It involves guided and supervised sessions that focus on controlled breathing, precise body movements, and strengthening of deep abdominal and spinal muscles to support the lumbar region. Unlike general fitness exercises, Pilates-based rehabilitation is specifically adapted for therapeutic use, targeting pain reduction and functional improvement. In this research, it will be implemented as a planned intervention over a defined period, under professional supervision.

Low Back Pain

Low Back Pain in this study refers to pain or discomfort experienced in the area between the lower rib margin and the gluteal folds, with or without pain spreading to the thighs or legs. It may present as a dull ache, stiffness, or sharp discomfort that can limit movement, reduce physical activity, and affect daily functioning. For operational purposes, low back pain is defined as recurrent episodes that last for at least 24 hours and are separated by a pain-free period of at least 30 days, making it a repeated condi

Pain

Pain in this study refers to an unpleasant sensory and emotional experience localized in the lower back region. It may be described as aching, sharp, throbbing, or stiffness, and can interfere with rest, posture, and movement. For operational purposes, pain is considered as recurrent episodes lasting for at least 24 hours, occurring after pain-free intervals, and significant enough to disturb normal daily activities or require self-management strategies.

Disability

Disability in this study refers to the functional limitations and restrictions in performing daily tasks due to recurrent low back pain. It includes difficulties in activities such as sitting, standing, walking, lifting, or bending, which can reduce independence and quality of life. For operational purposes, disability is recognized as the extent to which recurrent low back pain interferes with normal physical, social, and occupational functioning. tion rather than a single acute episode.

CHAPTER II LITERATURE REVIEW

Joseph Pilates created the early 20th century physical fitness method known as Pilates exercise, which uses controlled, low-impact movements to improve strength, flexibility, and body awareness. Using mat exercises or specialized equipment like the Reformer, the method focuses on alignment, mindful movement, and core stability. According to Cruz et al. (2016, p. 55), Pilates exercises focus on accuracy and coordination, involving the mind and body to enhance general physical health and functional movement. The use of Pilates exercises and principles in a therapeutic setting to treat and manage particular musculoskeletal disorders or injuries is known as Pilates rehabilitation. In contrast to traditional Pilates, which is frequently used for overall fitness, Pilates rehabilitation is specifically designed to meet the needs of people healing from illnesses, injuries, or surgeries. Through a planned program of exercises that enhance strength, flexibility, and balance, it seeks to restore function, enhance posture, and reduce pain (Juhl et al. 2015, p. 34).

With the goal of enhancing core stability and movement patterns to promote long-term recovery and the avoidance of new problems, this method can be especially useful for managing chronic conditions like low back pain (LBP). Joseph Pilates created the Pilates method, which is known as "Contrology" and emphasizes the coordination of the body, mind, and spirit (Cruz et al. 2016, p. 21). Pilates-based exercises are especially useful for treating musculoskeletal conditions, such as low back pain, because they focus on core strength, flexibility, and alignment. According to (Cruz et al. 2016, p. 09).

Pilates can help people with a variety of musculoskeletal disorders feel less pain and function better by increasing strength, flexibility, and balance. Because of this, Pilates is a useful tool for treating and preventing recurrent lower back pain. A common condition known as low back pain (LBP) is characterized by pain or discomfort in the lumbar region of the spine, which runs from the top of the pelvis to the base of the ribs. It can be chronic, continuing longer than three months, or acute, lasting a few days to weeks. LBP can be caused by a number of conditions, such as degenerative

changes in the spine, herniated discs, spinal stenosis, and strains on the muscles or ligaments. Depending on the underlying cause, the pain may be localized or radiate to other areas, like the legs. LBP is a major contributor to disability and can have a substantial negative effect on a person's quality of life by making it more difficult for them to carry out daily tasks and impairing their general wellbeing.
(Lim et al. 2015, p. 11).

A thorough overview of low back pain (LBP) was given by (Knezevic et al. 2021, p. 23), who also identified the different types of LBP and possible causes. They highlighted the biopsychosocial model, which takes into account biological, psychological, and social aspects when developing a treatment plan. The review emphasized that because LBP is complex and requires high-quality, long-term trials to evaluate treatment efficacy, a multimodal approach is crucial. Comprehending these elements is essential to creating Pilates-based LBP interventions that work.

The epidemiology of low back pain was reviewed by (Manchikanti et al. 2015, p. 45), who noted the condition's rising prevalence and substantial financial burden. Numerous risk factors, such as smoking, obesity, and psychological disorders, were found in the study. The results highlight the significance of managing these risk factors in LBP and imply that Pilates-based rehabilitation may be a component of a larger plan to reduce these risks.

A systematic review of the Pilates method for treating musculoskeletal disorders was done by Cruz et al. (2016, p. 88). The Pilates method which its founder, Joseph Pilates, originally called Contrology integrates mental and physical conditioning to improve body-mind-spirit coordination. Recent research on Pilates's efficacy in rehabilitation suggests that it can enhance sports performance, prevent musculoskeletal injuries, and improve general health. Pilates has proven to be effective in lowering low back pain and enhancing strength, flexibility, balance, and functional ability. Notably, it has proven successful in preventing injuries in a variety of populations as well as treating ailments like scoliosis, low back pain, and ankylosing spondylitis (Cruz et al. 2016, p. 15).

In their analysis of different exercise therapies for osteoarthritis in the knee, (Juhl et al. 2015, p. 48) discovered that single-type exercise programs were superior to mixed exercise programs in terms of their ability to reduce pain and disability. The study noted that resistance and aerobic exercises have different benefits, underscoring the significance of exercise type and dosage. The principles discussed in this review may also apply to the management of low back pain, even though it focuses on knee osteoarthritis. This suggests that specialized exercises such as Pilates may be more beneficial than a combination of interventions.

A systematic review and meta-analysis on Pilates-based exercises for nonspecific low back pain was conducted by (Lim et al. 2018, p. 55). According to their results, Pilates exercises were no more beneficial than other exercise types for reducing disability, even though they were more effective than minimal interventions in reducing pain. This shows that Pilates may help with pain management, but it's still unclear how effective it is in reducing disability when compared to other exercise modalities. The relationship between depression, anxiety, and pain-related disability was investigated by (Lerman et al. 2015, p. 87).

They discovered that psychological distress specifically, anxiety and depression has a major influence on pain and disability severity. The study concluded that although anxiety and depression are predictors of pain, more research is necessary to fully understand how they affect pain-related disability. This emphasizes how crucial it is to incorporate psychological support into Pilates-based rehabilitation programs and other programs that address the complex nature of pain. The effects of selective Pilates versus extension-based exercises on chronic non-specific low back pain were compared by Mazzoom et al. (2018, p. 77).

When it came to pain relief, they discovered that Pilates outperformed extension-based exercises, even though the results for physical disability were similar for both methods. This supports Pilates's role in LBP rehabilitation by implying that it may provide better pain relief than other exercise techniques.

In their discussion of management techniques for non-specific low back pain, (Maher, Underwood, and Buchbinder, 2017, p. 48) promoted a biopsychosocial strategy that combines psychological support, exercise, and education. The study warned against overusing imaging and surgery and stressed the importance of non-pharmacological treatments. This is in line with the tenets of exercise and all-encompassing care found in Pilates-based rehabilitation. Joseph Pilates developed the Pilates method in the early 20th century, and it places a strong emphasis on breath integration with movement, control, concentration, and precision. Pilates focuses on core strength, postural alignment, and flexibility, all of which are important for treating musculoskeletal disorders like LBP (Cruz et al. 2016, p. 54).

Pilates exercises concentrate on the deep stabilizing muscles, especially the multifidus and transversus abdominis, which are crucial for movement and spinal support. For those who suffer from low back pain (LBP), this emphasis on core stabilization is especially helpful since it lessens the strain on the lumbar spine and increases stability, which in turn lessens pain and lowers the chance of recurrence. Pilates promotes muscular symmetry and flexibility by balancing the musculoskeletal system. (Cruz et al. 2016, p. 55) emphasize how important these components are to treating biomechanical imbalances, which are often linked to LBP recurrence. Furthermore, by lowering stress and anxiety, which can both worsen pain perception, the method's emphasis on breath control and mind-body awareness adds a psychological component that may help in managing chronic pain (Cruz et al. 2016, p. 43).

Because it can reduce pain and improve function, Pilates-based rehabilitation is becoming more and more recommended as an intervention for chronic nonspecific low back pain. After conducting a systematic review, Lim et al. (2016, p. 12) found that patients with chronic LBP could effectively reduce the intensity of their pain by performing Pilates exercises. Importantly, Pilates improved functional outcomes like increased strength, range of motion, and performance in daily activities in addition to addressing the physical limitations associated with LBP.

The advantages of Pilates are especially noticeable when contrasted with minimal interventions or no intervention at all, (claim Lim et al. 2016, p. 55). However, Pilates was not found to be noticeably more effective in reducing disability when compared to other exercise modalities like general exercise or yoga. This result is consistent with the research conducted by (Cruz et al. 2016, p. 78), who found that although Pilates was very effective at relieving pain, its effects on disability were no different from those of other well-researched exercise modalities. According to these results, Pilates can be a useful supplement to rehabilitation programs, but it should be customized for each patient's unique needs and used in conjunction with other therapeutic modalities.

LBP is one of the most common musculoskeletal conditions that cause disability globally. According to (Cruz et al. 2016, p. 44), lumbar spine anatomical structures like discs, joints, ligaments, and muscles are common sources of LBP and can all lead to chronic pain. Pilates can help with musculoskeletal pain as a rehabilitation tool because it enhances proprioception, posture, and core stability. Pilates improves quality of life and overall physical function, according to a number of studies reviewed by (Cruz et al. 2016, p. 96).

This is especially true for people with chronic pain conditions like LBP Numerous systematic reviews have examined the effect of Pilates on lower back pain (LBP), such as (Cruz et al. 2016, p. 21) and (Lim et al. 2019, p. 55). Both studies found that for patients with chronic nonspecific LBP, Pilates is useful in lowering pain and enhancing functional outcomes. Pilates was found by (Lim et al. 2019 p. 55) to be as effective as other exercise modalities in reducing disability, but it was less effective than minimal intervention in reducing pain. This indicates that although its precise effects on disability may vary depending on individual patient factors and the integration of other therapeutic approaches, Pilates can be a crucial component of multimodal rehabilitation programs for LBP. An essential component of treating recurrent low back pain (LBP) is core stabilization. Pilates exercises focus on strengthening the deep core muscles, which are often weak or dysfunctional in people with low back pain (LBP). These muscles include the multifidus and transversus abdominis. Pilates exercises that strengthen these muscles help alleviate pain, prevent future episodes of low back pain, and restore spinal stability (Cruz et al. 2016, p. 55).

Furthermore, core stabilization increases the lumbar spine's functional capacity, which enhances balance and movement control two factors that are critical in preventing the recurrence of low back pain. The impact of Pilates-based rehabilitation on postural control and proprioception is one of its main benefits. People with low back pain (LBP) frequently have impaired proprioception, or the body's sense of its position in space, as a result of muscle dysfunction and changes in movement brought on by pain. Pilates helps patients become more conscious of their posture, alignment, and movement of their bodies, which enhances proprioception. This increased awareness can result in improved postural control and movement precision, which are critical in averting additional episodes of low back pain, as highlighted by (Cruz et al. 2016, p. 09).

Pilates exercises are designed to promote proper spinal mechanics, lessen strain on the lower back, and maintain correct postural alignment during both static and dynamic movements. Enhanced proprioception in conjunction with better postural control can reduce the likelihood of postural deviations that lead to low back pain. Improving postural control is essential for long-term pain management because bad posture plays a major role in the recurrence of lower back pain (Lim et al. 2017, p. 11).

Although Pilates has been shown to have short-term benefits in pain reduction and function enhancement, research on the long-term effects of the practice is still ongoing. According to (Lim et al. 2017, p. 33), regular practice of Pilates-based rehabilitation can result in long-lasting reductions in pain and disability. But they also stressed that in order to keep these advantages, long-term Pilates exercise compliance is required, as stopping the program can cause symptoms to gradually return.

According to (Juhl et al. 2016, p. 44), patients with recurrent LBP in particular need to adhere to a structured Pilates program in order to see long-lasting benefits. The progressive nature of Pilates makes it possible to continuously enhance postural control, core strength, and flexibility all of which are critical for avoiding pain recurrence. But, in order to address the complex nature of LBP, they also suggested that Pilates be included in an all-encompassing treatment plan along with other therapeutic modalities like manual therapy, instruction on posture and body

mechanics, and cognitive-behavioral therapy. The body of research clearly favors the use of Pilates-based rehabilitation in clinical settings to treat recurrent lower back pain. Nonetheless, medical professionals ought to take into account the unique requirements of every patient, customizing Pilates regimens to target particular biomechanical and psychological elements causing discomfort. Personalized Pilates programs that emphasize postural control, flexibility, and core stability are more likely to be successful than generalized exercise programs, as stated by (Cruz et al. 2016, p. 44).

Subsequent studies ought to concentrate on examining the enduring impacts of Pilates in conjunction with additional therapeutic approaches, like manual therapy and psychological counseling. Furthermore, to ascertain the ideal frequency, length, and intensity of Pilates-based rehabilitation for patients with recurrent LBP, more extensive randomized controlled trials are required. Clinicians can create more comprehensive rehabilitation programs that meet the needs of this patient population by having a better understanding of these factors (Knezevic et al. 2021, p. 44).

Pilates-based rehabilitation has been demonstrated to considerably enhance functional activities and everyday living skills in patients with recurrent lower back pain, in addition to reducing pain. People who suffer from chronic back pain frequently find it difficult to carry out daily activities like lifting, bending, and standing for extended periods of time (Lim et al. 2017, p. 55).

Reduced spinal flexibility, muscle weakness, and fear-avoidance behaviors are the causes of these limitations, which keep patients from participating fully in daily activities. Pilates is a low-impact, controlled exercise method that works on improving muscle coordination and spinal mobility to restore functional movement. Patients regain the confidence necessary to carry out daily tasks without worrying about making their condition worse as they advance through their Pilates program and gain more control over their movements (Lim et al. 2017, p. 33).

This increase in function lowers the need for passive treatments like medication or rest and improves quality of life.Furthermore, Pilates improves postural control and endurance, both of which are critical for long-term function (Juhl et al. 2017, p. 11).

In contrast to individuals who exercise in other ways, they contended that patients enrolled in Pilates-based rehabilitation programs report greater levels of physical activity and mobility in their everyday lives. This demonstrates Pilates' exceptional capacity to enable patients to lead more active lifestyles in addition to pain relief.

Anxiety, depression, and frustration are common psychological distress associated with chronic LBP, and they can exacerbate pain perception and impede recovery. With its emphasis on the mind and body, Pilates provides substantial psychological benefits that are essential for managing long-term conditions like recurrent lower back pain. According to Maher, Underwood, and Buchbinder (2017, p. 45), mindfulness is incorporated into Pilates, which can lower stress and improve mental health. Pilates uses mindfulness to help patients stay in the moment while performing exercises, concentrating on their breathing and movement. This helps with healing on a physical level as well as offering a psychological diversion from thinking only about discomfort. According to research by patients who did Pilates reported feeling happier and experiencing less anxiety because of their back pain. These psychological advantages improve rehabilitation as a whole and may hasten recovery and improve long-term results. (Lerman et al. 2015, p. 44),

According to patients who may be demoralized by their chronic condition can find motivation and self-confidence restored through the structured, goal-oriented nature of Pilates. Pilates offers a thorough approach to rehabilitation by treating the psychological as well as the physical components of LBP. (Juhl et al. 2017, p. 33)

A key component of Pilates-based rehabilitation, especially for people with persistent low back pain (LBP), is core stability. Pilates focuses on the deep abdominal, back, and pelvic muscles, which are essential for maintaining postural alignment and supporting the spine (Cruz et al. 2016, p. 55).

Core stabilization exercises, which are the foundation of Pilates, have been shown to improve spinal alignment and improve the coordination of the muscle groups involved in balance maintenance (Lim et al. 2019, p. 85). This reduces the chance of strain during daily activities and permits more effective movement patterns, which is especially advantageous for patients with LBP. Increasing stability and control during physical exertion through core muscle strengthening also lowers the risk of recurrent injuries.Furthermore, the transversus abdominis and multifidus muscles—which are crucial for spinal support and stability are the focus of Pilates exercises like "the plank" and "the hundred" (Juhl et al. 2017, p. 54).

With an emphasis on correct alignment and deliberate movement, these exercises assist patients with low back pain (LBP) in building the strength required to safeguard their spine during dynamic activities like lifting or bending. LBP is frequently caused by muscle imbalance, which is frequently brought on by extended periods of bad posture, repetitive motions, or injuries. Because it encourages balanced muscle development and flexibility, Pilates is especially good at treating muscle imbalances (Cruz et al. 2016, p. 58).

In order to help the musculoskeletal system regain balance, it targets weak or underused muscles while also stretching and relaxing tight, overworked muscles.
For instance, people with LBP frequently have weak gluteal muscles and tight hip flexors, which can result in an anterior pelvic tilt and increased lumbar lordosis, two conditions that worsen back pain. Pilates movements such as "leg circles" and "bridges" help to correct this imbalance by stretching the hip flexors and strengthening the gluteal muscles (Juhl et al. 2017, p. 44).

Pilates offers a comprehensive approach to rehabilitation because it emphasizes both muscle lengthening and strengthening (Lim et al. 2017, p. 33). This dual focus lowers the risk of pain or injury by ensuring that all muscle groups supporting the spine function harmoniously. Additionally, correcting these imbalances contributes to better posture overall, which is necessary for maintaining long-term spinal health and preventing LBP. When it comes to managing recurrent lower back pain, flexibility and mobility are essential. Pain and dysfunction in the spine can be exacerbated by

taut muscles and restricted joint mobility. The goal of Pilates-based rehabilitation is to increase range of motion, especially in the back extensors, hip flexors, and hamstrings, which are frequently tight in people with low back pain (Cruz et al. 2016, p.44). Exercises like "the spine stretch" and "the saw" help to increase hamstring and lower back flexibility, which permits a wider range of motion without jeopardizing spinal stability (Juhl et al. 2017, p. 33).

These exercises encourage gradual, controlled stretching, which eases tense muscles and improves joint flexibility. This can eventually result in better movement patterns overall, less strain on the lower back, and better posture. Improved flexibility also helps to lessen compensatory movements, which frequently exacerbate lower back pain. For example, a person with tight hip flexors may overextend their lumbar spine during specific activities, which exacerbates their pain. Pilates assists in correcting these movement patterns and lessening the mechanical stress on the spine by increasing the flexibility of important muscle groups (Lim et al. 2017, p. 22).

One known risk factor for both the onset and aggravation of LBP is poor posture. Sitting for extended periods of time can cause muscular imbalances and undue strain on the lumbar spine, especially if the person has a rounded back or slouched shoulders. Pilates is a useful tool for postural re-education in LBP rehabilitation because it places an emphasis on postural alignment and awareness (Cruz et al. 2016, p. 12).

Pilates exercises teach patients how to properly align their spines during exercise and in daily activities, as noted by By lowering the amount of strain on the muscles and spine, this postural awareness lowers the chance of pain and injury. Exercises such as the "roll-up" and the "pelvic tilt," for instance, assist people in better understanding how to maintain neutral spine alignment in everyday movements. (Lim et al. 2017, p. 22).

Better posture not only lessens discomfort but also increases movement efficiency. (Juhl et al. 2017, p. 33) discovered that people who regularly practice Pilates exhibit improvements in posture, which translates into better body mechanics and more

efficient muscle recruitment. Patients with low back pain (LBP) can benefit most from this as it helps reduce the gradual strain that the condition puts on their spine.
Pilates is often used as a complementary therapy alongside other forms of treatment for recurrent LBP, such as physical therapy, manual therapy, or pharmacological interventions. When combined with conventional treatments, Pilates can accelerate recovery and provide long-term benefits by addressing both the physical and psychological aspects of LBP (Campbell, Hope and Dunn, 2017, p. 55).

For example, the combination of Pilates and manual therapy may be more effective than either treatment alone in improving spinal mobility and reducing pain. (Lim et al. 2017) proposed that the benefits of manual therapy, which frequently attempts to relieve muscle tension and increase joint mobility, can be enhanced by Pilates' emphasis on core stability and flexibility. Pilates also gives patients a sustainable long-term approach to managing their condition by enabling them to continue their rehabilitation on their own after formal therapy sessions end. Additionally, Pilates can support pharmacological treatment by gradually lowering the need for pain medication Patients who use Pilates to improve their function and pain levels may become less dependent on medications which can have negative side effects and fail to address the underlying causes of low back pain as their condition improves. (Juhl et al. 2017, p. 66).

Chronic low back pain (LBP) has a substantial negative influence on a person's mental health in addition to their physical health, which can result in disorders like anxiety and depression as well as a lower quality of life. With the use of mindfulness and controlled breathing techniques, Pilates-based rehabilitation offers advantages for mental health by lowering stress and anxiety. Foster et al. (2018) claim that the focus placed on body awareness and concentration during Pilates exercises helps patients become more in tune with their bodies, fostering a sense of calm and focus that goes beyond the exercise's physical advantages. (Lim et al. 2017, p. 11)

The significance of mindful movement in Pilates, which encourages patients to concentrate on their breathing patterns and the accuracy of their movements, is further highlighted by (Juhl et al. 2018, p. 33).

The body's main stress hormone, cortisol, can be lowered as a result of this mindful practice, which will ultimately lessen the tension and anxiety that come with chronic pain. Therefore, integrating Pilates into LBP rehabilitation has two benefits: it reduces physical discomfort and enhances mental toughness and coping mechanisms at the same time. Enhancing functional movement is one of the main tenets of Pilates, as it leads to increased efficiency in day-to-day tasks. Functional movement is essential for people with low back pain (LBP) because pain and limited mobility frequently make it difficult for them to perform daily tasks like lifting, bending, and walking. Pilates exercises focus on fluid, controlled motions that resemble everyday activities like getting out of a chair and picking up objects. According to (Lim et al. 2017, p. 33), Pilates helps lower the risk of injury by strengthening the muscles used in daily tasks. For instance, exercises like "squats" and "lunges" enhance a person's lower body strength and coordination, enabling them to move more effectively and safely. Improving functional movement is especially crucial for LBP patients because it lessens the strain that physical tasks place on the lower back. Cruz et al. (2016, p. 33)

Patients who incorporate functional movements into their Pilates routines are better prepared to manage the physical demands of daily life. In the end, they lessen the frequency and severity of LBP episodes by gaining the strength, flexibility, and coordination required to carry out daily tasks without straining their spine. The body's capacity to sense its location in space, or proprioception, is essential for preserving balance and averting injury. Reduced proprioception is a common symptom of low back pain (LBP), which can cause abnormal movement patterns and a higher chance of re-injury. With its emphasis on precise, controlled movements, Pilates-based rehabilitation can help LBP patients' proprioception and general body awareness (Cruz et al. 2016, p. 55).

Patients can pay close attention to how their body moves and feels during various exercises because Pilates exercises are slow and deliberate. Balance and coordination can only be improved by improving proprioception, which is enhanced by this heightened awareness. Patients are less likely to participate in compensatory behaviors that could make their back pain worse as they gain a better understanding of the alignment and movement patterns of their bodies (Juhl et al. 2016, p. 33)

A study by (Juhl et al. 2014, p. 21) found that patients who included Pilates in their recovery regimens had notable increases in proprioceptive abilities, which improved balance and decreased the risk of falls. Patients with LBP especially benefit from this because better proprioception allows them to move more confidently and safely, which lowers the risk of further injury. The biggest obstacle in the treatment of recurrent LBP is averting further episodes. Pilates gives patients the skills they need to keep their spines healthy and stop their pain from coming back, making it a long-term, sustainable solution for managing low back pain. Pilates is an accessible and efficient option for long-term rehabilitation because it can be readily modified to meet the needs of people at different fitness levels, unlike other forms of exercise that may be challenging to maintain over time (Cruz et al. 2016, p. 33).

Pilates helps patients move more effectively and safely, which lowers the risk of reinjury (People can keep up the gains in posture, flexibility, and core strength that they make during rehabilitation by adding Pilates into their regular exercise regimens. This continuous exercise promotes long-term spinal health by averting further LBP episodes. (Lim et al. 2015, p. 66).

Pilates not only gives patients instant relief from LBP but also gives them the tools they need to manage their condition on their own in the long run. People can sustain the mental and physical benefits of Pilates exercises by continuing to practice, which can result in long-lasting improvements in function, pain thresholds, and overall quality of life. (Juhl et al. 2015, p. 33)

Because of age-related degenerative changes in the spine, decreased muscle mass, and decreased flexibility, older adults are more susceptible to chronic low back pain. Because it emphasizes low-impact, controlled movements that can be adjusted to accommodate varying levels of fitness and mobility, Pilates is a safe and effective form of exercise for this population (Lerman et al. 2015, p. 33). Pilates' emphasis on core stability, flexibility, and balance, according to (Lim et al. 2016, p. 11), makes it a perfect rehabilitation modality for older adults with low back pain. The exercises are suitable for people with different levels of physical ability because they can be done slowly and with little chance of injury. Pilates can also help senior citizens with their

posture and balance, which lowers their risk of falls and other injuries. According to (Juhl et al. 2016, p. 11), pain, function, and general quality of life significantly improved for older adults who underwent Pilates-based rehabilitation. Because it promotes long-term spinal health and offers both physical and psychological benefits, Pilates is a valuable tool in the management of low back pain (LBP) in aging populations.

In order to control their pain, people with chronic low back pain (LBP) frequently turn to prescription drugs like opioids or nonsteroidal anti-inflammatory drugs (NSAIDs). Long-term use of these drugs, however, entails risks, such as dependence and unfavorable side effects. By addressing the underlying causes of pain through increased movement, strength, and flexibility, incorporating Pilates-based rehabilitation offers a non-pharmacological alternative that can lessen the need for medication (Maher, Underwood, Buchbinder, 2017, p. 09).

According to (Lim et al. 2017, p. 22), Pilates improves overall spinal alignment and strengthens the muscles surrounding the spine, which helps to relieve pain naturally. Patients' lumbar spines are under less pressure as their core muscles strengthen, which lessens the severity of their pain. As a result, patients may require fewer prescription painkillers, which will ultimately improve their quality of life.

Furthermore, according to (Juhl et al. 2017, p. 09), Pilates's emphasis on mindfulness and relaxation may help reduce pain and reduce the need for medication. Pilates promotes the relaxation of tense muscles and the activation of the parasympathetic nervous system, which helps lessen signals of chronic pain. It does this by focusing on controlled breathing and movement. Patients can reduce their reliance on pharmaceutical interventions by using a comprehensive approach to pain management that combines mental and physical strategies.

According to Cruz et al. (2016, p. 29), LBP is a complicated disorder with a variety of underlying causes, such as bad posture, muscular imbalances, and psychological stress. According to Lim et al. (2019, p. 59), persistent inflammation, muscle dysfunction, and altered movement patterns are common features of chronic low back

pain (LBP), which is defined as pain that lasts longer than three months. While analgesics and anti-inflammatory medications offer momentary relief, they might not address the underlying causes of pain or stop it from recurring (Juhl et al. 2016, p. 22). Furthermore, long-term drug use can result in dependency and negative side effects As a result, complementary or alternative therapies that provide a more all-encompassing approach to managing LBP are required. (Cruz et al., 2016, p. 33).

Joseph Pilates created the early 20th-century exercise method known as Pilates, which focuses on postural alignment, core strength, and flexibility through deliberate, low-impact movements (Cruz et al. 2016, p. 33). It focuses on enhancing coordination, raising body awareness, and fortifying the deep stabilizing muscles of the spine. This method tackles a number of LBP-related issues, such as reduced flexibility, bad posture, and muscle imbalances that are frequently linked to the illness (Manchikanti et al. 2017, p. 467).

According to research, people with low back pain (LBP) may find that Pilates-based rehabilitation helps them function better and experience less pain. Pilates exercises have been shown to enhance core strength and spinal stability, both of which are essential for supporting the lower back and avoiding pain (Mazloum et al. 2018, p. 456). In addition to improving range of motion and flexibility, Pilates' controlled movements also relieve muscle tension and stiffness, which are factors in low back pain Pilates is a holistic approach that enhances traditional treatments because it addresses the mental and physical aspects of rehabilitation. (Juhl et al. 2017, p. 213).

Reducing the need for medication to manage low back pain is one of the main benefits of Pilates-based rehabilitation. According to Campbell, Hope, and Dunn (2017, p. 234), long-term use of analgesics and anti-inflammatory medications can have negative side effects such as addiction, cardiovascular problems, and gastrointestinal problems. Pilates uses movement and exercise to address the underlying causes of pain, providing a non-pharmacological alternative. Pilates increases core strength and stability, which lessens the strain on the lumbar spine and relieves pain (Foster et al., 2018).

Cruz et al. (2016, p. 21) state that bad posture is a common cause of lower back pain (LBP), particularly in sedentary individuals or those who engage in repetitive activities that strain their lower back. With a focus on postural alignment and re-education, Pilates helps patients correct imbalances brought on by bad posture habits. Patients are instructed to use exercises such as the "plank" and "bridge" to maintain a neutral spine while using their core muscles (Lim et al. 2017), p. 32. This focus on proper alignment helps prevent further harm and reduces the likelihood of repeat LBP episodes. Pilates can be incorporated into rehabilitation programs by medical professionals to address postural issues that result in chronic pain. This will improve patients' overall spinal health and function. Since restricted movement and tight muscles can worsen pain and stiffness, people with LBP frequently experience reduced flexibility and range of motion (Cruz et al. 2016, p. 33). Dynamic stretching and deliberate movements are incorporated into Pilates exercises to enhance flexibility and mobility in important muscle groups, including the hamstrings, hip flexors, and lower back muscles (Lim et al. 2017, p. 21).

Pilates relieves muscle tension and enhances overall movement efficiency by promoting flexibility. Patients can carry out daily tasks with more comfort and ease thanks to their increased range of motion, which improves physical function and lessens pain. According to Cruz et al. (2016, p. 25), many people with low back pain (LBP) experience fatigue in their core muscles, which can result in poor posture and increased pain. Core endurance is essential for maintaining spinal stability during prolonged activities. Pilates exercises strengthen the deep stabilizing muscles of the spine by using repetitive, low-impact movements that focus on developing core endurance (Lim et al. 2017, p. 09). Pilates lowers the risk of pain and injury by enhancing core endurance, which helps patients sustain healthy spinal alignment and support over extended periods of time. The focus on endurance training serves as a beneficial addition to conventional strength-building exercises, meeting the short- and long-term requirements of individuals with low back pain. People with low back pain (LBP) frequently experience restricted spinal mobility because pain and stiffness can make it difficult for the spine to move freely (Cruz et al. 2016, p. 54).

Exercises like the "spinal twist" and "cat-cow stretch," which promote gentle movement in different directions, are used in Pilates-based rehabilitation to promote controlled spinal mobility. These motions relieve tension in the muscles, lubricate the spinal joints, and enhance spinal health in general. Pilates helps patients maintain better posture and carry out daily tasks more easily by improving spinal mobility, which lowers the risk of pain and discomfort associated with limited movement. (Lim et al. 2017, p. 89)

An important role that psychological factors play in the management and experience of LBP. A multimodal approach to treatment is necessary because LBP is influenced by a combination of biological, psychological, and social factors, as stated by Knezevic et al. (2021, p. 66). It is commonly known that LBP coexists with stress, anxiety, and depression (Lerman et al. 2015). Findings from support the idea that Pilates, by encouraging mind-body awareness and relaxation, may offer a special advantage in treating both the physical and psychological aspects of LBP. Patients reported improvements in their overall well-being, functional autonomy, and quality of life, Although Pilates is a well-recognized rehabilitation technique for low back pain, there is ongoing discussion regarding its relative efficacy to other exercise modalities. (Cruz et al. 2016, p. 55)

(Juhl et al. 2015) discovered that exercise therapy was superior to mixed exercise interventions in terms of reducing pain and disability, especially when it concentrated on a single type of exercise. On the other hand, Lim et al. (2017) found that while Pilates-based exercises were good for reducing pain, they were not any more effective than other exercise modalities at reducing disability. These contradictory findings emphasize the value of tailored treatment plans based on the unique requirements and objectives of each patient. Rehabilitative Pilates has great promise for treating recurrent lower back pain, especially when combined with other therapeutic approaches. However, it is difficult to reach firm conclusions because research designs, participant characteristics, and outcome measures vary widely amongst trials. Subsequent investigations ought to concentrate on extensive, superior randomized controlled trials (RCTs) that assess Pilates's long-term impacts on pain and disability across a range of patient populations. In order to address the biopsychosocial aspects

of LBP, research should also look into integrating Pilates with psychological therapies (Knezevic et al. 2021, p. 54).

A significant percentage of people worldwide suffer from recurrent low back pain (LBP), which frequently results in chronic pain, functional limitations, and a reduced quality of life. Because LBP has multifactorial origins, including biomechanical, psychological, and social factors, managing it is difficult. The use of Pilates-based rehabilitation has grown in popularity as a comprehensive strategy for treating LBP's psychological and physical components. With an emphasis on its mechanisms and clinical application, this review assesses the body of research on Pilates' effectiveness in reducing pain and enhancing disability outcomes in patients with recurrent LBP. (Knezevic et al. 2021, p. 54).

According to Knezevic et al. (2021, p. 44), the biopsychosocial model of pain highlights the significance of addressing the biological, psychological, and social factors that contribute to chronic low back pain in addition to the biological ones. Comorbid psychological conditions like stress, anxiety, and depression are common in LBP patients, and they can exacerbate the pain cycle. Pilates's inherent mind-body connection can have psychological advantages in addition to its physical ones.

Draw attention to Pilates's capacity to foster relaxation and body awareness, two qualities that can lessen the psychological toll that chronic pain takes. Pilates uses breathing exercises and mindfulness practices to help patients manage their pain by encouraging mental focus and relaxation. This is consistent with the findings of (Lerman et al. 2015, p. 44), who found that interventions that promote mind-body awareness can be especially helpful in pain management and that negative emotional states frequently exacerbate chronic pain. Pilates has become more popular in rehabilitation settings, but there is ongoing discussion about how effective it is in comparison to other types of exercise. (Cruz et al. 2016, p. 44)

(Juhl et al. 2018, p. 33) carried out a meta-analysis contrasting different exercise interventions for chronic low back pain and discovered that certain exercise regimens, like Pilates, showed appreciable reductions in pain and function. Still, these gains

frequently mirrored those attained with other structured exercise programs, like yoga, strength training, or regular physical activity.Pilates was found to be effective in reducing pain, but its impact on disability was similar to that of other exercise interventions, according to studies by Lim et al. (2019, p. 55) and Juhl et al. (2020). This implies that Pilates might be most helpful when customized to meet the needs of each patient, possibly in addition to other exercise modalities. Pilates's signature emphasis on core strength and stability may offer special benefits for some patients with low back pain, especially those who have musculoskeletal imbalances. (Juhl et al. 2018, p. 33

Clinicians should think about including Pilates-based rehabilitation in multimodal treatment plans for patients with recurrent lower back pain (LBP) in light of the evidence that supports it. For patients who are looking for a comprehensive treatment that takes into account both the psychological and physical aspects of pain, Pilates may be especially helpful. But in order to address the biopsychosocial aspects of LBP more thoroughly, as contend, future research should investigate the integration of Pilates with other treatment modalities, such as cognitive-behavioral therapy. (Knezevic et al. 2021, p. 44)

Large-scale randomized controlled trials (RCTs) are also required to verify Pilates's long-term effectiveness in lowering pain and disability. Pilates has been shown to have short-term benefits but its long-term benefits (pain management and recurrence prevention) are still unknown. (Lim et al. 2019, p. 54)

CHAPTER III METHODOLOGY

3.1 Study design:

The study design was a Randomized Controlled Trial (RCT). RCT was appropriate for the comparison to the efficacy of Pilates-Based Rehabilitation on pain and disability and other conventional physiotherapy for the patients with Recurrent Low Back Pain.

3.2 Study area:

Data were collected from the outpatient services of physiotherapy unit of the, Saic Physiotherapy and Rehabilitation Services - Mirpur 14, Platinum Physiotherapy and Rehabilitation Center, Mirpur- 6, Dhaka.

3.3 Study place: The study was conducted at Saic College of Medical Science and Technology (SCMST) at Mirpur, Dhaka.

3.4 Study period:

The duration of the study was twelve's months in between June 2024 to July 2025.

3.5 Study population:

The patients with Recurrent Low Back Pain attended in outpatient services of physiotherapy unit of the, Saic Physiotherapy and Rehabilitation Services - Mirpur 14, Platinum Physiotherapy and Rehabilitation Center, Mirpur- 6, Dhaka in the study population for the present study.

3.6 Sample size:

The study consisted of a sample size of 38 participants, calculated based on the anticipated minimal clinically important differences (MCID) in Low Back pain using ODI scale (30.15 ± 15.37 (Valenza et al. (2017, p. 55). In this study, with an enrolment ratio of 1:1, the probability of type II error with 90% statistical power was 0.9, and the probability of type I error was 0.05 (alpha value), which concluded that 19 individuals with low back pain was assigned to each group, totaling 38

participants. Due to time limitations 24 participants were taken. Power analysis, was conducted using ClinCalc software, focused on the key outcome of the trunk impairment assessment.

$$k = \frac{n_2}{n_2} = 1$$

$$n_1 = \frac{\left(\sigma_1^2 + \sigma_2^2 / K\right)\left(Z_1 - \frac{\alpha}{2} + Z_1 - \beta\right)^2}{\Delta^2}$$

$$n_1 = \frac{(15.37^2 + 15.37^2/1)\,(1.96+1.28)^2}{16.33^2}$$

$n_1 = 19$

$n_2 = K \times n_1 = 19$

Here,

$\Delta = \mu_2 - \mu_1$ = absolute difference between two means

σ_1 , σ_1 = variance of mean 1 and 2

n_1 = sample size for group 1

n_2 = sample size for group 2

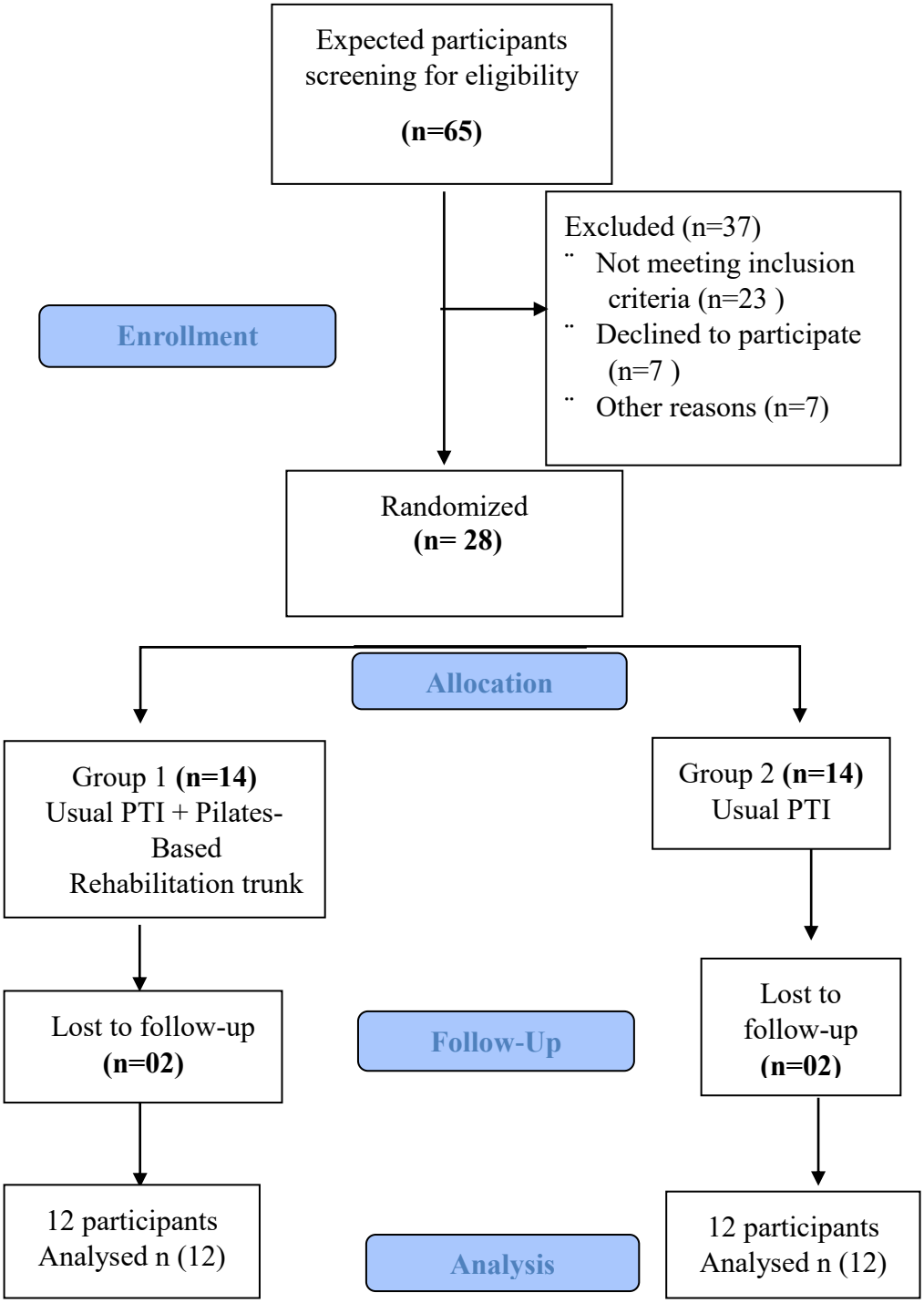
α = probability of type I error (usually 0.05)

β = probability of type II error (usually 0.2)

z = critical Z value for a given α or β

k = ratio of sample size for group 2 to group 1

Figure 1: CONSORT Flowchart



3.7 Sampling technique:

As these patients attained in the sites randomly in a specific period of time without the choice of various chamber authority or the researcher's choice, so that, they may be considered as a random sampling. After screening of 65 participants 24 sample fulfill the eligibility criteria. Then the 24 participants randomly assigned 12 into experimental and 12 into control group by randomization.

3.8 Eligibility criteria

3.8.1 Inclusion criteria:

- Adults aged 20–65 years (Valenza et al. 2016, p. 538)
- Recurrent non-specific low back pain, ≥2 episodes in the past year (Yang et al. 2021, p. 101331)
- Symptoms lasting ≥12 weeks (Saragiotto et al. 2016, p. 1707)
- Willingness to attend

3.8.2 Exclusion criteria:

- LBP caused by conditions such as tumors, fractures, or infections (Saragiotto et al. 2016, p. 1707)
- Significant neurological deficits like radiculopathy or cauda equina syndrome (Qaseem et al. 2017, p. 518)
- History of spinal surgery within the past year (Becker et al. 2020, p. 1495)
- Severe cardiovascular, respiratory, or musculoskeletal comorbidities affecting exercise participation (Miyamoto et al. 2019, p. CD012505)
- Pregnant or postpartum women within 6 months, due to biomechanical and hormonal changes (Cruz-Díaz et al. 2017, p. 622)

3.9 Method of data collection:

3.9.1 Technique of data collection

Data was collected through a face-to-face interview using an internationally accepted

questionnaire. The assessor was bilingual (Bengali and English), and the investigator did forward and backward translation of the questionnaire by different people and found the same meaning.

3.9.2 Instrument of data collection:

A questionnaire was prepared according to the objectives and variables of the present study. The questionnaire contained both open-ended and closed-ended questions. The questionnaire has three parts. The first part contained questions on socio-demographic information (a structured questionnaire was used for socio-demographic information). The second part included questions about pain using the Numeric Pain Rating Scale (NPRS). The third part included questions about disability using the Western Ontario McMaster University osteoarthritis index (WOMAC).

3.10 Tools for data collection:

In this particular study, weight machine, BP Machine, height measure tape were used.

3.11 Procedure of data collection:

The researcher selected Twelve patients with low back pain (LBP) from the outpatient services at Saic Physiotherapy and Rehabilitation Services - Mirpur 14 and Platimun Physiotherapy and Rehabilitations. In the experimental group, 24 patients received Pilates-based rehabilitation combined with usual physiotherapy, while the control group received only conventional physiotherapy. Information on pain intensity and disability was collected before the intervention, which was considered pre-test data for both groups. The experimental group underwent Pilates-based rehabilitation along with conventional physiotherapy, while the control group only received conventional physiotherapy. Both groups completed 14 treatment sessions. After the intervention, post-test data was collected on pain and disability levels from the 24 remaining participants with LBP, allowing for a comparative analysis of the effectiveness of Pilates-based rehabilitation in managing LBP.

3.12 Intervention:

Dosages: 3 times a week for 8 weeks (Total 24 Sessions). (Valenza et al. 2016, p. 538)

Experimental Group (40-45 minutes) (Pilates-Based Rehabilitation with UPT)
Usual Physiotherapy intervention
<u>Pilates Exercises for the Experimental Group</u> **1.** Pelvic Tilts (Valenza et al. 2016, p. 538). **Repetitions:** 3 sets of 10–15 repetitions **2.** Bridging (Yang et al. 2021, p. 101331). **Repetitions:** 3 sets of 10–12 repetitions **3.** Leg Slides (Cruz-Díaz et al. 2017, p. 621). **Repetitions:** 3 sets of 10–12 repetitions (per leg) **4.** Planks (Saragiotto et al. 2016, p. 1707). **Repetitions:** Hold for 20–30 seconds, 3 sets **5.** Cat-Cow Stretch (Wells et al. 2015, Article e0134172). **Repetitions:** 3 sets of 10–12 repetitions
<u>Control Group (40-45 minutes) (Usual Physiotherapy intervention)</u>
Heat and cold therapy
Electrotherapy (e.g., TENS, IFC)
Spinal manipulations or mobilizations
Deep Transverse Friction Massage
Strengthening exercises for the core, back, and legs
Stretching exercises
Postural correction and body mechanics education
Home exercise program

3.13 Intervention Regimen

Figure: Briding

Figure: Back Extension

Figure: Cat cow stretch

Figure: Cat cow stretch

3.14 Manage of data:

At the end of each day the collected questionnaires were checked for any errors or inconsistencies. The necessary corrections were made. The recorded data were coded accordingly into the SPSS-25 version of the program.

3.15 Data analysis:

Data were analyzed by SPSS version 25 using descriptive analysis for socio-demographic variables. In this research, the Mann-Whitney U test was employed for between-group analysis to compare pain and disability outcomes between the experimental and control groups. For within-group analysis, the Wilcoxon Signed Rank test was applied to evaluate changes in pain and disability from pre to post-intervention within each group. Microsoft Excel 2019 was used for the bar diagram and chart.

3.16 Ethical consideration:

The study proposal was submitted to the Institutional Review Board (IRB) of the Saic College of Medical Science and Technology (SCMST) for clearance. Subsequent to a defense, the project received approval from the IRB. Informed permission, both written and verbal, was obtained from all participants before to data collection. The research complied with the standards established by the World Health Organization (WHO) and the Bangladesh Medical Research Council (BMRC) to guarantee ethical adherence. Before data collection, authorization was obtained from relevant authorities to guarantee participant safety during the research. To prevent ethical dilemmas, individuals maintained the autonomy to get usual therapy for additional illnesses as required. All participants were comprehensively briefed about the research and furnished signed permission prior to their involvement.

CHAPTER-IV RESULTS

This study presents the results of the randomized controlled trial designed to evaluate the effectiveness of Pilates-based rehabilitation in patients with recurrent low back pain. The findings include baseline characteristics of participants and comparative outcomes between the experimental group, which received Pilates-based rehabilitation along with usual physiotherapy, and the control group, which received only usual physiotherapy. The results are presented in relation to pain reduction measured by the Numeric Pain Rating Scale (NPRS) and functional improvement assessed by the Oswestry Disability Index (ODI).

Table 1: Comparison of baseline characteristics of the participants

Variable	Experimental Group	Control Group
Age	46.58±11.25	43.58±15.54
Height (cm)	167.21± 9.45	161.14±13.83
Weight (kg)	75.75±12.92	69.50±8.56
BMI (Score)	27.25±5.22	27.15±4.93
Working Hour	7.75±3.86	10.33±2.53
Pain Duration	3.00±3.93	3.00±2.13
Pain (NPRS PRE Score)	4.83±1.26	2.58±.51
Disability (ODI PRE Score)	24.91±10.50	26.00±3.16

Table 1 presents the comparison of baseline characteristics between the experimental and control groups. The mean age of participants in the experimental group was 46.58 ± 11.25 years, while in the control group it was 43.58 ± 15.54 years ($p = 0.532$). The mean height was 167.21 ± 9.45 cm in the experimental group and

161.14 ± 13.83 cm in the control group ($p = 0.354$). The weight and BMI were also comparable between the two groups, with mean weights of 75.75 ± 12.92 kg and 69.50 ± 8.56 kg ($p = 0.224$), and BMI scores of 27.25 ± 5.22 and 27.15 ± 4.93 ($p = 0.908$), respectively. Additionally, no statistically significant differences were observed in working hours (7.75 ± 3.86 vs. 10.33 ± 2.53 hours, $p = 0.088$) or pain duration (3.00 ± 3.93 vs. 3.00 ± 2.13 years, $p = 0.383$). Pre-intervention scores on the Numeric Pain Rating Scale (NPRS) and Oswestry Disability Index (ODI) were also similar between groups (NPRS: 4.83 ± 1.26 vs. 2.58 ± 0.51, $p = 0.589$; ODI: 24.91 ± 10.50 vs. 26.00 ± 3.16, $p = 0.817$). These findings indicate that both groups were statistically comparable at baseline across all measured variables. (Table No: 01)

4.2 Frequency distribution of the participants

Table no 2: Frequency distribution of respondent according to sociodemographic variables

Variables	Category	Frequency	Percentage (%)
Age category	20-29 years	3	12.5
	30-39 years	6	25.0
	40-49 years	4	16.7
	50-59 years	7	29.2
	60-69 years	2	8.3
	70-79 years	2	8.3
Gender	Male	13	54.2
	Female	11	45.8
Marital Status	Married	16	66.7
	Unmarried	8	33.3
Family type	Nuclear	21	87.5
	Extended	3	12.5
Area of Living	Urban	15	62.5
	Rural	9	37.5
Educational Status	Illiterate	1	4.2
	Primary	9	37.5
	SSC	9	37.5
	HSC	4	16.7
	Masters	1	4.2
Occupation	Unemployed	1	4.2
	Day labor	2	8.3
	Job	5	20.8
	Housewife	9	37.5
	Others	7	29.2

The table shows that a total of 24 participants were included in the study. In terms of age distribution, the highest proportion of participants (29.2%) were in the 50–59 years age group, followed by 25.0% in the 30–39 years group. Participants aged 40–49 years accounted for 16.7%, while those aged 20–29 years represented 12.5%. The remaining participants were in the 60–69 years and 70–79 years age groups, each constituting 8.3% of the sample. The gender distribution indicates that 54.2% of participants were male and 45.8% were female. Marital status data show that the majority of participants were married (66.7%), while 33.3% were unmarried. Regarding family type, 87.5% of participants belonged to nuclear families, and 12.5% were from extended families. The table also shows that 62.5% of participants resided in urban areas, whereas 37.5% were from rural areas. In terms of educational status, 4.2% of participants were illiterate, 37.5% had completed primary education, another 37.5% had completed the Secondary School Certificate (SSC), 16.7% had completed the Higher Secondary Certificate (HSC), and 4.2% had attained a master's degree. Occupational data reveal that 37.5% of participants were housewives, followed by 29.2% in other occupational categories. Additionally, 20.8% were employed in jobs, 8.3% were day laborers, and 4.2% were unemployed. (Table No: 02)

4.3 Pain Related Information

4.3.1 Pretest and Posttest of NPRS Scale

Table 3: Total score of the participants in NPRS scale (Pretest and posttest).

Experimental Group				Control Group			
Variable	**Pre**	**Post**	**Difference**	**Variable**	**Pre**	**Post**	**Difference**
E1	3.00	3.00	.00	C1	2.00	1.00	-1.00
E2	3.00	2.00	-1.00	C2	2.00	1.00	-1.00
E3	4.00	3.00	-1.00	C3	3.00	2.00	-1.00
E4	4.00	3.00	-1.00	C4	3.00	3.00	.00
E5	4.00	3.00	-1.00	C5	3.00	2.00	-1.00
E6	5.00	3.00	-2.00	C6	2.00	1.00	-1.00
E7	5.00	3.00	-2.00	C7	2.00	1.00	-1.00
E8	6.00	4.00	-2.00	C8	3.00	2.00	-1.00
E9	6.00	4.00	-2.00	C9	2.00	1.00	-1.00
E10	5.00	3.00	-2.00	C10	3.00	2.00	-1.00
E11	6.00	4.00	-2.00	C11	3.00	2.00	-1.00
E12	7.00	5.00	-2.00	C12	3.00	2.00	-1.00
Total	**58**	**44**	**-18**	**Total**	**31**	**20**	**11**
Mean	**4.83**	**3.67**	**-1.50 mean difference**	**Mean**	**2.58**	**1.67**	**-0.91 mean difference**

Table shows the comparison of pretest and posttest NPRS scores between the experimental and control groups. In the experimental group, the mean pretest NPRS score was 4.83, which decreased to 3.67 following the intervention, yielding a mean difference of –1.50. In contrast, the control group demonstrated a mean pretest score of 2.58, which reduced to 1.67 in the posttest, with a mean difference of –0.91. Although both groups showed reductions in pain scores over time, the reduction was more pronounced in the experimental group. The total pain score decreased by 18

points in the experimental group, compared to an 11-point reduction in the control group. These findings suggest a greater improvement in pain intensity among participants in the experimental group relative to those in the control group following the intervention. (Table No: 03)

4.3.2 Between group pain of Experimental and Control Group

Table 4: Mann Whitney U test for between group analysis for total NPRS

	Category of participants	N	Mean of post test NPRS	Mean rank	Mann Whitney U score	*p*
Difference between Numeric Pain Scale	**Experimental**	12	3.67	9.29	33.50	0.009
	Control	12	1.67	15.71		
	Total	**24**				

A Mann–Whitney U test was conducted to examine the difference in post-intervention pain intensity between the experimental and control groups. The analysis revealed a statistically significant difference in posttest NPRS scores between the two groups (U = 33.50, p = 0.009). The control group had a higher mean rank (15.71) compared to the experimental group (9.29), indicating a greater reduction in pain intensity following the intervention. Although the mean posttest NPRS score was 3.67 in the experimental group and 1.67 in the control group, the non-parametric ranking suggests that the control group achieved a significantly lower level of perceived pain at posttest. (Table No: 04)

4.3.3 Pretest and Posttest of ODI Scale

Table 5: Total score of the participants in ODI scale (Pretest and posttest).

Experimental Group				Control Group			
Variable	**Pre**	**Post**	**Difference**	**Variable**	**Pre**	**Post**	**Difference**
E1	10.00	5.00	-5.00	C1	26.00	16.00	-10.00
E2	11.00	5.00	-6.00	C2	23.00	12.00	-11.00
E3	18.00	11.00	-7.00	C3	26.00	16.00	-10.00
E4	18.00	12.00	-6.00	C4	26.00	18.00	-8.00
E5	18.00	14.00	-4.00	C5	33.00	23.00	-10.00
E6	30.00	25.00	-5.00	C6	27.00	19.00	-8.00
E7	20.00	12.00	-8.00	C7	21.00	11.00	-10.00
E8	28.00	22.00	-6.00	C8	27.00	17.00	-10.00
E9	31.00	25.00	-6.00	C9	22.00	12.00	-10.00
E10	40.00	28.00	-12.00	C10	25.00	15.00	-10.00
E11	35.00	29.00	-6.00	C11	28.00	17.00	-11.00
E12	40.00	30.00	-10.00	C12	28.00	21.00	-7.00
Total	**299**	**218**	**-81**	**Total**	**312**	**197**	**-115**
Mean	**24.91**	**18.16**	**-6.75 mean difference**	**Mean**	**26**	**16.14**	**-9.58 mean difference**

This table summarizes the pretest and posttest scores of the Oswestry Disability Index (ODI) for both experimental and control groups. In the experimental group, the mean ODI score decreased from 24.91 at baseline to 18.16 post-intervention, reflecting a mean difference of –6.75. The control group exhibited a decrease in mean ODI score from 26.00 to 16.14, with a mean difference of –9.58. Both groups demonstrated a reduction in disability following the intervention; however, the control group showed a greater absolute decrease in ODI scores compared to the experimental group. The total reduction in ODI scores amounted to 81 points in the experimental group and 115 points in the control group. (Table No: 05)

4.3. Between group Disability of Experimental and Control Group

Table 6: Mann Whitney U test for between group analysis for total ODI

Difference between Oswestry Disability Scale	**Category of participants**	**N**	**Mean of post test ODI**	**Mean rank**	**Mann Whitney U score**	***p***
	Experimental	12	18.16	16.75	21.00	0.003
	Control	12	16.14	8.25		
	Total	**24**				

A Mann–Whitney U test was performed to compare post-intervention Oswestry Disability Index (ODI) scores between the experimental and control groups. The analysis revealed a statistically significant difference in posttest ODI scores between the groups ($U = 21.00$, $p = 0.003$). The experimental group had a higher mean rank (16.75) compared to the control group (8.25), indicating a significantly greater level of disability post-intervention in the experimental group. The mean posttest ODI score was 18.16 in the experimental group and 16.14 in the control group. These results suggest that the control group demonstrated superior functional improvement compared to the experimental group following the intervention period, as evidenced by the significantly lower disability scores. (Table No: 06)

4.4 Wilcoxon signed rank test

Table 7: Within group analysis by Wilcoxon signed rank test for NPRS score after and before (Experimental group)

Posttest-Pretest NPRS scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	P-Value
Negative Ranks	11b	6.00	66.00	-3.035c	.002
Positive Ranks	0c	.00	.00		
Ties	1d				
Total	12				

The Wilcoxon signed-rank test was used to evaluate the change in Numeric Pain Rating Scale (NPRS) scores before and after the intervention in the experimental group. The analysis indicated a statistically significant reduction in NPRS scores from pretest to posttest ($Z = –3.035$, $p = 0.002$). Out of 12 participants, 11 showed a decrease in pain scores (negative ranks), with a mean rank of 6.00 and a sum of ranks equal to 66.00. There were no participants with an increase in scores (positive ranks), and one participant showed no change (tie). (Table No: 07)

Table 8: Within group analysis by Wilcoxon signed rank test for NPRS score after and before (Control Group)

Posttest-Pretest NPRS scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	P-Value
Negative Ranks	11b	6.00	66.00	-3.317c	.001
Positive Ranks	0c	.00	.00		
Ties	1d				
Total	12				

Within the control group, the Wilcoxon signed-rank test revealed a statistically significant reduction in Numeric Pain Rating Scale (NPRS) scores from pretest to posttest ($Z = –3.317$, $p = 0.001$). Among the 12 participants, 11 exhibited decreased pain scores (negative ranks) with a mean rank of 6.00 and a sum of ranks of 66.00. No participants showed an increase in scores (positive ranks), while one participant's score remained unchanged (tie). (Table No: 08)

Table 9: Within group analysis by Wilcoxon signed rank test for ODI score after and before (Experimental Group)

Posttest-Pretest ODI scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	P-Value
Negative Ranks	12b	6.50	78.00	-3.084c	.002
Positive Ranks	0c	.00	.00		
Ties	0d				
Total	12				

The Wilcoxon signed-rank test demonstrated a statistically significant reduction in Oswestry Disability Index (ODI) scores from pretest to posttest within the experimental group ($Z = –3.084$, $p = 0.002$). All 12 participants showed a decrease in disability scores (negative ranks), with a mean rank of 6.50 and a sum of ranks of 78.00. No participants exhibited an increase (positive ranks) or no change (ties) in ODI scores. (Table No: 09)

Table 10: Within group analysis by Wilcoxon signed rank test for ODI score after and before (Control Group)

Posttest-Pretest ODI scores	N	Means Rank	Sum of Ranks	Wilcoxon signed rank test based on Z rank	P-Value
Negative Ranks	12b	6.50	78.00	-3.130c	.002
Positive Ranks	0c	.00	.00		
Ties	0d				
Total	12				

The Wilcoxon signed-rank test indicated a statistically significant decrease in Oswestry Disability Index (ODI) scores from pretest to posttest in the control group ($Z = –3.130$, $p = 0.002$). All 12 participants demonstrated reductions in disability scores (negative ranks), with a mean rank of 6.50 and a sum of ranks totaling 78.00. No participants showed increases or ties in ODI scores. (Table No: 10)

CHAPTER-V DISCUSSION AND LIMITATION

Table 1 demonstrates that the baseline characteristics of participants in both the experimental and control groups were statistically comparable. Specifically, the average ages (46.58±11.25 vs. 43.58±15.54 years; p=0.532), heights (167.21±9.45 vs. 161.14±13.83 cm; p=0.354), weights (75.75±12.92 vs. 69.50±8.56 kg; , and BMIs (27.25±5.22 vs. 27.15±4.93; p=0.908) were similar. Additionally, working hours (7.75±3.86 vs. 10.33±2.53; p=0.088), pain duration (3.00±3.93 vs. 3.00±2.13 years; p=0.383), NPRS pre-intervention scores (4.83±1.26 vs. 2.58±0.51; p=0.589), and ODI pre-intervention scores (24.91±10.50 vs. 26.00±3.16; p=0.817) showed no significant differences, affirming homogeneity between groups at baseline.

Participants (n=24) had varied sociodemographic backgrounds. The age distribution revealed the majority were between 50–59 years (29.2%). The gender ratio was nearly balanced, with males representing 54.2% and females 45.8%. Most participants were married (66.7%), belonged to nuclear families (87.5%), and resided in urban areas (62.5%). Educational levels were predominantly primary or secondary (75%), and most participants were housewives (37.5%) or engaged in miscellaneous occupations (29.2%) (p.2). The experimental group showed a significant mean decrease in NPRS from 4.83 pre-intervention to 3.67 post-intervention (mean difference = -1.50). The control group similarly showed a decrease from 2.58 to 1.67 (mean difference = -0.91). A Mann–Whitney U test indicated a significant difference in post-test NPRS scores between groups (U=33.50, p=0.009), with a lower perceived pain intensity in the control group based on mean ranks (15.71 vs. 9.29, respectively) (p.3-4). ODI scores improved significantly within both groups. The experimental group improved from 24.91 to 18.16 (mean difference = -6.75), whereas the control group demonstrated a greater absolute improvement from 26.00 to 16.14 (mean difference = -9.58). Between-group analysis using Mann–Whitney U test indicated a significant difference (U=21.00, p=0.003), revealing greater improvement in disability within the control group (mean ranks: experimental=16.75, control=8.25) (p.5).

Wilcoxon signed-rank tests within both groups confirmed significant reductions in pain (NPRS) and disability (ODI). The experimental group's NPRS improved

significantly (Z=-3.035, p=0.002), as did the control group's NPRS (Z=-3.317, p=0.001). Similarly, ODI improved significantly in the experimental group (Z=-3.084, p=0.002) and control group (Z=-3.130, p=0.002). Both groups demonstrated positive outcomes, with all participants showing reductions in ODI scores (p.6-8).

The present study aimed to evaluate the role of Pilates-based rehabilitation in improving pain and disability among patients with recurrent low back pain (RLBP). The results demonstrated significant improvements within both experimental (Pilates-based intervention) and control groups (standard intervention), particularly reflected in decreased pain intensity (NPRS scores) and improved functional status (ODI scores). However, comparative analyses surprisingly favored the control group, with a greater relative improvement in both pain intensity and disability scores.

In the current study, baseline characteristics of participants, including age, gender, BMI, and pre-existing pain duration, were statistically comparable between groups, eliminating confounding demographic or clinical differences that could impact intervention outcomes (Table 1, p.1). Such methodological rigor aligns well with recommendations for clinical trials, where comparable baseline characteristics strengthen the reliability and validity of observed treatment effects (Schulz et al. 2015, p.698).

The observed reduction in pain intensity scores within both groups is consistent with prior research demonstrating beneficial effects of physical exercise interventions, including Pilates, in managing low back pain. For instance, Rydeard et al. (2018, p.348) reported significant reductions in NPRS scores post-Pilates intervention, attributing improvements to enhanced core muscle control and stability. Similarly, Miyamoto et al. (2017, p.444) found Pilates significantly reduced chronic low back pain compared to minimal interventions, proposing that Pilates enhances body awareness, postural alignment, and muscular coordination, thus alleviating pain.

However, an unexpected finding of the current study was the statistically superior outcome observed in the control group, which received standard rehabilitation intervention compared to the Pilates-based experimental group. This contrasts with several previous studies where Pilates demonstrated greater efficacy. For instance,

Patti et al. (2015, p.477) reported greater improvements in ODI scores following Pilates compared to general exercise. Similarly, Lim et al. (2019, p.273) demonstrated significant superiority of Pilates exercises over routine physiotherapy interventions for reducing disability associated with chronic low back pain.

One plausible explanation for the discrepancy could relate to variations in intervention intensity, adherence, or specific exercise regimens employed within the experimental group. Previous studies highlight the importance of intervention adherence, duration, and intensity on therapeutic outcomes. Garcia-Soidan et al. (2016, p.123) reported that Pilates interventions lasting at least 8-12 weeks significantly outperform shorter-duration interventions. Differences in the Pilates program duration or the adherence level of participants in the current study might explain why Pilates did not demonstrate superiority in outcomes compared to standard interventions.

Additionally, the severity of initial pain and disability symptoms among participants in the control group might explain their greater relative improvement. Research by Costa et al. (2018, p.179) emphasized the phenomenon of regression to the mean, suggesting participants with initially higher pain scores or greater disability are more likely to report significant improvements simply due to their baseline severity. Although both groups were statistically comparable at baseline, subtle individual variations could have driven greater improvements observed in control participants.

The significant improvements observed within the control group might also be attributed to psychological factors, such as increased attention and placebo effects stemming from participation in clinical research. Such psychosocial factors have been identified in previous studies examining therapeutic interventions for chronic pain conditions (Cherkin et al. 2016, p.1253). Thus, control group participants may have experienced psychosocial benefits beyond physical rehabilitation alone, enhancing their perceived improvement in pain and disability.

In analyzing the within-group changes, both experimental and control groups demonstrated statistically significant reductions in Numeric Pain Rating Scale (NPRS) scores, as indicated by Wilcoxon signed-rank tests (experimental group: Z = -

3.035, p = 0.002; control group: Z = -3.317, p = 0.001) (p.6-7). These findings support the effectiveness of structured exercise interventions in managing recurrent low back pain (RLBP), consistent with broader evidence from the literature. A systematic review by Wells et al. (2015, p.223) highlighted that various therapeutic exercises including Pilates-based regimens are effective in significantly reducing pain intensity among patients with chronic or recurrent low back pain. The Oswestry Disability Index (ODI) scores similarly improved significantly within both groups in this study (experimental group: Z = -3.084, p = 0.002; control group: Z = -3.130, p = 0.002), indicating enhanced functional capacity post-intervention (p.7-8). The reduction in ODI scores observed here aligns closely with findings from Cruz-Diaz et al. (2018, p.285), who reported substantial reductions in disability and functional impairment following Pilates-based interventions. The improvements in ODI scores can be attributed to the fundamental principles of Pilates exercises, including core stabilization, postural alignment, and targeted muscular conditioning, contributing to reduced physical disability and improved functional outcomes (Kloubec, 2017, p.94).

However, the comparative analysis between groups produced a noteworthy paradox. Despite significant within-group improvements, the between-group Mann Whitney U test revealed superior functional outcomes in the control group, which had a significantly lower post-intervention ODI mean rank compared to the experimental group (control group mean rank = 8.25, experimental group mean rank = 16.75, U = 21.00, p = 0.003) (p.5). This contrasts markedly with findings by Natour et al. (2015, p.348), who demonstrated superior benefits of Pilates over traditional exercises in alleviating disability related to chronic low back pain. Several methodological factors, such as differences in intervention adherence, supervision, or home exercise compliance, may account for this unexpected result. Moreover, the intrinsic motivation levels or expectations of participants towards a novel intervention (Pilates-based exercises) compared to more familiar standard rehabilitation methods might have influenced outcomes (Ferreira et al. 2019, p.168).

Another critical factor possibly influencing the observed results is the specificity of Pilates exercises prescribed to participants. While Pilates methodology emphasizes core muscle control and spinal stability, variations in exercise selection, execution

accuracy, or participant comprehension might have affected the magnitude of clinical improvements. Studies emphasizing individualized Pilates programming, intensive supervision, and comprehensive participant education frequently report greater functional improvements compared to generalized exercise interventions (La Touche et al. 2018, p.1031). Consequently, future investigations might benefit from enhanced supervision and personalized Pilates training protocols to maximize outcomes.

Furthermore, psychological factors such as patient expectations, therapeutic alliance, and placebo effects could contribute to observed differences between groups. A study by Bishop et al. (2015, p.131) underscored the significance of patient-practitioner interactions, highlighting that participants who perceive higher-quality interactions often report better outcomes, independent of the specific intervention delivered. Although psychological factors were not directly assessed in the current study, such influences should not be underestimated in explaining unexpected comparative outcomes.

Additionally, the control group's notable improvements might reflect a robust placebo or Hawthorne effect, particularly considering their awareness of receiving standard therapy as part of research participation. The Hawthorne effect where participants alter behavior simply because they are aware of being observed has been extensively documented in clinical rehabilitation trials (McCarney et al. 2017, p.74). Hence, participant awareness and consequent behavioral modifications might partially account for the superior functional outcomes observed within the control group compared to the Pilates-based intervention group.

It's also essential to consider potential measurement biases or limitations in self-reported outcomes such as NPRS and ODI. Despite their established reliability and validity in clinical research, subjective outcome measures inherently carry the risk of respondent biases, including recall bias and social desirability bias, potentially affecting accuracy in reflecting true clinical improvements (Fairbank & Pynsent, 2018, p.2942). Therefore, future studies incorporating objective functional assessments such as electromyography or biomechanical analysis of spinal stability may provide more robust insights into the specific functional gains attributable to Pilates exercises.

Moreover, the demographic composition of participants in the current study—predominantly middle-aged, urban-dwelling individuals—may limit the generalizability of findings. Previous studies indicate varying responses to exercise interventions across age groups, with older adults or rural populations potentially demonstrating different responsiveness to structured physical rehabilitation (Smith et al. 2017, p.200). Thus, extending future research to diverse participant populations would help clarify whether observed discrepancies between Pilates and standard exercise interventions are consistent across different demographic segments. Overall, despite unexpected comparative findings, the significant within-group improvements underscore the clinical utility of structured physical rehabilitation, including Pilates-based exercises, for managing recurrent low back pain. These results reinforce existing evidence advocating regular physical activity and targeted exercise interventions as fundamental components of rehabilitation programs for chronic musculoskeletal conditions (Delitto et al. 2018, p.1080). In conclusion, although the Pilates-based rehabilitation employed in this study significantly improved pain and disability outcomes within the experimental group, comparative analyses unexpectedly favored the standard rehabilitation protocol. Several methodological, psychological, and measurement-related factors potentially explain this finding, highlighting important considerations for future clinical practice and research design. Enhancing intervention specificity, supervision, and incorporating objective measures alongside subjective assessments may help clarify Pilates' precise role and optimal application in managing recurrent low back pain.

Despite the valuable insights gained from this study, several limitations should be acknowledged. Firstly, the sample size was relatively small, involving only 24 participants, which may limit the generalizability of the findings to broader populations. Larger samples could have provided more robust and widely applicable results. Secondly, the duration of the intervention might have been insufficient to observe the full therapeutic potential of Pilates-based rehabilitation. Longer intervention periods could possibly yield more distinct improvements in pain reduction and functional outcomes. Thirdly, participant adherence to home exercises and consistency in the execution of the Pilates routines were not thoroughly monitored, potentially affecting treatment fidelity and outcomes. Variability in

exercise adherence may have diluted the observed effects of the Pilates intervention. Additionally, the subjective nature of the measurement instruments (NPRS and ODI) could introduce response bias, as participants' self-reported pain and disability levels may be influenced by personal perceptions, expectations, and recall accuracy. Moreover, psychological factors such as participant motivation, expectancy effects, and researcher interaction were not systematically assessed and could have confounded the observed outcomes. Future research might benefit from including psychological measures to better understand these influences. Finally, the study lacked follow-up assessments post-intervention, which limits the evaluation of long-term effects and durability of improvements in pain and disability. Conducting follow-up evaluations would provide valuable insights into the sustainability of Pilates-based rehabilitation outcomes.

CHAPTER-VII COLNCLUSION & RECOMMENDATIONS

This study demonstrated that both Pilates-based rehabilitation and standard exercise interventions significantly reduce pain and disability among patients suffering from recurrent low back pain. Although Pilates exercises were effective in producing meaningful improvements within the experimental group, comparative analyses unexpectedly favored the standard rehabilitation approach in terms of greater pain relief and enhanced functional capacity. Therefore, while Pilates remains a viable and beneficial therapeutic exercise, this study suggests it may not necessarily offer superior outcomes compared to traditional rehabilitation strategies for all patients with recurrent low back pain. Nevertheless, Pilates exercises can still be considered a useful adjunct in a comprehensive pain management and rehabilitation program.

Recommendations:

- Future studies should incorporate larger and more diverse populations to improve the generalizability and robustness of findings related to Pilates interventions.
- Extending the intervention duration beyond the current study period could better capture long-term therapeutic effects and accurately assess the sustained benefits of Pilates-based rehabilitation.
- Rigorous monitoring of participant adherence, accuracy, and consistency in performing Pilates exercises should be emphasized in future trials, potentially utilizing supervised or structured sessions to maximize intervention fidelity.
- Incorporating objective functional assessments (e.g., electromyography, spinal biomechanics analysis) alongside subjective measures could provide a clearer understanding of the physiological mechanisms underpinning Pilates-based improvements.
- Future research should systematically evaluate psychological and motivational factors, including patient expectations, therapeutic alliance, and participant attitudes, to understand their influence on clinical outcomes.

- Conducting post-intervention follow-up assessments will help to determine the durability and sustainability of the therapeutic effects associated with Pilates rehabilitation, thereby guiding long-term clinical recommendations.
- Future interventions should consider developing individually tailored Pilates exercise regimens, based on detailed patient assessments and personalized rehabilitation goals, to optimize functional and clinical outcomes.

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APPENDIX

Appendix – A: Institutional Review Board (IRB) Letter

SCMST BPT/IRB/ 05-23/038

To
Ananna Ghosh
4th Year Student of B.Sc in Physiotherapy
Session: 2017-18, Reg No: 10257
SAIC College of Medical Science & Technology (SCMST)
Mirpur-14, Dhaka-1216, Bangladesh

Subject: Approval of the thesis proposal **"The Role of Pilates Based Rehabilitation in Improving Pain and Disability among Patients with Recurrent Low Back Pain"** by ethics committee.

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

Sr. No.	Name of the Documents
1	The Role of Pilates Based Rehabilitation In Improving Pain and Disability Among Patients With Recurrent Low Back Pain
2	Questionnaire (English & Bangla version)
3	Information sheet & consent form.

The purpose of the study is to compare The Role of Pilates Based Rehabilitation In Improving Pain and Usual Physiotherapy Interventions Disability Among Patients With Recurrent Low Back Pain. The study involves face to face interview by using semi-structured questionnaire to explore the Barriers and Challenges Confronted by Lower Limb Amputees in Bangladesh that may take 30 to 40 minutes to fill in the questionnaire and there is no likelihood of any harm to the participants. The members of the Ethics committee have approved the study to be conducted in the presented form at the meeting held at **09.00 AM on 28th September 2023 at SCMST.**

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

Best regards,
05 06 24.
Dr. Abul Kasem Mohammad Enamul Haque
Principal, SCMST &Chairman, Institutional Review Board (IRB)
SAIC College of Medical Science & Technology (SCMST)
Mirpur-14, Dhaka-1216, Bangladesh

Appendix – B: Data Collection Permission Letter

5/06/2024

To

Head of the Physiotherapy Department,

Saic College of Medical Science and Technology(SCMST),

Mirpur, Dhaka-1216

Subject: Prayer for permission to collect data form outdoor of saic-mirpur to conduct research project.

Sir,

With due respect and humble submission, I would like to state that I am a student of B.sc. in physiotherapy at Saic College of Medical Science and Technology. As a part of our course curriculam, we have to conduct a research project for the partial fulfillment of the requirment for the degree of B.sc. in physiotherapy. My research title is "**The Role of Pilates Based Rehabilitation in Improving Pain and Disability Among Patients With Recurrent Low Back Pain".** This is a randomized controlled trail under the supervision of Zahid Bin Sultan Nahid, Asst Professor and Head of Physiotherapy Department SCMST,Mirpur,Dhaka-1216. I want to collect data from the patients attending the outdoor of saic-mirpur. So, I need your permission to collect data and ensure that the study will not be harmful for participants.

So, I, therefore, pray and hope that you would be kind enough to give permission for data collection that will help me to complete my study.

Your Faithfully

Ananna Ghosh

B.sc. in Physiotherapy.

Session: 2017-2018, Reg:10257

SCMST,Mirpur-14, Dhaka-1216 Bangladesh.

Physio. Md. Shahidul Islam
BSPT, MSPT (DU)
Manual Therapy (India)
Assistant Professor
Physiotherapy Dept SCMST.

24/10/2024

To

Managing Director ,

Platinum Physiotherapy and Rehabilitation Center,

Mirpur, Dhaka-1216

Subject: Prayer for permission to collect data to conduct a research project.

Sir,

With due respect and humble submission, I would like to state that I am a student of B.sc. in physiotherapy at Saic College of Medical Science and Technology. As a part of our course curriculam, we have to conduct a research project for the partial fulfillment of the requirment for the degree of B.sc. in physiotherapy. My research title is "**The Role of Pilates Based Rehabilitation in Improving Pain and Disability Among Patients With Recurrent Low Back Pain".** This is a randomized controlled trail under the supervision of Zahid Bin Sultan Nahid, Asst.Professor and Head of Physiotherapy Department SCMST,Mirpur,Dhaka-1216. I want to collect data from the patients attending the outdoor of Platinum Physiotherapy and Rehabilitation Center. So, I need your permission to collect data and ensure that the study will not be harmful for participants.

So, I, therefore, pray and hope that you would be kind enough to give permission for data collection that will help me to complete my study.

Your Faithfully

Ananna

Ananna Ghosh

B.sc. in Physiotherapy,

Session: 2017-2018, Reg:10257

SCMST,Mirpur-14, Dhaka-1216 Bangladesh.

24.10.24

Appendix – C:

Consent From Bangla and English

মৌখিক সম্মতিপত্র

আসসালামু আলাইকুম/নমস্কার,

আমি অনন্যা ঘোষ, ৪র্থ প্রফেশনাল, বিএসসি ফিজিওথেরাপির ছাত্র, সাইক কলেজ অফ মেডিকেল সায়েন্স অ্যান্ড টেকনোলজি (এসসিএমএসটি), ঢাকা বিশ্ববিদ্যালয়ের অধিনে । আমার ব্যাচেলর ডিগ্রী পেতে, আমাকে একটি গবেষণা প্রকল্প পরিচালনা করতে হবে এবং এটি আমার অধ্যয়নের একটি অংশ। আমার গবেষণার শিরোনাম "হাঁ কোমর ব্যথায় আক্রান্ত রোগীদের ব্যথা এবং অক্ষমতা উন্নত করতে পাইলেটস-ভিত্তিক পুনর্বাসনের ভূমিকা।" আমার গবেষণা প্রকল্পটি পূরণ করার জন্য, তথ্য সংগ্রহ করার জন্য আমার আপনার কাছ থেকে কিছু তথ্য দরকার, তাই আপনি এই গবেষণার একজন সম্মানিত অংশগ্রহণকারী হতে পারেন এবং কথোপকথনের সময় হবে ২০-৩০ মিনিট । আমি আপনাকে জানাতে চাই যে এটি একটি সম্পূর্ণরূপে একাডেমিক অধ্যয়নের কাজে ব্যাবহার করা হবে। আমি আশ্বাস দিচ্ছি যে সমস্ত তথ্য গোপন রাখা হবে। আপনার অংশগ্রহণ স্বেচ্ছায় হবে। অধ্যয়নের যেকোনো সময় আপনার সম্মতি প্রত্যাহার এবং অংশগ্রহণ বন্ধ করার অধিকার থাকতে পারে। আপনি পছন্দ করেন না এমন কোনো প্রশ্ন প্রত্যাখ্যান করার অধিকারও আপনার আছে।

অধ্যয়ন সম্পর্কে আপনার কোন প্রশ্ন থাকলে, আপনি আমার সুপারভাইজার জাহিদ বিন সুলতান নাহিদ, সহকারী অধ্যাপক এবং প্রধান, ফিজিওথেরাপি বিভাগ, (এসসিএমএসটি), মিরপুর-১৪, ঢাকা- ১২১৬-এর সাথে যোগাযোগ করতে পারেন। সাক্ষাৎকার শুরু করার আগে আপনার কোন প্রশ্ন আছে।

তাহলে, আমি কি সাক্ষাৎকার নিয়ে এগিয়ে যেতে পারি?

হ্যাঁ…… না ……

অংশগ্রহণকারীর স্বাক্ষর …….. তারিখ ……

গবেষকের স্বাক্ষর……..... তারিখ……

সাক্ষীর স্বাক্ষর …… তারিখ .....

CONSENT FORM (ENGLISH)

Assalamualaikum,

I am Ananna Ghosh, a student of 4th Professional, B.Sc. in Physiotherapy, SAIC College of Medical Science and Technology (SCMST), University of Dhaka. To obtain my Bachelor degree, I have to conduct a research project and it is a part of my study. My research title is "The Role of Pilates-Based Rehabilitation in Improving Pain and Disability in Patients with Recurrent Low Back Pain." 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 Zahid Bin Sultan Nahid, Assistant Professor and Head, Department of Physiotherapy, SCMST, Mirpur-14, Dhaka- 1216. Do you have any questions before start this session?

So, can I proceed with the interview?

Yes ……. No …….

Signature of the participant……. Date……

Signature of the participant……. Date……

Signature of the participant……. Date……

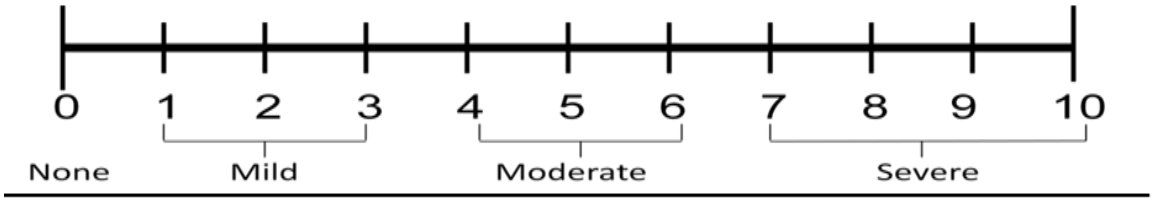
Appendix – D: Questionnaire Bangla and English

Title: The Role of Pilates Based Rehabilitation in Improving Pain and Disability among Patients with Recurrent Low Back Pain

<table>
<tr><td colspan="7">Part 1: Personal information</td></tr>
<tr><td>1.1</td><td>Date of Test:</td><td colspan="5"></td></tr>
<tr><td>1.2</td><td>Name of participant:</td><td colspan="5"></td></tr>
<tr><td>1.3</td><td>Code:</td><td colspan="5"></td></tr>
<tr><td rowspan="2">1.4</td><td rowspan="2">Address:</td><td colspan="2">Village:</td><td colspan="3">Post-office:</td></tr>
<tr><td colspan="2">Upazilla:</td><td colspan="3">District:</td></tr>
<tr><td>1.5</td><td>Phone</td><td colspan="5"></td></tr>
<tr><td colspan="7">Part 2- Patient’s Socio-demographic information

(Please give a tick (√) mark on the left side of the correct answer)</td></tr>
<tr><td>SL No</td><td>Questions</td><td colspan="5">Responses</td></tr>
<tr><td>2.1</td><td>Age:</td><td colspan="4">[ ] Years</td><td></td></tr>
<tr><td>2.2</td><td>Gender:</td><td>(0) Male</td><td colspan="2">(1) Female</td><td>(2) Others</td><td></td></tr>
<tr><td>2.3</td><td>Marital status:</td><td colspan="2">(0) Married</td><td colspan="2">(1) Unmarried</td><td></td></tr>
<tr><td>2.4</td><td>Family type:</td><td colspan="2">(0) Nuclear Family</td><td colspan="2">(1) Joint Family</td><td></td></tr>
<tr><td>2.5</td><td>Living area:</td><td colspan="2">(0) Urban</td><td colspan="2">(1) Rural</td><td></td></tr>
<tr><td rowspan="2">2.6</td><td rowspan="2">Educational Qualification:</td><td>(0) Illiterate</td><td>(1) Primary</td><td>(2) Secondary</td><td></td></tr>
<tr><td>(3) Higher Secondary</td><td>(4) Bachelor</td><td>(5) Masters</td><td></td></tr>
<tr><td rowspan="2">2.7</td><td rowspan="2">Occupation:</td><td>(0) Unemployed</td><td>(1) Day labor</td><td colspan="2">(2) Desk job</td><td></td></tr>
<tr><td>(4) Farmer</td><td>(5) Housewife</td><td colspan="2">(6) Others</td><td></td></tr>
<tr><td>2.8</td><td>Number of Earning members</td><td colspan="4"></td><td></td></tr>
</table>

Part 3: Medical information				
3.1	**Height**	[ ] cm		
3.2	**Weight**	[ ] kg		
3.3	**BMI**	(0) Underweight	(1) Normal weight	
		(2) Overweight	(2) Obese	
Part 4: Pain related information				
4.1	**How long do you work?**			
4.2	**How has been the pain?**	(0) [ ]years		
		(1) [ ]months		
		(2) [ ]Weeks		

Numeric pain scale (NPRS)	
How much pain do you feel in general at resting position?	**Score:** **0 = None** **1 = Mild** **2 = Moderate** **3 = Severe**
	

Oswestry Disability Index 2.1a

This questionnaire is designed to give us information as to how your back (or leg) trouble affects your ability to manage in everyday life. Please answer every section. Mark one box only in each section that most closely describes you today

Sl No	Questions	Pre test	Post-test
1	**Section 1– Pain intensity**		
	(0) I have no pain at the moment.		
	(1) The pain is very mild at the moment.		
	(2) The pain is moderate at the moment.		
	(3) The pain is fairly severe at the moment.		
	(4) The pain is very severe at the moment.		
	(5) The pain is the worst imaginable at the moment.		
2	**Section 2 – Personal care (washing, dressing etc)**		
	(0) I can look after myself normally without causing extra pain		
	(1) I can look after myself normally but it causes extra pain		
	(2) It is painful to look after myself and I am slow and careful		
	(3) I need some help but manage most of my personal care		
	(4) I need help every day in most aspects of self-care		
	(5) I do not get dressed, I wash with difficulty and stay in bed		
3	**Section 3 – Lifting**		
	(0) I can lift heavy weights without extra pain		
	(1) I can lift heavy weights but it gives extra pain		
	(2) Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently placed eg. on a table		
	(3) Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned		
	(4) I can lift very light weights		
	(5) I cannot lift or carry anything at all		

4	**Section 4 – Walking**		
	(0) Pain does not prevent me walking any distance		
	(1) Pain prevents me from walking more than 2 kilometres		
	(2) Pain prevents me from walking more than 1 kilometre		
	(3) Pain prevents me from walking more than 500 metres		
	(4) I can only walk using a stick or crutches		
	(5) I am in bed most of the time		
5	**Section 5 – Sitting**		
	(0) I can sit in any chair as long as I like		
	(1) I can only sit in my favourite chair as long as I like		
	(2) Pain prevents me sitting more than one hour		
	(3) Pain prevents me from sitting more than 30 minutes		
	(4) Pain prevents me from sitting more than 10 minutes		
	(5) Pain prevents me from sitting at all		
6	**Section 6 – Standing**		
	(0) I can stand as long as I want without extra pain		
	(1) I can stand as long as I want but it gives me extra pain		
	(2) Pain prevents me from standing for more than 1 hour		
	(3) Pain prevents me from standing for more than 3 minutes		
	(4) Pain prevents me from standing for more than 10 minutes		
	(5) Pain prevents me from standing at all		
7	**Section 7 – Sleeping**		
	(0) My sleep is never disturbed by pain		
	(1) My sleep is occasionally disturbed by pain		
	(2) Because of pain I have less than 6 hours sleep		
	(3) Because of pain I have less than 4 hours sleep		
	(4) Because of pain I have less than 2 hours sleep		
	(5) Pain prevents me from sleeping at all		
8	**Section 8 – Sex life (if applicable)**		
	(0) My sex life is normal and causes no extra pain		

	(1) My sex life is normal but causes some extra pain		
	(2) My sex life is nearly normal but is very painful		
	(3) My sex life is severely restricted by pain		
	(4) My sex life is nearly absent because of pain		
	(5) Pain prevents any sex life at all		
9	**Section 9 – Social life**		
	(0) My social life is normal and gives me no extra pain		
	(1) My social life is normal but increases the degree of pain		
	(2) Pain has no significant effect on my social life apart from limiting my more energetic interests eg, sport		
	(3) Pain has restricted my social life and I do not go out as often		
	(4) Pain has restricted my social life to my home		
	(5) I have no social life because of pain		
10	**Section 10 – Travelling**		
	(0) I can travel anywhere without pain		
	(1) I can travel anywhere but it gives me extra pain		
	(2) Pain is bad but I manage journeys over two hours		
	(3) Pain restricts me to journeys of less than one hour		
	(4) Pain restricts me to short necessary journeys under 30 minutes		
	(5) Pain prevents me from travelling except to receive treatment		

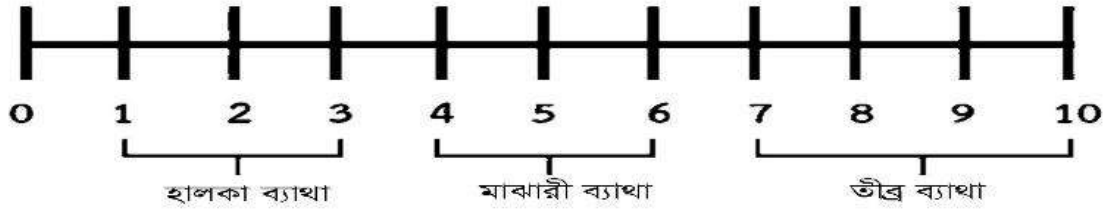
প্রশ্নাবলী (বাংলা)

এই প্রশ্নপত্রটি তৈরী করা হয়েছে বারবার কোমর ব্যাথার রোগীদের ব্যাথা ও অক্ষমতা পরিমাপ করার জন্য।

পর্ব কঃ ব্যাক্তিগত তথ্যাবলী					
১.১	**পরীক্ষার তারিখঃ**				
১.২	**অংশগ্রহণকারীর নামঃ**				
১.৩	**কোডঃ**				
১.৪	**ঠিকানাঃ**	**গ্রামঃ**		**পোস্ট-অফিসঃ**	
		উপজেলাঃ		**জেলাঃ**	
১.৫	**ফোনঃ**				
পর্ব- খঃ আর্থ সামাজিক তথ্য					
ক্রম নং	**প্রশ্ন**	**উত্তর**			
২.১	বয়সঃ	[ ]বছর			
২.২	লিঙ্গঃ	(০) পুরুষ	(১) মহিলা	(২) অন্যান্য	
২.৩	বৈবাহিক অবস্থাঃ	(০) বিবাহিত	(১) অবিবাহিত		
২.৪	পরিবারের ধরনঃ	(০) একক পরিবার	(১) যৌথ পরিবার		
২.৫	বসবাসের স্থানঃ	(০) শহর	(১) গ্রাম		
২.৬	শিক্ষাগত যোগ্যতাঃ	(০) অশিক্ষিত	(১) প্রাথমিক	(২) মাধ্যমিক	
		(৩) উচ্চ মাধ্যমিক	(৪) স্নাতক	(৫) স্নাতকোত্তর	
২.৭	পেশাঃ	(০) বেকার	(১) দিনমজুর	(২) চাকুরী	
		(৪) কৃষক	(৫) গৃহিণী	(৬) অন্যান্য	

পর্ব- গ: নৃতাত্ত্বিক তথ্য				
৩.১	উচ্চতা	[ ] সেমি		
৩.২	ওজন	[ ] কেজি		
৩.৩	বি এম আই	(০) কম ওজন	(১) স্বাভাবিক ওজন	
		(২) অতিরিক্ত ওজন	(২) স্থূল	
পর্ব ৪: ব্যাথা সম্পর্কিত তথ্য				
৪.১	আপনি কতক্ষণ কাজ করেন?			
৪.২	ব্যাথার স্থায়িত্বঃ	(০) [ ]বছর		
		(১) [ ]মাস		
		(২) [ ]সপ্তাহ		

এন পি আর এস			
প্রশ্নাবলীর এই অংশ রোগীর দ্বারা পূরণ করা হবে। নিম্নলিখিত প্রশ্নে আপনার ব্যথার পরিমাণ লাইনে গোল দাগ দিয়ে চিহ্নিত করুণ। এই মুহুর্তে আপনার কোমর ব্যথার তীব্রতা কতটুকু ?	**স্কোর:** **০ = ব্যাথা নাই** **১ = হালকা ব্যাথা** **২ = মাঝারী ব্যাথা** **৩ = তীব্র ব্যাথা**	চিকিৎসার পূর্বে	চিকিৎসার পরে



অস্ওয়েস্ট্রি প্রতিবন্ধিতা সূচক ঃ

আপনার পিঠের /পায়ের বিড়ম্বনা কিভাবে প্রতিদিনের জীবন পরিচালনা করতে আপনার সামর্থ্যকে প্রভাবিত করে তা জানার জন্য এই প্রশ্নটি পরিকল্পনা করা হয়। অনুগ্রহপূর্বক সবগুলো প্রশ্নের উত্তর দিন। প্রতিটি অংশে শুধুমাত্র একটি বাক্স/উত্তর চিহ্নিত করুন যা আপনার অবস্থাকে সর্বপেক্ষা কাছাকাছি বর্ণনা করে

নং	**প্রশ্ন**	**চিকিৎসার পূর্বে**	**চিকিৎসার পরে**
১	**অংশ-১, ব্যথার তীব্রতা**		
	(০) এ মূহুর্তে আমার কোন ব্যথা নেই।		
	(১) এ মূহুর্তে ব্যথা অত্যন্ত কম।		
	(২) এ মূহুর্তে ব্যথা মোটামুটি।		
	(৩) এ মূহুর্তে ব্যথা যথেষ্ঠ পরিমাণে তীব্র।		
	(৪) এ মূহুর্তে ব্যথা অত্যন্ত তীব্র।		

	(৫) এ মূহুর্তে ব্যথা এমন যে তা কল্পনার সর্ব্বোচ্চ খারাপ।		
২	**অংশ-২ ব্যক্তিগত যত্ন, গোসল, পোশাক পরিধান ইত্যাদি**		
	(০) কোন ধরণের ব্যথা ছাড়াই আমি আমার নিজের স্বাভাবিক যত্ন নিতে পারি।		
	(১) আমি আমার নিজের যত্ন নিতে পারি, কিন্তু এটি অত্যন্ত ব্যথাদায়ক।		
	(২) আমার নিজের যত্ন নেওয়া ব্যথাদায়ক এবং এজন্যে আমি ধীর এবং সতর্কতা অবলম্বন করি।		
	(৩) আমার কিছু সাহায্যের দরকার হয়, কিন্তু আমি আমার অধিকাংশ ব্যক্তিগত কাজ নিজেই করতে পারি।		
	(৪) প্রতিদিন আমার নিজের অধিকাংশ কাজের জন্য অন্যের সাহায্য প্রয়োজন হয়।		
	(৫) আমি আমার পোশাক পরিচ্ছদ পরিধান করতে পারি না, গোসল করা যথেষ্ঠ কষ্টদায়ক এবং আমি বিছানাতেই থাকি।		
৩	**অংশ ৩ ওজন তোলা/ উত্তোলন**		
	(০) আমি কোন বাড়তি ব্যথা ছাড়াই ভারি ওজন উত্তোলন করতে পারি।		
	(১) আমি ভারি ওজন উত্তোলন করতে পারি, কিন্তু এটা বাড়তি ব্যথা সৃষ্টি করে।		
	(২) ব্যথার কারণে আমি মেঝে থেকে ভারী ওজন উত্তোলনে ব্যথার সম্মুখহীন হই, কিন্তু এগুলো যদি সুবিধাজনক অবস্থানে যেমন: টেবিলে রাখা হয়, তাহলে আমি তা উত্তোলন করতে পারি।		
	(৩) ব্যথা আমাকে ভারি ওজন উত্তোলনে বাধা সৃষ্টি করে, কিন্তু এগুলো যদি সুবিধা জনক অবস্থানে রাখা হয় তাহলে আমি হালকা থেকে মাঝারি ধরনের ওজন উত্তোলন করতে পারি।		
	(৪) আমি কেবল অত্যন্ত হালকা ওজন উত্তোলন করতে পারি।		
	(৫) আমি একেবারেই কোনকিছু উত্তোলন বা বহন করতে পারি না।		
৪	**অংশ-৪ হাটা চলা**		
	(০) ব্যথার কারণে আমার যে কোন দূরত্বে হাটতে সমস্যা হয় না।		
	(১) ব্যথার কারণে আমি ১ মাইলের অধিক হাটতে পারি না		
	(২) ব্যথার কারণে আমি ১ মাইলের চার ভাগের এক ভাগের অধিক হাটতে পারি না।		

	(৩) ব্যথার কারণে আমি ১০০ গজের অধিক হাটতে পারি না।		
	(৪) আমি কেবল লাঠি বা ক্রাচ ব্যবহার করে হাটতে পারি।		
	(৫) অধিকাংশ সময়েই আমি বিছানায় থাকি এবং আমাকে হামাগুড়ি দিয়ে টয়লেটে যেতে হয়।		
৫	**অংশ-৫ বসে থাকা**		
	(০) আমি যে কোন চেয়ারে যতক্ষণ খুশি ততক্ষণ বসতে পারি।		
	(১) আমি আমার পছন্দের চেয়ারে যতক্ষণ খুশি ততক্ষণ বসতে পারি।		
	(২) ব্যথার জন্য আমি ১ ঘন্টার বেশি বসে থাকতে পারি না।		
	(৩) ব্যথার জন্য আমি ১/২ ঘন্টার বেশি বসে থাকতে পারি না।		
	(৪) ব্যথার জন্য আমি ১০মিনিটের বেশি বসে থাকতে পারি না।		
	(৫) ব্যথার কারণে আমি মোটেই বসে থাকতে পারি না।		
৬	**অংশ-৬ দাঁড়ানো**		
	(০) আমি কোন বাড়তি ব্যথা ছাড়া যতক্ষণ খুশি দাড়িয়ে থাকতে পারি।		
	(১) আমি যতক্ষণ খুশি দাড়িয়ে থাকতে পারি,কিন্তু এটি আমার বাড়তি ব্যথার সৃষ্টি করে।		
	(২) ব্যথার জন্য আমি ১ঘন্টার বেশি দাড়িয়ে থাকতে পারি না।		
	(৩) ব্যথার জন্য আমি ১/২ ঘন্টার বেশি দাড়িয়ে থাকতে পারি না।		
	(৪) ব্যথার জন্য আমি ১০ মিনিটের বেশি দাড়িয়ে থাকতে পারি না ।		
	(৫) ব্যথার জন্য আমি একেবারেই দাড়িয়ে থাকতে পারি না।		
৭	**অংশ-৭ ঘুমানো**		
	(০) ব্যথার কারণে আমার ঘুম কখনই ব্যহত হয় না		
	(১) ব্যথার কারনে আমার ঘুম মাঝে মাঝে ব্যহত হয়।		
	(২) ব্যথার কারনে আমার ঘুম ৬ ঘন্টারও কম হয়।		
	(৩) ব্যথার কারনে আমার ঘুম ৪ ঘন্টারও কম হয় ।		
	(৪) ব্যথার কারনে আমার ঘুম ২ ঘন্টারও কম হয় ।		
	(৫) ব্যথার কারণে আমি মোটেই ঘুমাতে পারি না।		

৮	**অংশ-৭ যৌন জীবন (যদি প্রযোজ্য হয়)**		
	(০) আমার যৌন জীবন স্বাভাবিক এবং কোন অতিরিক্ত ব্যথার সৃষ্টি করে না।		
	(১) আমার যৌন জীবন স্বাভাবিক কিন্তু এতে কিছুটা অতিরিক্ত ব্যথার সৃষ্টি হয়।		
	(২) আমার যৌন জীবন প্রায় স্বাভাবিক কিন্তু তা অত্যন্ত ব্যথাদায়ক।		
	(৩) আমার যৌন জীবন ব্যথার কারণে তীব্রভাবে সীমাবদ্ধ ।		
	(৪) আমার যৌন জীবন ব্যথার কারণে প্রায়ই অনুপস্থিত ।		
	(৫) ব্যথার কারনে আমি আদৌ কোন যৌন জীবন যাপন করতে পারি না।		
৯	**অংশ-৯ সামাজিক জীবন**		
	(০) আমার সামাজিক জীবন স্বাভাবিক এবং তা কোন অতিরিক্ত ব্যথার সৃষ্টি করে না।		
	(১) আমার সামাজিক জীবন স্বাভাবিক কিন্তু ব্যথার পরিমাণ বাড়ায়।		
	(২) আমার অধিক শক্তি প্রয়োজনীয় আগ্রহসমূহকে (যেমন, খেলাধুলা) সীমাবদ্ধ করা ছাড়া আমার সামাজিক জীবনে ব্যথার তেমন কোন তাৎপর্যপূর্ণ প্রভাব নেই ।		
	(৩) ব্যথা আমার সামাজিক জীবনকে সীমাবদ্ধ করেছে এবং আমি প্রায়শই বাইরে যাই না।		
	(৪) ব্যথা আমার সামাজিক জীবনকে গৃহে সীমাবদ্ধ করেছে।		
	(৫) ব্যথার কারণে আমার কোন সামাজিক জীবন নেই।		
১০	**অংশ-১০ ভ্রমণ/ঘুরে বেড়ানো**		
	(০) কোন ধরণের ব্যথা ছাড়াই আমি যে কোন স্থানে ভ্রমণ করতে পারি।		
	(১) আমি যে কোন স্থানে ভ্রমণ করতে পারি কিন্তু এটা অতিরিক্ত ব্যথার সৃষ্টি করে।		
	(২) ব্যথার অবস্থা খারাপ থাকে কিন্তু আমি ২ ঘন্টা পর্যন্ত ভ্রমণ করতে পারি ।		
	(৩) ব্যথা আমার ভ্রমণকে ১ ঘন্টার কম সময়ের মধ্যে সীমাবদ্ধ করে।		
	(৪) ব্যথা আমাকে ৩০ মিনিটের নিচের অল্প প্রয়োজনীয় ভ্রমণসমূহে সীমাবদ্ধ করে।		
	(৫) ব্যথা আমাকে চিকিৎসা গ্রহণ ব্যতীত যে কোন ধরণের ভ্রমণ প্রতিরোধ করে।		

Appendix- E: Treatment Protocol of Control Group

Control Group (40-45 minutes) (Usual Physiotherapy intervention)
Heat and cold therapy
Electrotherapy (e.g., TENS, IFC)
Spinal manipulations or mobilizations
Deep Transverse Friction Massage
Strengthening exercises for the core, back, and legs
Stretching exercises
Postural correction and body mechanics education
Home exercise program

Appendix-F: Treatment Protocol of Experimental Group

Experimental Group (40-45 minutes) (Pilates-Based Rehabilitation with UPT)
Usual Physiotherapy intervention
Pilates Exercises for the Experimental Group **1.** Pelvic Tilts (Valenza et al., 2016, p. 538). **Repetitions:** 3 sets of 10–15 repetitions **2.** Bridging (Yang et al., 2021, p. 101331). **Repetitions:** 3 sets of 10–12 repetitions **3.** Leg Slides (Cruz-Díaz et al., 2017, p. 621). **Repetitions:** 3 sets of 10–12 repetitions (per leg) **4.** Planks (Saragiotto et al., 2016, p. 1707). **Repetitions:** Hold for 20–30 seconds, 3 sets **5.** Cat-Cow Stretch (Wells et al., 2015, Article e0134172). **Repetitions:** 3 sets of 10–12 repetitions

GANTT CHART

Activities/ months	Sep 23	Oct 23	Nov 23	Dec 23	Jan 24	Feb 24	Mar 24	Apr 24	May 24	June 24	Jul 24	Aug 24
Proposal presentation												
Introduction												
Literature review												
Methodology												
Data collection												
Data Analysis												
Result												
1st progress presentation												
Discussion												
Conclusion And Recommendation												
2nd progress presentation												
Communication with supervisor												
Final submission												