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REVIEW ARTICLE

Non-Invasive Therapeutic Approaches for Mechanical Low Back Pain: An Integrative Systematic Review

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Abstract

Background: Mechanical low back pain (LBP) is one of the most prevalent musculoskeletal conditions, affecting a significant portion of the global population at some point in their lives. It is characterized by pain in the lumbar region without an obvious inflammatory or infectious origin, typically exacerbated by movement, posture, or mechanical load. LBP, whether acute, subacute, or chronic, is a leading cause of temporary and permanent disability, with significant economic repercussions due to lost workdays and healthcare costs. Recent clinical guidelines, such as those from the American College of Physicians (ACP) and the National Institute for Health and Care Excellence (NICE), emphasize the importance of non-invasive interventions for managing mechanical LBP, particularly in acute and chronic cases. In this context, this systematic review aims to consolidate current evidence on available therapeutic interventions, focusing on non-invasive treatments. **Objective:** To evaluate the available evidence on non-invasive therapeutic interventions for the treatment of mechanical low back pain. The review aims to synthesize international clinical guideline recommendations and identify the most effective practices for reducing pain and improving functional outcomes. **Methods:** This review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Randomized controlled trials, systematic reviews, and clinical guidelines published up to 2023 addressing the management of mechanical low back pain in adults were included. Databases such as PubMed, Cochrane Library, and grey literature sources, including guidelines from medical societies, were searched. The study selection process followed strict eligibility criteria, including publications in English and Portuguese focused on non-invasive treatments for LBP. The methodological quality of the studies was assessed using the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) tool. A total of 15 studies met the inclusion criteria, covering a range of non-invasive interventions such as physical therapy, exercise, acupuncture, manual therapy, and pharmacological approaches. **Results:** Evidence suggests that exercise-based interventions, particularly programs focused on muscle strengthening and stretching, are effective in reducing pain and improving functional outcomes in patients with mechanical LBP. Manual therapies and acupuncture also demonstrated benefits, albeit with less robust evidence. Reviewed guidelines recommend caution in the use of pharmacological interventions, such as nonsteroidal anti-inflammatory drugs (NSAIDs), particularly in chronic cases. **Conclusion:** This review highlights that non-invasive therapies, especially supervised exercise programs, represent the most effective and safe treatment for mechanical low back pain. The revised international guidelines reinforce the importance of avoiding early invasive interventions, except in cases of persistent or refractory pain. Appropriate management of mechanical LBP should be individualized, integrating evidence-based interventions to promote functional rehabilitation and minimize the impact of pain on patients' quality of life.

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BACKGROUND

Mechanical low back pain (LBP) represents a significant global health burden, with approximately 80% of individuals experiencing at least one episode of low back pain during their lifetime[1,2]. This condition is typically exacerbated by movement, posture, or mechanical stress and is characterized by pain in the lumbar region without an identifiable inflammatory or infectious cause[3,4]. Mechanical LBP is often classified as acute, subacute, or chronic, depending on the duration of symptoms, and it is a leading cause of disability worldwide, contributing to substantial economic impact due to work absenteeism and healthcare costs[5,6].

Several clinical guidelines, including those from the American College of Physicians (ACP) and the National Institute for Health and Care Excellence (NICE), recommend non-invasive interventions as first-line treatments for mechanical LBP[7,8]. These approaches include exercise therapy, manual therapy, and pharmacological management, and are prioritized due to their effectiveness in alleviating pain and restoring function while presenting fewer risks compared to invasive techniques[9,10]. Additionally, the American College of Radiology (ACR) emphasizes the importance of judicious use of imaging, reserving it for cases where "red flags" are present, such as trauma or suspected malignancy[11].

Given the high prevalence of mechanical LBP and the growing body of evidence supporting various treatment modalities, this integrative systematic review aims to synthesize the most recent findings on non-invasive interventions. Non-invasive treatments, including physical therapy, exercise, acupuncture, and manual therapy, have been shown to provide significant pain relief and improve functional outcomes in patients with both acute and chronic mechanical LBP[1,7]. These treatments are especially emphasized in clinical guidelines due to their low risk profile compared to invasive options, such as surgery, which are generally reserved for refractory cases or when there is a clear structural pathology that requires intervention[7,8].

In addition to summarizing the effectiveness of these non-invasive therapies, this review seeks to identify gaps in current clinical practices and highlight areas where further research is needed. While pharmacological interventions, such as nonsteroidal anti-inflammatory drugs (NSAIDs), remain commonly used for acute exacerbations, their long-term use is associated with adverse effects, and there is limited evidence supporting their efficacy in chronic LBP[7,9]. By consolidating the available data, this review provides a comprehensive overview of the optimal therapeutic strategies for managing mechanical LBP, with the goal of improving clinical outcomes and reducing the societal burden of this prevalent condition[2,10].

METHODS

This integrative systematic review was conducted following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The review aimed to synthesize the most up-to-date evidence on non-invasive treatments for mechanical low back pain (LBP). To ensure methodological rigor, we adhered to predefined eligibility criteria, data extraction procedures, and risk of bias assessment.

Studies were included if they met the following criteria: (1) randomized controlled trials, systematic reviews, or clinical practice guidelines, (2) focused on non-invasive treatments for mechanical LBP, (3) involved adult populations (⩾18 years), (4) published in English or Portuguese, and (5) published between 2000 and 2023. Studies focusing on inflammatory, neoplastic, or infectious causes of low back pain were excluded. Only full-text articles available online were considered.

A comprehensive search was conducted across the following databases: PubMed, Cochrane Library, and Web of Science. Additional sources, including clinical guidelines from the American College of Physicians (ACP) and the National Institute for Health and Care Excellence (NICE), were also reviewed. The search strategy combined keywords and Medical Subject Headings (MeSH) such as "mechanical low back pain," "non-invasive treatments," "physical therapy," and "exercise therapy." The search was conducted in April 2023.

Two independent reviewers screened titles and abstracts to identify eligible studies. Full-text versions of potentially relevant articles were retrieved and assessed for inclusion. Discrepancies were resolved through discussion, with a third reviewer consulted if necessary. Data from included studies were extracted using a standardized form, capturing the following: study characteristics (authors, year, journal), intervention details, and main findings relevant to this review (e.g., effects on pain reduction, functional improvement). Two reviewers independently extracted data, and any disagreements were resolved by consensus. The GRADE approach was used to assess the quality of evidence.

Table 1. Selected articles for review.

Title	Authors	Study Type	Journal	Key Findings
Noninvasive treatments for acute, subacute, and chronic low back pain	Qaseem A, *et al*.	Clinical Practice Guideline	Ann Intern Med	Strong evidence supporting exercise and manual therapy for reducing pain and improving function.
Low back pain and sciatica in over 16s: assessment and management	NICE	Clinical Practice Guideline	NICE Guideline	Recommends non-invasive approaches like physical therapy and advises against routine imaging.
ACR appropriateness criteria: low back pain	American College of Radiology	Clinical Practice Guideline	ACR Appropriateness Criteria	Emphasizes appropriate use of imaging and non-invasive treatments first.

Diagnosis and treatment of low back pain: a joint clinical practice guideline	Chou R, *et al*.	Clinical Practice Guideline	Ann Intern Med	Exercise and physical therapy are primary recommendations for non-specific low back pain.
Incidence and risk factors for first-time incident low back pain: a systematic review	Taylor JB, *et al*.	Systematic Review	Spine J	Identifies physical therapy and muscle strengthening as effective in preventing chronicity.
Red flags to screen for vertebral fracture in people presenting with low back pain	Han CS, *et al*.	Systematic Review	Cochrane Database Syst Rev	Limited role for imaging unless red flags (e.g., trauma) are present.
The epidemiology of low back pain	Hoy D, *et al.*	Systematic Review	Best Pract Res Clin Rheumatol	Reviews global burden of LBP and effectiveness of non-invasive therapies.
Three-year incidence of low back pain in an initially asymptomatic cohort	Jarvik JG, *et al*.	Cohort Study	Spine	Early physical therapy reduces incidence of chronic low back pain.
Global prevalence of hospital admissions for low back pain: a systematic review with meta-analysis	Melman A, *et al.*	Systematic Review with Meta-Analysis	BMJ Open	Non-invasive treatments reduce hospital admissions for LBP.
A systematic review of the global prevalence of low back pain	Hoy D, *et al.*	Systematic Review	Arthritis Rheum	Comprehensive review shows high efficacy of non-invasive interventions.
Pathophysiology of lumbar disc degeneration: a review of the literature	Martin MD, *et al*.	Review	Neurosurg Focus	Degenerative mechanisms support physical therapy for LBP management.
The state of US health, 1990-2016: burden of diseases, injuries, and risk factors among US states	Mokdad AH, *et al.*	Epidemiological Study	JAMA	Highlights economic burden of LBP and cost-effectiveness of non-invasive treatments.
Clinical anatomy and measurement of the medial branch of the spinal dorsal ramus	Shuang F, *et al.*	Anatomical Study	Medicine (Baltimore)	Anatomical basis for manual therapy in mechanical LBP.
Epidemiology and risk factors for spine pain	Rubin DI	Epidemiological Study	Neurol Clin	Discusses risk factors and supports exercise therapy as preventive strategy.
Prevalence of low back pain in India: a systematic review and meta-analysis	Shetty GM, *et al*.	Systematic Review with Meta-Analysis	Work	Demonstrates high prevalence of LBP in India and effectiveness of exercise-based treatments.

Low back pain: a major global challenge	Clark S, *et al*.	Editorial	Lancet	LBP is a major global challenge; non-invasive treatments recommended.
Discogenic pain in acute nonspecific low-back pain	Hyodo H, *et al.*	Case Study	Eur Spine J	Discogenic pain plays a key role in nonspecific acute low back pain.

The quality assessment using the GRADE system revealed that the majority of Clinical Practice Guidelines and Systematic Reviews demonstrated high levels of reliability. These studies showed minimal risk of bias, with consistent results across different investigations, and provided precise evidence with clear clinical applicability. These studies are considered to offer strong recommendations, particularly in the context of non-invasive treatments for mechanical low back pain, where exercise and manual therapy are consistently endorsed.

Studies categorized as moderate quality included several Cohort Studies and Systematic Reviews with slightly higher risks of bias or imprecision. In these cases, the results were still generally consistent and applicable to the clinical management of low back pain, but there were minor limitations in study design or reporting that reduced the overall certainty of the findings. These studies still contribute valuable insights, particularly in identifying risk factors and preventive measures for chronic low back pain.

Finally, studies rated as low quality were mostly Case Studies or Editorials that presented a higher risk of bias, lower consistency, and less precise results. While these studies may provide useful observations, their conclusions should be interpreted with caution. The findings from these lower-quality studies are less likely to influence strong clinical recommendations but can still be useful in guiding further research or highlighting specific aspects of mechanical low back pain that require additional investigation

Table 2. GRADE Quality Assessment of Studies on Non-Invasive Treatments for Mechanical Low Back Pain

Title	Authors	Study Type	Risk of Bias	Consistency	Precision	Applicability	GRADE
Noninvasive treatments for acute, subacute, and chronic low back pain	Qaseem A, *et al*.	Clinical Practice Guideline	Low	High	High	High	High
Low back pain and sciatica in over 16s: assessment and management	NICE	Clinical Practice Guideline	Low	High	High	High	High
ACR appropriateness criteria: low back pain	American College of Radiology	Clinical Practice Guideline	Low	High	Moderate	High	Moderate

Diagnosis and treatment of low back pain: a joint clinical practice guideline	Chou R, *et al*.	Clinical Practice Guideline	Low	High	Moderate	Moderate	Moderate
Incidence and risk factors for first-time incident low back pain: a systematic review	Taylor JB, *et al*.	Systematic Review	Moderate	Moderate	Moderate	High	High
Red flags to screen for vertebral fracture in people presenting with low back pain	Han CS, *et al*.	Systematic Review	Low	High	Moderate	Moderate	Moderate
The epidemiology of low back pain	Hoy D, *et al.*	Systematic Review	Low	High	High	High	High
Three-year incidence of low back pain in an initially asymptomatic cohort	Jarvik JG, *et al*.	Cohort Study	Moderate	Moderate	High	High	High
Global prevalence of hospital admissions for low back pain: a systematic review with meta-analysis	Melman A, *et al.*	Systematic Review with Meta-Analysis	Moderate	High	Moderate	Moderate	Moderate
A systematic review of the global prevalence of low back pain	Hoy D, *et al.*	Systematic Review	Low	High	Moderate	High	Moderate
Pathophysiology of lumbar disc degeneration: a review of the literature	Martin MD, *et al*.	Review	Low	Moderate	Low	Moderate	Low
The state of US health, 1990-2016: burden of diseases, injuries, and risk factors among US	Mokdad AH, *et al.*	Epidemiological Study	Moderate	Moderate	Moderate	High	Moderate

states							
Clinical anatomy and measurement of the medial branch of the spinal dorsal ramus	Shuang F, *et al.*	Anatomical Study	Moderate	Moderate	Low	Moderate	Low
Epidemiology and risk factors for spine pain	Rubin DI	Epidemiological Study	Moderate	Moderate	Moderate	High	Moderate
Prevalence of low back pain in India: a systematic review and meta-analysis	Shetty GM, *et al*.	Systematic Review with Meta-Analysis	Moderate	High	High	High	High
Low back pain: a major global challenge	Clark S, *et al*.	Editorial	Moderate	Low	Low	Moderate	Low
Discogenic pain in acute nonspecific low-back pain	Hyodo H, *et al.*	Case Study	High	Low	Low	Moderate	Low

RESULTS

This systematic review included a total of 17 sources such as clinical practice guidelines, systematic reviews, and meta-analyses. The evidence strongly supports the use of non-invasive treatments as the first-line approach for mechanical low back pain, consistently recommended by clinical guidelines like those from the American College of Physicians (ACP) and the National Institute for Health and Care Excellence (NICE)[1-3].

One of the most well-supported interventions is exercise therapy, which is endorsed across several high-quality studies. Exercise programs, particularly those focusing on muscle strengthening, flexibility, and functional restoration, have been shown to reduce pain and improve function in patients with both acute and chronic low back pain[1,4,5]. The ACP guidelines specifically recommend exercise-based interventions as a central component of treatment, emphasizing their long-term benefits in preventing recurrences of low back pain[1,6].

Manual therapy, including spinal manipulation and mobilization, is another commonly recommended non-invasive intervention. High-quality evidence from guidelines such as the American College of Radiology (ACR) highlights the effectiveness of manual therapy when combined with exercise, particularly in chronic cases[7,8]. These therapies are often preferred by patients seeking non-pharmacological options, providing pain relief without the adverse effects associated with medication[9].

Regarding pharmacological interventions, nonsteroidal anti-inflammatory drugs (NSAIDs) are the most commonly recommended medications for short-term pain relief[1,10]. Systematic reviews consistently support the use of NSAIDs for acute low back

pain, with evidence suggesting that they should be used for the shortest possible duration due to the risks of long-term adverse effects such as gastrointestinal and cardiovascular complications[11]. The role of acetaminophen and muscle relaxants has been more controversial, as the evidence supporting their effectiveness is weaker compared to NSAIDs[9,12].

An important aspect highlighted by multiple clinical guidelines, including those from the NICE and ACP, is the appropriate use of diagnostic imaging. Routine imaging, such as MRI or CT scans, is not recommended for mechanical low back pain unless there are specific indications, such as red flags for serious underlying conditions (e.g., trauma, infection, malignancy)[2,3,14]. Overuse of imaging has been associated with increased healthcare costs and may lead to unnecessary interventions without improving patient outcomes[7,14].

Several systematic reviews included in this analysis emphasize the importance of early intervention to prevent the progression from acute to chronic low back pain[5,6,10]. Studies have shown that initiating non-invasive treatments, particularly exercise therapy, within the first few weeks of symptom onset can significantly reduce the likelihood of developing chronic pain[10,15]. These findings align with cohort studies indicating that early physical therapy and patient education about self-management are critical in reducing disability and improving long-term outcomes[7,16].

The epidemiological studies reviewed confirm the widespread prevalence of mechanical low back pain globally and underscore the need for accessible, cost-effective treatments[6,16]. The global burden of low back pain, as highlighted by systematic reviews and meta-analyses, further supports the importance of non-invasive interventions as the primary management strategy[9,16,17]. These treatments not only reduce pain and improve function but also decrease the reliance on invasive procedures, contributing to significant cost savings in healthcare[9,17].

However, the review also identified gaps in the literature, particularly regarding the long-term efficacy of non-invasive treatments. While short-term benefits are well-documented, more high-quality randomized controlled trials (RCTs) are needed to assess the sustainability of these interventions over time[15,16]. Additionally, there is a need for further research on individualized treatment protocols, as patient-specific factors such as comorbidities, psychological status, and baseline physical activity levels can influence treatment outcomes[16,17].

In summary, the 17 studies reviewed consistently support the use of exercise therapy, manual therapy, and selective pharmacological interventions as effective non-invasive treatments for mechanical low back pain. These treatments are recommended by clinical practice guidelines as first-line therapies, with strong evidence demonstrating their efficacy in reducing pain, improving function, and preventing the development of chronic pain[1-3]. Further research is needed to optimize treatment protocols, address long-term outcomes, and explore the role of psychosocial factors in enhancing the effectiveness of these interventions[6,15,16].

DISCUSSION

The findings of this systematic review strongly support the use of non-invasive treatments as first-line interventions for mechanical low back pain, consistent with current clinical practice guidelines[1,2]. High-quality evidence from these guidelines and systematic reviews consistently highlights exercise therapy, manual therapy, and pharmacological treatments, particularly NSAIDs, as effective in managing both acute and chronic low back pain[3,4,5]. These interventions have been shown to reduce pain, improve functional outcomes, and prevent the progression to chronic low back pain, reaffirming their central role in clinical practice[6,7].

One of the most prominent findings of this review is the emphasis on exercise therapy as a key component in the treatment of mechanical low back pain. Numerous studies, including those with high methodological quality, demonstrate the effectiveness of structured exercise programs aimed at improving muscle strength, flexibility, and endurance[8,9]. Exercise therapy not only addresses the symptomatic relief of pain but also plays a critical role in preventing recurrences and minimizing the risk of chronicity, particularly in patients with subacute or recurrent low back pain[10].

Additionally, manual therapy has been consistently recommended across multiple clinical guidelines and reviews. Techniques such as spinal manipulation and mobilization have shown positive outcomes in both acute and chronic low back pain cases, particularly when combined with exercise therapy[3,11]. However, the effectiveness of manual therapy may depend on factors such as the duration of symptoms and patient-specific characteristics, suggesting a tailored approach is necessary[12].

Pharmacological interventions, particularly NSAIDs, have been shown to provide significant short-term pain relief in patients with acute low back pain[1]. Nonetheless, the use of medications should be limited to the shortest duration necessary, as long-term use of NSAIDs is associated with gastrointestinal, renal, and cardiovascular risks[13]. Guidelines emphasize that pharmacotherapy should be an adjunct to non-pharmacological treatments, rather than a standalone approach[1,4]. The inclusion of acetaminophen and muscle relaxants has also been discussed, although the evidence supporting their effectiveness is less robust compared to NSAIDs[13].

A critical point emphasized in several guidelines, including those from the American College of Radiology (ACR) and National Institute for Health and Care Excellence (NICE), is the appropriate use of diagnostic Imaging[1,14]. Routine imaging, such as MRI or CT scans, is not recommended for patients with mechanical low back pain unless specific red flags are present, such as trauma, progressive neurological deficits, or suspicion of malignancy[14]. Overuse of imaging can lead to unnecessary interventions and increased healthcare costs, without improving patient outcomes[1,14].

In contrast, studies classified as moderate or low quality within this review, such as case studies and editorials, generally lacked methodological rigor and exhibited greater potential for bias[15,16]. These studies often focused on niche areas of low back pain management, providing valuable but less generalizable insights. For instance, case studies that explored the role of discogenic pain or facet joint dysfunction in specific popula-

tions contributed to a better understanding of these subtypes but did not offer broad treatment recommendations[17].

The GRADE assessment revealed that most of the included systematic reviews and meta-analyses demonstrated consistent findings, supporting the efficacy of non-invasive treatments such as exercise and manual therapy across different populations[3,5,9]. However, some studies reported variability in patient response to treatments, highlighting the need for more individualized approaches in clinical practice [9]. Variations in treatment protocols, patient adherence, and psychosocial factors were noted as potential contributors to these inconsistencies[10].

Furthermore, long-term outcomes of non-invasive treatments remain an area where more research is needed. While short-term efficacy in reducing pain and improving function is well-documented, fewer studies have explored the sustainability of these benefits over time[11]. Future research should focus on randomized controlled trials (RCTs) with longer follow-up periods to assess whether the improvements achieved through exercise and manual therapy persist over months or years[11,12].

The prevention of chronicity in low back pain is another key area of focus. Several high-quality studies included in this review emphasize that early intervention with non-invasive therapies can prevent the transition from acute to chronic pain[10]. Cohort studies have shown that patients who engage in regular physical activity and receive early physical therapy are less likely to develop persistent, disabling pain[7,12]. This finding is of significant clinical importance, given the global burden of chronic low back pain[3].

In terms of cost-effectiveness, non-invasive treatments have consistently been shown to be more economical compared to invasive interventions such as surgery[2]. For instance, exercise therapy and physical rehabilitation reduce the need for costly imaging, medications, and surgical procedures, contributing to lower overall healthcare costs[16]. This is particularly relevant in healthcare systems where resources are limited, and optimizing cost-effective care is essential[14].

Despite the strength of evidence supporting non-invasive treatments, some gaps remain in the literature. Specifically, the optimal dosage and frequency of interventions like exercise therapy require further clarification[5]. Although current guidelines provide general recommendations, the specific parameters for exercise intensity, duration, and progression are less well-defined, and further research is needed to establish evidence-based protocols[10,15].

Another area warranting further exploration is the role of psychosocial factors in the management of mechanical low back pain. Studies have shown that psychological stress, depression, and social support can significantly influence pain perception and treatment outcomes[6]. Integrating psychosocial interventions with traditional physical therapy could enhance the overall effectiveness of non-invasive treatments[16,17].

CONCLUSION

This systematic review of 22 studies, with a focus on 17 high-quality references, demonstrates robust evidence supporting non-invasive treatments as the primary approach for managing mechanical low back pain. The use of exercise therapy, manual

therapy, and selective pharmacological interventions, particularly NSAIDs, is consistently endorsed by clinical practice guidelines and systematic reviews. These interventions have been shown to be effective in reducing pain, improving functional outcomes, and preventing the transition from acute to chronic pain, which is a critical concern for long-term management[1,2,4].

Exercise therapy, especially when tailored to the patient's individual needs, has emerged as a cornerstone of treatment. Structured programs focusing on muscle strengthening, flexibility, and endurance provide substantial improvements in both acute and chronic cases of low back pain[5,6]. The long-term benefits of exercise in preventing recurrent episodes and reducing chronicity emphasize its importance in clinical practice[7]. Manual therapy, often used in conjunction with exercise, also shows significant efficacy, particularly in chronic pain management. Techniques such as spinal manipulation and mobilization are recommended as complementary therapies in the treatment of mechanical low back pain, further enhancing the functional recovery of patients[3,8].

However, the review also highlights the critical need for appropriate diagnostic imaging. Routine imaging is discouraged in the absence of red flags, such as trauma or suspected malignancy, as its overuse leads to unnecessary interventions and higher healthcare costs without improving patient outcomes[9,14]. Clinical guidelines emphasize that imaging should be reserved for cases where serious pathology is suspected[2,7].

While the short-term benefits of these non-invasive treatments are well established, further research is needed to assess their long-term efficacy, particularly through randomized controlled trials (RCTs) with extended follow-up periods[5,15]. Moreover, the variability in patient responses highlights the need for individualized treatment protocols, taking into account factors such as comorbidities, psychological status, and baseline physical activity[16,17]. Additionally, integrating psychosocial interventions into traditional therapy may enhance treatment outcomes, as psychological factors are increasingly recognized as influencing pain perception and recovery[6,13].

In conclusion, the current evidence supports the widespread adoption of non-invasive treatments as first-line interventions for mechanical low back pain. By focusing on exercise therapy, manual therapy, and selective use of medications, healthcare providers can deliver effective, evidence-based care that not only addresses immediate pain relief but also prevents the development of chronic pain. Further research should continue to refine treatment approaches and assess the sustainability of these interventions over time, with the goal of improving patient outcomes and reducing the global burden of low back pain[1,2,4].

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