Effects of McKenzie and Proprioceptive Neuromuscular Facilitation Exercises on Mechanical Low Back Pain in Middle-Aged Patients

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ABSTRACT:

Objective: Mechanical low back pain (MLBP) is highly prevalent among middle-aged adults and contributes substantially to disability and reduced quality of life. Exercise-based rehabilitation remains a core conservative management strategy. However, evidence directly comparing McKenzie exercise and proprioceptive neuromuscular facilitation (PNF) exercise in middle-aged populations remains limited. This study compared the effects of McKenzie and PNF exercises on pain intensity, lumbar range of motion (ROM) and functional disability in middle-aged adults with MLBP. Methodology: A 6-week quasi-experimental study was conducted among 30 participants aged 40–65 years with MLBP. Participants were allocated to either a McKenzie exercise group (n=15) or a PNF exercise group (n=15). Both groups received 18 supervised treatment sessions over 6 weeks. Outcome measures were assessed at baseline, week 3 and week 6. Pain intensity was measured using the Numeric Rating Scale (NRS), lumbar ROM using the Modified-Modified Schober Test and fingertip-to-floor test and functional disability using the Oswestry Disability Index (ODI). Repeated-measures analysis of variance and Bonferroni post hoc analysis were used for statistical analysis. Results: Both groups demonstrated significant improvements over time in pain intensity, lumbar ROM, and functional disability ($P<0.01$). A significant between-group difference was observed for pain reduction at week 6 favoring the McKenzie group (mean difference, 0.733; 95% confidence interval, 0.032–1.435; $P=0.041$). No significant between-group differences were identified for lumbar ROM or ODI outcomes ($P>0.05$). Conclusion: The findings of the present study demonstrate that both interventions are effective conservative rehabilitation strategies for middle-aged adults with MLBP. Significant improvements were observed in pain intensity, lumbar mobility, and functional disability following 6 weeks of supervised intervention. McKenzie exercise demonstrated superior effectiveness for pain reduction compared with PNF exercise, suggesting that repeated directional movement and self-management strategies may provide enhanced analgesic benefits in this population.

Keywords: Mechanical low back pain, McKenzie method, PNF exercise.

Introduction

Low back pain (LBP) is one of the most prevalent musculoskeletal disorders and remains the leading cause of disability worldwide. Recent global burden studies reported that approximately 628.8 million individuals were affected by LBP in 2021, with the burden expected to continue rising despite reductions in age-standardized rates. The condition contributes substantially to healthcare costs, reduced productivity, activity limitation, and diminished quality of life, making it a major global public health concern (Li et al., 2024). Mechanical low back pain (MLBP) is frequently categorized as non-specific LBP. It accounts for most clinical presentations and is associated with impaired mobility, decreased work productivity and reduced quality of life. MLBP originates primarily from spinal musculoskeletal structures including muscles, ligaments, facet joints and intervertebral discs without identifiable serious spinal pathology. The burden of LBP is increasing globally, particularly among middle-aged adults due to occupational demands, sedentary behavior, psychosocial stressors and age-related degenerative changes. In Malaysia, the prevalence rates reported range from 12.4% to 84.6% across different occupational groups and populations where nurses, drivers, healthcare professionals and office workers are among the highest-risk groups (Abas, W. A. B. W., et al., 2023).

Current clinical practice guidelines strongly recommend exercise therapy as a management for chronic and recurrent LBP (George et al., 2021). A recent systematic review strongly supports the effectiveness of exercise therapy in improving pain and functional outcomes in individuals with low back pain (Viderman et al., 2025). Among the commonly prescribed physiotherapy approaches are the McKenzie method and proprioceptive neuromuscular facilitation (PNF) exercises. The McKenzie method, also referred to as Mechanical Diagnosis and Therapy (MDT). This method emphasizes repeated spinal movements, identification of directional preference, posture correction and patient self-management. Previous studies have demonstrated that McKenzie exercise can reduce pain and improve functional outcomes in individuals with non-specific LBP (Alhakami et al., 2019; Hennemann et al., 2024; Oliveira Almeida et al., 2023; Putri et al., 2021). PNF exercise is a rehabilitation approach designed to improve neuromuscular coordination, flexibility, muscular strength and movement control through proprioceptive input and resisted movement patterns (Adler et al., 2014). Evidence from systematic reviews and meta-analyses indicates that PNF training can reduce pain and disability and improve functional performance in individuals with chronic LBP (Arcanjo et al., 2022; Gao et al., 2022; Ling-Xin et al., 2022; Suresh et al., 2022).

Although both interventions are widely used clinically, comparative evidence between the two interventions remains limited, especially in middle-aged adults. Most previous studies focused on younger populations or chronic non-specific LBP without emphasizing middle-aged individuals. Therefore, the present study aimed to compare the effects of McKenzie and PNF exercises on pain intensity, lumbar ROM and functional disability among middle-aged adults with MLBP.

Materials and Methods

Study design

This study adopted a quasi-experimental design with randomized group allocation and single blinding to compare the effect of McKenzie method and PNF exercise. Ethical approval was obtained from the Research Ethics Committee of AIMST University. (AUHEC/FAHP/2023/22/02/R2).

Inclusion criteria

Participants who fulfilled the following criteria were included:

- Aged between 40 and 65 years
- Presence of MLBP with or without radiating symptoms

- Able to understand instructions and provide informed consent

Exclusion criteria

Participants were excluded if they had:

- Diagnosed spinal pathology including disc herniation, radiculopathy, spinal stenosis, spondylolisthesis, or vertebral fracture
- Previous lumbar spine surgery
- Neurological disorders affecting trunk control
- Visceral disease, tumor, or kidney disease
- Any LBP treatment within the preceding 3 months

Outcome measures

Assessments were performed at baseline (T1), week 3 (T2), and week 6 (T3).

Pain intensity

Pain intensity was assessed using the Numeric Rating Scale (NRS).

Lumbar range of motion

Lumbar flexion and extension were measured using the Modified-Modified Schober Test. Lumbar lateral flexion was assessed using the fingertip-to-floor test while thoracolumbar rotation was measured using tape measurement.

Functional disability

Functional disability was assessed using the Oswestry Disability Index (ODI).

Intervention protocol

Participants were randomly allocated to either the McKenzie exercise group or the PNF exercise group.

McKenzie exercise group

The McKenzie protocol consisted of:

- Prone lying
- Prone extension
- Extension in lying
- Extension in standing
- Flexion in lying
- Flexion in sitting
- Flexion in standing

Exercises were performed for 10 repetitions, 2 sets with 3-minute rest intervals.

PNF exercise group

The PNF intervention included:

- Rhythmic stabilization training
- Combination of isotonic exercises targeting trunk flexors and extensors

Exercises were performed with therapist-applied resistance using sitting postures and progressive stabilization techniques. Exercises were performed for 10 repetitions, 3 sets with 3-minute rest intervals.

Data were analyzed using IBM SPSS Statistics version 26. Continuous variables were expressed as mean±standard deviation, while categorical variables were presented as frequencies and percentages. Repeated-measures analysis of variance (ANOVA) was performed to determine within-group and between-group differences across time points. Mauchly's test of sphericity was conducted to evaluate variance assumptions, and Greenhouse-Geisser correction was applied when sphericity assumptions were violated. Bonferroni pairwise comparison tests were used for post hoc analysis. Effect sizes were reported using partial eta squared values. Statistical significance was established at $P<0.05$.

Results

Table 4.1: Demographic Data of Study Participants

	Mean (SD)	Frequency	Percentage (%)
Gender			
Male		14	46.7
Female		16	53.3
Race			
Malay		14	46.7
Chinese		9	30.0
Indian		7	23.3
Severity			
Acute		10	33.3
Chronic		20	66.7
Age	51.50 (6.947)		

Note: SD: Standard deviation

Figure 4.1: Comparison of Pain Score (NRS) between McKenzie Method and PNF Exercise based on Time

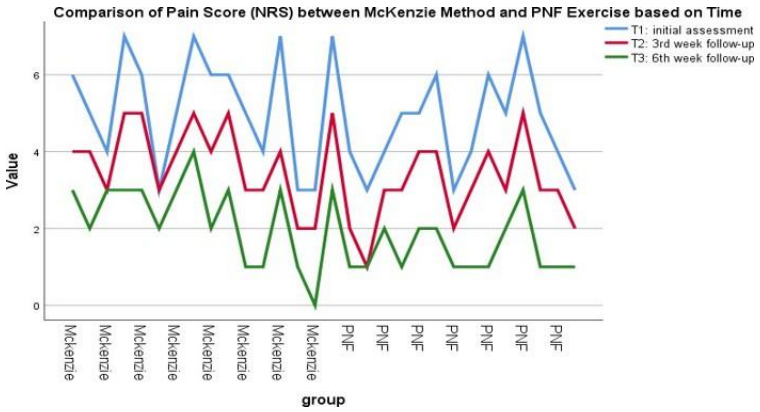

Table 4.2: Results of pain score (NRS) after McKenzie method and PNF exercise

NRS	McKenzie Method					PNF Exercise				
	Mean	SD	95% CI		p-value	Mean	SD	95% CI		p-value
			Lower	Upper				Lower	Upper	
T1	5.13	1.457	4.33	5.94		4.73	1.335	3.99	5.47	
T2	3.73	1.033	3.16	4.31	0.000**	3.13	1.125	2.51	3.76	0.000**
T3	2.27	1.100	1.66	2.88		1.53	0.743	1.12	1.94	

Note: SD: Standard deviation ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up ; **p < 0.01

Figure 4.2: Comparison of Lumbar ROM (Flexion) between McKenzie Method and PNF Exercise based on Time

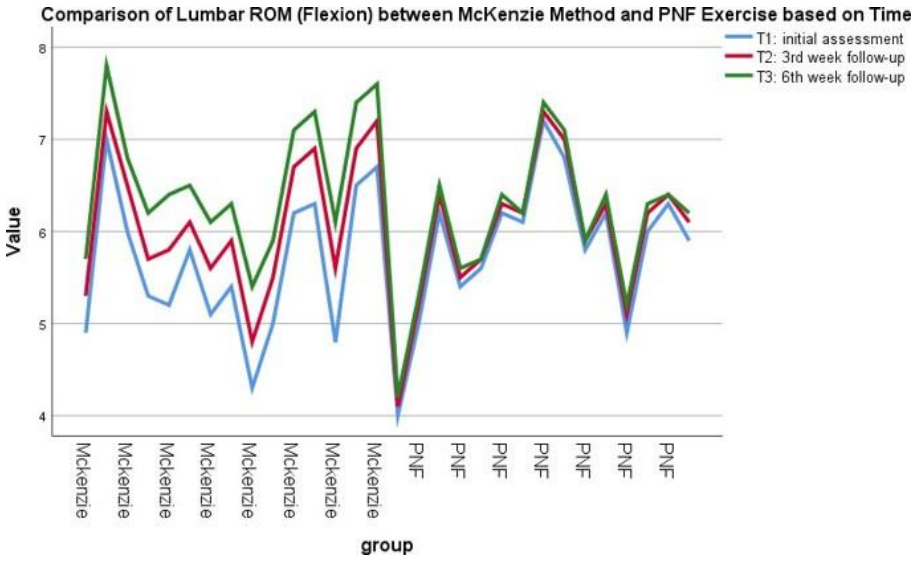

Table 4.3: Results of lumbar ROM (flexion) after McKenzie method and PNF exercise

Flexion	McKenzie Method					PNF Exercise				
			95% CI					95% CI		
	Mean	SD	Lower	Upper	p-value	Mean	SD	Lower	Upper	p-value
T1	5.633	0.7898	5.196	6.071		5.840	0.7881	5.404	6.276	0.000**
T2	6.120	0.7523	5.703	6.537	0.000**	5.980	0.7876	5.544	6.416	0.001**
T3	6.573	0.7265	6.171	6.976		6.053	0.7864	5.618	6.489	0.000**

Note: SD: Standard deviation ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up ; **p < 0.01

Table 4.4: Comparison of mean lumbar ROM (flexion) between two treatment groups based on time (n=30)

Flexion	Comparison	MD	95% CI		p-value
			Lower	Upper	
T1	McKenzie - PNF	-0.207	-0.797	0.383	0.479
T2		0.140	-0.436	0.716	0.622
T3		0.520	-0.046	1.086	0.070

Note: MD: Mean difference; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up

Figure 4.3: Comparison of Lumbar ROM (Extension) between McKenzie Method and PNF Exercise based on Time

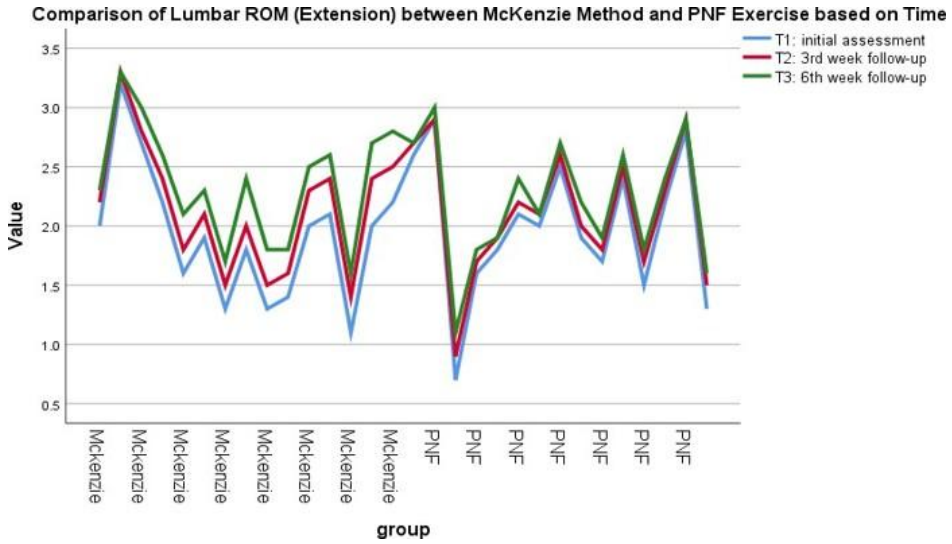

Table 4.5: Results of lumbar ROM (extension) after McKenzie method and PNF exercise

Extension	McKenzie Method					PNF Exercise				
	Mean	SD	95% CI		p-value	Mean	SD	95% CI		p-value
			Lower	Upper				Lower	Upper	
T1	1.920	0.5532	1.614	2.226		2.000	0.5976	1.669	2.331	
T2	2.147	0.5303	1.853	2.440	0.000**	2.113	0.5579	1.804	2.422	0.000**
T3	2.367	0.4967	2.092	2.642		2.207	0.5311	1.913	2.501	

Note: SD: Standard deviation ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up ; **p < 0.01

Figure 4.4: Comparison of Lumbar ROM (Left Lateral Flexion) between McKenzie Method and PNF Exercise based on Time

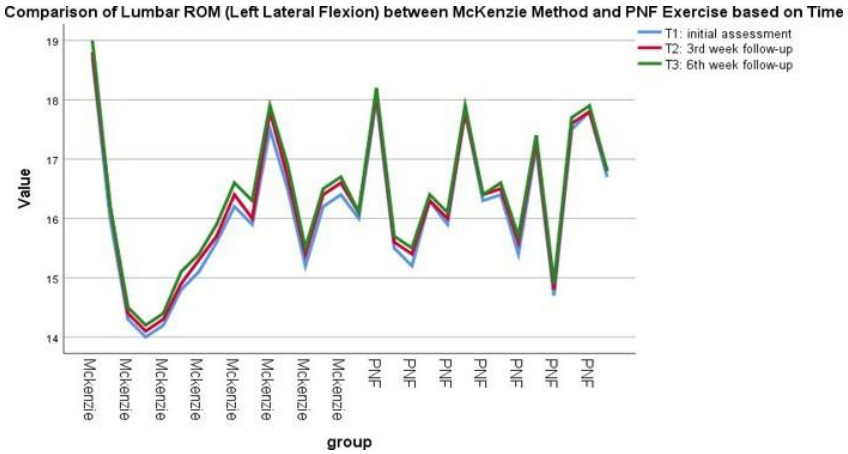

Table 4.6: Results of lumbar ROM (left lateral flexion) after McKenzie method and PNF exercise

Left Lateral	McKenzie Method					PNF Exercise				
	Mean	SD	95% CI		p-value	Mean	SD	95% CI		p-value
			Lower	Upper				Lower	Upper	
T1	15.773	1.2663	15.072	16.475		16.447	1.0336	15.874	17.019	
T2	15.933	1.2938	15.217	16.650	0.000**	16.540	1.0013	15.986	17.094	0.000**
T3	16.073	1.3107	15.348	16.799		16.620	1.0044	16.064	17.176	

Note: SD: Standard deviation ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up ; **p < 0.01

Table 4.7: Comparison of mean lumbar ROM (left lateral flexion) between two treatment groups based on time (n=30)

Left Lateral Flexion	Comparison	MD	95% CI		p-value
			Lower	Upper	
T1	McKenzie - PNF	-0.673	-1.538	0.191	0.122
T2		-0.607	-1.472	0.259	0.162
T3		-0.547	-1.420	0.327	0.210

Note: MD: Mean difference ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up

Figure 4.5: Comparison of Lumbar ROM (Right Lateral Flexion) between McKenzie Method and PNF Exercise based on Time

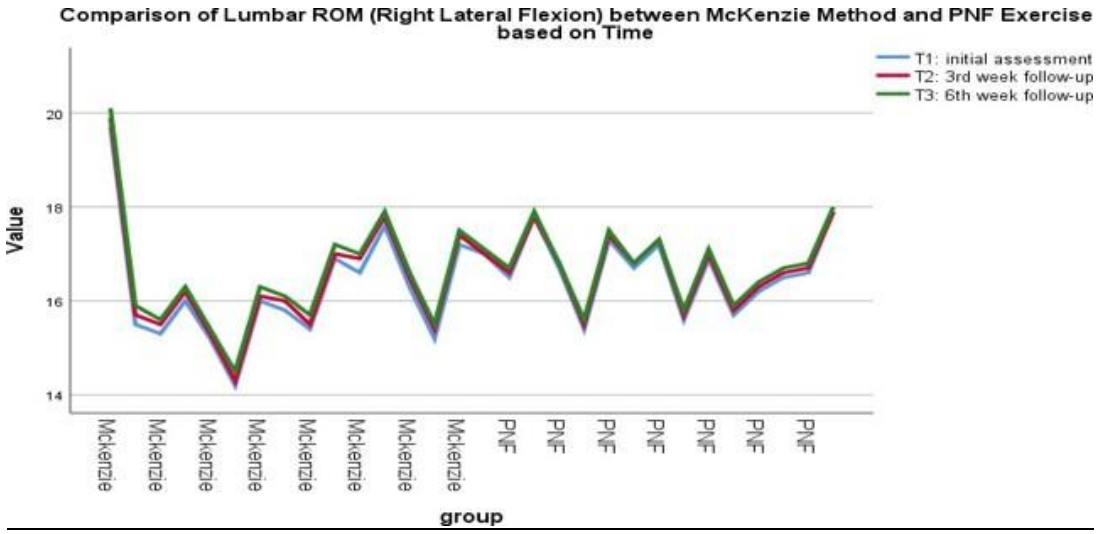

Table 4.8: Results of lumbar ROM (right lateral flexion) after McKenzie method and PNF exercise

Right Lateral	McKenzie Method					PNF Exercise				
			95% CI					95% CI		
	Mean	SD	Lower	Upper	p-value	Mean	SD	Lower	Upper	p-value
T1	16.193	1.3107	15.468	16.919		16.667	0.7374	16.258	17.075	
T2	16.367	1.3318	15.629	17.104	0.000**	16.747	0.7120	16.352	17.141	0.000**
T3	16.507	1.3344	15.768	17.246		16.827	0.7066	16.435	17.218	

Note: SD: Standard deviation ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up

Table 4.9: Comparison of mean lumbar ROM (right lateral flexion) between two treatment groups based on time (n=30)

Right Lateral Flexion	Comparison	MD	95% CI		p-value
			Lower	Upper	
T1	McKenzie - PNF	-0.473	-1.269	0.322	0.233
T2		-0.380	-1.179	0.419	0.338
T3		-3.320	-1.119	0.479	0.419

Note: MD: Mean difference ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up

Figure 4.6: Comparison of Lumbar ROM (Left Rotation) between McKenzie Method and PNF Exercise based on Time

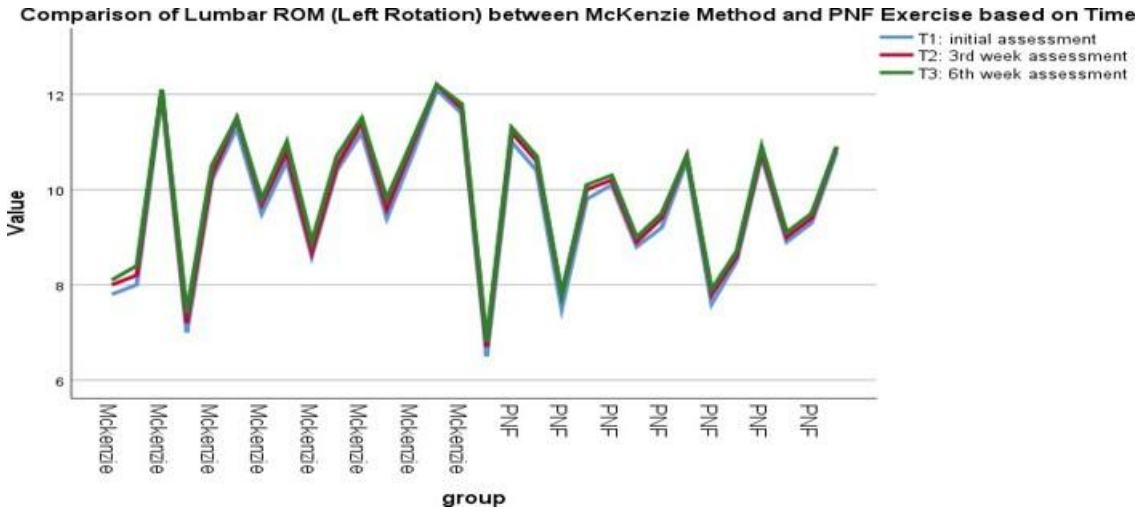

Table 4.10: Results of lumbar ROM (left rotation) after McKenzie method and PNF exercise

Left Rotation	McKenzie Method					PNF Exercise				
	Mean	SD	95% CI		p-value	Mean	SD	95% CI		p-value
			Lower	Upper				Lower	Upper	
T1	10.027	1.5935	9.144	10.909		9.313	1.3606	8.560	10.067	
T2	10.187	1.5729	9.316	11.058	0.000**	9.467	1.3356	8.727	10.206	0.000**
T3	10.313	1.5231	9.470	11.157		9.547	1.3309	8.810	10.284	

Note: SD: Standard deviation ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up ; **p < 0.01

Table 4.11: Comparison of mean lumbar ROM (left rotation) between two treatment groups based on time (n=30)

Left Rotation	Comparison	MD	95% CI		p-value
			Lower	Upper	
T1	McKenzie - PNF	0.713	-0.395	1.822	0.198
T2		0.720	-0.371	1.811	0.187
T3		0.767	-1.836	0.303	0.153

Note: MD: Mean difference ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up

Figure 4.7: Comparison of Lumbar ROM (Right Rotation) between McKenzie Method and PNF Exercise based on Time

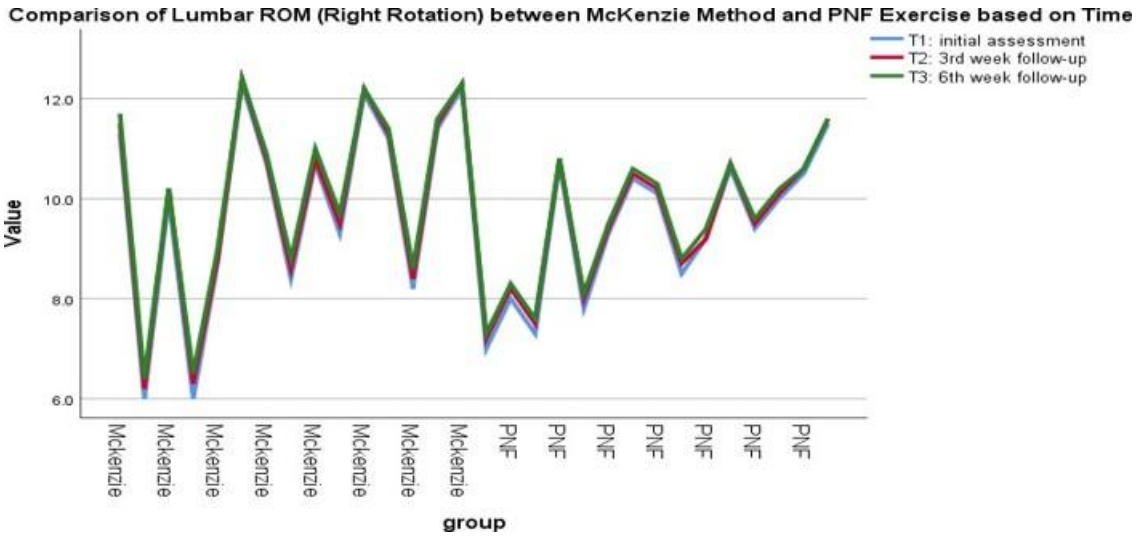

Table 4.12: Results of lumbar ROM (right rotation) after McKenzie method and PNF exercise

Right Rotation	McKenzie Method					PNF Exercise				
	Mean	SD	95% CI		p-value	Mean	SD	95% CI		p-value
			Lower	Upper				Lower	Upper	
T1	9.900	2.0778	8.749	11.051		9.353	1.3658	8.597	10.110	0.000**
T2	10.053	2.0301	8.929	11.178	0.000**	9.480	1.3246	8.746	10.214	0.001**
T3	10.180	1.9706	9.089	11.271		9.560	1.2927	8.844	10.276	0.000**

Note: SD: Standard deviation ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up ; **p < 0.01

Table 4.13: Comparison of mean lumbar ROM (right rotation) between two treatment groups based on time (n=30)

Right Rotation	Comparison	MD	95% CI		p-value
			Lower	Upper	
T1	McKenzie - PNF	0.547	-0.768	1.862	0.402
T2		0.537	-0.709	1.855	0.367
T3		0.620	-0.626	1.866	0.317

Note: MD: Mean difference ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up

Figure 4.8: Comparison of Oswestry Disability Index (ODI) between McKenzie Method and PNF Exercise based on Time

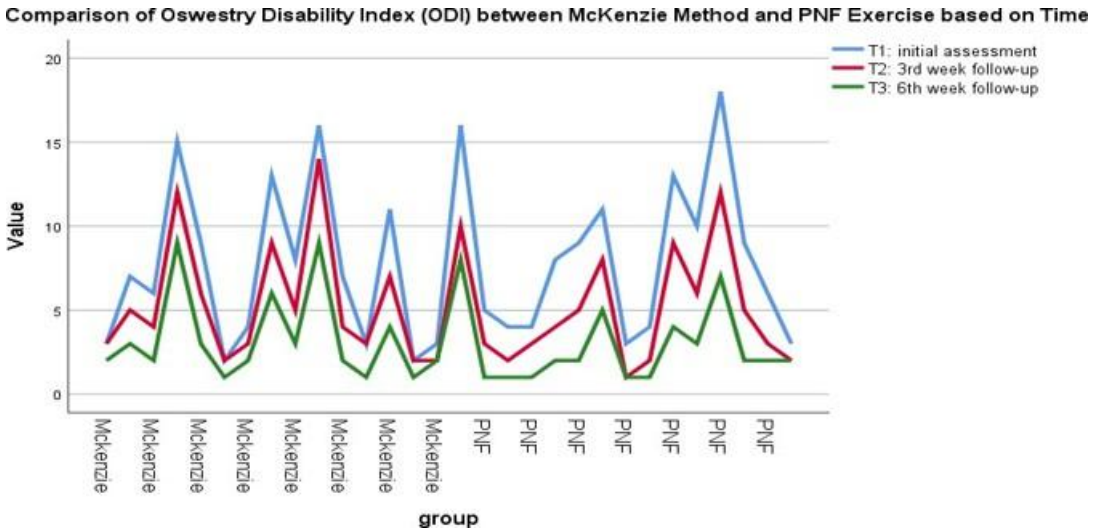

Table 4.14: Results of Oswestry Disability Index (ODI) Score after McKenzie Method and PNF Exercise

ODI	McKenzie Method					PNF Exercise				
	Mean	SD	95% CI		p-value	Mean	SD	95% CI		p-value
			Lower	Upper				Lower	Upper	
T1	7.27	4.698	4.67	9.87		8.20	4.739	5.58	10.82	
T2	5.40	3.680	3.36	7.44	0.000**	5.00	3.338	3.15	6.85	0.000**
T3	3.33	2.637	1.87	4.79		2.80	2.242	1.56	4.04	

Note: SD: Standard deviation ; CI: Confidence interval ; T1: pre-treatment (baseline) ; T2: 3rd week follow-up ; T3: 6th week follow-up ; **p < 0.01

Discussion

The present study compared the effects of McKenzie and PNF exercises on pain intensity, lumbar ROM, and functional disability among middle-aged adults with MLBP. The findings demonstrated that both interventions significantly improved all measured clinical outcomes following 6 weeks of rehabilitation. However, McKenzie exercise demonstrated significantly greater pain reduction at week 6 compared with PNF exercise.

The McKenzie method emphasizes repeated directional movements and end-range loading strategies to promote symptom centralization and improve spinal mechanics. It also incorporates self-management principles that encourage active patient participation during rehabilitation. Evidence from recent systematic reviews and meta-analyses indicates that McKenzie-based interventions can reduce pain intensity and improve functional outcomes in individuals with chronic and non-specific LBP (Hennemann et al., 2024; Putri et al., 2021). Alhakami et al. (2019) reported significant improvements in pain and disability following McKenzie exercise compared with conventional exercise programs. Similarly, Namnaqani et al. (2019) demonstrated better short-term pain reduction compared with manual therapy, while Kayani et al. (2021) found improvements in pain intensity and lumbar range of motion following McKenzie exercise combined with stabilization training. Although the overall effect size may be modest (Putri et al., 2021), the evidence supports the clinical usefulness of McKenzie-based rehabilitation.

Both intervention groups demonstrated significant improvements in lumbar ROM across the intervention period. Improvements were observed in lumbar flexion, extension, lateral flexion, and rotation. Reduced spinal mobility is commonly associated with pain-related muscle guarding, reduced flexibility, altered movement behavior and trunk muscle dysfunction in individuals with MLBP. Therefore, improving lumbar mobility is important for restoring normal movement patterns and reducing mechanical loading stress.

No statistically significant between-group differences were observed for lumbar ROM outcomes. This finding suggests that both interventions may be similarly effective in improving spinal mobility despite utilizing different therapeutic principles. Clinically, this indicates that both McKenzie and PNF exercise approaches may be appropriate for restoring lumbar movement and functional flexibility in middle-aged adults with MLBP.

The present findings are supported by previous studies investigating PNF interventions in chronic LBP populations. Evidence from recent systematic reviews and meta-analyses demonstrates that PNF exercise interventions

significantly improve pain intensity and functional outcomes in individuals with chronic LBP (Arcanjo et al., 2022; Gao et al., 2022; Ling-Xin et al., 2022). Research by Arcanjo et al. (2022) reported significant reductions in pain and disability, while Gao et al. (2022) demonstrated improvements in pain intensity and lumbar function. Additionally, Kim and Lee (2017) found that PNF-based exercises improved pain and pulmonary function in this population. Collectively, these findings support the effectiveness of PNF exercise as a rehabilitation strategy for chronic low back pain.

The present findings are in line with previous research examining the influence of the McKenzie method on spinal mobility in individuals with LBP. The McKenzie approach utilizes repeated end-range movements tailored to a patient's directional preference, which may help restore segmental mobility and improve movement efficiency of the lumbar spine. Evidence from recent high-quality systematic reviews indicates that McKenzie-based interventions can lead to improvements in spinal mobility and functional movement patterns in individuals with non-specific LBP (Oliveira Almeida et al., 2023; Namnaqani et al., 2019).

A recent Cochrane systematic review reported that McKenzie interventions contribute to improvements in physical function, which are closely associated with enhanced spinal movement capacity (Oliveira Almeida et al., 2023). Similarly, Namnaqani et al. (2019) also found that McKenzie method demonstrated favorable outcomes in improving movement performance when compared with manual therapy approaches. These improvements may be attributed to the repeated movement strategies that encourage restoration of normal kinematics and reduction of movement limitations.

Functional disability, as measured by the Oswestry Disability Index (ODI) demonstrated significant improvement following the intervention period in both groups. Improvements in ODI scores reflect enhanced ability to perform daily functional activities and reduced limitations in movement. These changes may be associated with improvements in spinal mobility, neuromuscular coordination, and overall movement efficiency, which contribute to better functional independence. The current findings are consistent with recent literature that supports exercise-based interventions can effectively reduce disability and enhance functional capacity in individuals with non-specific LBP (Viderman et al., 2025; Salehi et al., 2024).

The lack of significant between-group differences in ODI outcomes suggests that both intervention approaches may be similarly effective in improving functional status. While different exercise strategies may target distinct physiological mechanisms, both appear capable of enhancing trunk control, movement coordination, and functional performance to a level sufficient for meaningful disability reduction. Oliveira Almeida et al. (2023) also reported comparable functional outcomes across different conservative exercise approaches indicating that multiple rehabilitation strategies can yield similar improvements in disability despite variations in technique.

The findings of the present study have several important clinical implications. First, exercise-based rehabilitation should remain a primary management strategy for middle-aged adults with MLBP due to its effectiveness in improving pain, mobility, and functional performance. Second, clinicians may consider prioritizing McKenzie exercise when pain reduction is the primary treatment goal because the present findings demonstrated better pain improvement compared with PNF exercise. Third, PNF exercise remains clinically valuable particularly for individuals requiring trunk stabilization training, neuromuscular control enhancement and movement coordination rehabilitation. Importantly, the present study contributes additional evidence specific to middle-aged adults, a population frequently underrepresented in comparative rehabilitation research. Middle-aged individuals often present with combined

occupational stress, sedentary behavior, reduced flexibility and degenerative musculoskeletal changes that may influence rehabilitation outcomes differently compared with younger populations. Therefore, the current findings provide clinically relevant evidence supporting conservative physiotherapy interventions in this age group.

Several limitations should be considered when interpreting the present findings. First, the relatively small sample size may limit statistical power and generalizability. Second, the study did not include long-term follow-up assessment. Therefore, the sustainability of treatment effects remains uncertain. Third, psychosocial factors such as fear-avoidance beliefs, depression, stress, and physical activity levels were not evaluated despite their known influence on low back pain outcomes.

Future studies should include larger trials with long-term follow-up assessments and incorporation of psychosocial outcome measures. Additional investigation regarding optimal treatment frequency, progression protocols and combined intervention strategies may further strengthen rehabilitation outcomes for MLBP.

Conclusion

Both McKenzie and PNF exercise interventions effectively reduced pain and improved lumbar ROM as well as functional disability in middle-aged adults with MLBP. McKenzie exercise demonstrated superior pain reduction compared with PNF exercise, while both interventions produced comparable improvements in lumbar mobility and disability.

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