

## “Mechanistic and Clinical Outcomes of Core Strengthening and Stabilization Exercises in Lumbar Disc Prolapse: Effects on Pain, Range of Motion, Endurance, and Functional Disability.”

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### Abstract

#### Background:

Lumbar disc herniation is a leading cause of back pain and functional disability, frequently managed using conservative rehabilitation approaches. Stabilization exercises are widely prescribed; however, their clinical effectiveness remains variably reported.

**Objective:** To review the effects of stabilization exercise-based rehabilitation on pain, disability, and functional improvements in individuals with lumbar disc herniation.

**Methods:** A comprehensive systematic search was performed across the databases including PubMed, Scopus, PEDro, and Cochrane Library was conducted in accordance with PRISMA guidelines. Randomized controlled trials evaluating stabilization exercises in adults with lumbar disc herniation were included. The study quality was assessed using the PEDro scale and risk of bias was assessed using the Cochrane RoB 2 tool.

**Results:** A total of 12 randomized controlled trials involving 485 participants were included. Most studies demonstrated significant improvements in pain intensity, disability scores, trunk endurance, and functional performance following stabilization exercise interventions compared to conventional therapy or minimal intervention.

**Conclusion:** Stabilization exercise-based rehabilitation appears to be an effective conservative intervention for reducing pain and disability and improving functional outcomes in individuals with lumbar disc herniation. These findings support the integration of stabilization exercises into routine rehabilitation practice.

**Keywords:** Lumbar disc herniation, stabilization exercises, pain, endurance, disability

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### 1. Introduction

Lumbar Disc Herniation (LDH) is a syndrome in which lumbar disc degeneration, rupture of the annulus fibrosus, and protrusion of the nucleus pulposus irritate and compress the nerve root and cauda equina, resulting in lumbar pain and/or lower limb pain<sup>1</sup>.

LDH is a spinal pathology frequently associated with neurological dysfunction and significant functional limitation, and it remains one of the leading causes of disability worldwide. The annual incidence of lumbar disc prolapse is estimated to be approximately 5–10 cases per 1,000 adults, with a male-to-female ratio of 2:1<sup>2</sup>. In recent years, the incidence of LDH has increased, particularly among younger populations, which has been attributed to prolonged sedentary behavior, occupational demands, and reduced levels of physical activity<sup>3</sup>.

In 2010, the United Kingdom National Institute for Health and Care Excellence (NICE) recommended conservative management as the first-line treatment for chronic low back pain, emphasizing strong evidence supporting the effectiveness of exercise therapy in symptom reduction and functional improvement<sup>4</sup>. Previous research has demonstrated that appropriately prescribed exercises can enhance lumbar muscle function while reducing fatigue and mechanical stress on the spine<sup>5</sup>.

Despite the widespread clinical use of stabilization exercises in lumbar disc herniation, considerable variability exists in exercise protocols, outcome measures, and reported effectiveness. Clinicians continue to face uncertainty regarding the optimal role of stabilization exercises within conservative rehabilitation programs. Therefore, a systematic synthesis of available randomized controlled trials is required to clarify the clinical benefits of stabilization

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exercise-based rehabilitation in individuals with lumbar disc herniation.

The systematic review was aimed to assess the impact of stabilization exercises on pain, disability, and functional outcomes in individuals with lumbar disc herniation.

## 2. Purpose of the Study

The purpose of the below mentioned systematic review is to provide a research based and critically appraised overall effectiveness of specifically stabilizing exercises in Disc Prolapse. These exercises are supported for the benefits they have on the spine, good posture, and on the ability to minimize the use of medication by developing the muscles of the spine. Some of the targets of this review include; secondary synthesis of extant literature about these exercise modalities and evaluation of their effects on patient outcomes and determining existing gap in the existing literature to recommend areas for future research. These findings will enhance pragmatic evidence on treatment and management of disc prolapse for future investigations.

## 3. Methods & Methodology

This study was registered with the PROSPERO database under the registration number [CRD420251022917].

### 3.1 Search Strategy

A extensive search was performed utilizing databases like Pubmed, Embase and Cochrane Library. Keywords such as lumbar PIVD, lumbar disc herniation, disc prolapse, core stability exercises, stability exercises and related terms were used. The advanced search strategy was employed to integrate Medical Subject Headings (MeSH), related keywords, and the Boolean operators ('AND'/'OR') were included.

### 3.2 Study Screening and Selection Process

- **Title and Abstract Screening:** Titles and abstracts were fully imported into MENDELEY desktop (Version 2.130.2) by which duplicates and irrelevant articles which did not meet the inclusion criteria were removed.
- **Full Text Screening:** Full-text versions were retrieved for studies that were selected during preliminary screening. If a full-text version was unavailable through databases or electronic searches, the corresponding authors were contacted. In cases where no response was received or the authors were unable to provide the requested manuscript, the study was excluded from the review.

### 3.3 Data Extraction

Two reviewers independently extracted data and the findings were validated by comparing them against the original data, ensuring accurate extraction using established MeSH terms and keywords.. The gathered information was meticulously verified to ensure accuracy and consistency.

### 3.4 Eligibility Criteria:

**3.4.1 Inclusion criteria:** Included studies were restricted to randomized controlled trials published in English; from 2005 to 2024.

#### Population:

- Adults aged 15 years and older experiencing Chronic back pain - lumbar disc herniation (defined as pain lasting longer than three months).

#### Intervention:

- Studies focusing on Lumbar stabilization exercises and other interventions in addition with stability exercises.

#### Comparison:

- Studies that compare Lumbar stabilization exercises to standard care, or other intervention, or other forms of rehabilitation/exercise.

#### Outcome Measures:

- Studies that report on at least one of the following outcomes:
  - Reduction in pain intensity (using validated pain scales)
  - Improvement in Range of Motion
  - Improvement in Endurance
  - Improvement in functional disability

#### Study Design:

- Randomized controlled trials (RCTs)

#### Date Range:

- Studies published from 2005 to 2024.

### 3.4.2 Exclusion criteria

#### Population:

- Studies involving participants under 15 years of age.
- Individuals with acute back pain (pain lasting less than three months) or with specific lumbar conditions (e.g., fractures, tumors) that require different management.

#### Intervention:

- Studies that do not focus on Lumbar stabilization exercises or that include a exercise regimen post surgically.

#### Comparison:

- Studies that do not include a control group or a comparison intervention.

#### Study Design:

- Non-peer-reviewed articles, case reports, opinion pieces, editorials, and anecdotal evidence.
- Studies that are purely observational without a comparative element.
- Grey literature and unpublished studies were excluded

#### Date Range:

- Studies published more than 20 years ago.

Other exclusions were the data not pertaining to the review of interest, outcomes are not relevant and

information within this study redundant with other included literature were also considered in the exclusion criteria.

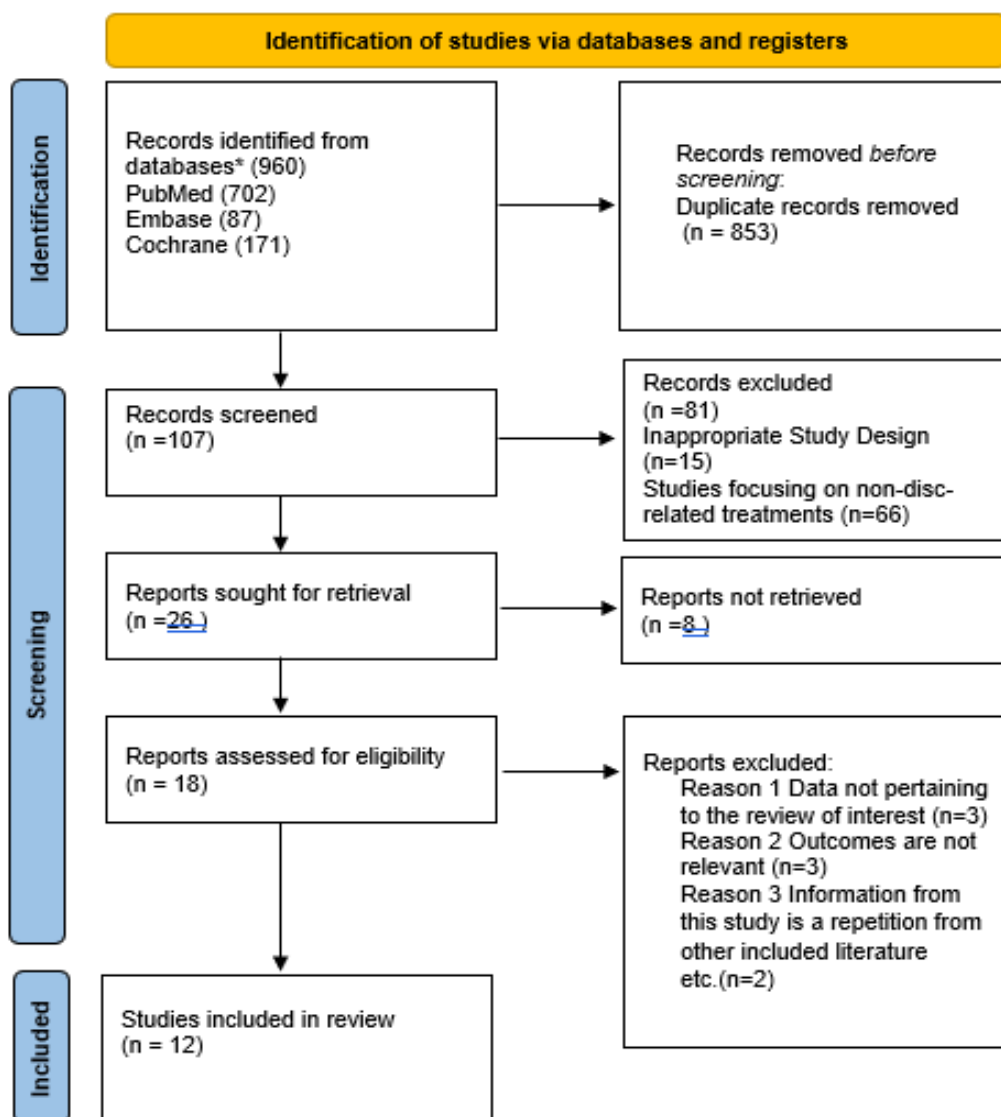


FIGURE 1 : PRISMA flowchart.

#### 4. Results:

**4.1 Literature search:** A literature search was performed in major electronic databases including PubMed, Embase, and the Cochrane Library initially identified 960 articles. After removing duplicates, 107 articles remained. Of these, 81 articles were excluded as there were inappropriate Study Design and studies focusing on non-disc-related treatments. Additionally, 8 articles were excluded due to the data not pertaining to the review of interest, outcomes were not relevant and information within this study redundant with other included literature etc. Ultimately, 12 full-text articles were deemed eligible for inclusion. The selection

process is shown in the Figure 1 PRISMA flowchart, with detailed included study characteristics in Table 2.

#### 4.2 Quality assessment

##### 4.2.1 Pedro scale

The PEDro scale was used to evaluate the methodological quality of the randomized controlled trials. (Table 1). PEDro scale based on a Delphi list of trial characteristics which consists of 11 items. Each item is scored as either met or not met, and the total score equals the sum of the met items (0-10). Scores are categorized as poor (0-3), fair (4-5), good (6-8), and

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excellent (9-10). The selected trials achieved high methodological quality, as evaluated by the PEDro scale. Two study scored 9, (Bakhtiary, Luiz Armando) two study scored 8, (Gaozeh, Sania Naz) four studies scored 7, (Yasser Rad, Min Sang, Abbas Jamil, Sucheta

Golhar) three studies scored 6,(Jeong-il Kang, Yazdani, Chaoqun Ye) and one study scored 5 (Gulsen). Any disparity in scores was resolved by discussion and thorough re-evaluation.

**Table 1:** Assessment of studies using Pedro Score

S. No.	Study	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
1	Yasser Mohebbi Rad (2021)	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
2	Sania Naz (2024)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
3	Gaowgzeh (2020)	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes
4	Gulsen, Mustafa (2019)	NO	No	No	Yes	No	No	No	Yes	Yes	Yes
5	Chaoqun Ye (2015)	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes
6	Min-sang Mo (2016)	Yes	Yes	NO	Yes	NO	No	Yes	Yes	Yes	Yes
7	Sucheta Golhar (2016)	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
8	Mohammad Abbas Jamil (2023)	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
9	Jeong-il Kang (2017)	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes
10	Amir Hossein Yazdani (2016)	No	Yes	No	Yes	No	No	No	Yes	Yes	Yes
11	Amir Hoshang Bakhtiary (2005)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
12	Luiz Armando Vidal Ramos (2017)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

**4.2.2 Risk of Bias Assessment**

Risk of bias of the included studies in the analysis was evaluated by Cochrane Rob 2 tool, and the results are depicted in Figure 2.

Weight	Study ID	D1	D2	D3	D4	D5	Overall	
1	Yasser Mohebbi Rad et al 2021							Low risk
2	Sania Naz et al 2024							Some concerns
3	Gaowgzeh et al 2020							D1 Randomisation process

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FIGURE 2 RoB Assessment Summary

5. Discussion

The included studies primarily assessed the impact of stabilization exercise interventions on pain, disability, and functional capability. Outcome measures commonly included pain intensity scales, disability indices, and functional endurance tests. Results are summarized below according to outcome domains. Stabilization exercises continue to play a pivotal role in non-surgical rehabilitation strategies for disc prolapse yet their clinical application is often underutilized despite compelling evidence. Through this review, we integrated insights from rigorously designed randomized controlled trials, revealing consistent improvements not only in pain reduction and functional mobility, but also in muscular endurance and range of motion. These outcomes collectively highlight the potential of targeted

core exercises to shift treatment paradigms, especially in populations with prolonged sedentary habits or recurrent symptoms. However, the variability in protocols and adherence rates across studies indicates a pressing need to standardize regimens that are both effective and feasible in clinical practice. This discussion integrates the main findings and explores their impact on clinical practice.

Lumbar Stabilizing Exercise reactivates and strengthens muscles, that provide long term spinal stabilization. These exercises are targeted on the co-activation of Transversus Abdominus and Multifidus, the primary local stabilizers. In lumbar disc herniation, subacute and chronic low back pain, stabilization exercises have been shown to be more effective<sup>16, 18-19</sup>.

Table 2

S. No.	Author, Year	Group and Participants	Study Design	Intervention	Duration	Outcome variables	Conclusion
1.	Yasser Mohebbi Rad et al., (2021)	G1: N=12 G2: N=10 G3: N=10	RCT	G1: Suspension exercises G2: Core stability exercises G3: no intervention	8 weeks	Superficial EMG, Pain, Range of motion.	Suspension exercises yielded better results in pain reduction and muscle activation compared to the core stability training
2.	Sania Naz et al., (2024)	G1: N=5	RCT	G1: TENS therapy.	8 weeks	Pain and MODI.	Both TENS and CSE

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		G2 : N=5		G2: Core stability exercises.			significantly reduce pain and disability, although CSE demonstrated to have superior outcomes.
3.	Gaowgzeh et al., (2020)	G1: N=16 G2: N=15	RCT	The study group (G1) received Spinal Decompression Therapy with Core Stabilization Exercises and interferential current (IFC),  G2 Control group: Core Stabilization Exercises and interferential current (IFC),	8 weeks	NRS and Modified Oswestry Questionnaire.	Combining SDT with CSE has proven to be more effective than using CSE alone.
4.	Gulsen & Koz, et al., (2019)	G1: N= 16 G2: N=16 G3: N=16 G4: N=16	RCT	G1: Lumbar stabilization group G2: PNF techniques (pelvis patterns) G3: Physiotherapy G4: Control	4 weeks	Oswestry Disability Questionnaire, VAS, Trunk muscle strength, Trunk muscle endurance	Evidence suggests that lumbar stabilization exercises demonstrate superior efficacy compared to PNF exercises in the management of lumbar disc herniation
5.	Chaoqun Ye et al., (2015)	G1: N=30 G2: N=33	RCT	G1: LSSE group G2: GE group	1 year	VAS, ODI.	LSSE demonstrates more effectiveness compared to GE, and physical therapy, such as LPL, necessary during acute LDH.
6.	Min-sang Mo et al.,(2016)	G1: N=15 G2: N=15.	RCT	G1; Study group  G2: Control group	8 weeks	The maximum flexion force of the lumbar muscle (peak torque of flexor) and peak torque	Integrated rehabilitation combining neurodynamic techniques with lumbar

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						of extensor were measured to measure Lumbar muscular strength and ODI to measure disability	stabilization exercises is a highly effective way to increase core strength and reducing functional disability in patients with lumbar disc herniation
7.	Sucheta Golhar et al., (2016)	G1: Group A. N= 10 G2: Group B. N = 10	RCT	G1: Specific stabilization exercise G2: Conventional back extension exercise.	4 weeks.	Pain perception evaluated using the VAS. Disability evaluated using the Ronald – Morris Disability Questionnaire (RMDQ).	Specific stabilization exercises yielded more marked relief compared to the conventional approach.
8.	Mohammad Abbas Jamil et al., (2023)	G1: Group A. N=26 G2; Group B. N=26	RCT	G1: Controlled conventional treatment and core stabilizing exercises. Group 2: Conventional treatment.	6 months	NPRS used to evaluate pain and ODI for disability. Apart from this Biering-Sorenson and trunk flexion endurance tests were used.	Core exercises are a superior treatment for reducing pain improving endurance and functional capability in individuals with herniated discs and low back pain".
9.	Jeong-il Kang et al., (2017)	G1: N=15 G2: N=15	RCT	G1: Balance center stabilization resistance exercise group (experimental group I) G2: Three-dimensional stabilization exercise group (experimental group II).	4 weeks	Disc herniation index was evaluated using MRI, sacral angle was assessed using X-ray, and back function was assessed using the KODI.	Lumbar stabilization exercises involving controlled pelvic movements enhance sacroiliac joint mobility and stability, resulting in greater pelvic and lumbar movement enhanced proprioception and facilitate recovery of lumbar disc function.
10.	Amir Hossein Yazdani et al., (2016)	G1: Lumbar Stabilization in Males N=13	RCT	G1: Lumbar Stabilization in Males	6 weeks	Pain was measured using VAS	The findings suggest that males with lumbar disc

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		G2: Lumbar Stabilization in Females N=51		G2: Lumbar Stabilization in Females			herniation experienced a greater decrease in pain following six weeks of exercise training than females
11.	Amir Hoshang Bakhtiary (2005)	G1: Group A performed a LSE protocol N=30 G2: Group B performed the opposite. N=30	RCT	Group A underwent a four-week lumbar stabilization exercise (LSE) intervention upon enrollment, followed by a four-week non-exercise phase.  Group B completed the intervention in the opposite order, with an initial four-week non-exercise phase followed by four weeks of LSE.	4 weeks	Pain measured on a VAS, trunk flexion; straight leg raising (SLR) angle without pain and time to complete ADL tasks were assessed.	The findings indicate that a LSE may enhance ADL in disc herniation patients.
12.	Luiz Armando Vidal Ramos et al., (2017)	G1: Segmental stabilization group N=15 G2: TENS group N=14	RCT	G1: The segmental stabilization group. G2: TENS group who received electrotherapy .	8 weeks	Pain was measured using a VAS, functional disability using the Oswestry Disability Index, muscle activation and fatigue with electromyography, and assessment of transversus abdominis activation using biofeedback unit	TENS therapy only treats pain, failing to improve muscle function or reduce disability, whereas stabilization exercises provide superior, comprehensive results in disc herniated patients

# Surface EMG: Surface electromyography, TENS: Transcutaneous electrical nerve stimulation, MODI: Modified Oswestry Disability Index, CSE: Core stabilization exercises, NRS: Numerical rating scale, SDT: Spinal decompression therapy, PNF techniques: Proprioceptive neuromuscular facilitation techniques, VAS: Visual Analogue Scale, LSSE Group: Lumbar

spine stabilization exercise Group, GE Group: General exercise Group, LPL: Low-power laser, ODI: Oswestry Disability Index, RMDQ: Ronald – Morris Disability Questionnaire, NPRS: Numeric Pain Rating Scale, KODI: Korean Oswestry Disability Index, LSE: Lumbar stabilization exercise, ADL: Activities of daily living, SLR: Straight leg raise.

### 5.1 Pain Outcomes

According to our results, some studies reported a reduction in pain due to core stability and suspension exercises in people with intervertebral disk herniation<sup>20-21</sup>.

Core stability exercises make the muscles that were inactivated due to LBP more actively involved<sup>22</sup>. These exercises increase strength and coordination of muscles, thereby reduce pain in people with chronic LBP<sup>23</sup>.

### 5.2 Disability Outcomes

Letafatkar et al. 2017, study findings suggested that core stabilization resistance training improves spinal function, leading to reduced pain and gains in proprioception, mobility, and overall quality of life<sup>23</sup>. The study also showed significant and distinct improvements across different categories of the KODI and disc herniation index categories.

### 5.3 ROM

Lumbar herniated nucleus pulposus does not occur due to lumbar pain or disability, but more frequently occurs due to deterioration of the related muscles or functions interacting with them adjunctively. In addition, it is said that the joint range of motion is limited due to the loss of muscle strength and flexibility caused by occupational factors, mode of action, specific changes in posture, or degenerative disease<sup>24</sup>.

LSSE is a comprehensive rehabilitation program involving postural training, deep muscle reactivation, stretching and strengthening of the prime movers of the spine, and subsequent progression to functional exercises<sup>25-27</sup>. LSSE also improves the range in movement, muscle strength, and body posture by stretching and strengthening of the prime movers of the spine and postural training<sup>25,27</sup>. Several studies have shown that LSSE improves<sup>28-29</sup> leads to improvement in functional capacity and helps prevent degenerative disc disease.

The effect of CSE that provide stability and decrease the risk of subsequent injury through the activation of deep trunk muscles, which is useful in treating the pain and disability in chronic LBP<sup>30</sup>. Franca et al., 2010 carried out a study to compare abdominal and trunk muscle strengthening exercises with lumbar stabilization exercises, focusing on their effects on pain, functional disability, and transverse abdominal muscle activation. Lumbar stabilization exercises group showed significant improvements than those in the strengthening group. In particular, transverse abdominal muscle activation increased considerably in the lumbar stabilization exercise group compared with the strengthening group<sup>28</sup>.

### 5.4 Endurance

Muscular endurance is an important measure in determining overall physical fitness and functional ability. As a result, many studies have examined how trunk muscles help protect the spine from excessive loading. These muscles support proper posture and allow

controlled movement of the body during flexion and extension. Based on the theory, reduction of trunk muscle endurance lead to muscle fatigue and increased pressure on the soft tissues and inactive structures of the spine<sup>31</sup>. Also, because the muscles endurance capacity indicates the fatigue of muscles, it is believed that people with less muscular strength in trunk muscles, are more prone to structural pressures, it may cause inappropriate pressure on the spine and chronic low back pain<sup>31,32</sup>.

### 6. Clinical Implications

The findings of this review indicate that stabilization exercises are a valuable component of conservative rehabilitation for lumbar disc herniation. Improvements in pain and disability suggest enhanced trunk muscle control and postural regulation. Clinicians may consider incorporating stabilization exercises as part of a structured rehabilitation program, particularly in individuals with persistent functional limitations.

### 7. Limitations of the Review

Included studies used varied durations, techniques, and frequency of stabilization exercises, limiting direct comparison and synthesis. Although the majority of studies were of moderate to high quality, a few scored lower on the PEDro scale, which may affect the reliability of their findings. Additionally, the limited number of studies evaluating long-term outcomes leaves gaps in understanding the sustained effects of lumbar stabilization exercises.

### 8. Future Research Directions

Given the variability in regimen types, intensity, and duration across studies, future trials should focus on establishing standardized lumbar stabilization protocols tailored for specific stages of disc herniation. Longitudinal studies are needed to evaluate sustained pain reduction, functional gains, and recurrence rates over time. Exploring how digital tools (e.g., wearable sensors, app-based rehabilitation platforms, EMG feedback systems) can enhance engagement, adherence, and precision in lumbar stabilization training.

### 9. Conclusion

Stabilization exercise-based rehabilitation appears to be an effective conservative intervention for reducing pain and disability and improving functional outcomes in individuals with lumbar disc herniation. These findings support the integration of stabilization exercises into routine rehabilitation practice. Further high-quality studies with standardized protocols are warranted.

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#### Declaration of Interest

The authors declare no conflict of interest.

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#### **Data availability statement**

Not applicable. All data analysed in this systematic review were obtained from previously published studies.

#### **Informed consent**

Not applicable. This study is a systematic review based on previously published literature and did not involve direct participation of human subjects.