Research Article

Effects of Core Stability and Mckenzie Exercises in Mechanical Non Specific Low Back Pain with Extension Preference

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Short title: Effects of Core Stability and Mckenzie Exercises in Mechanical NSLBP

Abstract:
Objective: Low back pain is a leading cause of disability worldwide. To address this prevalent issue, various treatments have been recommended, with core stability and McKenzie exercises being among the most evidence-based options. However, recent comparison studies lack mechanical assessment and functional tests. This study aims to compare the effects of core stability and McKenzie exercises on range of motion, pain, disability, and function in patients with mechanical low back pain.
Materials & Methods: In this clinical trial, 22 patients received core stability exercises, and 22 patients received McKenzie exercises based on individual mechanical assessments. Before treatment, each patient underwent mechanical assessment via the McKenzie Mechanical Assessment form, pain assessment using the Visual Analog Scale (VAS), disability evaluation with the Oswestry Disability Index (ODI) questionnaire, muscle control and function assessment with unilateral single limb stance, and range of motion evaluation using fingertip-to-floor (FTF) distance measurements. After eight sessions over two weeks of intervention, all variables were measured again.

Results: Both groups showed significant improvements in trunk flexion range of motion, disability, functional status and pain ($P > 0.05$). However, there were no significant differences between the two groups ($P < 0.05$).
Conclusion: Both core stabilization and McKenzie exercises are effective in reducing pain, disability, increasing range of motion, and enhancing functional status in patients with mechanical low back pain.
Keywords: low back pain, Exercise therapy, Core stability, Range of motion

Introduction:

Low back pain is a prevalent musculoskeletal disorder that affects a large portion of the global population and is recognized by the World Health Organization (WHO) as one of the leading causes of disability in humans. The majority of these cases are classified as mechanical non-specific low back pain, characterized by an unknown injury to the vertebral column (1). In approximately 90% of chronic low back pain cases, clinicians are unable to pinpoint a specific diagnosis or pathological cause, leading to the classification of chronic non-specific low back pain.

Recent reviews have demonstrated that passive interventions such as ultrasound, thermal agents, and massage, without incorporating exercise therapy, are not as effective as exercise-based treatment regimens in reducing pain in adults with chronic non-specific low back pain (2). Core stability, which involves maintaining a neutral spinal position to improve core stability, helps in effectively transmitting force from muscle contractions to the vertebral column, ultimately reducing the risk of premature fatigue and injury (3)

The abdominal muscles, specifically the Transverse Abdominis and Multifidus, play a crucial role in the local stability of the lumbar spine. These muscles are essential for providing stability and proprioceptive inputs to the lumbar spine (4). Proprioception, a key component of the somatosensory system, provides sensory inputs to the central nervous system and aids in postural control.

Studies indicate that patients with low back pain often exhibit decreased proprioception compared to individuals without back pain, leading to difficulties in maintaining a neutral spinal position and contributing to ongoing pain (5). Reduced anticipatory capacity of the Transverse Abdominis muscle in patients with low back pain can result in diminished local protective function in the lumbar spine, indicating poor motor control and weakness in this muscle and the Multifidus. These muscles are critical stabilizers that help reduce pressure on the lumbar spine and are important risk factors associated with chronic low back pain (6).

Various methods are available for treating low back pain, with exercise therapy being highlighted as one of the most beneficial interventions, especially for managing subacute and chronic low back pain according to the American Physical Therapy Association (APTA) guidelines (7). Core stability exercises focus on co-contracting the abdominal muscles through motor learning, connecting them to the thoracolumbar fascia to enhance stiffness and local stability by increasing intra-abdominal pressure (8). Additionally, these exercises can induce changes in the motor cortex of the brain, improving muscle behavior and supporting the essential functions of core stabilizer muscles (9) and also can reduce pain and disability and improve proprioception in patients with low back pain (10-12).

McKenzie exercises represent another type of exercise therapy that offers a comprehensive system for assessing, classifying, and treating musculoskeletal disorders, with a focus on patient self-management (13). Studies have indicated that when performed by a skilled therapist, the McKenzie method exhibits appropriate reliability (13-16) and can lead to reductions in pain, drug consumption, and improvements in activities of daily living for patients with low back pain (17-

20) by centralization phenomenon (17) and also is applicable in managing chronic non specific low back pain as mentioned in previous guidelines (7).
In alignment with the APTA guidelines for managing low back pain, motor control and directional preference exercises, such as McKenzie exercises, are considered among the most evidence-based approaches for managing low back pain; although it can be prescribed in any phases of low back pain, but it has more evidences in chronic stage (7).
Despite exercise therapy being a crucial element in the treatment of chronic low back pain, there is a lack of conclusive evidence regarding the more effective type of exercises. Therefore, further research is essential to compare the effects of these exercise modalities (2). No studies has compared the effects of McKenzie and core stability exercises on balance with functional tests. A study aimed to compare pain, disability, and the thickness of the Transverse Abdominis and Multifidus muscles after intervention between McKenzie and core stability exercises (19).
In summarizing the existing research with similar titles, it is noted that there was a lack of mechanical assessment and the use of the ODI, which is considered the gold standard questionnaire for low back pain due to its highest reliability and repeatability among all indexes. Additionally, none of these studies incorporated functional tests to assess patients (19-23)
Experts typically utilize a set of clinical tests to evaluate muscle coordination and lumbar spine stability, emphasizing the need for reliability in these assessments. Among the few standardized and validated functional tests for assessing lumbar muscle coordination clinically, the functional single limb stance stands out for its appropriate reliability, with Kappa coefficient ranges between 0.88-1 (24).
Several studies have been conducted to compare the effects of McKenzie and core stability exercises, each using different outcome measures, leading to contradictory results (23, 25-27). While some studies showed that McKenzie exercises were more effective than manual therapy and core stability exercises, others reported the opposite. Limited evidence exists comparing the two methods in terms of lumbar spine range of motion. Most studies indicated that core stability exercises were more effective in reducing disability and increasing the thickness of core stabilizer muscles, but a study by Hlaing et al. pointed out that the relationship between reduced pain and disability and increased thickness of core stabilizer muscles might not be significant (28).
In a 2021 study conducted in India on 30 patients, core stability exercises were found to be more effective in reducing pain and disability in low back pain patients compared to McKenzie exercises(25). Conversely, a study in Pakistan in 2021 with 120 patients reported that McKenzie exercises were more effective in reducing pain and disability compared to routine physiotherapy that included simple back extensor strengthening, pelvic tilt, cat-lion stretch, lion, static abdominal crunch, and reverse crunch exercises (29).
Given the high prevalence of low back pain, the limited evidence on the most effective exercise modalities, and the conflicting results from previous studies, further research in this field is imperative. Mechanical assessments were lacking in most studies, and in the sole study conducted in Iran, there was a failure to incorporate ODI questionnaire and range of motion assessments alongside mechanical assessments using McKenzie forms and functional tests. Moreover, there was a lack of attention to tailoring exercises based on directional preferences (McKenzie Exercises**)**. Addressing these gaps could potentially streamline treatment, reduce costs, and enhance patient satisfaction.

Materials and Method:

Study design:

This study was a randomized clinical trial in which participants were selected using simple non-random sampling method and conducted in Faculty of Rehabilitation, Shahid Beheshti University of Medical Sciences.

Study participants:
The study conducted on 44 men and women patients suffering chronic low back pain. Sample size obtained from mean and standard deviation of similar study (25).

Inclusion criteria:
Participants aged between 30-65 with a body mass index (BMI) below 30, experiencing mechanical low back pain with extension directional preference, a sub category of non specific low back pain which is first confirmed by mechanical assessment form before intervention for both groups, with or without radiculopathy, were referred and diagnosed by medical doctors and had a minimum pain intensity of 3 on VAS. No history of abdominal or lumbar surgeries within the past month, and a baseline to identify their painful positions.

Exclusion criteria:
Exclusion criteria included structural problems such as spondylosis, disc herniation, excessive lordosis, kyphosis, and scoliosis as indicated in Magnetic resonance imaging (MRI) reports by a clinician. Patients with a history of tumors, recent trauma or fractures, infections within the past month, incontinence, pregnancy, short hamstrings, brain injuries, vestibular disorders, alcohol or drug addiction, or those unwilling to continue in the study were also excluded.

Study procedure:
Therapists matched the inclusion and exclusion criteria and assigned a number to each participant using a random method involving a dice, where even numbers were allocated to the McKenzie exercises group and odd numbers to the core stability exercises group. Patients were unaware of their assigned group to maintain blinding throughout the study.
Assessments were conducted using the Mechanical Diagnosis and Treatment (MDT) form, and patients were divided into two groups: Group 1 received McKenzie exercises, and Group 2 received core stability exercises. Both groups were assessed using the ODI, which evaluates patient disability through 10 questions covering various life situations, as well as pain intensity using the VAS, muscle control and balance via the functional single limb stance, and the FTF distance measurement in centimeters. At the end of the first session, patients were instructed not to utilize any other interventions (30).

Study measurements:
The FTF distance measurement involves the distance between fingertips and the floor with extended knees in a standing position. The single limb stance test assesses muscle control, with the patient standing one meter away from a striped wall and flexing each hip and knee to approximately 60 degrees for 20 seconds on each side. The therapist observes for deviations from the vertical and horizontal lines to determine test results (24).

Study interventions:
The McKenzie exercises were divided into three stages based on extension directional preference and gradual progress of exercises:
1. Patients initially lay prone for 5 minutes and if symptoms did not worsen or peripheralize (indicating poor prognosis), they progressed to stage 2.
2. Stage 2 involved lying prone with elbow extension for 5 minutes.
3. In the final stage, patients performed 10 repetitions of full extension in a lying position with 2-second pauses between repetitions.

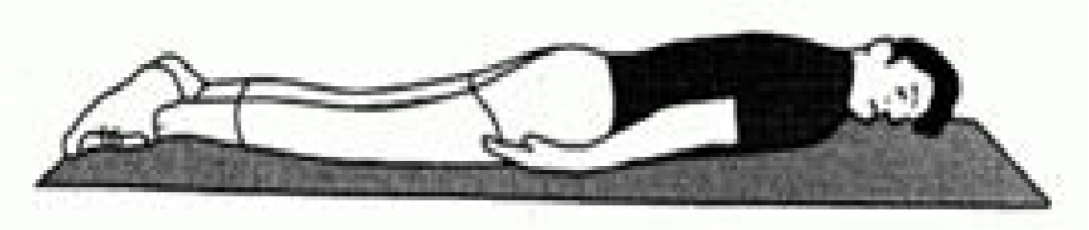


Figure 1: Prone lying

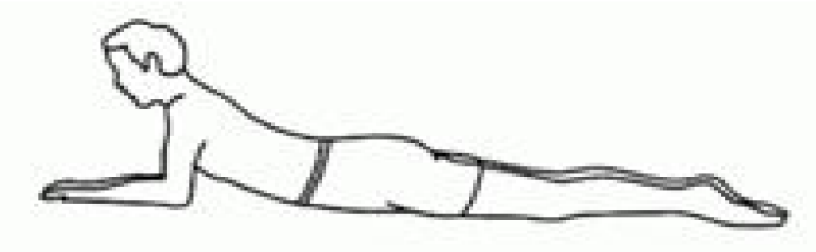


Figure 2: Prone on elbow

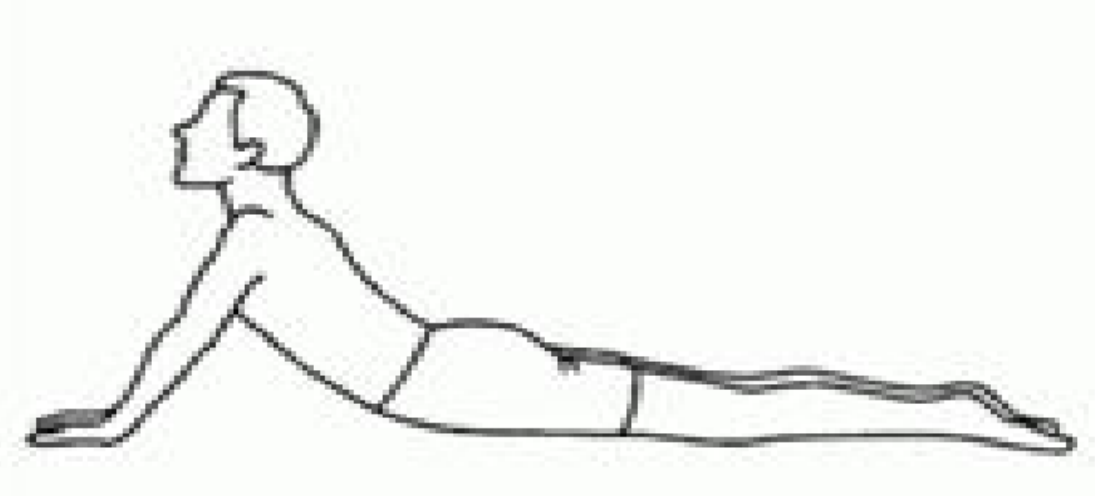


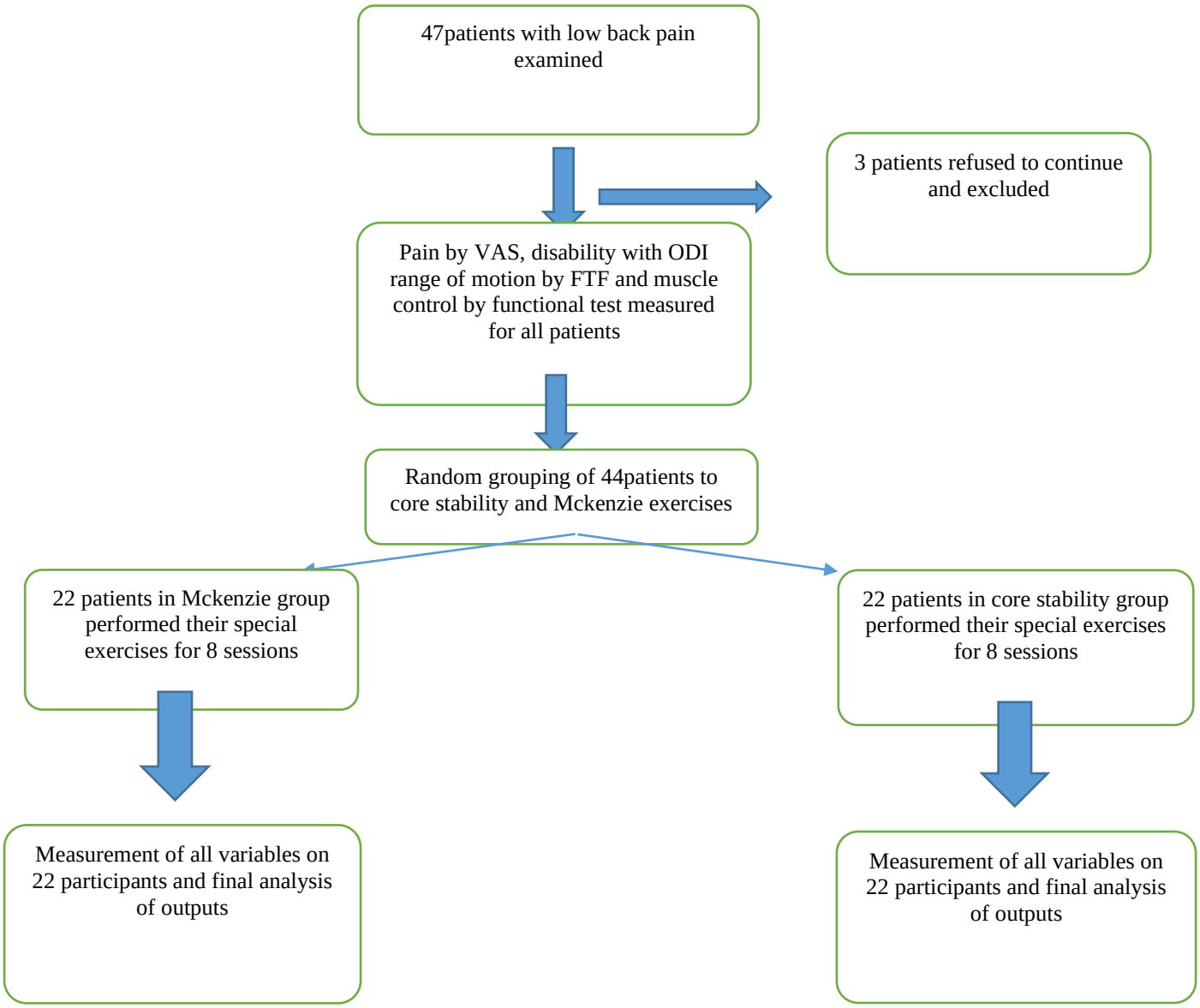
Figure 3: Extension on elbow

Core stability exercises consisted of:
- Abdominal drawing in performed for 2 sets with a 5-second pause between sets.
- Bridge exercises and unilateral prone leg extensions were performed with extended knees following a similar protocol.

The intervention for both groups lasted for 2 weeks, with 4 sessions per week (31). At the end of the intervention period, pain, disability, range of motion (ROM), and functional tests were reassessed. The sample size for each group was determined based on similar studies (23), resulting in a total of 44 participants evenly split between the two groups. Data was collected from patient files, and statistical analysis was conducted using IBM SPSS Statistics 22.
Ethical considerations for the study were in accordance with the guidelines of the Shahid Beheshti University of Medical Sciences ethical committee. Ethical approval was obtained under the IR.SBMU.RETECH.REC.1402.093 code, and the clinical trial was registered under the

IRCT20230806059059N1 code. All participants provided informed consent before participating in the study.

Table 1:Flow chart of study procedure



Statistical analysis:
This study involved 44 patients with low back pain who were divided into two groups: the McKenzie group and the core stability group. In the McKenzie group, there were 22 patients, comprising 10 men and 12 women. The core stability group also had 22 patients, with an equal split of 11 men and 11 women. A Chi-square test for the gender variable yielded a p-value of 0.763, indicating a homogeneous distribution of gender in both groups, signifying no significant differences between the groups in this regard.

Table 2: Demographic variables of participants

Variable	group	number	Standard deviation	Mean	T	p-value
Age	Mckenzie	22	10.97	43.909	-0.113	0.911
	Core stability	22	10.31	44.273		
Height	Mckenzie	22	10.869	169.32	0.518	0.607
	Core stability	22	9.442	167.73		
Weight	Mckenzie	22	10.714	68.32	1.04	0.304
	Core stability	22	8.923	65.23		
BMI*	Mckenzie	22	1.957	23.64	0.367	0.716
	Core stability	22	1.764	23.44		

*:Body mass index

Regarding the normality of demographic variables, an independent t-test was conducted, revealing statistically insignificant differences between the groups in these variables, indicating homogeneity in demographic characteristics across both groups. For quantitative variables, with the exception of VAS2, which exhibited a p-value > 0.05 in the Shapiro-Wilk test and displayed a normal distribution in both groups, all other quantitative variables had at least one p-value < 0.05 in the Shapiro-Wilk test, indicating an abnormal distribution that required non-parametric tests to compare differences. The statistical indices of quantitative variables before the intervention are presented in Table 3.

Table 3: quantitative variables before and intervention

Group	Quantity	ODI1	ODI2	FTF1	FTF2	VAS1	VAS2
Mckenzie exercises	Mean	15.273	8.727	5.318	3.75	5.72	3.045
	Number	22	22	22	22	22	22

	Standard deviation	6.4474	6.0642	5.9533	4.5139	2.027	1.5577
Core stability exercises	Mean	13.955	8.5	10.705	9.273	5.773	3.136
	Number	22	22	22	22	22	22
	Standard deviation	6.4474	5.4138	13.5178	11.6586	1.631	1.9098
	p-value	0.371†	0.981†	0.299†	0.191†	0.868†	0.863*

ODI: Oswetry disability index, FTF: Fingertip to floor distance, VAS: Visual analogous scale
*Based on independent t-test
† Based on Mann-Whitney test

The results from Table 3 demonstrated that before the intervention, all quantitative variables showed p-values > 0.05, indicating insignificant differences between the groups. The qualitative variable also exhibited a p-value > 0.05 in the Pearson-Chi square test, suggesting a homogeneous distribution of the variable between the groups before the intervention. The differences in the distribution of quantitative variables after the intervention were found to be insignificant ($p > 0.05$ for VAS2 in both groups based on an independent t-test and $p > 0.05$ for FTF2 and ODI2 in the Mann-Whitney non-parametric test).The functional test variable after the intervention between the groups also yielded a p-value > 0.05 in the Pearson-Chi square test, indicating no significant statistical differences in its distribution. Table 4 compares differences between quantitative variables before and after intervention.

Table 4: comparing quantitative variables before and after intervention

Groups			**Mean**	**Standard deviation**	**p-value***
Mckenzie Exercises	**First pair**	**VAS1**	5.727	2.0279	0.000
		VAS2	3.045	1.5577	
	Second pair	**ODI1**	15.273	6.4747	0.000
		ODI2	8.727	6.0646	
Core stability Exercises	**First pair**	**VAS1**	5.773	1.6310	0.000
		VAS2	3.136	1.9098	
	Second pair	**ODI1**	13.955	6.4474	0.000
		ODI2	8.5	5.4138	

ODI: Oswetry disability index, FTF: Fingertip to floor distance, VAS: Visual analogous scale
*Based on Wilcoxon test

The p-values for the range of motion were 0.001 for the McKenzie group and 0.034 for the core stability group. As per the results in Table 5, quantitative variables, including VAS, disability score, and range of motion, exhibited significant statistical differences before and after the intervention ($p < 0.05$ in the Wilcoxon test), but no differences between the groups were observed.
Table 5 compares differences between functional test variable before and after intervention.

Table 5: differences between functional test before and after intervention

Group			**Functional test2 (after intervention)**		**Total**	**p-value***
Mckenzie exercises	**Functional test1 (before intervention)**	+	6	10	16	0.001
		-	2	4	6	
	Total				22	
Core stability exercises	**Functional test1 (before intervention)**	+	4	9	13	0.031
		-	3	6	9	
	Total				22	

*Based on Mcnemar test

According to the results in Table 5, the functional test variable showed significant differences ($p < 0.05$) before and after the intervention in both groups.

Discussion:
This study aimed to compare the effectiveness of McKenzie and core stability exercises in improving pain, disability, range of motion, and muscle control in patients with nonspecific low back pain. Participants were selected based on predetermined inclusion and exclusion criteria and were then randomly assigned to either the McKenzie or core stability exercise group following a mechanical assessment. Each group engaged in the prescribed exercises for a total of 8 sessions, with variables reassessed at the conclusion of the intervention.
The mechanism behind McKenzie exercises remains a topic of debate, with previous notions suggesting that repetitive movements may realign protruded discs now being debunked (32). Current understandings point towards mechanisms such as endorphin release, a phenomenon observed in various forms of exercise, which may help reduce pain perception and anxiety, thus facilitating the treatment of mechanical low back pain (2). Additionally,the centralization phenomenon resulted from McKenzie exercises may aid in reducing pain and enhancing treatment outcomes (35). As MDT institute explains, responds in this method reports in two

forms, symptomatic responses includes centralization or reducing intensity of pain based on VAS score or questionnaires such ODI and mechanical response including range of motion. So, patients with radiculopathy could report any of these forms but patients without radiculopathy could not report centralization for their complaints. So it seems differentiating patients with or without radiculopathy were clinically unimportant in this study. Furthermore, repetitive movements prescribed in this method may have a corrective effect of patients posture which could cause worsening pain. However, the postural correction theory is still under debate as previous studies have shown that lumbar lordosis and lumbosacral angle were not associated with the incidence of low back pain (33).These types of exercises are easily educated, patient dependent and has immediate effect after performing which reduces costs of treatment and improves patients trust. Core stability exercises are theorized to improve pain and disability through neuromuscular adaptations, targeting the recruitment patterns of trunk muscles rather than focusing on hypertrophy. Specifically, muscles such as the Transverse Abdominus and Multifidus are believed to have delayed reaction times and altered recruitment patterns in patients with low back pain, leading to compromised proprioception and motor function. By restoring normal recruitment frequencies, core stability exercises aim to establish pain-free and stable postures for daily activities, consequently improving movement quality, balance, and postural control (5, 23, 26).

While there are conflicting findings in the literature regarding the efficacy of McKenzie versus core stability exercises, with some studies suggesting one approach may be more beneficial than the other (23, 25, 28, 34), the results of this study indicated no significant differences between the two groups in terms of pain reduction, disability improvement, range of motion, and muscle control. These findings align with previous research by Halliday et al. (2019), which also reported similar outcomes in terms of pain intensity (28).

In conclusion, this study focused on individuals, both male and female, experiencing low back pain with or without radiculopathy. After stringent participant selection and randomization, the efficacy of McKenzie versus core stability exercises was evaluated using standardized assessments such as the MDT assessment form. While both types of exercises demonstrated benefits in reducing pain intensity, improving disability, increasing range of motion, and enhancing muscle control, no significant differences between the two intervention groups were observed in this study.

Limitations:

1-In this study, myofascial pain and patterns were not considered which in most of cases are present along with other sources of pain and disability

2- A follow-up may add validity to these findings.

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Authors contributions:

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☒ Conceived and designed the analysis

☒ Collected the data

☒ Contributed data or analysis tools

☐ Performed the analysis

☒ Wrote the paper

☐ Other contribution

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☒ Contributed data or analysis tools

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☐ Wrote the paper

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☐ Wrote the paper

☐ Other contribution

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☒ Contributed data or analysis tools

☒ Performed the analysis

☐ Wrote the paper

☐ Other contribution

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☐ Collected the data

☒ Contributed data or analysis tools

☐ Performed the analysis

☐ Wrote the paper

☐ Other contribution

Conflict of interest

I am submitting a manuscript for consideration of publication in Modern Journal of Rehabilitation . The manuscript
is entitled
Effects of Core Stability and Mckenzie Exercises in Non Specific Low Back Pain
It has not been published elsewhere and that it has not been submitted
simultaneously for publication elsewhere.
We know of no conflicts of interest associated with this publication. As corresponding author, I confirm that the manuscript has been read and approved for submission by all the named authors.
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Yours Sincerely,

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