Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Systematic Reviews / Literature Reviews
ISSN (Print): 2303-1921
ISSN (Online): 2722-0443
Volume 14, Number 1, Pages 479-484 (2026)
DOI: https://doi.org/10.24843/mifi.000001809

Exercise Interventions for Pain and Function in Older Adults with Low Back Pain: A Systematic Review

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Received 11 April 2026; Revised 16 April 2026; Accepted 18 April 2026; Published 12 May 2026

Abstract

Background: Chronic low back pain (LBP) is highly prevalent among older adults and contributes to functional decline and reduced quality of life. Exercise therapy is widely recommended; however, the effectiveness of different exercise modalities remains unclear.
Objective: To evaluate the effectiveness of exercise interventions on pain, physical function, and muscle strength in older adults with chronic low back pain.
Methods: This systematic review followed PRISMA 2020 guidelines. Four databases (Scopus, PubMed, Google Scholar, and Semantic Scholar) were searched from January 2015 to January 2026. Randomized controlled trials involving adults aged ≥60 years were included. Study selection and data extraction were conducted by two independent reviewers. Methodological quality was assessed using the Physiotherapy Evidence Database (PEDro) scale. Data were synthesized narratively due to heterogeneity.
Results: Five randomized controlled trials involving 473 participants were included. PEDro scores ranged from 6 to 7, indicating good methodological quality. Exercise interventions, including Dynamic Neuromuscular Stabilization (DNS), corrective exercises, neuromuscular electrical stimulation (NMES), and biofeedback-based training, improved functional outcomes such as gait speed, balance (Timed Up and Go), and disability indices. However, quantitative effect sizes, confidence intervals, and p-values were not consistently reported across studies, limiting direct comparison of intervention effectiveness. No intervention demonstrated consistent superiority across all outcomes.
Conclusion: Exercise interventions improve physical function and reduce disability in older adults with chronic LBP, although effects on pain vary. The overall certainty of evidence is moderate due to heterogeneity and methodological limitations. Individualized exercise programs are recommended.

Keywords
Exercise Therapy; Low Back Pain; Aged; Physical Function; Muscle Strength

Introduction

Population aging represents a major global demographic transition, accompanied by a substantial increase in the prevalence of chronic musculoskeletal disorders. Among these, low back pain (LBP) remains one of the leading causes of disability worldwide and disproportionately affects older adults.[1] The Global Burden of Disease study reported that the number of individuals living with LBP exceeded 600 million cases globally, reflecting a significant and persistent public health challenge.[2] In older populations, LBP is strongly associated with reduced physical function, impaired mobility, and decreased quality of life, thereby contributing to loss of independence and increased healthcare utilization.[1]

The clinical impact of LBP in older adults extends beyond pain intensity alone. Chronic LBP is frequently linked to muscle weakness, reduced flexibility, and impaired neuromuscular control, all of which contribute to functional limitations and increased fall risk.[3,4] These impairments often initiate a cycle of inactivity and deconditioning, further exacerbating disability. The presence of age-related conditions such as sarcopenia and osteoporosis further complicates clinical management, limiting treatment options and influencing therapeutic outcomes.[1] Consequently, interventions targeting both pain and functional capacity are essential in this population.

Exercise therapy has been consistently recommended as a first-line intervention for LBP due to its effectiveness, accessibility, and cost-efficiency.[4,5] Clinical guidelines emphasize various exercise modalities, including strengthening, stretching, motor control training, and aerobic exercise, as key components of non-pharmacological management.[6] However, despite these recommendations, current guidelines provide limited specificity regarding optimal exercise parameters such as type, intensity, frequency, and duration, particularly for older adults.[6] This lack of detailed guidance presents a challenge for clinicians seeking to implement evidence-based, individualized interventions in geriatric populations.

Several systematic reviews and meta-analyses have demonstrated the overall effectiveness of exercise interventions in reducing pain and improving function in individuals with LBP.[4,7] Nevertheless, most of these studies primarily focus on general adult populations and often exclude older adults or include them in limited numbers.[1] As a result, the applicability of these findings to older populations remains uncertain. Moreover, existing evidence highlights considerable heterogeneity in exercise modalities, intervention protocols, and outcome measures, which further complicates the interpretation and translation of findings into clinical practice.[7]

A previous systematic review by Vadalà et al.[8] specifically examined physical activity interventions in elderly patients with chronic LBP; however, it did not comprehensively evaluate diverse exercise modalities or consider detailed intervention characteristics such as frequency, duration, and intensity. Additionally, more recent randomized controlled trials have introduced novel approaches, including Dynamic Neuromuscular Stabilization (DNS), neuromuscular electrical stimulation (NMES), and biofeedback-assisted training, which have not been fully synthesized in earlier reviews.[9] These developments indicate a need for an updated and more focused synthesis of current evidence.

Despite the growing body of research, a clear gap remains in the literature regarding the comparative effectiveness of different exercise interventions specifically in older adults with chronic LBP. Existing studies are fragmented, vary in methodological quality, and often lack standardized outcome reporting. Furthermore, there is limited integration of evidence based on methodological rigor and intervention characteristics, which is essential for informing clinical decision-making.

Therefore, this systematic review aims to address these gaps by synthesizing current evidence from randomized controlled trials on the effectiveness of exercise interventions in older adults with chronic low back pain. Using a structured approach based on PRISMA 2020 guidelines, this review evaluates the effects of exercise interventions on pain, physical function, and muscle strength.

The research question is formulated based on the PICO framework as follows: in older adults (Population) with chronic low back pain, how do exercise interventions (Intervention), compared with control or alternative interventions (Comparison), affect pain, physical function, and muscle strength outcomes (Outcome). This review is expected to provide a clearer understanding of the role of different exercise modalities in geriatric LBP management and to support the development of more specific, evidence-based clinical recommendations.

Methods

This study was designed as a systematic review conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The objective was to identify, critically appraise, and synthesize evidence from randomized controlled trials evaluating the effectiveness of exercise interventions in older adults with chronic low back pain. A review protocol was developed prior to the study; however, it was not registered in an international database such as PROSPERO. This limitation is acknowledged and may affect methodological transparency.

A comprehensive literature search was performed across four electronic databases: Scopus, PubMed, Google Scholar, and Semantic Scholar. The search covered studies published between January 2015 and January 2026. The final search was conducted in January 2026. The search strategy combined Medical Subject Headings (MeSH) and free-text terms using Boolean operators. The core search string applied in PubMed was as follows: (“low back pain” OR “lumbar pain”) AND (“exercise” OR “exercise therapy” OR “physical training”) AND (“older adults” OR “elderly” OR “aged”) AND (“randomized controlled trial” OR “RCT”). Equivalent adaptations of this strategy were applied to other databases.

Studies were selected based on predefined inclusion and exclusion criteria. Eligible studies were randomized controlled trials involving participants aged 60 years or older with chronic non-specific low back pain. Interventions had to include structured exercise programs such as strengthening, stretching, motor control training, or aerobic exercise. Studies were required to report at least one of the following outcomes: pain intensity, physical function, or muscle strength. Only full-text articles published in English or Indonesian were included. Studies were excluded if they involved non-exercise interventions, non-elderly populations, or specific pathological causes of low back pain.

The study selection process was conducted independently by two reviewers. Initially, titles and abstracts were screened to identify potentially eligible studies. Full-text articles were then assessed for eligibility. Disagreements between reviewers were resolved through discussion and consensus. If necessary, a third reviewer was consulted. Data extraction was performed using a standardized form developed for this review. Extracted variables included study characteristics (author, year, country), participant characteristics (sample size, age, clinical condition), intervention details (type, frequency, duration), comparison groups, outcome measures, and main findings. The extraction process was conducted independently by two reviewers to ensure accuracy and consistency.

Methodological quality and risk of bias were assessed using the Physiotherapy Evidence Database (PEDro) scale, a validated tool for evaluating randomized controlled trials in rehabilitation research.[10,11] The PEDro scale consists of 11 items assessing internal validity and statistical reporting, with scores ranging from 0 to 10. Studies scoring ≥6 were considered to have good methodological quality. The use of the PEDro scale was justified due to its widespread application and relevance in physiotherapy research, although it does not fully replace comprehensive risk-of-bias tools such as Cochrane RoB 2.

Due to substantial heterogeneity in intervention types, outcome measures, and study protocols, a meta-analysis was not performed. Instead, data were synthesized using a structured narrative approach. Studies were grouped based on the type of intervention, including neuromuscular control exercises, corrective exercises, technology-assisted interventions, and multicomponent exercise programs. This approach allowed for comparison of patterns and trends across studies.

Heterogeneity was assessed qualitatively by examining differences in study populations, intervention characteristics (frequency, duration, intensity), and outcome measures. Potential sources of variability, including participant baseline characteristics and adherence rates, were considered during interpretation. Publication bias was not formally assessed using funnel plots due to the limited number of included studies (<10). This limitation is acknowledged. No statistical software was used for meta-analysis, as quantitative synthesis was not conducted. Data management and organization were performed using spreadsheet software. Certainty of evidence was evaluated qualitatively based on study design, methodological quality (PEDro scores), and consistency of findings. A formal GRADE assessment was not conducted, which represents a limitation of this review.

Although a formal GRADE assessment was not conducted, the overall certainty of evidence was evaluated narratively based on study design, methodological quality (PEDro scores), consistency of findings, and heterogeneity across studies. The certainty of evidence was considered moderate, as all included studies were randomized controlled trials with generally good methodological quality, but the presence of heterogeneity and incomplete reporting of quantitative outcomes reduced confidence in the overall estimates. Ethical approval was not required for this study as it involved analysis of previously published data without direct human participant involvement.

Results

The results are presented to describe the study selection process, characteristics of included studies, methodological quality, and outcomes related to pain, physical function, and muscle strength. The process of study identification, screening, and inclusion is summarized in a PRISMA 2020 flow framework. A total of 614 records were identified through database searching (Scopus n = 200; PubMed n = 122; Google Scholar n = 200; Semantic Scholar n = 92). After removal of duplicates (n = 177), 437 records were screened based on titles and abstracts. Of these, 363 records were excluded. Seventy-four full-text articles were assessed for eligibility, and 44 were excluded due to not meeting inclusion criteria. The main reasons for exclusion included عدم reporting relevant outcomes (n = 7), PEDro scores <6 (n = 17), and non-exercise interventions (n = 1). Ultimately, five randomized controlled trials were included in the qualitative synthesis.

The study selection process was conducted systematically in accordance with the PRISMA 2020 guidelines to ensure transparency and reproducibility. All identified records were screened through a structured process, including duplicate removal, title and abstract screening, and full-text eligibility assessment based on predefined inclusion and exclusion criteria. The detailed flow of study selection is presented in Figure 1.

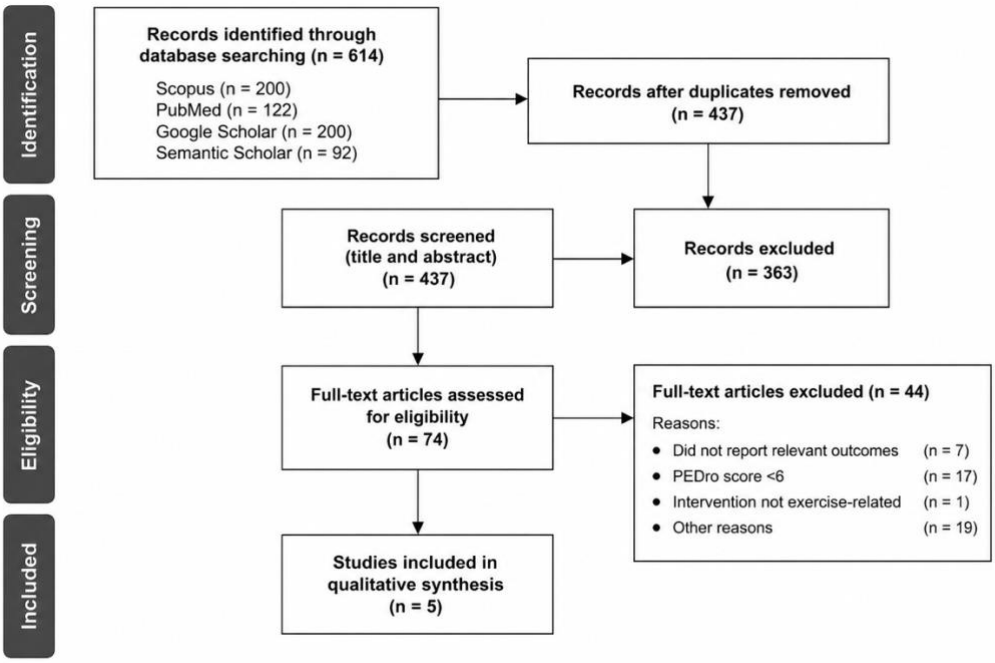

Figure 1. PRISMA 2020 Flow Diagram of Study Selection adapted to PRISMA 2020 standard flow diagram.

To provide an overview of the included evidence, the characteristics of the selected studies are summarized narratively, while detailed information is presented in Table 1.

Table 1. Characteristics of Included Studies

Study	Country	Sample (n) & Age	Intervention	Comparison	Duration	Outcomes	Main Findings
Schulz et al., 2019[12]	USA	n=241; mean age ~73 yrs	Multicomponent exercise + home program	Home exercise only	12 weeks	Muscle strength, TUG, RMDQ	No significant between-group differences; all groups improved
Karartı et al., 2023[13]	Turkey	n=70; mean age ~68 yrs	DNS + conventional therapy	Conventional therapy	6 weeks	FMS, TUG, 6MWT	Greater improvement in functional movement and balance
Madadi-Shad et al., 2019[14]	Iran	n=36; mean age ~68 yrs	Corrective exercise	Control (no intervention)	16 weeks	Gait, EMG, pain (VAS), disability	Significant improvement in gait, pain, and disability
Hicks et al., 2016[9]	USA	n=64; mean age ~70 yrs	Trunk training + NMES	Passive intervention	12 weeks	TUG, gait speed, ODI	Functional improvement at 6-month follow-up
Feldwieser et al., 2018[9,15]	Germany	n=62; mean age ~74 yrs	Bridging exercise + biofeedback	Standard care/control	12 weeks	ODI, BST, strength	Improved muscle endurance; mixed disability outcomes

The five included randomized controlled trials were conducted across different regions, including the United States, Turkey, Iran, and Germany. A total of 473 participants were included, with all studies involving older adults aged ≥60 years. Sample sizes ranged from 36 to 241 participants. The interventions varied considerably and included multicomponent exercise programs, Dynamic Neuromuscular Stabilization (DNS), corrective exercise, trunk muscle training augmented with neuromuscular electrical stimulation (NMES), and biofeedback-based bridging exercises. Intervention duration ranged from 6 to 16 weeks, with session frequencies between one and three times per week. Outcome measures were heterogeneous and included pain intensity (e.g., Visual Analog Scale), physical function (e.g., Timed Up and Go, gait speed, disability indices such as ODI and RMDQ), and muscle strength or endurance (e.g., Biering-Sørensen test, isometric trunk strength). The methodological quality of included studies was assessed using the PEDro scale. A summary of PEDro scores is presented in Table 2.

Table 2. Methodological Quality Assessment Using PEDro Scale

Study	PEDro Score	Randomization	Concealed Allocation	Assessor Blinding	Intention-to-Treat	Follow-up ≥85%
Schulz et al., 2019[12]	7	Yes	Yes	No	Yes	Yes
Karartı et al., 2023[13]	7	Yes	Yes	Yes	No	Yes
Madadi-Shad et al., 2019[14]	7	Yes	No	Yes	Yes	Yes
Hicks et al., 2016[9]	7	Yes	Yes	Yes	No	Yes
Feldwieser et al., 2018[9,15]	6	Yes	Yes	No	Yes	No

All five studies demonstrated good methodological quality, with PEDro scores ranging from 6 to 7 out of 10. All studies reported random allocation and between-group comparisons. However, none of the studies implemented blinding of participants or

therapists, and only some reported assessor blinding. Intention-to-treat analysis and adequate follow-up (>85%) were inconsistently reported.

The findings of the included studies are presented based on intervention type and reported outcomes, with detailed data provided in Table 1 to minimize redundancy. Overall, variations in intervention approaches were associated with differences in functional, strength-related, and pain outcomes. Neuromuscular control–based interventions, particularly Dynamic Neuromuscular Stabilization (DNS) combined with conventional therapy, were associated with improvements in functional movement patterns and balance performance. These improvements were reflected in functional measures such as the Timed Up and Go test, indicating enhanced mobility and postural control among participants.

Similarly, corrective exercise interventions demonstrated beneficial effects on gait-related parameters, alongside reductions in disability and pain intensity. These findings suggest that targeted biomechanical correction may contribute to improved movement efficiency and functional outcomes in older adults with low back pain. Technology-assisted interventions, including those incorporating neuromuscular electrical stimulation (NMES) and biofeedback, were associated with improvements in functional performance and muscle endurance. Reported functional gains included reductions in Timed Up and Go time and increases in gait speed. However, the magnitude and consistency of these effects varied across studies, reflecting differences in intervention protocols and follow-up duration.

In contrast, multicomponent and supervised exercise programs showed improvements across study groups, regardless of intervention type. Nevertheless, no consistent differences were observed between supervised and home-based exercise programs in long-term outcomes, suggesting that the added benefit of supervision may be limited in certain contexts.

Due to heterogeneity in interventions, outcome measures, and study designs, a meta-analysis was not performed. Instead, findings were synthesized narratively based on intervention categories and outcomes. Across studies, improvements in physical function were consistently reported, particularly in mobility, balance, and disability indices. Improvements in muscle strength and endurance were also observed in several interventions. In contrast, findings related to pain reduction were inconsistent, with some studies reporting significant improvements while others showed no statistically significant differences between groups. However, most included studies did not consistently report effect sizes, confidence intervals, or standardized mean differences, which limits the ability to determine the magnitude of treatment effects and perform quantitative comparisons.

Discussion

This systematic review synthesized evidence from five randomized controlled trials to evaluate the effectiveness of exercise interventions on pain, physical function, and muscle strength in older adults with chronic low back pain (LBP). Overall, the findings indicate that exercise-based interventions consistently improve physical function and, to a lesser extent, muscle strength and endurance. However, the effects on pain reduction remain inconsistent across studies, reflecting variability in intervention types, outcome measures, and follow-up duration.

A key finding of this review is the consistent improvement in functional outcomes, particularly mobility, balance, and disability indices. Interventions such as Dynamic Neuromuscular Stabilization (DNS) and corrective exercise demonstrated meaningful improvements in movement quality and gait efficiency. These findings are aligned with previous evidence suggesting that motor control–based interventions enhance neuromuscular coordination and postural stability, which are critical determinants of functional independence in older adults.[3,5] The observed improvements in Timed Up and Go (TUG) performance and gait parameters support the role of targeted neuromuscular training in addressing age-related declines in motor control and balance.[3,8]

In contrast, the effects of exercise interventions on pain reduction were less consistent. While some studies reported significant reductions in pain intensity, others found no statistically significant differences between intervention and control groups. This inconsistency may be explained by several factors, including differences in baseline pain severity, intervention dosage, and the multidimensional nature of pain perception in older adults. Pain in this population is often influenced by psychosocial factors, comorbidities, and central sensitization mechanisms, which may not be fully addressed by exercise interventions alone.[16] These findings are consistent with prior systematic reviews indicating that exercise may have a stronger impact on functional outcomes than on pain intensity.[4]

The heterogeneity of interventions represents a major challenge in interpreting the findings. The included studies varied substantially in terms of exercise modality (e.g., multicomponent training, DNS, NMES-assisted training, biofeedback), frequency (1–3 sessions per week), and duration (6–16 weeks). This variability limits direct comparability and precludes quantitative synthesis. However, an important pattern emerges: no single exercise modality demonstrated clear superiority across all outcomes. Instead, effectiveness appears to depend on the alignment between intervention characteristics and specific patient needs. For example, corrective exercise was particularly effective in populations with biomechanical impairments, while NMES-assisted training showed delayed functional benefits, suggesting cumulative or longer-term effects. The absence of consistently reported effect sizes and confidence intervals across studies represents a significant limitation, as it restricts the ability to evaluate the clinical relevance and magnitude of observed improvements. Future trials should adopt standardized reporting guidelines to improve interpretability and comparability.

Another important observation relates to the role of technology-assisted interventions. Interventions incorporating neuromuscular electrical stimulation (NMES) and biofeedback demonstrated improvements in specific outcomes such as muscle endurance and functional performance. These findings suggest that augmenting exercise with technological support may enhance neuromuscular activation and motor learning. However, the benefits were not consistently superior across all domains, indicating that such approaches may be more suitable as adjunctive rather than standalone interventions.

The methodological quality of the included studies was generally good, with PEDro scores ranging from 6 to 7. Nevertheless, several limitations were consistently observed, including the lack of blinding of participants and therapists, which is inherent in exercise-based trials. In addition, variability in adherence rates, dropout rates, and outcome measurement tools may have influenced the results. Importantly, the absence of standardized reporting of effect sizes and confidence intervals limits the ability to assess the magnitude and clinical relevance of observed effects. From a certainty-of-evidence perspective, the findings should be interpreted with caution, as moderate-quality evidence is primarily derived from a limited number of studies with heterogeneous methodologies and incomplete statistical reporting.

This review also highlights the importance of considering heterogeneity in both study design and participant characteristics. Differences in age range, comorbidities, and baseline functional status may have contributed to variability in outcomes. For instance, studies involving participants with specific conditions such as pronated feet demonstrated more pronounced improvements with targeted interventions, suggesting that patient stratification may be critical in optimizing treatment effectiveness.

Several limitations should be acknowledged. First, the small number of included studies limits the generalizability of findings and prevents formal assessment of publication bias. Second, the absence of meta-analysis restricts the ability to quantify pooled effects. Third, the review relied primarily on the PEDro scale for methodological assessment, without incorporating a comprehensive risk-of-bias framework such as Cochrane RoB 2 or GRADE. Finally, heterogeneity in interventions and outcome measures limits direct comparison across studies.

From a clinical perspective, the findings support the use of exercise interventions as a core component of physiotherapy management for older adults with chronic LBP. However, the variability in outcomes suggests that exercise programs should be individualized based on patient characteristics, functional limitations, and specific therapeutic goals. Interventions targeting neuromuscular control and functional movement appear particularly beneficial for improving mobility and balance, which are critical for maintaining independence in older populations.

Future research should focus on standardizing intervention protocols and outcome measures to improve comparability across studies. High-quality randomized controlled trials with larger sample sizes and longer follow-up periods are needed to better understand long-term effects. Additionally, the integration of formal evidence grading systems such as GRADE would strengthen the interpretation of findings. Further investigation into the role of combined and technology-assisted interventions is also warranted.

Conclusion

This systematic review demonstrates that exercise interventions are effective in improving physical function and reducing disability in older adults with chronic low back pain, although their effects on pain reduction are inconsistent. No single exercise modality showed clear superiority across all outcomes, indicating that intervention effectiveness depends on alignment with patient characteristics and targeted functional goals. The overall certainty of evidence is moderate due to methodological limitations and heterogeneity among studies.

Clinically, these findings support the implementation of structured and individualized exercise programs as a central component of physiotherapy management for older adults with low back pain, particularly those targeting neuromuscular control and functional mobility.

Future research should prioritize high-quality randomized controlled trials with standardized outcome measures, longer follow-up periods, and comprehensive evaluation of intervention parameters to strengthen the evidence base and improve clinical applicability. This review provides updated evidence highlighting the importance of individualized exercise-based interventions in optimizing functional outcomes in older adults with low back pain and contributes to the growing body of geriatric physiotherapy research.

Author Contribution

Dilfu Ahsan Zahrudin: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing original draft.
Andrew Wijaya Saputra: Investigation, Validation, Visualization, Writing review and editing.

Acknowledgments

The authors would like to acknowledge all researchers whose studies contributed to this systematic review and provided valuable scientific insights into the management of low back pain in older adults.

Conflict of Interest Statement

The authors declare no conflict of interest.

Funding Sources

This study received no external funding.

Ethics Statement

Ethical approval was not required for this study as it involved the analysis of previously published data and did not include direct human or animal participants.

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