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Exercise Therapy in the Management of Chronic Low Back Pain: Current Evidence and Practical Implications – A Narrative Review

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Abstract

Background: Chronic low back pain (CLBP) is a multifactorial condition influenced by physical, psychological and social factors. Exercise therapy is a core element of conservative management, yet it encompasses highly heterogeneous interventions differing in type, dose, delivery and patient populations.

Aim: The aim of this narrative review is to summarize current evidence on the effectiveness and safety of exercise therapy for CLBP, with particular attention to different exercise modalities, optimal dose parameters, individualization, special populations, delivery methods and practical clinical implications.

Material and methods: A narrative review of the literature was conducted primarily through PubMed and completed in August 2026. The search was limited to studies published in the preceding five years involving adult participants with chronic low back pain. Systematic reviews, meta-analyses, randomized controlled trials and other relevant peer-reviewed publications addressing exercise-based interventions were included on the basis of relevance to the review objectives.

Results: Exercise therapy produces a clinically important reduction in pain intensity (approximately 15 points on a 0–100 scale) and a smaller improvement in functional disability compared with no treatment, usual care or placebo (moderate-certainty evidence). No single exercise modality has demonstrated consistent superiority. Regular participation (approximately 15–30 minutes per session, three times per week, programmes lasting at least 16 weeks) appears favourable. Benefits are most evident versus inactive controls and diminish when exercise is compared with other active conservative treatments. Adherence, individualization and continued physical activity beyond the supervised period are key determinants of outcome. Exercise is generally safe, with mild, transient musculoskeletal symptoms being the most common adverse effects. Evidence supports its use across older adults and selected more complex presentations, as well as via supervised, home-based and digital delivery modes.

Conclusions: Exercise therapy is an effective, adaptable and safe non-pharmacological intervention for CLBP. Clinical outcomes depend less on the specific modality chosen than on adequate dose, sustained adherence and a patient-centred approach that integrates individual preferences, functional goals and, when indicated, psychological strategies.

Key words: chronic low back pain, exercise therapy, physical activity, rehabilitation, narrative review

1. Introduction

Chronic low back pain (CLBP) is a complex condition characterized by persistent pain and limitations in physical functioning. Its development and persistence are influenced by the interaction of physical, psychological, and social factors, highlighting the need for diverse and individually tailored treatment approaches, among which exercise therapy plays an important role [1, 2].

Exercise therapy encompasses a broad range of interventions, including motor control exercises, strengthening and resistance training, aerobic and aquatic exercises, Pilates, yoga, and other forms of therapeutic exercise [2, 3, 4]. Exercise programs may also vary in terms of duration, frequency, intensity, and the overall intervention period [5, 6]. This diversity makes exercise therapy a broad and heterogeneous area of rehabilitation, in which the appropriate selection of an exercise program is an important aspect of clinical practice.

The aim of this narrative review is to summarize the current evidence regarding the effectiveness and safety of exercise therapy for CLBP, with consideration of different exercise modalities, patient populations, and modes of delivery. The review also discusses factors relevant to clinical practice, including individualization of exercise programmes, adherence, progression, and patient education.

2. Research materials and methods

This study was conducted as a narrative review of the current literature on exercise therapy in the management of chronic low back pain (CLBP). A literature search was conducted primarily through the PubMed database and was completed in August 2026. The search was limited to studies published within the five years preceding the search date and involving adult human participants with chronic low back pain. The review included systematic reviews, meta-analyses, randomized controlled trials, and other relevant peer-reviewed studies addressing exercise-based interventions for CLBP, including different exercise modalities, methods of exercise delivery, and selected patient populations. Publications were selected based on their relevance to the objectives and scope of the review.

3. Results

3.1. Practical implications for exercise therapy

Systematic reviews and meta-analyses support exercise therapy as a core component of conservative management of chronic low back pain (CLBP). Overall, exercise is associated with improvements in pain and physical function compared with no or minimal intervention. The magnitude of these effects is generally modest [7]. Therefore, exercise should be

considered an effective component of CLBP management, while expectations regarding complete symptom resolution should remain realistic.

Current evidence does not indicate that a single exercise approach is universally superior for patients with CLBP. Comparisons between different exercise modalities have generally shown similar, relatively small benefits. Substantial heterogeneity is observed in the available evidence [2]. Exercise prescription should be guided by the individual patient's clinical characteristics, functional capacity, preferences, and ability to engage in the programme. The training plan should be adapted to the patient's initial physical capacity and functional limitations and modified according to symptom response and progress over time, rather than following a rigid protocol. Clinicians should aim to provide an appropriate level of physical challenge while maintaining the patient's ability to participate consistently.

Adherence is therefore an important factor in the effectiveness of exercise therapy. Exercise programmes that are acceptable, accessible, and compatible with the patient's preferences and daily routine are more likely to be maintained over time. Patient education may further support adherence by improving understanding of the role of physical activity. Exercise can consequently be considered not only as a therapeutic intervention but also as a means of promoting long-term self-management.

Exercise delivery can also be adapted to individual needs and circumstances. Supervised exercise can provide support with exercise selection, technique, progression, and reassurance, particularly during the initial stages of rehabilitation. The longer-term goal should generally be to promote patient independence and the integration of physical activity into everyday life. Home-based and remotely supported programmes may therefore complement supervised rehabilitation when appropriate [8, 9].

3.2. Overall effectiveness versus no treatment

Available systematic reviews and meta-analyses consistently support the effectiveness of exercise therapy over no treatment, usual care, or placebo for reducing pain in adults with CLBP. The strongest evidence comes from the 2021 Cochrane review by Hayden et al. It included 249 randomized controlled trials and 24,486 participants. Compared with no treatment, usual care, or placebo, exercise therapy produced a clinically important reduction in pain intensity at the earliest follow-up, with moderate-certainty evidence. The pooled effect was approximately 15 points on a 0–100 scale (MD −15.2, 95% CI −18.3 to −12.2), corresponding to the prespecified threshold for a clinically important difference [7]. These

findings indicate that the benefits of exercise extend beyond a purely statistical improvement and are likely to be perceptible to patients in everyday clinical practice.

The effect on functional disability appears to be more modest. In the same Cochrane review, exercise resulted in an average improvement of 6.8 points on a 0–100 scale compared with no treatment, usual care, or placebo (MD −6.8, 95% CI −8.3 to −5.3). Although this effect was statistically meaningful and supported by moderate-certainty evidence, it did not reach the prespecified 10-point threshold for a minimal clinically important difference [7]. This distinction is clinically relevant because improvement in pain intensity does not necessarily translate into a proportionally significant improvement in functional limitations. Exercise may therefore be best understood as an intervention that provides a meaningful reduction in pain. While producing smaller, although potentially still relevant, improvements in disability and physical function.

The effect size also appears to depend on the comparator and the timing of outcome assessment. The benefits of exercise are most clearly demonstrated when exercise is compared with interventions involving little or no active treatment. When exercise is compared with other active conservative interventions, the differences become substantially smaller. In the Cochrane review, exercise was associated with a mean decrease of approximately 9 points in pain and 4 points in functional limitations compared with other conservative treatments. Neither of which reached the predefined threshold for a clinically important difference [7]. Subgroup analyses suggested that exercise may be more effective than education or advice alone, and some non-exercise physical therapy interventions. No clear difference was observed when exercise was compared with manual therapy [7]. Thus, the available evidence supports exercise as an effective component of conservative care, but does not suggest that exercise necessarily provides a large additional benefit over every other active treatment.

3.3. Comparison of specific exercise modalities

This observation is also supported by network meta-analytic evidence examining different exercise prescription characteristics. A 2025 network meta-analysis found significant benefits across various exercise durations and frequencies compared with control conditions, with particularly favorable rankings for interventions involving approximately 15–30 minutes per session, three sessions per week, and programmes lasting at least 16 weeks [6]. Tai Chi received the highest ranking among the exercise modalities investigated in that analysis. However, the authors emphasized the limited number of studies and the predominance of Asian populations;

therefore, these findings should be interpreted cautiously [6]. Rather than establishing a universal optimal exercise prescription, these results suggest that regularity, sufficient exercise exposure, and sustained participation may be important factors influencing treatment response. The duration of treatment effects is another important consideration. Exercise appears to have its clearest effects during the short-term treatment period, particularly within the first several weeks to approximately three months. This pattern is consistent with the findings of the Cochrane review and the broader literature, in which improvements in pain and disability are commonly assessed at the end of the active intervention period [2,7]. However, the persistence of these improvements over longer follow-up periods is less consistent. Because exercise is a behavioural intervention that requires continued participation, long-term outcomes may depend partly on whether patients maintain an adequate level of physical activity after the structured treatment period has ended. Exercise should therefore not be viewed solely as a time-limited therapeutic procedure, but rather as a strategy for establishing sustainable physical activity and self-management behaviours.

The importance of continued participation is further supported by evidence examining exercise adherence. A recent analysis of exercise adherence in adults with chronic non-specific low back pain found that higher adherence was associated with greater improvements in pain intensity and functional limitations [10]. Although the certainty of this evidence was limited, these findings suggest that adherence may be an important factor contributing to treatment outcomes and may partly explain why effects observed under controlled trial conditions do not always persist after structured supervision ends. Exercise programmes that are excessively demanding, difficult to integrate into daily life, or poorly matched to patient preferences may result in lower long-term adherence despite potentially favourable physiological effects.

The lack of consistent evidence for the superiority of a single exercise modality has important practical implications. Different forms of exercise, including Pilates, yoga, resistance training, motor control exercise, aerobic exercise, walking, and other active approaches, may all provide clinically relevant benefits when appropriately prescribed [2]. Clinicians can therefore select an intervention according to patient characteristics, preferences, functional goals, and available resources rather than relying exclusively on the presumed superiority of a specific modality. Patient preference may be particularly important because an exercise programme that is perceived as acceptable, achievable, and compatible with everyday life is more likely to be maintained over time.

At the same time, findings from individual network meta-analyses may identify relative differences between exercise modalities. In the network meta-analysis by Hayden et al., all investigated exercise types were effective for improving pain and disability, with the exceptions of stretching exercises for pain and the McKenzie method for disability. Pilates showed the largest effects for both pain and disability in the analysed network, while mind-body and core-based exercises showed relatively favourable effects for pain, and strength and core-based exercises showed relatively favourable effects for disability. [4]. These findings indicate differences in relative treatment effects within the analysed network, but they should not be interpreted as establishing the universal superiority of Pilates or any other modality for all patients with CLBP. Differences in study populations, intervention characteristics, comparators, and the indirect nature of some network comparisons should be considered when interpreting these results.

A randomized controlled trial comparing dynamic neuromuscular stabilization (DNS) with conventional core exercises further highlights the distinction between exercise modalities [11]. While both interventions led to significant, time-dependent improvements in pain intensity and disability, no significant between-group differences emerged for VAS, Oswestry Disability Index, or Roland-Morris Disability Questionnaire scores. However, DNS achieved superior enhancements in core muscle contractility and standing postural control. These findings suggest that distinct exercise modalities may induce unique physiological and functional adaptations without necessarily yielding divergent pain or disability outcomes.

Similarly, a trial comparing an eight-week, twice-weekly aquatic physiotherapy program with land-based therapeutic exercise demonstrated how modality-specific benefits can vary [12]. Both groups demonstrated improvements in selected parameters, though between-group differences were largely restricted to pain intensity and social role functioning. While the aquatic group exhibited notable within-group gains in pain, overall function, and general health status, between-group differences across most secondary outcomes remained non-significant. Given the small sample size and participant attrition, these results should be interpreted with caution and do not demonstrate a clear superiority of aquatic therapy over land-based exercise. Subsequent reviews have broadly supported the view that exercise modality alone does not fully determine treatment effectiveness. A systematic review of systematic reviews evaluating nine exercise categories—including aerobic exercise, aquatic exercise, motor control exercise, resistance training, Pilates, sling exercise, traditional Chinese exercise, walking, and yoga—found mainly small benefits for pain and disability compared with no or minimal intervention

[2]. Importantly, the review did not identify major differences in effectiveness between the different exercise types. The certainty of evidence ranged from very low to moderate, reflecting substantial heterogeneity between studies and methodological limitations of many of the underlying systematic reviews [2]. These findings suggest that the beneficial effects of exercise in CLBP are unlikely to depend exclusively on the selection of a particular exercise modality.

The overall magnitude of benefit should also be communicated realistically to patients. Exercise should not be presented as a treatment that reliably eliminates pain or restores normal function in every individual with CLBP. Rather, the evidence indicates a moderate and clinically meaningful effect on pain, accompanied by smaller improvements in functional disability [7]. Setting realistic expectations may help support treatment engagement and long-term adherence. Patients may also experience benefits that are not fully captured by pain and disability scales, including greater confidence in movement, improved physical capacity, increased participation in daily activities, and reduced reliance on passive forms of treatment. Nevertheless, these potential benefits should be considered complementary to, rather than substitutes for, the established outcomes reported in clinical trials.

Overall, the available evidence supports exercise therapy as an effective non-pharmacological intervention for CLBP when compared with no treatment, usual care, or placebo. The most robust evidence indicates a clinically meaningful reduction in pain, while improvements in functional disability are statistically significant but generally smaller and less likely to reach established thresholds for clinical importance [7]. Evidence from systematic reviews suggests that these benefits are not restricted to a single exercise modality, although the certainty of evidence varies considerably between modalities [2]. Network meta-analytic findings may indicate relative differences between specific exercise approaches, such as the favourable effects observed for Pilates in our analysis; however, these findings should be interpreted within the context of the specific evidence network rather than as evidence of universal superiority. The practical effectiveness of exercise is likely to depend not only on the characteristics of the intervention but also on exercise dose, adherence, patient preferences, and continuation of physical activity over time [6,10]. Exercise should therefore be considered a central component of CLBP management, with the choice and progression of the programme individualized to support sustained participation and clinically meaningful improvement.

3.4. Optimal dose, frequency and duration of exercise programs

Despite the well-established role of exercise in the management of chronic low back pain (CLBP), the optimal dose of physical activity remains undefined. Systematic reviews generally report small to moderate improvements in pain and functional limitations following exercise therapy compared with no treatment, usual care, or placebo [7]. However, there is significant variation regarding the type, intensity, frequency, and duration of the exercises [7]. Consequently, available data do not currently allow for the determination of a single, universal, and optimal exercise regimen for all patients.

Available evidence suggests that regular Pilates, strength training, core-strengthening exercises, and mind-body exercises can be effective. Improvements have been reported in programmes involving at least 1–2 sessions per week lasting less than 60 minutes, with intervention durations (e.g., for Pilates or core exercises) ranging from approximately 3 to 9 weeks. A recent network meta-analysis found that sessions lasting 15–30 minutes were associated with significant pain reduction and achieved the highest SUCRA score among the analyzed session duration categories [6]. These findings should be interpreted with caution due to the limited number of studies and significant data heterogeneity.

Exercise frequency may also influence treatment outcomes. In the same network meta-analysis identified three sessions per week as the top-ranked option (with a SUCRA score of 87%) [6]. This finding, however, does not establish three weekly sessions as a universally optimal frequency. The wider body of evidence does not demonstrate a consistent advantage of this frequency over programmes involving fewer or more sessions per week. Differences in outcomes may instead reflect the combined influence of total training volume, exercise intensity, adherence, and the degree of professional supervision [5, 7].

The duration of the program may also influence outcomes. A network meta-analysis rated programs lasting at least 16 weeks most highly, as they were associated with greater improvements than 6- or 12-week programs [6]. However, this does not imply that shorter programs are ineffective or that all patients require 16 weeks of supervised therapy. Rather, it supports the continuation of regular physical activity beyond the initial rehabilitation period [13]. Likewise, evidence regarding specific types of exercise also supports an individualized approach. Yoga provides small improvements in pain and function compared with no exercise, but does not appear to differ significantly from other back-focused exercises in terms of functional outcomes. Network meta-analysis published in JOSPT reported beneficial effects of Pilates, resistance training, core stabilization exercises, and mind-body exercises on pain and

functional limitations [5]. At present, there is insufficient evidence to establish a clear and consistent advantage of one modality over the others. The choice of exercise may therefore be guided not only by its potential therapeutic effects but also by the patient's preferences, physical abilities, symptoms, and likelihood of maintaining the program over time.

In clinical practice, a reasonable starting point may be a 15–30 minute exercise session performed approximately three times a week, with a gradual increase in training volume, intensity, and complexity according to symptom tolerance and functional goals. An initial period of approximately 8–12 weeks can help establish a regular exercise habit and allow assessment of the clinical response. If beneficial and well-tolerated, the program may be continued for 16 weeks or longer with further adjustments made according to the patient's needs.

In summary, current evidence does not indicate a single, optimal exercise dosage for all individuals with chronic low back pain (CLBP). Exercise duration, frequency, and program length should be regarded as flexible, evidence-based ranges rather than rigid limits. They should be tailored to the individual's symptoms, physical capacity, preferences, adherence, comorbidities, and functional goals.

3.5. Effects according to specific outcomes

The effects of exercise therapy for chronic low back pain (CLBP) vary depending on the outcome assessed. The most consistent evidence relates to reductions in pain intensity and functional limitations, whereas data regarding health-related quality of life and psychosocial outcomes are less well established. Evidence concerning the prevention of recurrent episodes is also considerably less developed than that relating to symptom relief.

Pain

Pain reduction is one of the most consistently reported benefits of exercise therapy in individuals with CLBP. A Cochrane review by Hayden et al., which included 249 studies, provided moderate-certainty evidence that exercise is more effective than no treatment, usual care, or placebo in reducing pain; the mean difference was −15.2 points on a 0–100 scale [7]. Compared with other conservative treatments, exercise also produced improvements in pain (MD −9.1 points) and functional limitations (MD −4.1 points). However, although these differences were statistically significant, they did not reach the prespecified threshold for a

clinically important effect. The certainty of the evidence was also affected by substantial heterogeneity between the interventions included in the review.

Results from network meta-analyses suggest that various types of exercise can reduce pain, although no single type has demonstrated a clear, universal advantage. Hayden et al. observed beneficial effects across several exercise categories [4]. However, a broader systematic review of systematic reviews by Grooten et al. found that motor control exercises, Pilates, resistance training, traditional Chinese exercises, and yoga were generally associated with small, short-term improvements in pain compared with no or minimal intervention. Importantly, the review did not identify significant differences in effectiveness between the different exercise types [2]. Findings from individual randomized controlled trials are broadly consistent with these results. For example, a 10-week tailored Pilates programme performed twice weekly improved pain and functional outcomes in older women with chronic non-specific low back pain, with benefits observed at follow-up [14]. In another randomized trial, a six-week Pilates programme performed twice weekly was compared with home-based exercise and resulted in greater improvements in some outcomes, although the between-group differences should be interpreted in relation to clinical relevance [15].

In conclusion, exercise therapy should therefore be considered an effective method for reducing pain in chronic low back pain (CLBP), although the expected magnitude of improvement is generally modest and may vary according to the comparator, exercise characteristics, adherence, and patient population.

Disability and functional limitations

Improvement in disability is another important outcome of exercise therapy. A Cochrane review found moderate-certainty evidence that exercise reduces functional limitations compared with no treatment (MD −6.8/100); however, this difference did not reach the threshold for the minimal clinically important difference established in the review [7]. This distinction is important because a statistically significant improvement in disability does not necessarily translate into a clinically meaningful change for individual patients.

Evidence from studies investigating specific interventions further supports the beneficial effects of exercise on functional outcomes. In a study comparing Pilates with home-based exercise, Pilates resulted in significantly greater improvements in disability immediately after the intervention and at follow-up, although the magnitude of the between-group difference should be interpreted in relation to its clinical relevance [15]. Similarly, a systematic review and meta-

analysis indicated that isolated lumbar extension strength training can improve disability and physical function in adults with non-specific low back pain [16]. Furthermore, a recent systematic review with meta-analysis and meta-regression found a small long-term benefit of exercise therapy over manual therapy for disability. However, the between-group difference was considered not clinically relevant [17]. Exercise may also be incorporated into broader multimodal rehabilitation programmes. For example, a randomized controlled trial found that exercise combined with manual therapy produced greater improvements in disability than exercise alone or exercise combined with kinesiotaping, with clinically meaningful improvements in disability observed in the combined exercise and manual therapy group [18]. However, the small sample size and the specific treatment protocols used in the study should be considered when interpreting these findings.

Overall, exercise therapy has been shown to reduce functional limitations, although the average effect is generally small to moderate. Clinically meaningful improvements may be more likely when exercise is combined with progressive functional activity and tailored to the patient's individual limitations, capabilities, and functional goals.

Health-related quality of life

Although physical activity may improve quality of life, this outcome has been studied less consistently than pain and disability. A randomized clinical trial by Peng et al. compared therapeutic aquatic exercise with physical therapy modalities and reported improvements in pain, physical function, health-related quality of life, sleep quality, and mental health in the aquatic exercise group [3]. These findings suggest that aquatic exercise may provide benefits extending beyond pain intensity alone.

Similar findings have been reported for Pilates. Tottoli et al. found that a six-week Pilates programme resulted in greater improvements in health-related quality of life compared with home-based exercise, with some benefits persisting at follow-up [15]. Importantly, the effects differed according to the outcome and follow-up period, illustrating the importance of considering both statistical and clinical significance.

Overall, exercise may influence health-related quality of life through mechanisms extending beyond pain reduction, including improvements in physical function and sleep quality, greater confidence in movement, and increased participation in daily activities. However, substantial variation in the quality-of-life measures used and the types of exercise interventions

investigated limits the certainty regarding the magnitude and durability of these effects compared with the more established evidence for pain reduction.

Fear-avoidance attitudes, kinesiophobia, and other psychosocial effects

Psychological factors, including fear of movement, concerns about re-injury, and avoidance of physical activity, may play an important role in maintaining disability in individuals with CLBP. Interventions that gradually increase confidence in movement may therefore have effects that go beyond pain relief alone. For this reason, psychosocial factors are increasingly recognized as an important component of the management and rehabilitation of chronic low back pain.

Psychological and behavioural factors may also contribute to outcomes during exercise-based rehabilitation for chronic low back pain. A secondary analysis by Vicente-Mampel et al. examined the influence of patient-reported outcomes on the effects of exercise therapy, manual therapy, and kinesiotaping, highlighting the potential relevance of patient-reported factors when interpreting treatment outcomes [19]. In addition, higher adherence to exercise has been associated with greater improvements in pain intensity and functional limitations, suggesting that sustained participation may be an important factor in achieving favourable outcomes [10]. Evidence from randomized controlled trials suggests that combining exercise with interventions addressing education, pain-related beliefs, and behavioural factors may provide additional benefits for some patients with chronic low back pain [20,21]. However, the magnitude and consistency of these effects vary across interventions and patient populations. Such an approach may be particularly relevant for patients in whom psychosocial factors, including fear of movement or avoidance behaviours, interfere with participation in physical activity. Importantly, this does not imply that every patient with chronic low back pain requires formal psychological therapy. Rather, assessment of psychosocial factors may help identify patients who may benefit from additional education, behavioural support, or a broader multimodal rehabilitation approach alongside exercise therapy [20,21].

These findings are compatible with the biopsychosocial rationale for exercise therapy. Its role may extend beyond muscle strengthening or the correction of presumed biomechanical abnormalities, as exercise can provide graded exposure to movement and may support confidence and self-efficacy. Nevertheless, current evidence remains insufficient to conclude that conventional exercise alone consistently produces clinically meaningful improvements in fear-avoidance beliefs or kinesiophobia. Patients presenting with pronounced fear, avoidance

behaviours, or kinesiophobia may therefore benefit from a multimodal approach combining exercise with patient education, selected cognitive-behavioural strategies, or cognitive-functional interventions.

Recurrence and Long-Term Outcomes

Scientific evidence regarding the recurrence of low back pain is considerably weaker than that concerning pain intensity and disability. Most studies on exercise therapy for chronic low back pain primarily assess pain severity and functional limitations during or shortly after treatment, rather than the frequency, timing, or severity of subsequent pain episodes. Consequently, it cannot currently be claimed that physical exercise definitively prevents the recurrence of symptoms in patients with CLBP.

Available follow-up data suggest that some benefits of exercise may persist after the conclusion of supervised treatment. For instance, the study by Tottoli et al. included a six-month follow-up period and demonstrated sustained improvements in some functional and quality-of-life outcomes following Pilates compared with home-based exercise [15]. Other studies suggest that continued physical activity may help preserve functional improvements, although the evidence is not sufficient to conclude that exercise definitively prevents recurrence.

From a clinical perspective, this distinction is significant. Exercise should not necessarily be regarded solely as a short-term intervention intended to reduce current symptoms. Establishing sustainable physical activity habits may also support long-term self-management and help patients remain physically active after formal rehabilitation has ended. Nevertheless, the evidence supporting the effectiveness of exercise for preventing recurrence is less convincing than that regarding pain relief and reduction of disability. Future studies should therefore examine recurrence as a predefined outcome rather than treating it as a secondary or incidental measure.

Summary of outcome-specific effects

Overall, the most consistent evidence supports the use of exercise therapy to reduce pain and improve functional disability in individuals with CLBP. The average effects of these improvements are generally modest, although individual patients may experience clinically meaningful benefits. Evidence regarding health-related quality of life is promising and suggests that some benefits may persist beyond the intervention period. Exercise may also positively influence kinesiophobia, fear of movement, and self-efficacy, although these psychosocial

effects are less consistently demonstrated and may vary depending on the intervention and individual patient characteristics.

In contrast, evidence regarding the prevention of recurrent episodes remains insufficient to support definitive conclusions. Exercise should therefore be considered primarily as an intervention aimed at improving current pain, function, and participation, while its potential role in reducing future episodes should be regarded as a possible additional benefit rather than an established outcome.

3.6. Individualization and combination with psychological interventions

The effectiveness of exercise therapy for chronic low back pain (CLBP) depends not only on the type and dose of exercise but also on the extent to which the intervention is adapted to the patient's clinical condition, preferences, functional limitations, and psychosocial needs. Current evidence does not support the universal superiority of any single exercise modality for all patients with CLBP. Exercise programmes should therefore be adapted to therapeutic goals, baseline physical capacity, symptom response, and barriers to participation. Individualization may involve choosing an appropriate type of exercise modality, modification of exercise intensity and volume, adjustment of the level of supervision, and gradual progression of functional demands.

An extensive Cochrane review by Hayden et al. found beneficial effects of exercise therapy on pain and function across a wide range of exercise approaches. However, substantial heterogeneity between interventions prevented the identification of a single optimal programme [7]. Similar findings have been reported in network meta-analyses, which indicate that various exercise categories, including strengthening exercises, motor control training, Pilates, and mind-body exercises, may reduce pain and disability, without consistent evidence that any single modality is universally more effective than the others [5]. Taken together, these findings support a patient-centred approach in which exercise selection is based on individual needs and clinical characteristics rather than on a rigid standardized protocol.

Patient preferences are another important component of individualized care and may influence long-term adherence to exercise. Programmes should therefore be not only effective but also acceptable, accessible, and compatible with the patient's lifestyle. Previous experience with physical activity, self-efficacy, available resources, and personal goals may all be relevant when planning treatment. The purpose of exercise should be to progressively improve physical

capacity and participation in daily activities rather than to correct a presumed specific biomechanical abnormality.

Individualized exercise prescription may be particularly relevant in patients presenting with psychological and behavioural factors that may contribute to persistent disability, such as fear of movement or injury, kinesiophobia, pain catastrophizing, low self-efficacy, or concerns about spinal damage. In these cases, exercise can be introduced gradually and progressed according to the patient's response, with the aim of building confidence in movement and reducing fear associated with physical activity. However, exercise alone may have limited effects on some psychosocial factors. For patients experiencing more pronounced psychosocial barriers, combining exercise therapy with appropriate psychological strategies may therefore be beneficial.

This approach is consistent with the biopsychosocial model of CLBP, which recognizes that pain-related disability may result from interactions among biological, psychological, and social factors. Psychological interventions, particularly cognitive behavioural therapy (CBT), may address maladaptive beliefs about pain, catastrophizing, avoidance behaviours, and coping strategies. Exercise, on the other hand, provides an opportunity to gradually increase physical activity, improve functional capacity, and build confidence in movement. Combining these approaches may therefore address complementary factors associated with persistent disability. Evidence from randomized controlled trials supports the potential value of combining exercise with education and interventions addressing pain-related psychological and behavioural factors, although the size and consistency of these effects vary across studies [20,21]. Such an approach may be particularly relevant for patients whose psychological factors substantially limit physical activity. Importantly, this does not imply that every patient with CLBP requires formal psychological therapy. Rather, assessment of psychosocial factors may help identify patients who may require additional support beyond exercise therapy alone [20,21].

In clinical practice, psychologically informed exercise can be incorporated into a patient-centred approach to CLBP management. Therapists can combine education about pain and movement with strategies aimed at reducing fear of injury, gradually reintroducing activities that patients may have been avoiding, and strengthening self-efficacy. These strategies can be integrated with strengthening, aerobic, and functional exercises and adjusted according to the patient's response to treatment. When marked avoidance, pain catastrophizing, anxiety, or other psychological barriers persist, a structured psychological intervention, such as CBT, may be considered as an additional part of rehabilitation.

Overall, the integration of exercise and psychological interventions should be based on an individualized assessment of the patient's goals, capabilities, symptom response, and barriers to activity. Exercise therapy should therefore be viewed not as a rigid protocol but as a flexible intervention whose content, intensity, and delivery can be modified according to the patient's clinical needs and response to treatment.

3.7. Special populations and delivery methods

Although most evidence on exercise therapy for chronic low back pain (CLBP) concerns adults with non-specific symptoms, available data support its application across different patient populations and modes of delivery. Importantly, the available evidence suggests that exercise should be individualized according to the patient's age, functional capacity, clinical presentation, and access to rehabilitation rather than prescribed as a uniform intervention.

Older adults constitute a group of particular importance. In this population, chronic low back pain (CLBP) often co-occurs with limited mobility, balance disorders, and age-related functional limitations. A systematic review and meta-analysis of randomized controlled trials in adults aged ≥60 years found that exercise therapy improved pain, disability, mobility, and both physical and mental aspects of quality of life [22]. Benefits were observed across several exercise modalities, including aerobic, strengthening, and mind–body approaches. Individualized programmes may therefore be preferable in older adults, particularly when balance, functional capacity, and exercise tolerance need to be considered. This is supported by trials investigating tailored pilates and combinations of dynamic neuromuscular stabilization with the Feldenkrais method. Such an intervention reported improvements in pain, function, balance, and postural control in older women with CLBP [14,23].

Exercise-based rehabilitation may also be relevant to patients with more complex clinical presentations. In individuals with persistent CLBP following spinal surgery, cognitive functional therapy has been investigated against a programme combining core exercises and manual therapy, highlighting the potential role of exercise within broader rehabilitation strategies addressing physical and psychosocial contributors to persistent pain [24]. Evidence from patients with radicular symptoms further suggests that targeted exercise may improve pain, disability, strength, and lumbar muscle characteristics. Supporting the use of appropriately adapted exercise even when CLBP is accompanied by neurological features [25]. However, evidence in these specific populations remains more limited than that available for non-specific CLBP, and exercise prescription should therefore be guided by appropriate clinical assessment.

The mode of exercise delivery may additionally influence accessibility and adherence. Home-based exercise represents a practical and relatively low-cost option, particularly when regular supervised rehabilitation is difficult to access. Comparative evidence indicates that both supervised and home-based programmes can improve clinical outcomes. However, supervised interventions may provide additional benefits through individualized progression, monitoring, and correction of exercise technique [10,26]. Importantly, the superiority of a specific supervised modality should not be interpreted as evidence that unsupervised exercise is ineffective. Rather, differences between delivery methods may partly reflect adherence, therapeutic dose, and the degree of individualization achieved.

Digital and telerehabilitation approaches provide an additional means of delivering exercise therapy, particularly for patients facing geographical or logistical barriers to conventional rehabilitation. Recent evidence on AI-assisted multimodal telerehabilitation suggests that digitally delivered exercise can represent a feasible approach for managing non-specific CLBP [8]. Such interventions may also facilitate remote monitoring and individualized progression. Their effectiveness depends on adequate patient engagement and the ability to provide appropriate feedback and adaptation.

For special populations, individualized exercise prescription and appropriate monitoring appear particularly important. While home-based and digital approaches may expand access to rehabilitation without necessarily replacing supervised care.

3.8. Safety and adverse events of exercise therapy

Exercise therapy for chronic low back pain (CLBP) is generally considered to have a favorable safety profile and a low risk of serious adverse events. Evidence from systematic reviews, network meta-analyses, and umbrella reviews consistently indicates that clinically significant complications directly attributable to exercise are uncommon. Across the available literature, serious adverse events are reported very rarely. Deaths, severe injuries requiring hospitalization, and persistent complications related to appropriately prescribed exercise programmes are hardly ever described. This promising safety profile is an important consideration when exercise therapy is recommended as a first-line management strategy for CLBP. This is particularly important given that the condition often requires long-term rather than short-term treatment.

The adverse effects most frequently reported in exercise trials are generally mild, transient, and musculoskeletal in essence. These include delayed-onset muscle soreness (DOMS), temporary

exacerbation of low back or lumbosacral pain, fatigue, and minor discomfort related to adapting to a new or increased physical load. Patients may also experience transient symptoms in other musculoskeletal regions, such as the shoulder, hip, or knee. Such symptoms typically occur during the initial stages of an exercise programme or following an increase in exercise intensity and usually resolve spontaneously within several days. Importantly, short-term discomfort does not necessarily indicate harm or treatment failure. In many cases, does not require discontinuation of exercise.

A temporary increase in pain may be particularly relevant when introducing exercises that impose greater mechanical or muscular demands. Studies investigating different exercise modalities, including yoga, strengthening, and higher-intensity exercise, have reported transient symptom exacerbations in a proportion of participants. These episodes have generally been self-limiting and have not been associated with serious clinical consequences. This distinction is clinically important because fluctuations in pain intensity are common in patients with CLBP and may occur independently of the underlying structural or functional status of the lumbar spine. Consequently, mild and short-lived symptom aggravation should generally be interpreted in the context of the overall clinical response rather than automatically regarded as an adverse event requiring cessation of treatment.

Overall, the available evidence supports exercise therapy as a safe intervention for most individuals with CLBP when appropriately prescribed and progressed. Most exercise-related symptoms are mild, transient, and reversible, whereas serious complications appear to be uncommon. The potential benefits of regular physical activity include reductions in pain and disability and improvements in physical function and quality of life. It also appears to outweigh the risk of adverse effects for most patients. Nevertheless, safety should not be considered independent of exercise prescription: appropriate screening, individualized dosing, gradual progression, patient education, and monitoring of symptom response are essential components of effective and safe exercise-based rehabilitation.

4. Discussion

Overall, the reviewed evidence supports the effectiveness of exercise therapy in the management of chronic low back pain, however the magnitude of benefit varies across outcomes. Exercise therapy produces a clinically important reduction in pain. Additionally, it also improves physical function, however the effect is smaller than that observed for relieving

pain. These effects are clinically important when exercise is compared with no treatment, usual care or placebo, yet the overall improvement remains moderate [1].

This discrepancy between effects on pain and function is relevant. Patients may experience substantial pain relief while showing very minimal improvement in motor function, which may continue to impact their life negatively. For this reason, clinicians should monitor changes in pain and function as separate domains.

In addition, no single exercise modality has demonstrated clear superiority. It is a point of further discussion which types of exercise are most effective for reducing pain and improving function.

The benefits of exercise therapy are most evident when it is compared with interventions involving little or no active treatment. When exercise is compared with other active interventions, such as manual therapy or education, the between-group differences shrink considerably and often fall below thresholds for clinical importance. This pattern is expected, as many active treatments share overlapping mechanisms. As a result, head-to-head comparisons tend to show smaller incremental benefits. The practical implication is that exercise should not be seen as superior to every other evidence-based conservative option, but rather as a reliable and versatile component within a broader package of care.

Taken together, evidence shows exercise therapy as a meaningful and important part of chronic low back pain management rather than a definite cure. Improvements are significant yet incomplete; many patients continue to experience residual pain and limitations in function. It is important to set realistic expectations with patients and encourage long-term engagement with physical therapy. In clinical practice this means presenting exercise as a strategy that can reduce pain, improve function and support self-management, while acknowledging that outcomes vary between individuals and that additional interventions - such as education, psychological support or other modalities - may be required for some patients [20,21].

5. Results

Current evidence demonstrates that exercise therapy is effective in the management of chronic low back pain when compared against non-active controls [16, 26]. Evidence shows that exercise produces a clinically meaningful reduction of pain, alongside a more modest improvement in physical function. This discrepancy indicates that pain relief does not automatically translate into an equivalent functional recovery. However, when exercise is compared with other active conservative interventions (such as manual therapy or patient education), between-group differences shrink substantially [27].

Furthermore, current evidence indicates that no single exercise modality is universally superior for all patients with low back pain. Numerous modalities have been evaluated - including Pilates, motor control exercises (MCE), resistance/strength training, aerobic exercise, yoga, Tai Chi, aquatic therapy and targeted gluteal muscle strengthening combined with core stabilization, all showing positive functional outcomes [28]. Ultimately, patient engagement, adherence and consistency appear to be more critical factors than the specific exercise modality selected [29].

Regarding exercise dosage, the literature does not support a rigid, universal prescription, but rather identifies optimal parameters for therapeutic responsiveness. Exercise session durations of 15 to 30 minutes demonstrate optimal effectiveness for pain relief, while a frequency of 3 sessions per week appears to be the most beneficial weekly schedule [30]. Additionally, program durations exceeding 16 weeks demonstrate superior long-term outcomes compared to shorter programs. Current evidence indicates that high-intensity exercise does not provide superior clinical benefits compared to low-intensity exercise, but it is associated with a higher rate of adverse events [31].

In summary, exercise therapy serves as an effective, adaptable and non-pharmacological component of chronic low back pain management. Although no single modality or strict dosage protocol holds universal superiority, optimal clinical outcomes depend on adherence, intervention duration and a patient-centered approach.

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