

Comparative Study of Core and Diaphragmatic Strengthening Versus Standard Physiotherapy on Core Stability, Forced Vital Capacity, and Clinical Outcomes in Non-Specific Low Back Pain

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ABSTRACT

Background: Non-specific low back pain (NSLBP) is a leading cause of disability worldwide. Traditional physiotherapy often focuses on general strengthening and posture correction, whereas core and diaphragmatic strengthening exercises target both spinal stability and respiratory function. However, the comparative effects of these two approaches on core stability, forced vital capacity (FVC), and clinical outcomes have not been adequately studied.

Objective: To compare the effects of core and diaphragmatic strengthening exercises versus standard physiotherapy on core stability, forced vital capacity, and clinical outcomes in individuals with non-specific low back pain.

Methods: This prospective cohort study involved 60 participants diagnosed with NSLBP. Participants were assigned to two groups based on their treatment preferences or clinical indication: Group 1 (Core and Diaphragmatic Strengthening) and Group 2 (Standard Physiotherapy). Group 1 received exercises aimed at improving core stability and diaphragmatic function, while Group 2 received standard physiotherapy focused on general strengthening, stretching, and postural education. Outcomes were measured at baseline, 4 weeks, and 8 weeks, including core stability (McGill Trunk Muscle Endurance Test), forced vital capacity (spirometry), and clinical outcomes (Visual Analog Scale for pain and Oswestry Disability Index).

Results: Both groups showed significant improvements in core stability, FVC, and clinical outcomes. Group 1 demonstrated greater improvements in trunk endurance ($p < 0.05$) and forced vital capacity ($p < 0.05$) compared to Group 2. Additionally, pain and disability scores improved more significantly in Group 1, with a greater reduction in VAS ($p < 0.05$) and ODI ($p < 0.05$).

Conclusion: Core and diaphragmatic strengthening exercises appear to be more effective than standard physiotherapy in improving core stability, forced vital capacity, and clinical outcomes in individuals with non-specific low back pain. These findings suggest that

incorporating core and diaphragmatic exercises into rehabilitation programs for NSLBP may lead to better outcomes.

Keywords: Non-specific low back pain, core stability, diaphragmatic strengthening, forced vital capacity, physiotherapy, clinical outcomes, trunk endurance.

INTRODUCTION

Non-specific low back pain (NSLBP) is a significant public health issue, affecting individuals across all age groups and socioeconomic backgrounds. It is characterized by persistent pain in the lower back, which cannot be attributed to a specific identifiable cause, such as trauma, disease, or infection¹. According to the Global Burden of Disease Study, NSLBP is one of the leading causes of disability worldwide, contributing to a substantial economic burden due to lost work productivity, healthcare costs, and long-term disability. The majority of individuals with NSLBP do not have a clear pathological origin for their symptoms, making the condition particularly challenging to treat².

Conventional treatment for NSLBP typically focuses on alleviating pain, improving mobility, and addressing postural abnormalities. Standard physiotherapy often includes a combination of therapeutic exercises, stretching, strengthening, and postural correction. Physiotherapists may also emphasize patient education on proper body mechanics to prevent exacerbation of symptoms. Despite the widespread use of these interventions, evidence on their long-term efficacy in improving core stability, respiratory function, and clinical outcomes such as pain reduction and disability is mixed³.

Core stability, which refers to the ability to control and stabilize the trunk during dynamic movement, has gained significant attention in recent years as a central element of rehabilitation for NSLBP. A stable core provides the necessary support for the spine, reducing strain on the lumbar region, improving posture, and preventing injury. Core stability exercises often target the deep abdominal muscles, such as the transversus abdominis, multifidus, and pelvic floor

muscles, which play a critical role in stabilizing the spine. In addition to musculoskeletal benefits, core stability has been linked to improvements in functional movement and overall quality of life⁴.

While core strengthening has been widely studied, **diaphragmatic strengthening** is an emerging component of rehabilitation for NSLBP that is often overlooked. The diaphragm plays a critical role in both respiration and core stability, and proper diaphragmatic breathing can enhance trunk stabilization by increasing intra-abdominal pressure. Some studies suggest that improving diaphragmatic function can help decrease pain and improve function in individuals with chronic low back pain. Diaphragmatic breathing exercises can reduce muscle tension in the lower back, enhance spinal alignment, and contribute to relaxation, thus providing a holistic approach to NSLBP management⁵.

The integration of **diaphragmatic strengthening with core stability exercises** may offer a more comprehensive approach to treating NSLBP, addressing both the musculoskeletal and respiratory components that contribute to the condition⁶. However, while core and diaphragmatic strengthening exercises have been proposed as beneficial for NSLBP, there is limited research directly comparing these exercises with standard physiotherapy. Specifically, it is unclear whether a program focused on core and diaphragmatic strengthening leads to superior outcomes in core stability, forced vital capacity (FVC), and clinical outcomes such as pain and disability when compared to conventional physiotherapy techniques⁷.

Forced vital capacity (FVC), a measure of lung function, has been suggested as a potential outcome in NSLBP management because it reflects the ability to generate forceful exhalation through the diaphragm.

It is hypothesized that diaphragmatic strengthening exercises can improve FVC, as they promote better diaphragm function, thereby improving the patient's ability to engage in physical activities that may otherwise exacerbate back pain. The relationship between respiratory function and core stability has not been well-explored in the context of NSLBP, warranting further investigation⁸.

Given the significant limitations of current treatment options, the need for more effective therapeutic interventions for NSLBP is evident. This study seeks to compare the effectiveness of **core and diaphragmatic strengthening exercises** with **standard physiotherapy** on core stability, forced vital capacity, and clinical outcomes (pain and disability) in individuals with NSLBP. By doing so, we aim to explore whether the combination of these exercises offers a more comprehensive and effective approach to NSLBP rehabilitation, leading to improved outcomes for individuals suffering from this pervasive condition⁹. Non-specific low back pain (NSLBP) is a complex and multifactorial condition that affects a large portion of the global population, causing significant pain, disability, and a reduction in quality of life. Current treatments primarily focus on symptom management through conventional physiotherapy, which includes strengthening exercises, stretching, and postural correction. However, these approaches often fail to provide lasting relief or address the underlying issues contributing to the condition^{10,14}.

Emerging evidence suggests that **core stability exercises**, which target the deep trunk muscles, and **diaphragmatic strengthening**, which improves respiratory function and abdominal pressure regulation, may be beneficial for individuals with NSLBP. These exercises not only focus on improving spinal stability but also aim to enhance respiratory capacity, which can have a secondary impact on pain relief and overall functional capacity^{11,13}. Despite the potential benefits, there is a lack of

comprehensive studies directly comparing core and diaphragmatic strengthening exercises with traditional physiotherapy in terms of core stability, forced vital capacity, and clinical outcomes.

This study is needed to fill this gap in the literature by exploring how **core and diaphragmatic strengthening exercises** compare to **standard physiotherapy** in improving core stability, respiratory function (measured by forced vital capacity), and clinical outcomes such as pain intensity and disability in individuals with NSLBP. The findings could inform clinical practice and lead to more targeted, effective rehabilitation strategies for managing NSLBP^{12,15}.

Aim

The aim of this study is to compare the effects of core and diaphragmatic strengthening exercises versus standard physiotherapy on core stability, forced vital capacity, and clinical outcomes (pain and disability) in individuals with non-specific low back pain (NSLBP).

Objectives

1. To evaluate the impact of core and diaphragmatic strengthening exercises on core stability and forced vital capacity in individuals with NSLBP.
2. To compare the clinical outcomes (pain and disability) between core and diaphragmatic strengthening exercises and standard physiotherapy.
3. To provide evidence for the effectiveness of integrating core and diaphragmatic strengthening in rehabilitation for NSLBP.

HYPOTHESIS

Null Hypothesis (H₀)

There is no significant difference in core stability, forced vital capacity, and clinical outcomes (pain and disability) between individuals with non-specific low back pain (NSLBP) who receive core and diaphragmatic strengthening exercises and those who receive standard physiotherapy.

Alternative Hypothesis (H₁)

Core and diaphragmatic strengthening exercises lead to significantly greater improvements in core stability, forced vital capacity, and clinical outcomes (pain and disability) compared to standard physiotherapy in individuals with non-specific low back pain (NSLBP).

MATERIALS AND METHODS

Study Design:

This was a prospective cohort study conducted over 8 weeks. The study was approved by the institutional ethics committee, and written informed consent was obtained from all participants.

Participants:

Sixty individuals diagnosed with NSLBP (without specific underlying pathology) were recruited. Participants were divided into two groups based on clinical recommendation or preference:

- **Group 1 (Core and Diaphragmatic Strengthening):** This group participated in exercises that aimed to strengthen the core muscles (e.g., pelvic tilts, planks, leg raises) and improve diaphragmatic breathing.
- **Group 2 (Standard Physiotherapy):** This group received conventional physiotherapy, which included strengthening exercises for the back and abdominal muscles, stretching, and posture correction.

Inclusion criteria included individuals aged 18-60 years with a diagnosis of NSLBP lasting more than 3 months. Exclusion criteria included individuals with a history of major spinal surgery, other musculoskeletal or neurological disorders, or any respiratory conditions.

Interventions:

- **Group 1:** Participants performed a structured core strengthening program (e.g., abdominal exercises, planks) and diaphragmatic breathing exercises three times per week for 8 weeks.
- **Group 2:** Participants underwent a standard physiotherapy program that included back and abdominal muscle strengthening, flexibility exercises, and education on body mechanics, posture, and ergonomics, three times per week for 8 weeks.

Outcome Measures:

- **Core Stability:** Measured using the McGill Trunk Muscle Endurance Test (MTMEXT), which includes tests such as the trunk flexor endurance test, trunk extensor endurance test, and side bridge test.
- **Forced Vital Capacity (FVC):** Measured using spirometry to assess respiratory function.
- **Clinical Outcomes:**
 - **Pain:** Assessed using the Visual Analog Scale (VAS), which measures pain intensity from 0 to 10.
 - **Disability:** Assessed using the Oswestry Disability Index (ODI), which evaluates the degree of disability related to back pain.

STATISTICAL ANALYSIS:

Data were analyzed using SPSS software. Descriptive statistics were used to summarize baseline characteristics. Paired t-tests were used to assess within-group changes from baseline to post-treatment. Independent t-tests were used to compare between-group differences. A significance level of $p < 0.05$ was set for all analyses.

Table 1: Statistical Analysis Table

Variable	Group	Time Point	Mean	Standard Deviation (SD)	Within-Group p-value	Between-Group p-value
Core Stability (seconds)	Group 1	Baseline	120.00	15.00		
		4 Weeks	140.00	12.00	$p < 0.05$	$p < 0.05$
	8 Weeks	168.00	10.00	$p < 0.05$		
	Group 2	Baseline	118.00	14.00		

		4 Weeks	125.00	13.00	p < 0.05	
		8 Weeks	135.00	11.00	p < 0.05	
Forced Vital Capacity (FVC) (L)	Group 1	Baseline	3.00	0.30		
		4 Weeks	3.20	0.25	p < 0.05	p < 0.05
		8 Weeks	3.30	0.22	p < 0.05	
	Group 2	Baseline	3.05	0.28		
		4 Weeks	3.10	0.26	p < 0.05	
		8 Weeks	3.18	0.23	p < 0.05	
Pain (VAS, 0-10)	Group 1	Baseline	7.50	1.20		
		4 Weeks	5.00	1.00	p < 0.05	p < 0.05
		8 Weeks	3.00	0.80	p < 0.05	
	Group 2	Baseline	7.30	1.10		
		4 Weeks	6.20	1.05	p < 0.05	
		8 Weeks	5.50	0.90	p < 0.05	
Disability (ODI, %)	Group 1	Baseline	45.00	5.00		
		4 Weeks	30.00	4.00	p < 0.05	p < 0.05
		8 Weeks	20.00	3.50	p < 0.05	
	Group 2	Baseline	46.00	6.00		
		4 Weeks	40.00	5.00	p < 0.05	
		8 Weeks	35.00	4.50	p < 0.05	

RESULTS & DISCUSSION

Both groups showed significant improvements in core stability, FVC, pain, and disability over the 8-week period.

- **Core Stability:** Group 1 showed a 40% improvement in trunk endurance ($p < 0.05$), while Group 2 showed a 15% improvement.
- **Forced Vital Capacity:** Group 1 demonstrated a 10% increase in FVC ($p < 0.05$), whereas Group 2 showed a 4% increase.
- **Pain and Disability:** Group 1 reported a significant reduction in pain (VAS, $p < 0.05$) and disability (ODI, $p < 0.05$), compared to Group 2.

The results suggest that core and diaphragmatic strengthening exercises have a more significant impact on improving core stability, respiratory function, and clinical outcomes compared to standard physiotherapy in patients with NSLBP. Core strengthening exercises may provide enhanced spinal support, while diaphragmatic breathing exercises could improve posture and reduce muscle tension,

contributing to the overall improvement in symptoms.

The study design (prospective cohort) allowed for the inclusion of a broader range of patients who chose their preferred intervention, but it also introduces some limitations, such as a lack of randomization and potential bias in group selection. Further research, potentially with larger sample sizes and controlled conditions, is necessary to confirm these findings.

CONCLUSION

Core and diaphragmatic strengthening exercises may be more effective than standard physiotherapy in improving core stability, forced vital capacity, and clinical outcomes in patients with NSLBP. These exercises address both musculoskeletal and respiratory factors that contribute to low back pain, offering a more comprehensive treatment approach. This therapeutic strategy could be considered as part of integrated rehabilitation for NSLBP.

Limitations

The study's non-randomized design, small sample size, and short duration may limit

the generalizability and long-term applicability of the results. Additionally, self-reported clinical outcomes and lack of blinding could introduce bias.

Future Scope

Future research could involve randomized controlled trials with larger sample sizes and longer follow-up periods to confirm the effectiveness of core and diaphragmatic strengthening exercises, as well as explore their mechanisms and applicability in diverse populations.

Consent: Informed consent was taken from all participants in the study for the publication work in the journal.

Declaration by Authors

Ethical Approval: This study was approved by our institutional ethical committee.

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Conflict of Interest: NIL

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