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COMPARATIVE EFFECTS OF MCKENZIE THERAPY AND CORE STABILIZATION EXERCISES ON PAIN, DISABILITY, AND FUNCTIONAL OUTCOMES IN PATIENTS WITH CHRONIC NONSPECIFIC LOW BACK PAIN: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Background: *Chronic nonspecific low back pain (CNSLBP) is a common musculoskeletal condition associated with persistent pain, functional disability, and reduced physical performance. McKenzie therapy and core stabilization exercises are widely used physiotherapy interventions; however, their comparative effectiveness across different clinical and functional outcomes remains unclear.*

Objective: *To compare the effects of McKenzie therapy and core stabilization exercises on pain intensity, functional disability, and functional performance in patients with chronic nonspecific low back pain.*

Methods: *A two-arm, parallel-group randomized controlled trial was conducted at IIMCT–Railway General Hospital, Rawalpindi, Pakistan, from March 2024 to August 2024. A total of 60 participants with chronic nonspecific low back pain were allocated into two groups. Group A (n = 30) received McKenzie therapy, while*

Group B (n = 30) received core stabilization exercises. Both groups underwent supervised interventions for six weeks, with three sessions per week, lasting approximately 45 minutes per session. Pain intensity, functional disability, and functional performance were assessed before and after the intervention using the Numeric Pain Rating Scale (NPRS), Modified Oswestry Disability Index (MODI), and Five Times Sit-to-Stand Test (5×STS), respectively. Data was analyzed using IBM SPSS Statistics version 27, with statistical significance set at p less than 0.05.

Results: *Both intervention groups demonstrated statistically significant improvements in all three outcome measures following the six-week treatment program (p less than 0.001). McKenzie therapy produced a greater reduction in pain intensity, with NPRS scores decreasing from 6.85 ± 1.15 to 2.35 ± 0.95, compared with 6.70 ± 1.20 to 3.15 ± 1.10 in the core stabilization group (p = 0.002). Similarly, functional disability improved more in the McKenzie group, with MODI scores decreasing from 41.2 ± 8.1% to 15.8 ± 6.2%, compared with 40.5 ± 7.9% to 20.4 ± 6.8% in the core stabilization group (p = 0.003). Conversely, core stabilization exercises produced greater improvement in functional performance, with 5×STS completion time decreasing from 16.1 ± 3.2 to 10.8 ± 2.5 seconds, compared with 16.4 ± 3.4 to 12.9 ± 2.9 seconds in the McKenzie group (p = 0.008).*

Conclusion: *Both McKenzie therapy and core stabilization exercises were effective in improving pain intensity, functional disability, and functional performance in patients with chronic nonspecific low back pain. McKenzie therapy demonstrated greater effectiveness in reducing pain and functional disability, whereas core stabilization exercises produced greater improvements in functional performance. Both interventions may be considered valuable physiotherapy approaches, with treatment selection guided by individual patient needs and rehabilitation goals.*

1. INTRODUCTION

Low back pain (LBP) is one of the most prevalent musculoskeletal disorders and a major contributor to disability, reduced productivity, and healthcare utilization worldwide. It represents a substantial public health challenge because of its recurrent nature, prolonged course, and negative impact on physical functioning and quality of life. According to the Global Burden of Disease (GBD) Study 2021, approximately 619 million individuals experienced LBP globally in 2020, and this number is projected to increase to 843 million by 2050. Furthermore, LBP accounted for approximately 69 million years lived with disability in 2020, highlighting its considerable contribution to the global burden of disease (1, 2). The increasing prevalence of LBP, particularly in working-age adults, emphasizes the need for effective, accessible, and evidence-based rehabilitation strategies (2, 3).

Chronic low back pain (CLBP), generally defined as pain persisting or recurring for more than 12 weeks, is particularly challenging because its clinical presentation frequently involves a combination of physical, psychological, and social factors. Chronic nonspecific low back pain (CNSLBP) refers to persistent lumbar pain without an identifiable specific underlying pathology, such as malignancy, infection, vertebral fracture, inflammatory disease, or other serious spinal disorders. Unlike specific spinal conditions, CNSLBP cannot usually be attributed to a single anatomical structure or pathological mechanism. Patients commonly experience restricted spinal mobility, reduced muscular endurance, impaired movement coordination, fear of physical activity, and limitations in performing routine activities (4). These impairments may interfere with occupational responsibilities, household activities, sleep, and

overall quality of life. Consequently, CNSLBP should be approached as a multidimensional musculoskeletal condition rather than simply a localized mechanical disorder (1, 5).

The management of CNSLBP remains an important challenge for physiotherapists because no single therapeutic intervention has demonstrated consistent superiority across all patients. Contemporary rehabilitation approaches increasingly emphasize patient education, maintenance of physical activity, individualized exercise prescription, and restoration of functional capacity. The World Health Organization (WHO), in its 2023 guideline for the management of chronic primary low back pain, recommended structured exercise programs as an important component of nonsurgical management. The guideline also emphasized individualized and person-centered care, recognizing that patients may require different combinations of therapeutic interventions according to their clinical presentation and functional limitations (5). Within physiotherapy practice, the McKenzie Method of Mechanical Diagnosis and Therapy (MDT) and core stabilization exercises are frequently prescribed approaches for managing CNSLBP. Both interventions aim to reduce pain and improve physical functioning; however, they employ different therapeutic principles and exercise strategies.

The McKenzie Method, also known as Mechanical Diagnosis and Therapy, is an assessment-based treatment approach that classifies patients according to their symptomatic and mechanical responses to repeated movements and sustained postures. It emphasizes the identification of directional preference, centralization of symptoms, and individualized exercise prescription. Repeated lumbar movements, particularly in the direction that produces a favorable symptomatic response, are used to improve movement tolerance, reduce pain, and facilitate independent self-management. A major strength of this approach is its emphasis on patient participation and the development of self-management strategies that can be continued outside the clinical setting. Recent evidence suggests that the McKenzie Method may produce clinically meaningful improvements in pain and disability, particularly among patients with chronic LBP who demonstrate a directional preference. A 2024 systematic review and meta-analysis involving 743 participants reported that McKenzie-based treatment delivered by credentialed therapists was associated with improvements in short-term pain and disability compared with other conservative interventions, although the certainty of evidence ranged from low to moderate (6).

In contrast, core stabilization exercises focus on improving strength, endurance, coordination, and neuromuscular control of the muscles responsible for maintaining lumbopelvic stability. These exercises commonly target the transversus abdominis, multifidus, diaphragm, pelvic floor, and other trunk musculature involved in controlling spinal movement. The underlying rationale is that improved coordination and functional capacity of the trunk muscles may enhance load distribution, movement control, and tolerance to daily physical activities. Core stabilization programs generally progress from low-load activation and motor control exercises to more challenging functional activities involving limb movements, balance, and trunk endurance. This progressive approach may be particularly beneficial for individuals who demonstrate reduced trunk endurance, impaired lumbopelvic control, or difficulty maintaining spinal stability during functional tasks. However, the effectiveness of stabilization exercises may depend on exercise selection, training intensity, program duration, patient adherence, and individual functional deficits.

2. LITERATURE REVIEW

2.1 Evidence supporting the McKenzie Method

The McKenzie Method has received considerable attention in the conservative management of chronic nonspecific LBP because of its systematic assessment procedures and individualized exercise prescription. Unlike generalized exercise programs, MDT attempts to identify specific movement directions that improve or aggravate symptoms. Centralization, characterized by the migration of distal symptoms towards the lumbar region, is considered an important clinical response during assessment and treatment. Through repeated movements and education, the approach aims to improve patients' ability to recognize symptom-provoking activities, modify movement patterns, and independently manage recurrent episodes of pain.

Recent evidence has provided further support for the clinical application of the McKenzie Method. Hennemann et al. (2024) conducted a systematic review and meta-analysis evaluating McKenzie treatment

delivered by credentialed therapists in patients with chronic LBP and directional preference. Five randomized controlled trials involving 743 participants were included. Their findings indicated that the McKenzie Method produced clinically important improvements in short-term pain and disability compared with alternative exercise approaches, although the certainty of evidence varied across comparisons and follow-up periods. These findings suggest that patients demonstrating a directional preference may particularly benefit from an individualized mechanical treatment approach (6). Nevertheless, the findings should not be generalized to all patients with CNSLBP because the review specifically focused on individuals with directional preference.

A Pakistani study by Aqil et al. (2021) compared the McKenzie approach with lumbar stabilization exercises in 30 patients with chronic LBP. Participants received eight treatment sessions over two weeks, and outcomes were assessed using the Numeric Pain Rating Scale (NPRS) and Modified Oswestry Disability Index (MODI). Both groups demonstrated improvements in pain and functional disability; however, the lumbar stabilization group demonstrated significantly greater improvements in the selected outcomes. This study provides relevant evidence from the Pakistani clinical setting and suggests that stabilization-based rehabilitation may offer additional benefits for some patients. However, its relatively small sample size, short intervention period, and limited follow-up restrict the generalizability of its findings (7).

These findings demonstrate that although the McKenzie Method can be beneficial in reducing pain and disability, its effectiveness may vary according to patients' mechanical presentations and responses to repeated movements. Furthermore, improvements in pain do not necessarily translate into equivalent improvements in muscular endurance, trunk control, and overall functional performance. Therefore, evaluating the McKenzie Method against an intervention specifically targeting these functional components is clinically justified.

2.2 Evidence supporting core stabilization exercises

Core stabilization exercises are widely incorporated into physiotherapy programs for CNSLBP because of their emphasis on neuromuscular coordination and functional control of the lumbopelvic region. Altered trunk muscle activation, reduced endurance, and impaired coordination have been reported in individuals experiencing persistent LBP. Stabilization-based rehabilitation attempts to address these impairments through progressive activation, strengthening, and endurance training of the trunk musculature. The ultimate objective is not simply to increase muscle strength but to improve the capacity of the trunk to maintain appropriate control during static and dynamic activities.

Sengul et al. (2021) conducted a randomized controlled trial investigating the effects of stabilization exercises on pain, disability, and core stability in patients with nonspecific LBP. Thirty-seven participants were allocated to stabilization exercise and conventional exercise groups, with both interventions delivered over six weeks. The investigators assessed pain, disability, trunk muscle endurance, strength, flexibility, and functional performance. Their findings demonstrated improvements in several clinical and physical performance measures in both groups, while stabilization exercises produced greater improvements in selected outcomes, including pain during activity, endurance, and functional performance (8). These findings support the potential value of stabilization-based interventions, particularly when rehabilitation aims to address physical impairments beyond pain intensity alone.

Further evidence was provided by Hussain et al. (2024), who investigated the effects of core stability exercises combined with dynamic stretching in patients with chronic LBP in Pakistan. Their randomized controlled trial included 48 participants allocated to routine physiotherapy or routine physiotherapy supplemented with core stability exercises and dynamic stretching. Pain intensity, lumbar range of motion, and physical disability were assessed using the NPRS, goniometer, and Oswestry Disability Index, respectively. The intervention group demonstrated significant improvements in pain, disability, and lumbar mobility. These findings support the integration of core stabilization into physiotherapy rehabilitation programs. However, because core exercises were combined with dynamic stretching and routine physiotherapy, the independent contribution of core stabilization could not be established (9).

Similarly, a 2024 randomized controlled trial comparing isometric and isotonic core stabilization exercises highlighted the importance of exercise selection when designing rehabilitation programs for patients with

chronic nonspecific LBP. Both approaches were investigated in relation to pain and disability, reflecting continued clinical interest in identifying the most appropriate exercise strategies for this population (10). Nevertheless, variations in exercise protocols, intensity, duration, and patient characteristics make direct comparisons between stabilization programs difficult.

Collectively, these findings indicate that core stabilization exercises can improve pain-related outcomes and functional capacity in individuals with chronic nonspecific LBP. However, the observed benefits should not be interpreted as evidence that stabilization exercises are universally superior to other active rehabilitation approaches. Their effectiveness may depend on the presence of specific muscular and movement-control impairments, the progression of exercises, and the consistency of treatment delivery.

2.3 Comparative evidence: McKenzie therapy versus core stabilization

Although both McKenzie therapy and core stabilization exercises are commonly used in the rehabilitation of CNSLBP, their therapeutic mechanisms differ considerably. The McKenzie approach primarily emphasizes mechanical assessment, directional preference, symptom centralization, repeated movements, and patient-directed self-management. Conversely, core stabilization exercises emphasize neuromuscular control, trunk muscle endurance, lumbopelvic coordination, and progressive functional strengthening. Despite these differences, both approaches share the common objective of reducing pain, minimizing disability, and improving the ability to perform daily activities.

Comparative evidence has produced variable findings regarding the relative effectiveness of these interventions. Aqil et al. (2021), in their Pakistani randomized controlled trial, reported greater improvements in pain and disability following lumbar stabilization exercises compared with the McKenzie approach (7). In contrast, the systematic review by Hennemann et al. (2024) demonstrated favorable outcomes for McKenzie therapy compared with alternative exercise approaches in patients with chronic LBP and directional preference (6). These apparently different findings may be explained by variations in patient selection, intervention protocols, treatment duration, and the clinical characteristics of the participants.

Importantly, Jiang et al. (2024) conducted a systematic review and meta-analysis of 25 randomized controlled trials involving 1,253 participants to compare motor control training with Pilates, the McKenzie Method, and conventional physical therapy. Motor control training demonstrated significant improvements in pain and physical function compared with the combined alternative interventions. However, subgroup analyses did not identify statistically significant differences between motor control training and the McKenzie Method for pain or physical function. The findings suggest that both approaches may provide comparable benefits in certain clinical populations, although the interventions and outcomes included in the review were heterogeneous (11).

The available literature therefore does not establish a universally superior intervention for all patients with CNSLBP. While McKenzie therapy may be particularly appropriate for individuals demonstrating a clear directional preference, core stabilization may be beneficial for those with impaired trunk endurance and lumbopelvic motor control. Moreover, improvement in one outcome does not necessarily indicate equivalent improvement in other domains. For example, an intervention may produce substantial reductions in pain without achieving comparable improvements in functional endurance or activity-related disability. Consequently, comparative evaluation should incorporate multiple clinically meaningful outcomes rather than relying exclusively on pain intensity.

2.4 Research gap and rationale for the present study

Despite the growing body of evidence supporting both McKenzie therapy and core stabilization exercises, several important limitations remain. First, previous studies have reported inconsistent findings regarding their comparative effectiveness, with some demonstrating greater improvements following stabilization exercises and others supporting McKenzie-based treatment. Second, existing studies frequently differ in intervention duration, exercise progression, treatment frequency, assessment instruments, and participant characteristics, limiting the comparability of their findings. Third, several investigations have evaluated core stabilization as an adjunct to conventional physiotherapy or combined it with other

interventions, making it difficult to determine its independent therapeutic effects. Fourth, some studies have focused primarily on pain and disability without adequately examining broader functional outcomes. Evidence from Pakistan is particularly relevant because occupational demands, physical activity patterns, access to rehabilitation services, and healthcare-seeking behaviors may influence the clinical presentation and management of chronic LBP. Although Pakistani studies have investigated McKenzie therapy and stabilization-based interventions, the available evidence remains limited by small samples, short treatment periods, and differences in study protocols. The 2021 study by Aqil et al. provides a direct comparison of McKenzie therapy and lumbar stabilization; however, its short intervention period and limited follow-up highlight the need for further adequately powered randomized controlled trials (7). The 2024 study by Hussain et al. provides additional local evidence for core stabilization, but its combined intervention design does not establish the independent comparative effectiveness of core stabilization against McKenzie therapy (9).

Therefore, a well-designed randomized controlled trial directly comparing McKenzie therapy with core stabilization exercises is warranted to generate more reliable evidence regarding their relative effects on pain, disability, and functional outcomes in patients with CNSLBP. The present study aims to address this gap by evaluating both interventions under a standardized treatment protocol using clinically relevant outcome measures. By comparing their effects on pain intensity, functional disability, and physical functioning, this research may help physiotherapists identify more effective and evidence-based rehabilitation strategies for individuals with chronic nonspecific low back pain, particularly within the Pakistani healthcare context.

GENERAL OBJECTIVE

To compare the effects of McKenzie therapy and core stabilization exercises on pain intensity, functional disability, and functional outcomes in patients with chronic nonspecific low back pain.

Specific Objectives

1. To determine the effects of McKenzie therapy on pain intensity, functional disability, and functional outcomes in patients with chronic nonspecific low back pain.
2. To determine the effects of core stabilization exercises on pain intensity, functional disability, and functional outcomes in patients with chronic nonspecific low back pain.
3. To compare the effectiveness of McKenzie therapy and core stabilization exercises in improving pain intensity, functional disability, and functional outcomes between the two treatment groups.

3. METHODOLOGY

3.1 Study Design

A two-arm, parallel-group randomized controlled trial was conducted to compare the effects of McKenzie therapy and core stabilization exercises on pain intensity, functional disability, and functional outcomes in patients with chronic nonspecific low back pain.

3.2 Study Setting and Duration

The study was conducted at the Institute of Medical Sciences, IIMCT–Railway General Hospital, Rawalpindi, Pakistan, from March 2024 to August 2024.

3.3 Study Population

The study population consisted of adult patients presenting with chronic nonspecific low back pain at the outpatient physiotherapy department of IIMCT–Railway General Hospital, Rawalpindi.

3.4 Sample Size and Sampling Technique

A total of 48 participants were included in the study. Participants fulfilling the predefined eligibility criteria were recruited through a non-probability consecutive sampling technique. Following baseline assessment, participants were randomly allocated into two equal groups, with 24 participants in each group. Group A received McKenzie therapy, whereas Group B received core stabilization exercises.

3.5 Eligibility Criteria

Inclusion Criteria

- Male and female patients aged 18–60 years.
- Individuals experiencing nonspecific low back pain for at least 12 weeks.
- Patients with pain localized to the lumbar region, with or without referred pain to the buttocks.
- Participants who were able to understand and perform the prescribed exercises.

Exclusion Criteria

- Specific spinal pathologies, including vertebral fractures, spinal infections, malignancies, and inflammatory spinal disorders.
- Previous lumbar spine surgery.
- Progressive neurological deficits or severe radiculopathy.
- Severe osteoporosis or other contraindications to therapeutic exercise.
- Pregnancy.
- Participation in another structured low back pain rehabilitation program during the study period.

3.6 Randomization and Group Allocation

The 48 eligible participants were randomly allocated into two treatment groups. Group A consisted of 24 participants who received McKenzie therapy, while Group B consisted of 24 participants who received core stabilization exercises. Both groups underwent their respective interventions for six weeks.

3.7 Intervention Protocol

Both groups received supervised physiotherapy interventions over six weeks, with three treatment sessions per week, resulting in a total of 18 sessions per participant. Each session lasted approximately 45 minutes. The treatment frequency, session duration, and overall intervention period were kept consistent between groups to ensure comparable treatment exposure.

Group A: McKenzie Therapy

Participants allocated to Group A received McKenzie-based Mechanical Diagnosis and Therapy (MDT). The treatment program was individualized according to mechanical assessment and symptomatic responses to repeated lumbar movements and sustained postures. Directional preference was identified through clinical assessment, and exercises were prescribed accordingly. The program included repeated lumbar extension, flexion, or lateral movements, depending on individual symptomatic responses. Postural education, movement correction, and self-management strategies were also incorporated. Exercise progression was determined according to symptom response and individual tolerance.

Group B: Core Stabilization Exercises

Participants allocated to Group B received a structured core stabilization exercise program designed to improve trunk muscle activation, endurance, and lumbopelvic control. The program included abdominal bracing, transversus abdominis activation, pelvic tilts, bridging, quadruped opposite arm-leg raises (bird-dog), and modified plank exercises. Exercises were progressively advanced according to participants' functional abilities and exercise tolerance. Proper breathing, controlled movements, and maintenance of neutral spinal alignment were emphasized throughout the intervention.

3.7.1 Treatment Schedule

The intervention schedule for both groups was designed for six weeks, with three supervised sessions per week and approximately 45 minutes per session.

Table A. General treatment schedule for both intervention groups

Treatment parameters	Protocol
Total intervention duration	6 weeks
Treatment frequency	3 sessions per week
Total treatment sessions	18 sessions
Duration of each session	45 minutes
Total supervised treatment time	810 minutes (13.5 hours)
Group A	McKenzie therapy
Group B	Core stabilization exercises

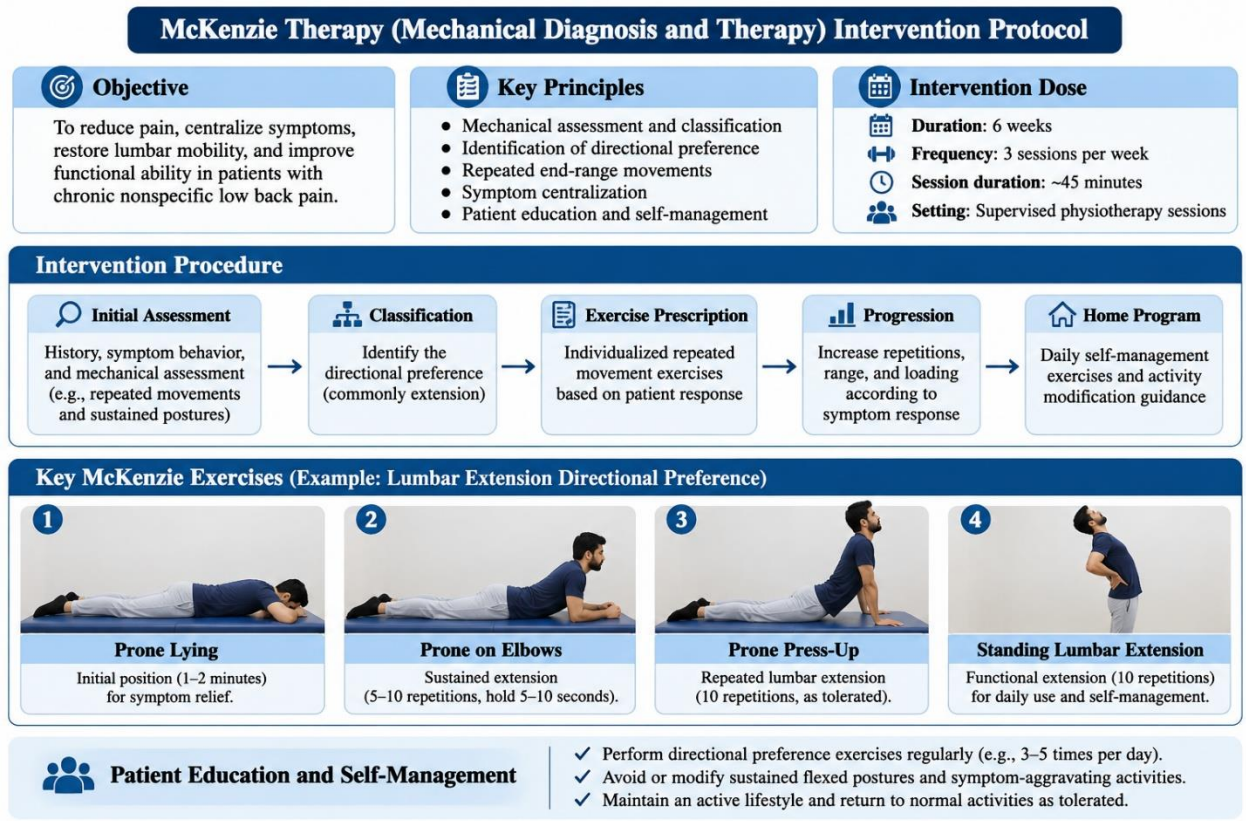


Figure A. McKenzie Therapy (Mechanical Diagnosis and Therapy) Intervention Protocol

Table B. Six-week McKenzie therapy intervention protocol (Group A)

Week	Therapeutic exercises	Dosage
Week 1	Mechanical assessment, postural education, identification of directional preference, and repeated movements in the preferred direction	10 repetitions per exercise
Week 2	Progression of repeated lumbar movements in the identified directional preference and postural correction	10–15 repetitions
Week 3	Progression to sustained positions and self-directed repeated movements according to symptomatic response	10–15 repetitions; 5–10-second holds where appropriate
Week 4	Advanced directional movements and functional movement integration	15 repetitions
Week 5	Progression of mechanical exercises, functional movement control, and independent symptom management	15–20 repetitions

Week 6	Consolidation of directional preference exercises, functional integration, and self-management education	15–20 repetitions

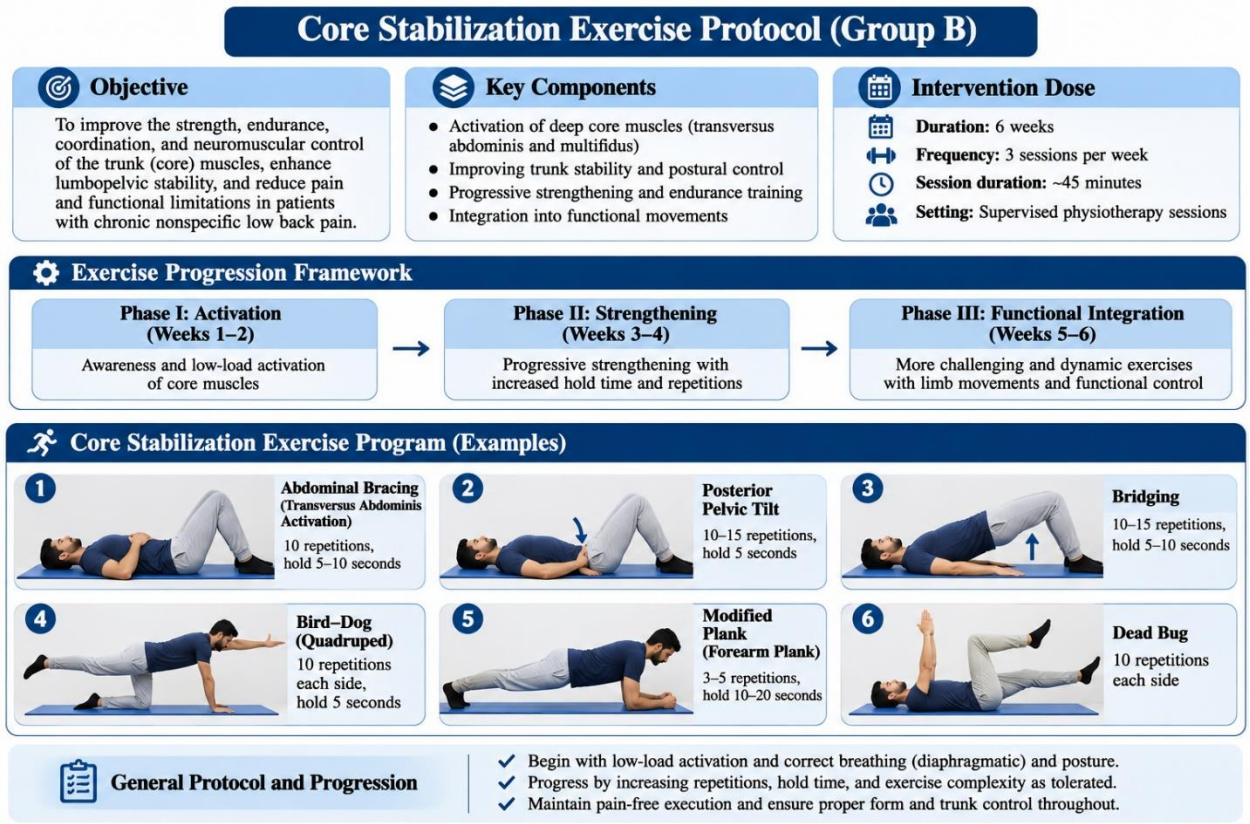


Figure 3. Core Stabilization Exercise Protocol for Patients with Chronic Nonspecific Low Back Pain.

Table C. Six-week core stabilization exercise protocol (Group B)

Week	Therapeutic exercises	Dosage
Week 1	Abdominal bracing, transversus abdominis activation, and pelvic tilts	2 sets × 10 repetitions
Week 2	Abdominal bracing, pelvic tilts, and basic bridging	2 sets × 10–12 repetitions
Week 3	Bridging, abdominal bracing, and quadruped arm and leg movements	2 sets × 10 repetitions
Week 4	Bird-dog exercise, bridging, and modified plank	3 sets × 10 repetitions; plank holds of 10–15 seconds
Week 5	Advanced bridging, bird-dog, and modified plank exercises	3 sets × 12 repetitions; plank holds of 15–20 seconds
Week 6	Progressive core stabilization exercises incorporating bridging, bird-dog, and plank variations	3 sets × 12–15 repetitions; plank holds of 20–30 seconds

Table 4. Standardized structure of each treatment session

Session component	Duration
Initial assessment and warm-up	5 minutes
Assigned therapeutic exercise program	30 minutes
Patient education, movement correction, and cool-down	10 minutes
Total session duration	45 minutes

3.8 Outcome Measures

The effects of both interventions were evaluated using standardized outcome measures at baseline and immediately after completion of the six-week intervention program.

- **Pain Intensity:** Pain intensity was assessed using the Numeric Pain Rating Scale (NPRS), an 11-point scale ranging from 0 (no pain) to 10 (worst imaginable pain).
- **Functional Disability**: Functional disability was measured using the Modified Oswestry Disability Index (MODI), which evaluates the impact of low back pain on daily activities, including personal care, lifting, walking, sitting, standing, sleeping, and social participation. Higher scores indicated greater functional disability.
- **Functional Performance:** Functional performance was assessed using the Five Times Sit-to-Stand Test (5×STS), which measured the time required by participants to complete five consecutive sit-to-stand movements from a standardized chair. Longer completion times indicated poorer functional performance.

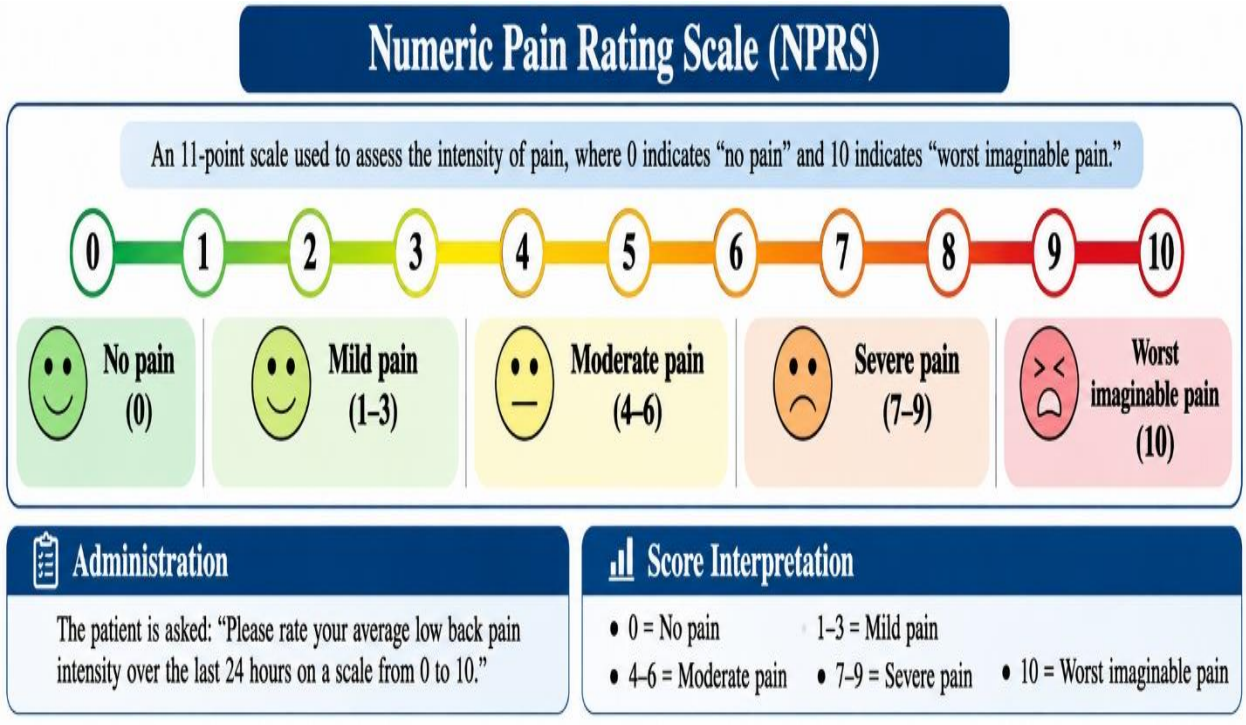


Figure C. Numeric Pain Rating Scale (NPRS) used to assess pain intensity in patients with chronic nonspecific low back pain.

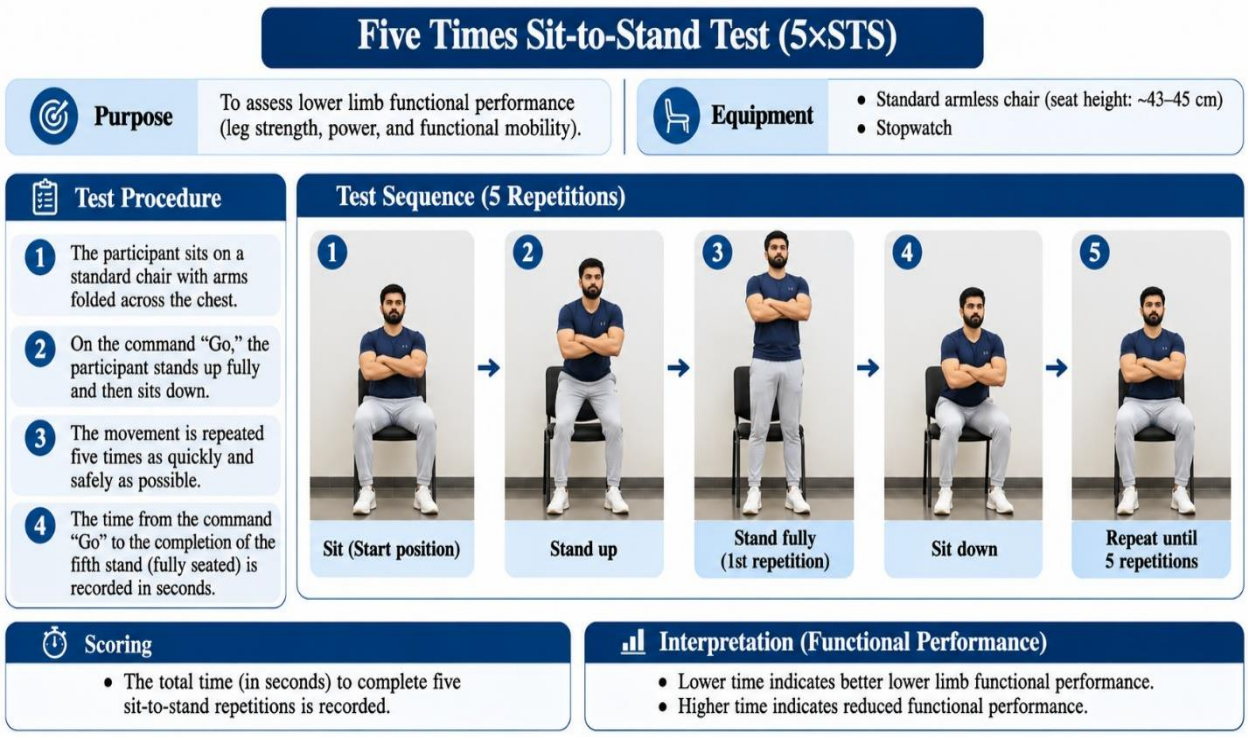


Figure D. Five Times Sit-to-Stand Test (5×STS) for the assessment of functional performance in patients with chronic nonspecific low back pain.

3.9 Data Collection Procedure

Following ethical approval, eligible participants were recruited from IIMCT–Railway General Hospital, Rawalpindi. Written informed consent was obtained before data collection. Demographic and clinical information was recorded, followed by baseline assessment of pain intensity, functional disability, and functional performance using NPRS, MODI, and 5×STS, respectively. Participants were subsequently allocated into their respective intervention groups and received the prescribed treatment programs for six weeks. Following completion of the intervention period, all outcome measures were reassessed using the same standardized procedures to determine within-group improvements and between-group differences.

3.10 Statistical Analysis

Data was entered and analyzed using IBM SPSS Statistics version 27. Descriptive statistics were calculated for demographic and clinical characteristics. Continuous variables were presented as mean ± standard deviation or median and interquartile range, depending on their distribution, while categorical variables were presented as frequencies and percentages. Normality was assessed before inferential statistical analysis. Within-group changes from baseline to post-intervention were analyzed using paired-sample t-tests or Wilcoxon signed-rank tests, as appropriate. Between-group differences were assessed using independent-sample t-tests or Mann–Whitney U tests, as appropriate. A mixed-design analysis of variance was used, where appropriate, to examine group, time, and group-by-time interaction effects. Statistical significance was considered at a p-value of less than 0.05.

3.11 Ethical Considerations

Ethical approval was obtained from the relevant institutional ethical review committee before commencement of the study. Written informed consent was obtained from all participants. Confidentiality and anonymity were maintained throughout the research process. Participants were informed about the study procedures, potential benefits, and their right to withdraw from the study at any stage without affecting their routine healthcare.

4. RESULTS

4.1 Participants' Characteristics

A total of 72 patients were assessed for eligibility, of whom 24 were excluded. The remaining 48 participants were randomly allocated into two groups: Group A (n = 24), receiving McKenzie therapy, and Group B (n = 24), receiving core stabilization exercises. All participants completed the six-week intervention, and all 48 were included in the final analysis, with no loss to follow-up (Figure 1).

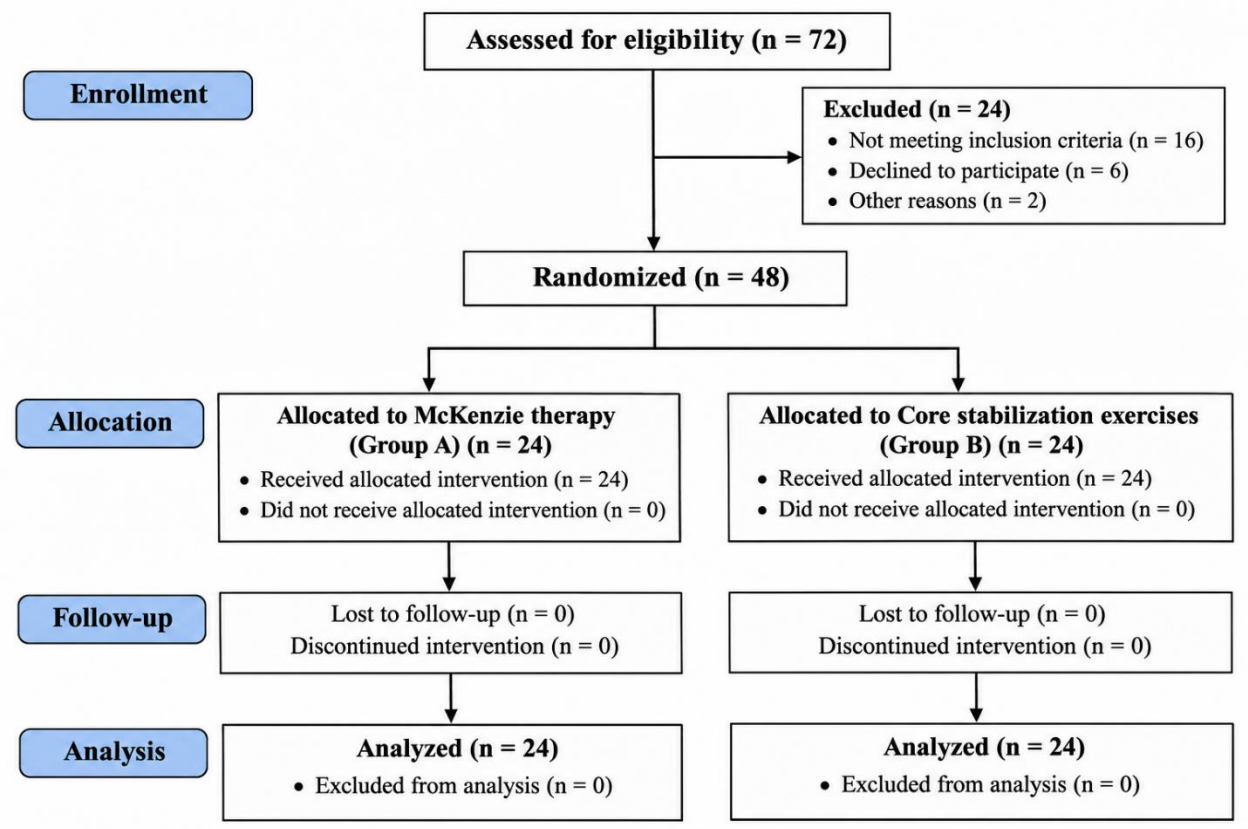


Figure 1. CONSORT flow diagram illustrating participant recruitment, randomization, allocation, follow-up, and analysis in the two intervention groups.

4.2 Baseline Demographic and Clinical Characteristics

The baseline demographic and clinical characteristics of participants are presented in Table 1. The mean age of participants was 43.1 ± 10.4 years in Group A and 42.6 ± 9.8 years in Group B. Regarding gender distribution, Group A comprised 16 (53.3%) male and 14 (46.7%) female participants, whereas Group B comprised 15 (50.0%) male and 15 (50.0%) female participants. At baseline, the mean NPRS score was 6.85 ± 1.15 in Group A and 6.70 ± 1.20 in Group B. The mean MODI score was 41.2 ± 8.1% in Group A and 40.5 ± 7.9% in Group B. Similarly, the mean completion time for the Five Times Sit-to-Stand Test (5×STS) was 16.4 ± 3.4 seconds in Group A and 16.1 ± 3.2 seconds in Group B. No, statistically significant differences were observed between the two groups in baseline demographic and clinical characteristics (p greater than 0.05), indicating that both groups had comparable baseline measurements.

Table 1. Baseline demographic and clinical characteristics of participants

Variable	Group A: McKenzie (n=30)	Group B: Core stabilization (n=30)	p-value
Age (years)	43.1 ± 10.4	42.6 ± 9.8	0.812
Male, n (%)	16 (53.3)	15 (50.0)	0.796
Female, n (%)	14 (46.7)	15 (50.0)	—
NPRS	6.85 ± 1.15	6.70 ± 1.20	0.621
MODI (%)	41.2 ± 8.1	40.5 ± 7.9	0.734

5×STS (sec)	16.4 ± 3.4	16.1 ± 3.2	0.728

4.3 Effects of McKenzie Therapy and Core Stabilization Exercises on Pain Intensity

Pain intensity was assessed using the Numeric Pain Rating Scale (NPRS) before and after the six-week intervention program. Both treatment groups demonstrated statistically significant reductions in pain intensity following their respective interventions. In Group A, the mean NPRS score decreased from 6.85 ± 1.15 at baseline to 2.35 ± 0.95 following McKenzie therapy, representing a mean improvement of 4.50 ± 1.05 points (p less than 0.001). Similarly, Group B demonstrated a reduction in the mean NPRS score from 6.70 ± 1.20 to 3.15 ± 1.10 following core stabilization exercises, representing a mean improvement of 3.55 ± 1.15 points (p less than 0.001). The between-group comparison demonstrated a statistically significant difference in pain reduction (p = 0.002). McKenzie therapy produced a significantly greater reduction in pain intensity compared with core stabilization exercises.

Table 2. Comparison of pain intensity between the two treatment groups

NPRS score	Group A: McKenzie (n=30)	Group B: Core stabilization (n=30)
Pre-intervention	6.85 ± 1.15	6.70 ± 1.20
Post-intervention	2.35 ± 0.95	3.15 ± 1.10
Mean improvement	4.50 ± 1.05	3.55 ± 1.15
Within-group p-value	less than 0.001	less than 0.001
Between-group p-value	—	0.002

4.4 Effects of McKenzie Therapy and Core Stabilization Exercises on Functional Disability

Functional disability was evaluated using the Modified Oswestry Disability Index (MODI). Both intervention groups demonstrated statistically significant improvements in functional disability following the six-week treatment program. In Group A, the mean MODI score decreased from 41.2 ± 8.1% before intervention to 15.8 ± 6.2% after McKenzie therapy, representing a mean improvement of 25.4 ± 6.35 percentage points (p less than 0.001). Similarly, Group B demonstrated a reduction in the mean MODI score from 40.5 ± 7.9% to 20.4 ± 6.8% following core stabilization exercises, representing a mean improvement of 20.1 ± 6.50 percentage points (p less than 0.001). The between-group comparison revealed a statistically significant difference in functional disability improvement (p = 0.003). McKenzie therapy demonstrated a significantly greater reduction in functional disability compared with core stabilization exercises.

Table 3. Comparison of functional disability between the two treatment groups

MODI score (%)	Group A: McKenzie (n=30)	Group B: Core stabilization (n=30)
Pre-intervention	41.2 ± 8.1	40.5 ± 7.9
Post-intervention	15.8 ± 6.2	20.4 ± 6.8
Mean improvement	25.4 ± 6.35	20.1 ± 6.50
Within-group p-value	less than 0.001	less than 0.001
Between-group p-value	—	0.003

4.5 Effects of McKenzie Therapy and Core Stabilization Exercises on Functional Performance

Functional performance was assessed using the Five Times Sit-to-Stand Test (5×STS), with the time required to complete the test recorded in seconds. Both groups demonstrated statistically significant improvements in functional performance following their respective interventions. In Group A, the mean 5×STS completion time decreased from 16.4 ± 3.4 seconds at baseline to 12.9 ± 2.9 seconds following McKenzie therapy, representing a mean improvement of 3.5 ± 2.55 seconds (p less than 0.001). Similarly, Group B demonstrated a reduction in completion time from 16.1 ± 3.2 seconds to 10.8 ± 2.5 seconds following core stabilization exercises, representing a mean improvement of 5.3 ± 2.60 seconds (p less than 0.001). The between-group comparison demonstrated a statistically significant difference in functional

performance improvement (p = 0.008). Core stabilization exercises produced a significantly greater reduction in 5×STS completion time compared with McKenzie therapy.

Table 4. Comparison of functional performance between the two treatment groups

5×STS (seconds)	Group A: McKenzie (n=30)	Group B: Core stabilization (n=30)
Pre-intervention	16.4 ± 3.4	16.1 ± 3.2
Post-intervention	12.9 ± 2.9	10.8 ± 2.5
Mean improvement	3.5 ± 2.55	5.3 ± 2.60
Within-group p-value	less than 0.001	less than 0.001
Between-group p-value	—	0.008

4.6 Overall Comparative Effects of Both Interventions

The overall comparative analysis demonstrated that both McKenzie therapy and core stabilization exercises produced statistically significant improvements in pain intensity, functional disability, and functional performance following the six-week intervention program. McKenzie therapy demonstrated significantly greater improvements in pain intensity, measured through NPRS (p = 0.002), and functional disability, assessed using MODI (p = 0.003), compared with core stabilization exercises. In contrast, core stabilization exercises demonstrated significantly greater improvement in functional performance, measured through the Five Times Sit-to-Stand Test (p = 0.008). These findings indicate that both interventions improved the assessed clinical outcomes, although their comparative effects differed across the outcome measures. McKenzie therapy demonstrated greater improvement in pain reduction and functional disability, whereas core stabilization exercises demonstrated greater improvement in functional performance.

Table 5. Summary of comparative treatment effects

Outcome measure	Intervention showing greater improvement	Between-group p-value
Pain intensity (NPRS)	McKenzie therapy	0.002
Functional disability (MODI)	McKenzie therapy	0.003
Functional performance (5×STS)	Core stabilization exercises	0.008

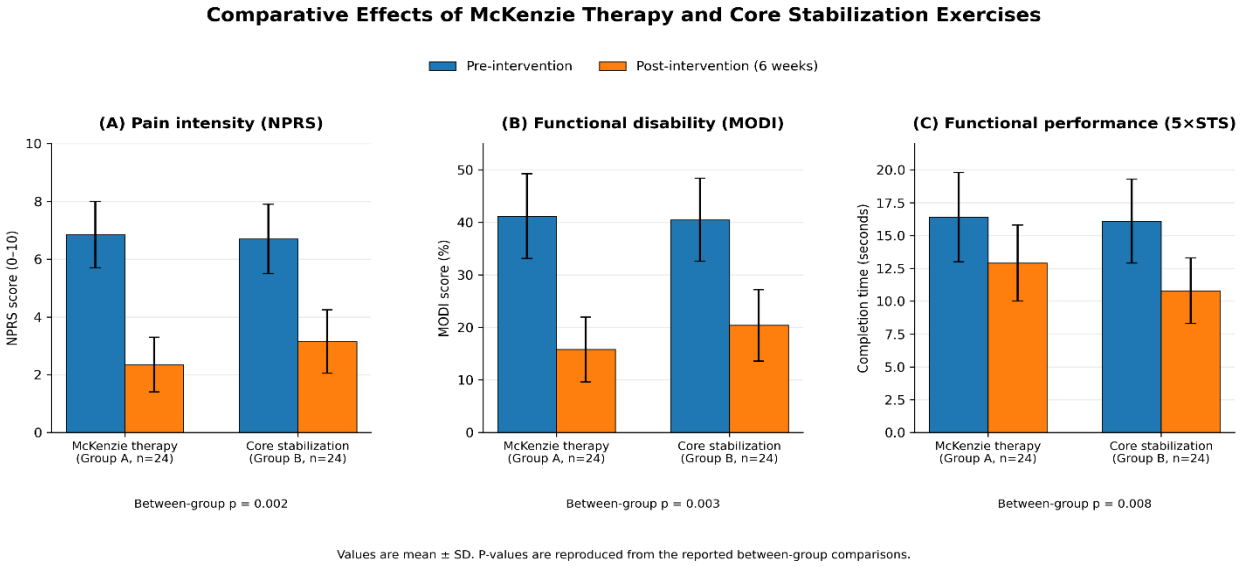


Figure 2. Comparative effects of McKenzie therapy and core stabilization exercises on (A) pain intensity (NPRS), (B) functional disability (MODI), and (C) functional performance (5×STS) at baseline and following six weeks of intervention. Values are presented as mean ± standard deviation.

5. DISCUSSION

5.1 Overview of the Principal Findings

The present randomized controlled trial compared the effects of McKenzie therapy and core stabilization exercises on pain intensity, functional disability, and functional performance in patients with chronic nonspecific low back pain. Both interventions were delivered over six weeks, with three supervised treatment sessions per week, and their effects were evaluated using the Numeric Pain Rating Scale (NPRS), Modified Oswestry Disability Index (MODI), and Five Times Sit-to-Stand Test (5×STS). The findings demonstrated that both McKenzie therapy and core stabilization exercises produced statistically significant improvements in all three outcome measures following the intervention period. However, differences were observed in their comparative effectiveness. McKenzie therapy demonstrated significantly greater improvements in pain intensity and functional disability, whereas core stabilization exercises produced significantly greater improvements in functional performance. Specifically, the McKenzie group demonstrated a greater reduction in NPRS scores (4.50 ± 1.05 versus 3.55 ± 1.15; $p = 0.002$) and MODI scores (25.4 ± 6.35 versus 20.1 ± 6.50 percentage points; $p = 0.003$) compared with the core stabilization group. Conversely, the core stabilization group demonstrated a greater reduction in 5×STS completion time (5.3 ± 2.60 versus 3.5 ± 2.55 seconds; $p = 0.008$). These findings suggest that although both interventions are beneficial for managing chronic nonspecific low back pain, their relative effects may differ according to the clinical outcome being assessed.

5.2 Effects of McKenzie Therapy and Core Stabilization Exercises on Pain Intensity

Pain reduction is an important treatment objective in patients with chronic nonspecific low back pain because persistent pain can interfere with mobility, physical activity, occupational performance, and participation in daily activities. In the present study, both intervention groups demonstrated significant reductions in pain intensity following six weeks of treatment. However, McKenzie therapy produced a significantly greater reduction in NPRS scores compared with core stabilization exercises. The greater improvement observed in the McKenzie group may be associated with the individualized nature of the Mechanical Diagnosis and Therapy approach. McKenzie therapy involves identifying patients' directional preferences through repeated movement assessment and prescribing exercises according to their symptomatic responses. Repeated movements, postural correction, and patient education may contribute to improved movement tolerance and reduced pain-related limitations. Furthermore, its emphasis on independent symptom management may help patients recognize and modify activities that aggravate their symptoms. These findings are consistent with the systematic review and meta-analysis conducted by Hennemann et al. (2024), which evaluated McKenzie treatment delivered by credentialed therapists in patients with chronic low back pain and directional preference. The review reported clinically meaningful improvements in short-term pain and disability compared with alternative interventions. The authors highlighted the potential effectiveness of individualized McKenzie treatment, particularly among patients demonstrating a favorable directional preference (6). The improvement in NPRS scores observed in the present study is consistent with this evidence. However, the findings differ from those reported by Aqil et al. (2021), who compared the McKenzie approach with lumbar stabilization exercises in patients with chronic low back pain. Their study reported greater improvements in pain and disability following lumbar stabilization exercises compared with McKenzie treatment (7). This difference may be related to variations in intervention duration, exercise protocols, participant characteristics, and clinical responses to treatment. Aqil et al. (7) delivered eight treatment sessions over two weeks, whereas the present study involved 18 supervised sessions over six weeks. The findings also need to be considered in relation to the systematic review conducted by Jiang et al. (2024), which compared motor control training with the McKenzie Method, Pilates, and conventional physical therapy. Their analysis demonstrated improvements in pain and physical function following motor control training, although subgroup comparisons did not establish statistically significant differences between motor control training and the McKenzie Method for pain or physical function (11). Differences in intervention classification and study populations may partly explain the variation between these findings and the present results. Overall, the greater reduction in pain intensity following McKenzie therapy suggests that an individualized mechanical treatment approach may provide benefits for pain management in patients with chronic nonspecific low

back pain. Nevertheless, the findings should be interpreted within the context of the study population and the specific intervention protocols used.

5.3 Effects of McKenzie Therapy and Core Stabilization Exercises on Functional Disability

Functional disability represents an important consequence of chronic nonspecific low back pain and may affect activities such as walking, sitting, standing, lifting, personal care, and occupational participation. In the present study, functional disability was assessed using the Modified Oswestry Disability Index. Both intervention groups demonstrated statistically significant reductions in MODI scores following the six-week treatment program. However, McKenzie therapy produced significantly greater improvement compared with core stabilization exercises. The greater improvement in the McKenzie group may be associated with its emphasis on individualized movement assessment, repeated directional movements, postural correction, and patient self-management. These components may help patients improve their tolerance to daily activities and reduce movement-related limitations. The structured approach to identifying symptom-provoking movements and promoting independent exercise performance may also contribute to improvements in functional disability. The findings are supported by Hennemann et al. (2024), who reported improvements in disability following McKenzie treatment delivered by credentialed therapists, particularly among patients with chronic low back pain and directional preference (6). Their findings support the clinical relevance of individualized mechanical assessment and exercise prescription in the management of chronic low back pain. Nevertheless, the present findings differ from the study conducted by Aqil et al. (2021), in which lumbar stabilization exercises demonstrated greater improvements in functional disability than the McKenzie approach (7). This difference indicates that the comparative effectiveness of rehabilitation interventions may depend on treatment duration, patient selection, exercise progression, and the clinical characteristics of participants. Evidence from stabilization-based rehabilitation also supports the improvements observed in the present study. Sengul et al. (2021) reported improvements in pain, disability, and core stability following stabilization exercises in patients with nonspecific low back pain. Their findings demonstrated additional benefits of stabilization exercises in selected physical performance and endurance outcomes (8). Similarly, Hussain et al. (2024) reported improvements in pain, disability, and lumbar mobility following a program combining core stability exercises and dynamic stretching with routine physiotherapy (9). Although these findings support the inclusion of core stabilization exercises in rehabilitation programs, the combined intervention design limits the ability to determine the independent contribution of core stabilization. In the present study, core stabilization exercises also produced a substantial reduction in functional disability. However, the greater improvement following McKenzie therapy suggests that its individualized mechanical approach may have provided additional benefits in reducing activity-related disability within the study population.

5.4 Effects of McKenzie Therapy and Core Stabilization Exercises on Functional Performance

Functional performance is an important component of rehabilitation because improvements in pain and disability do not necessarily translate into equivalent improvements in physical capacity. In the present study, functional performance was assessed using the Five Times Sit-to-Stand Test, which measures the time required to complete five consecutive sit-to-stand movements. Both groups demonstrated statistically significant reductions in 5×STS completion time following the intervention. However, core stabilization exercises produced significantly greater improvement than McKenzie therapy. The mean completion time decreased by 5.3 ± 2.60 seconds in the core stabilization group compared with 3.5 ± 2.55 seconds in the McKenzie group ($p = 0.008$). The greater improvement observed following core stabilization exercises may be associated with their emphasis on trunk muscle activation, neuromuscular coordination, muscular endurance, and lumbopelvic control. The intervention included abdominal bracing, transversus abdominis activation, pelvic tilts, bridging, bird-dog exercises, and modified plank variations. The progressive nature of these exercises may have contributed to improvements in the physical control and coordination required during functional movements. The findings are consistent with Sengul et al. (2021), who investigated stabilization exercises in patients with nonspecific low back pain and reported improvements in selected physical performance, endurance, and core stability outcomes (8). Their findings support the potential role of stabilization-based rehabilitation in addressing physical impairments

associated with chronic low back pain. Similarly, Hussain et al. (2024) demonstrated improvements in clinical and physical outcomes following core stability exercises combined with dynamic stretching and routine physiotherapy (9). These findings further support the use of stabilization-based exercise programs as part of conservative rehabilitation for chronic low back pain. The results are also relevant to the systematic review and meta-analysis by Jiang et al. (2024), which examined motor control training and other exercise-based interventions for nonspecific low back pain. Their findings demonstrated improvements in pain and physical function following motor control training, supporting the importance of exercise-based approaches targeting neuromuscular function (11). The superior improvement in 5×STS performance observed in the present study suggests that core stabilization exercises may offer benefits when rehabilitation aims to improve functional movement performance. However, because the 5×STS test evaluates integrated functional activity, the observed improvement cannot be attributed exclusively to changes in core muscle strength or stability.

5.5 Comparative Effectiveness of McKenzie Therapy and Core Stabilization Exercises

The comparative findings of the present study demonstrate that McKenzie therapy and core stabilization exercises produced improvements across all three assessed outcomes, although neither intervention demonstrated superiority across every outcome measure. McKenzie therapy demonstrated greater improvements in pain intensity and functional disability, whereas core stabilization exercises demonstrated greater improvement in functional performance. These findings highlight the importance of evaluating multiple clinical outcomes when comparing rehabilitation interventions rather than relying exclusively on pain reduction. The differences between the interventions may be related to their distinct therapeutic principles. McKenzie therapy emphasizes mechanical assessment, directional preference, repeated movements, symptom response, and self-management. In contrast, core stabilization exercises primarily target trunk muscle activation, neuromuscular coordination, endurance, and lumbopelvic control. The comparative findings are particularly relevant when considered alongside the available literature. Aqil et al. (2021) reported greater improvements following lumbar stabilization exercises compared with McKenzie therapy (7), whereas Hennemann et al. (2024) reported favorable outcomes associated with McKenzie treatment in patients demonstrating directional preference (6). Furthermore, Jiang et al. (2024) found no statistically significant difference between motor control training and the McKenzie Method in their subgroup comparisons for pain and physical function (11). The variation in findings across these studies suggests that the relative effectiveness of exercise-based interventions may be influenced by differences in patient characteristics, clinical presentation, intervention protocols, treatment duration, and outcome measures. The present findings therefore support the clinical application of both approaches in the management of chronic nonspecific low back pain. McKenzie therapy may be particularly useful when the primary rehabilitation objectives involve reducing pain and functional disability, whereas core stabilization exercises may be particularly valuable when improving functional movement performance is an important treatment priority. The selection of an appropriate intervention should consequently consider individual patient assessment, functional limitations, treatment goals, and response to exercise.

5.6 Clinical Implications

The findings of this study have important implications for physiotherapy practice and the rehabilitation of patients with chronic nonspecific low back pain. Both McKenzie therapy and core stabilization exercises demonstrated beneficial effects across the assessed clinical outcomes, supporting their use as active rehabilitation approaches. The greater improvement in pain intensity and functional disability following McKenzie therapy suggests that individualized mechanical assessment and directional exercise prescription may be valuable components of rehabilitation. Physiotherapists may consider this approach for patients whose symptoms demonstrate a favorable response to repeated movements in a particular direction. On the other hand, the greater improvement in functional performance following core stabilization exercises highlights the importance of incorporating progressive trunk activation, endurance training, and neuromuscular control exercises into rehabilitation programs. These exercises may be particularly relevant for patients experiencing difficulties with functional movements and physical

activities. The findings also emphasize that treatment selection should not be based solely on pain intensity. Functional disability and physical performance should be considered when developing individualized rehabilitation programs. A patient-centered approach that addresses the specific clinical and functional requirements of everyone may help optimize rehabilitation outcomes.

5.7 Strengths of the Study

An important strength of this study was the direct comparison of two commonly used physiotherapy interventions for chronic nonspecific low back pain. Both groups received structured six-week treatment programs with similar treatment frequency and session duration, allowing comparison under standardized intervention conditions. Another strength was the assessment of multiple clinically relevant outcomes, including pain intensity, functional disability, and functional performance. The use of NPRS, MODI, and the Five Times Sit-to-Stand Test provided a broader evaluation of treatment effects than relying on pain intensity alone. Furthermore, the randomized controlled trial design provided a comparative framework for evaluating the effectiveness of McKenzie therapy and core stabilization exercises.

5.8 Limitations of the Study

Despite its findings, several limitations should be considered when interpreting the results. First, the study was conducted at a single healthcare facility, which may limit the generalizability of the findings to other clinical settings and populations. Second, the intervention period was limited to six weeks, and no longer-term follow-up assessment was reported. Therefore, the persistence of improvements following the completion of treatment remains uncertain. Third, the study evaluated outcomes using NPRS, MODI, and the Five Times Sit-to-Stand Test. Although these instruments assessed important clinical and functional domains, other aspects of chronic low back pain, including lumbar range of motion, trunk muscle endurance, quality of life, and psychological factors, were not included. Fourth, the study compared two active exercise-based interventions without including a usual-care or no-intervention control group. Consequently, the findings primarily describe comparative effectiveness between the two treatment approaches. Finally, the findings should be interpreted in relation to the specific intervention protocols and participant characteristics used in this study. Further randomized controlled trials involving larger samples, multicenter settings, and longer follow-up periods are required to establish the long-term comparative effectiveness of these interventions.

6. CONCLUSION

The present randomized controlled trial demonstrated that both McKenzie therapy and core stabilization exercises were effective in improving pain intensity, functional disability, and functional performance in patients with chronic nonspecific low back pain following a six-week intervention program. However, the comparative findings demonstrated differences in the effectiveness of the two interventions across the assessed outcomes. McKenzie therapy produced significantly greater improvements in pain intensity, measured using the Numeric Pain Rating Scale, and functional disability, assessed using the Modified Oswestry Disability Index. In contrast, core stabilization exercises produced significantly greater improvements in functional performance, measured using the Five Times Sit-to-Stand Test. These findings suggest that McKenzie therapy may provide greater benefits in reducing pain and functional disability, whereas core stabilization exercises may offer greater improvements in functional movement performance. Therefore, both interventions represent beneficial physiotherapy approaches for managing chronic nonspecific low back pain, and their selection should be guided by individual patient characteristics, clinical presentation, functional limitations, and rehabilitation goals. Further randomized controlled trials with larger sample sizes, multicenter recruitment, and long-term follow-up are recommended to establish the sustained effects and comparative effectiveness of these interventions.

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