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Review Article

Diaphragmatic breathing and core stability in low back pain: a scoping review of combined exercise approaches, mechanisms and clinical outcomes

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ABSTRACT

Low Back Pain is among the most common musculoskeletal disorders associated with persevering pain, disability and impaired neuromuscular control. Ailment of deep core musculature together with altered breathing patterns may compromise spinal stability. Combined diaphragmatic breathing with core stabilization exercises may enhance postural control and augment clinical outcomes. This review aimed to explore and summarize the existing evidence on the use of integrated diaphragmatic breathing with core stabilization exercises in individuals with LBP, emphasizing on intervention characteristics, mechanisms and clinical outcomes. A scoping review was conducted in accordance with recognized methodological frameworks. Electronic databases such as PubMed, Scopus, Cochrane, Web of Science, PEDro, CINAHL, Google Scholar were searched for the studies published from 2000 to 2025. Eligible literature included RCTs, narrative reviews, systematic reviews and meta-analyses involving adults with acute or chronic LBP. Interventions combining diaphragmatic breathing with core stabilization exercises were selected. Outcomes of interest comprised pain intensity, disability, functional integrity, trunk muscle activation, respiratory parameters, postural stability and psychological factors. Study selection entailed title and abstracts screening followed by full-text review, and findings were synthesized descriptively. The reviewed evidence demonstrated that combined interventions resulted in greater improvements in outcomes compared to core stabilization alone. Proposed mechanisms include improved intra-abdominal pressure regulation, enhanced neuromuscular coordination and better lumbopelvic stability. This review underscores the clinical importance of incorporating diaphragmatic breathing and core stability interventions into comprehensive LBP management pathways to optimise pain reduction, functional recovery and long-term clinical outcomes.

Keywords: Diaphragmatic breathing, Trunk control, Lumbopelvic stability, Low back pain.

INTRODUCTION

One of the most common musculoskeletal conditions worldwide, low back pain continues to be the primary cause of years spent disabled in all age groups [1]. Pain or discomfort that is localised between the inferior gluteal folds and the costal margins, with or without radiation to the lower limbs, is its clinical definition [2]. A large percentage of people suffer from chronic LBP, which is commonly described as pain lasting more than 12 weeks. CLBP has severe negative effects on one's physical, mental and financial well-being [3,4]. According to epidemiological data, roughly 23% of people have chronic symptoms and over 80% of people experience LBP at some point in their lives [3]. Because CLBP is complex, its management is more difficult and requires all-encompassing rehabilitation techniques.

The long-term efficacy of pharmacological treatment for CLBP has been limited, and it is frequently linked to side effects and dependency problems [4]. As a result, non-pharmacological therapies, especially exercise-based rehabilitation, are highly recommended as first -line management in current clinical practice guidelines [7,8]. Through neuromuscular re-education and strength augmentation, exercise therapy seeks to alleviate pain, restore functional capacity and improve spinal mobility. Core stability training has become a key component of CLBP therapy among several exercise modalities [5].

The capacity to regulate the trunk's position and motion over the pelvis to provide the best possible force production and transfer during functional tasks is referred to as "core stability" [6].

Anatomically, the core is frequently defined as cylindrical structure made up of diaphragm superiorly, pelvic floor inferiorly, paraspinal muscles posteriorly and abdominal muscles anteriorly [7]. Muscles are often classified as global and local stabilizers within this system. While local stabilizers like transverse abdominis, lumbar multifidus, pelvic floor muscles and diaphragm are in charge of segmental spinal control, global muscles produce torque and movement [8].

Despite the fact that core stabilization exercises have been shown to have positive effects on pain and disability, results aren't always constant and not all patients experience an acceptable improvement [9]. The search for more therapeutic approaches to improve functional integration and core muscle activation has increased due to variability in treatment outcomes. In recent years, greater emphasis has been placed on the role of diaphragm in posture regulation and spinal stabilization. Traditionally recognized as a primary respiratory muscle, the diaphragm is now considered an essential contributor to trunk stability through intra-abdominal pressure regulation [10]. When diaphragm contracts in coordination with transverse abdominis, pelvic floor muscles and multifidus, it helps to generate abdominal pressure, reducing stress on lumbar spine and enhances segmental stability [11].

Individuals with recurrent or CLBP often exhibit diaphragmatic fatigue and dysfunction which may compromise both respiratory and postural functions [12]. Impaired diaphragmatic activity can disrupt trunk stability and intra-abdominal pressure regulation, thereby contributing to pain and functional limitations [13]. These findings support the inclusion of diaphragmatic breathing exercises within rehabilitation strategies for CLBP.

Diaphragmatic breathing exercises focuses on controlled and slow breathing patterns that facilitate diaphragmatic descent during inhalation along with coordinated activation of abdominal and pelvic floor muscles during exhalation [14]. Beyond improving respiration, these exercises have been shown to enhance chest expansion, reduce sympathetic nervous system activity and promote activation of deep trunk stabilizers [15]. From a biopsychological perspective, regulated breathing may also influence pain perception by modulating central pain processing, reducing anxiety and improving sleep quality [16].

The effects of combined DBEs with core stabilization exercises in people with CLBP have been evaluated in several RCTs. Evidence suggests that these interventions lead to better outcomes in pain reduction, functional improvement and muscle activation, compared to core stabilization exercises alone [17]. Improved transverse abdominis recruitment, chest expansion and respiratory parameters indicate augmented neuromuscular coordination and respiratory efficiency [18]. Furthermore, integrated breathing and core therapies have demonstrated positive effects on psychosocial factors including fear-avoidance beliefs and sleep quality [19].

Systematic reviews and meta-analyses further reinforce the clinical value of breathing-focused interventions for CLBP. Breathing exercises have been associated with improvements in pulmonary function indicators like forced vital capacity (FVC) and FEV1/FVC ratio, along with significant reductions in pain intensity and disability scores [20]. These findings highlight the interrelationship of respiratory function, trunk stability and musculoskeletal health.

Despite increasing evidence, there is heterogeneity in the existing literature with respect to intervention protocols, breathing methods, outcome measures and theoretical perspectives. Preceding reviews have generally focused on either breathing exercises or core stabilization exercises independently, with limited attention on integrated interventions and their underlying mechanisms. Consequently, a scoping review is required to extensively map the current evidence, clarify proposed mechanisms and identify gaps for future research.

Understanding the interaction between diaphragmatic breathing and core stabilization is highly relevant for physiotherapy practice, particularly in the development of holistic and patient-centered rehabilitation protocol. By targeting both mechanical and neurophysiological contributors to CLBP, combined interventions may offer more effective and sustainable approach to pain reduction and functional recovery.

Aim

To scrutinize and summarize the available literature on the effectiveness of combined diaphragmatic breathing and core stability exercises in individuals with acute and chronic low back pain.

Objectives

To identify and describe the types, dosage and characteristics of combination diaphragmatic breathing and core stabilization therapies utilised in LBP therapy.

To study the postulated physiological and neuromuscular mechanisms including intra-abdominal pressure regulation, trunk muscle activation and respiratory-postural integration.

To summarize the clinical outcomes associated with these therapies including pain intensity, functional impairment, muscle activity, respiratory parameters, postural control, sleep quality and psychosocial aspects.

To highlight gaps in current knowledge and make recommendations for future research and physiotherapy practice.

Review of literature

Low back pain and core dysfunction

According to Theo Vos et al. (2020), who evaluated the global incidence od 369 diseases and injuries across 204 nations, LBP is one of the prevalent musculoskeletal disorders worldwide and a prominent source of disability across all age categories. Richard A. Deyo and James N. Weinstein (2001) described CLBP as a complex disorder associated with physical impairment, abnormal

movement patterns, psychological distress and reduced quality of life. Likewise, Jan Hartvigsen et al. (2018) concluded that although traditional biomechanical models mainly concentrated on spinal loading and structural abnormalities, contemporary evidence suggests deficits in neuromuscular control as the important factor in persistent LBP. A systematic review conducted by Damian Hoy et al. (2012) reported that individuals with CLBP frequently exhibit delayed or impaired activation of deep trunk stabilizing muscles, especially the transverse abdominis and lumbar multifidus, thereby compromising spinal stability. Furthermore, Federico Balague et al. (2012) concluded that because impaired neuromuscular control reduces segmental spinal stability and increases the risk of recurrent pain episodes, rehabilitation strategies focusing on core stability have become an important component of physiotherapy management for CLBP.

Core stability and trunk muscle coordination

Roger Chou, Richard A. Deyo and colleagues (2017) identified core stability as the ability of the musculoskeletal and neuromuscular systems to maintain or control trunk position throughout both static and dynamic activity. The World Health Organization (2023), in its recommendation for non-surgical care of chronic primary low back pain, conceived the core as a functional unit compromising of the abdominal muscles, paraspinal muscles, pelvic floor and diaphragm that act synergistically to stabilize the spine. According to Jill A. Hayden, Maurits W. van Tulder and colleagues (2005), disruption in any component of this system might affect load transfer over the lumbopelvic region, potentially leading to discomfort and functional restrictions.

Role of diaphragm in spinal stability

Paul W. Hodges and Simon C. Gandevia (2000) established that although the diaphragm is generally considered the principal muscle of respiration, it is also actively involved in postural control and trunk stabilization during functional tasks. Expanding on this concept, Pavel Kolar, Jan Sulc and colleagues (2012) reported that coordinated contraction of diaphragm with abdominal and pelvic floor muscles facilitates regulation of intra-abdominal pressure, thereby reducing stress on lumbar spine and fostering segmental stability. In a similar context, R. D'Hooge, Paul W. Hodges and Henry Tsao (2013) demonstrated that diaphragmatic activity is not only involved in breathing, but also in postural tasks requiring trunk stabilization. Moreover, Ben E. Smith, Charlie Littlewood and Stephen May (2014) unveiled that exhaustion of inspiratory muscles may disturb the postural control in individuals with CLBP. Collectively, data demonstrate that diaphragmatic dysfunction might negatively influence both respiratory efficiency and spinal stability, hence supporting the introduction of breathing-based therapies into core rehabilitation programs for persons with CLBP.

Diaphragmatic breathing exercises in low back pain

Liesbeth Janssens, Alison K. McConnell, Mieke Pijnenburg and colleagues (2015) reported that diaphragmatic breathing exercises involves controlled inspiration and expiration allowing diaphragmatic descent, expansion of rib cage and coordinated activation of abdominal muscles. Similarly, Ji-In Kang, Dong-Kyu Jeong and Hyeon Choi (2016) revealed that breathing based-exercises can alter trunk muscle activation, regulate autonomic nervous system and contribute to pain modulation beyond their respiratory advantages. Marshall Hagins and Elizabeth M. Lamberg (2011) reported that people suffering through CLBP often exhibit altered breathing patterns, and specific breathing exercises may enhance chest expansion and respiratory functions while also reducing pain severity and disability. Earlier experimental research conducted by Liesbeth Janssens, Steven Brumagne, Kris Polspoel and colleagues (2010) demonstrated that fatigued inspiratory muscles can adversely affect postural stability, emphasizing the importance of respiratory muscle function in spinal stability and overall functional performance. Additionally, Wolf E. Mehling, Ellen K. Hamel, Michael Acree and colleagues (2005) showed that breathing-based therapeutic interventions may also result in positive psychosocial outcomes such as decrease in anxiety, sleep disturbances and fear-avoidance beliefs in people with CLBP. All of these results point to be multifaceted advantages of diaphragmatic breathing exercises, which support the biopsychosocial model of pain therapy by enhancing respiratory mechanics, trunk muscle coordination, pain perception and psychosocial well-being.

Combined diaphragmatic breathing and core stability interventions

According to Brett E. Anderson and Kathryn C. Huxel Bliven (2016), in people with chronic non-specific LBP, combining diaphragmatic breathing with core stabilization exercises can result in greater improvements in pain reduction, functional disability and trunk muscle activation than core stabilization exercises done alone. Similarly, electromyographic investigation by Jessica Stephens, Jennifer Davidson, Joseph DeRosa and colleagues (2017) showed that breathing and core training together improve coordination across trunk stabilizing muscles and increase activation of transverse abdominis. Furthermore, research conducted by Pradeep Tekur, S. Chametcha, R.N. Hongasandra and Nagarathna Raghuram (2010) demonstrated that breathing-focused interventions can enhance chest expansion and respiratory efficiency, suggesting better coordination between respiratory and postural systems. More recently, Y. Li, Q. Zhao, X. Zhang and colleagues (2025) found that participants receiving both breathing training and core stabilization exercises experienced greater improvements in sleep quality and reduced fear-avoidance behaviors, underscoring broader therapeutic benefits of this combined approach. Collectively, these findings imply that diaphragmatic breathing may strengthen neuromuscular coordination and improve intra-abdominal pressure regulation,

thereby increasing the effectiveness of core stabilization exercises and contributing to better functional outcomes for people with CLBP.

Proposed mechanisms of action

Arif Usman, Tarun Tanwar and Zubia Veqar (2023) proposed that the effectiveness of integrated diaphragmatic breathing and core stabilisation exercises may be attributed to better intra-abdominal pressure regulation, improved coordination among respiratory and postural muscles, and increased proprioceptive input to the CNS. Improvements in diaphragmatic function may also reduce excessive lumbar spinal loading and increase spinal stiffness during functional activities, supporting improved trunk stability, according to Behzad Amiri and Erika Zemkova (2023). Additionally, controlled breathing interventions may modulate central pain processing through autonomic nervous system regulation, reducing pain perception and stress-related symptoms in people with CLBP, according to a systematic review and meta-analyses by Xiang Jiang and colleagues (2024). Nevertheless, despite these encouraging results, conclusions about the ideal parameters for combined breathing and core stability training are limited by significant variation in intervention protocols, training length, outcome measures and overall study quality.

METHODOLOGY

Study Design

In order to map the scope, features and type of evidence pertaining to combined diaphragmatic breathing and core stability interventions in people with LBP, this study was carried as a scoping review. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) framework, which was developed by Arksey and O'Malley, and improved by Levac et al., served as the basis for the review approach.

Eligibility criteria

The Population-Concept-Context (PCC) framework was used to create eligibility requirements.

Population: Adults (≥18 years) with mechanical or non-specific LBP, whether acute, subacute or chronic.

Concept: Interventions that integrate core stabilization, trunk control or lumbar stabilization exercises with diaphragmatic or respiratory breathing exercises.

Context: Community-based, outpatient, clinical and rehabilitative settings.

The sources examined were randomised controlled trials, quasi-experimental studies, controlled clinical trials, observational studies, systematic reviews and meta-analyses that were published in English between January 2000 and March 2025.

Exclusion criteria

Narrative commentary, conference abstracts, editorials and case reports.

Research pertaining to children

Research that only focuses on passive, pharmacological or surgical procedures.

Information sources

The following databases were searched thoroughly for relevant literature:

Scopus

Web of Science

PubMed/ MEDLINE

Cochrane Library

CINAHL

Google Scholar

Search Strategy

Medical Subject Headings (MeSH) and free-text phrases associated with breathing techniques, core stability and low back discomfort were combined to create search methods. "Low Back Pain", "Chronic Low Back Pain, "Diaphragmatic Breathing", "Breathing Exercises", "Core Stabilisation," and "Trunk Control" were among the key terms. Search tactics were modified for every database and Boolean operators ("AND", "OR") were used.

Study Selection

Duplicate records were eliminated once all obtained records were loaded into reference management software. There were two phases to study selection process:

Title and abstract screening according to predetermined eligibility standards.

Full-text screening of publications that might be relevant.

Two reviewers independently carried out the screening and differences were settled by discussion and consensus.

Data extraction

A pilot test was conducted on a standardized data extraction form. Among the extracted data were:

The year of publication and Author(s)

Research design and country

Sample size and participant characteristics

An explanation of core stability and breathing techniques

The dosage of intervention (frequency, duration, intensity)

Outcome measures

Key findings related to pain, disability, muscle activation, respiratory parameters, postural control and psychosocial outcomes.

Data Synthesis

A descriptive and narrative approach was used to synthesize the data in accordance with the methodology of the scoping review. The results were categorized thematically according to the features of intervention, suggested mechanisms of action and documented clinical results. Since the goal was to map the available evidence rather than assess treatment efficacy, a formal risk-of-bias evaluation was not carried out.

Ethical Consideration

Since this study simply examined already published material, ethical approval was not necessary.

Figure 1: PRISMA-ScR flow diagram illustrating the study selection process for the scoping review on combined diaphragmatic breathing and core stability interventions in low back pain

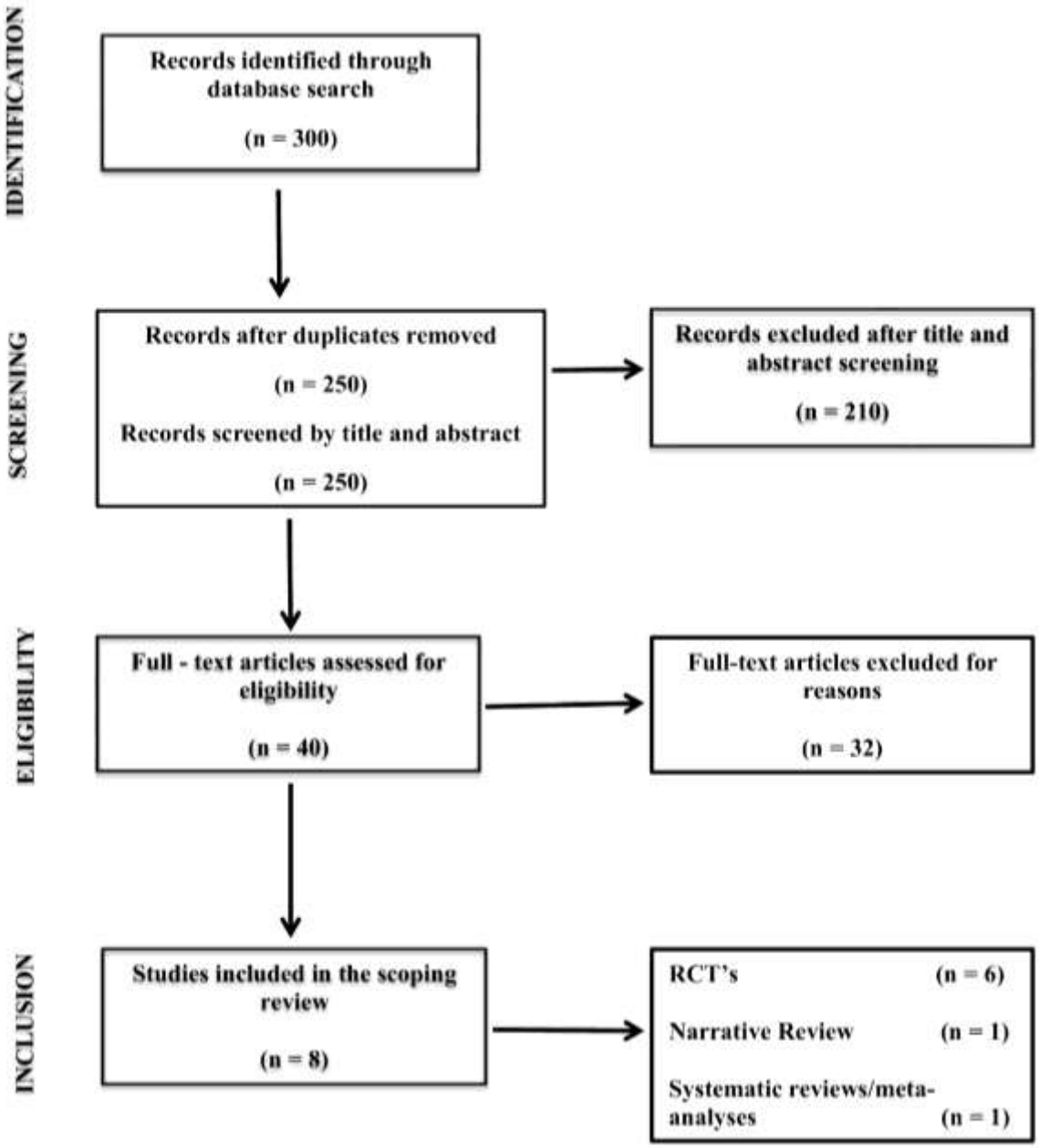

Table 1. Represents the characteristics of studies included in this scoping review, highlighting study design, population, intervention characteristics and outcome domains.

Author (Year)	Country	Study Design	Population (n)	Intervention	Comparator	Duration/ Frequency	Outcomes Reported
Mehling et al. (2005)	USA	RCT	Adults with CLBP (n = 28)	Breathing awareness training combined with physiotherapy	Conventional Rehabilitation	8 weeks; weekly sessions	Pain intensity, functional disability, psychosocial outcomes
Anderson & Huxel Bliven (2016)	USA	Narrative review	CLBP populations	Breathing exercises integrated with stabilization concepts	Not applicable	Not applicable	Pain modulation, trunk stability, breathing–posture interaction
Park et al. (2019)	South Korea	RCT	Adults with CLBP (n = 43)	Diaphragmatic breathing + lumbar stabilization exercises	Lumbar stabilization exercises	4 weeks; 3 sessions/week	Pulmonary function (FVC, FEV_1), disability (ODI)
Borujeni et al. (2020)	Iran	RCT	Young adults with CLBP (n = 48)	Breathing exercises + strength training	Strength training alone	8 weeks; daily sessions	Pain intensity (VAS)
Ahmadnezhad et al. (2020)	Iran	RCT	Adults with CLBP (n = 47)	Breathing exercises + strength training	Strength training alone	8 weeks; 2×/day	Pain (VAS), pulmonary function
Park et al. (2020)	South Korea	RCT	Adults with CLBP (n = 59)	Breathing exercises + lumbar stabilization	Lumbar stabilization only	6 weeks; 5×/week	Pulmonary outcomes, trunk stability
Jiang et al. (2024)	China	Systematic review	CLBP (n = 677 across 13 RCTs)	Breathing-based exercise interventions	Conventional rehabilitation	4–12 weeks	Pain, disability, pulmonary function

		& meta-analysis					
Li et al. (2025)	China	RCT	Adults with CNLBP (n ≈ 60)	Core training combined with breathing exercises	Core training alone	8 weeks; supervised	Pain, disability, sleep quality, muscle activation

RESULTS

Overview of included evidence

A body of research on the effectiveness of diaphragmatic breathing, either alone or in conjunction with core stabilization exercises in patients with CLBP was found through the scoping review. This evidence included RCTs, quasi-experimental studies and systematic reviews. Despite variations in sample size, intervention duration (ranging from 4 to 12 weeks), exercise intensity and outcome measures, the included studies consistently investigated the association between respiratory control and trunk stability.

Characteristics of interventions

Diaphragmatic breathing was commonly incorporated into core stability programs targeting the diaphragm, lumbar multifidus, pelvic floor muscles and transverse abdominis. The interventions integrated controlled breathing techniques with static and dynamic core exercises, focusing coordinated breathing during movement, intra-abdominal pressure regulation and abdominal draw-in maneuvers. In contrast, comparison groups typically received conventional core stabilization exercises, strengthening programs or standard physiotherapy without focused breathing retraining.

Thematic Synthesis of Outcomes

Pain Reduction

Most of the trials reported statistically and clinically reductions in pain intensity following combined interventions. Pain results measured through VAS or NPRS consistently showed greater improvements with integrated approaches compared to core stabilization exercises solely. Findings from systematic reviews confirmed moderate-to-large effect sizes for breathing-focused interventions in reducing the severity of CLBP.

Functional disability

Multiple studies reported significant improvements in functional outcomes assessed using Oswestry Disability Index (ODI). When compared to control groups, participants who underwent combined breathing and core stabilization program exhibited greater reductions in disability scores, depicting improved lumbar stability and functional recovery.

Neuromuscular and core muscle activation

Electromyographic and biomechanical assessments demonstrated improved activation and coordination of deep trunk muscles, especially transverse abdominis following diaphragmatic breathing incorporation. Several studies also reported improvements in muscle activation timings, endurance and symmetry, highlighting the importance of diaphragmatic breathing in optimizing neuromuscular control and spinal stability mechanisms.

Respiratory and psychosocial outcomes

Studies incorporating breathing exercises showed improvements in pulmonary function parameters such as chest expansion and forced vital capacity (FVC). The multifactorial effect of breathing-centered intervention is further demonstrated by few trials outlining the positive impact on fear-avoidance attitudes, sleep quality and general psychological well-being.

Mechanical insights

Reviewed study suggested that diaphragmatic breathing enhances spinal stability mechanistically by improving intra-abdominal pressure, better diaphragm-pelvic floor synergy and more efficient load transfer across lumbopelvic region. These mechanisms appear to contribute to improved postural control, reduced pain and better functional performance.

Evidence gap

Though findings were promising, differences in intervention protocol, outcome assessment and follow-up durations limited direct comparison across studies. The literature also revealed two important gaps, i.e. insufficient evidence on long-term outcomes and limited use of kinematic analyses or mechanistic imaging studies.

DISCUSSION

This scoping review unveiled consistent improvements in pain, functional performance, neuromuscular coordination, respiratory and psychosocial domains on combining diaphragmatic breathing with core stability exercises in people with LBP. Integrated interventions were associated to reduced pain intensity and disability when compared to core stabilisation therapy alone, highlighting the importance of breathing control in advancing clinical results [18,19,21]. These results are consistent with modern rehabilitation approaches that prioritize neuromuscular coordination and motor control over individual muscle strengthening [6,12].

Through improved intra-abdominal pressure regulation and improved coordination between the diaphragm, transversus abdominis, lumbar multifidus and pelvic floor muscles, diaphragmatic breathing may contribute to spinal control, as evidenced by improvements in trunk muscle activation and lumbopelvic stability reported across studies [9,10,11]. The dual function of diaphragm in respiratory and postural stability is reinforced by this respiratory-postural synergy, which offers a tenable molecular explanation for the better results seen with combination therapies [10].

Improvements in respiratory function and psychosocial outcomes such as decreased fear-avoidance attitudes and increased movement confidence, were also shown in a no. of investigations [17,20,21]. These results demonstrate the multifaceted effects of breathing-integrated rehabilitation and bolster its applicability in a

biopsychosocial framework for the treatment of LBP [2,3]. Improved respiratory efficiency contributes to correct posture and reduced spinal loading, which may also lower compensatory muscle overactivity [23,24].

Despite favorable findings, substantial differences in the intervention protocols, outcome assessment and follow-up duration made the comparison difficult among studies. Lack of standardized breathing-core training protocols and the paucity of long-term evidence illustrates the significant gaps within current literature [22,24]. Future studies should focus on developing standardized intervention designs, incorporating mechanistic outcome measures and conducting long-term follow up to strengthen the evidence base and improve clinical applicability.

CONCLUSION

This scoping review discovered that combining diaphragmatic breathing with core stability exercises may reduce pain, improve functional capacity, result in better neuromuscular control and respiratory efficiency in patients with LBP, compared to core stabilization exercises alone. The findings authenticate theoretical concepts that identify diaphragm as an important contributor in respiration and postural stability through coordinated activation of deep trunk muscles and intra-abdominal pressure regulation. Thus, incorporating breathing retraining into a physiotherapy-led core stabilisation program may improve movement control and overall clinical outcomes. However, heterogeneity in intervention protocols and outcome measures underscores the need for standardised, theory-based exercise frameworks and additional high-quality research to inform clinical practice.

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