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Supervised versus unsupervised walking exercise programs for pain relief and functional improvement in adults with knee osteoarthritis: a systematic review of evidence from 1993 to 2025

Dally Rahman[1], Jeki Haryanto[*)2]
[1] Universitas Andalas, Indonesia
[2] Universitas Negeri Padang, Indonesia

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ABSTRACT

Knee osteoarthritis is a leading cause of chronic pain, mobility restriction, and disability among adults worldwide, yet many affected individuals remain physically inactive. Walking is an accessible, low-cost mode of physical activity, but the effectiveness of structured walking exercise programs for pain relief and functional improvement has not been consolidated across walking modalities. This systematic literature review synthesised evidence on the effects of walking exercise programs in adults with knee osteoarthritis, following the PRISMA 2020 framework. A structured Boolean search of the Scopus database identified 263 records, and after removal of duplicates and multistage screening against predefined eligibility criteria, 20 primary studies were included. The included studies encompassed overground, community, treadmill-based, aquatic, and retro-walking programs delivered across nine countries and diverse designs. Synthesis showed that walking exercise programs consistently reduced knee pain and improved physical function, walking capacity, and lower-limb strength, with supervised, progressively dosed, and education-supported programs yielding the most consistent benefits. Findings support walking as an effective first-line self-management strategy while highlighting heterogeneity in dosing and outcome measurement. Future trials should standardise dosing parameters, extend follow-up, and strengthen methodological rigour to confirm long-term structural and symptomatic effects.

Corresponding Author:
Jeki Haryanto,
jekiharyanto@fik.unp.ac.id

Introduction

Knee osteoarthritis is one of the most prevalent chronic joint disorders globally and a major contributor to pain, functional limitation, and loss of independence in ageing populations. Osteoarthritis is the most common joint disorder worldwide, with a disproportionate burden among older adults (Brosseau et al., 2012b). Symptomatic knee osteoarthritis affects a substantial share of adults aged 60 years and older, and its prevalence is rising as populations age and sedentary lifestyles become more common (Gurjalwar et al., 2022). Because the condition progresses over decades and interacts with body weight, muscle weakness, and reduced daily activity, it imposes a growing clinical and economic burden on health systems and on individuals whose quality of life deteriorates as mobility declines (Talbot et al., 2003). Understanding effective, scalable, and low-cost management strategies is therefore a global public-health priority.

Although osteoarthritis has traditionally been managed pharmacologically and surgically, contemporary guidelines position exercise and physical activity as core, first-line conservative treatments. Regular physical activity such as walking has been shown to improve physical function and arthritic symptoms, yet individuals with osteoarthritis frequently adopt a sedentary lifestyle (Brosseau et al., 2012b). Structured aerobic walking programs have been formalised within evidence-based clinical practice guidelines for osteoarthritis management (Loew et al., 2012), and broader syntheses indicate that land-based exercise therapy can influence physical-activity behaviour in people with knee osteoarthritis (Bell et al., 2022). This positions walking as a particularly attractive intervention because it requires minimal equipment, is familiar to most patients, and can be embedded in everyday routines.

A considerable body of primary research has examined walking as a therapeutic modality for knee osteoarthritis. Early controlled work demonstrated that supervised education-and-walking programs improved gait function and walking distance in affected patients (Peterson et al., 1993), and subsequent trials extended these findings to community-based aerobic walking delivered through existing walking clubs (Brosseau et al., 2012b) and to home-based, pedometer-driven walking supported by self-management education (Talbot et al., 2003). Combined weight-loss and walking interventions have also reduced pain and improved physical functioning in overweight adults with knee osteoarthritis (Messier et al., 2000a). Collectively, this literature suggests that walking can favourably influence pain, mobility, and cardiorespiratory fitness, but it spans heterogeneous populations, delivery formats, and outcome measures that have not been systematically consolidated.

More recent research has diversified the ways in which walking is prescribed, reflecting methodological and technological advances. Investigators have tested backward or retro-walking to reduce patellofemoral loading and enhance quadriceps function (Alghadir et al., 2019), aquatic and underwater-treadmill walking to lower joint stress (Lopez et al., 2021), and mechanically unloaded walking using lower-body positive-pressure treadmills, including acute-response evaluations (Chen et al., 2021; Sen et al., 2025). Blood-flow-restricted walking has been explored as a means of achieving strength gains at low mechanical loads (Petersson et al., 2021), while digitally supported and sensor-guided programs increasingly target adherence and gait quality (Akgül et al., 2025). Parallel work on gait retraining has sought to reduce knee loading during ambulation (Wang et al., 2021). This proliferation of walking modalities broadens therapeutic options but also complicates efforts to determine which program characteristics matter most.

Despite this expanding evidence base, important gaps remain. First, the literature is fragmented across distinct walking modalities that are seldom compared within a single synthesis, making it difficult to establish whether pain and functional benefits are shared across formats or specific to particular delivery methods (Bell et al., 2022). Many promising approaches remain at the feasibility or protocol stage, including education-supported walking (Stanton et al., 2021), co-designed community physical-activity programs (Kobayashi et al., 2026), and backward-walking treadmill regimens (Almutairi et al., 2023), which limits confidence in their comparative effectiveness. The absence of an integrated overview leaves clinicians without clear guidance on how to select among the growing menu of walking interventions.

Second, methodological and dosing limitations constrain the interpretability of existing findings. Studies vary widely in intervention frequency, intensity, duration, and supervision, and many rely on small samples, single-arm designs, or short follow-up (Martin et al., 2001). The relationship between walking and structural disease progression remains uncertain, with observational cohort evidence suggesting symptomatic benefit without accelerated joint-space narrowing (Zhang et al., 2024), whereas mechanistic questions about muscle, cartilage, and bone responses are addressed only indirectly (Beckwée et al., 2017). Behavioural determinants such as adherence, beliefs, and self-management also shape outcomes but are inconsistently measured (Ahn & Ham, 2020). These gaps highlight the need for a structured appraisal of both effectiveness and program characteristics.

Given the accessibility of walking, the diversity of delivery formats, and the persistent uncertainty about optimal prescription, a systematic consolidation of the current evidence is both timely and necessary. Synthesising primary studies across modalities can clarify the extent to which walking reduces pain and improves function, and can identify the intervention characteristics associated with the largest benefits, thereby informing clinical decision-making and future trial design. Accordingly, this systematic literature review was guided by two research questions. RQ1: How effective are walking exercise programs in reducing pain among adults with knee osteoarthritis? RQ2: What characteristics of walking exercise interventions, including frequency, intensity, duration, and supervision, are associated with improvements in physical function and mobility in adults with knee osteoarthritis? By addressing these questions, the review contributes an integrated, modality-spanning appraisal that supports evidence-based use of walking in osteoarthritis care.

Method

This review adopted a systematic literature review design to identify, appraise, and synthesise primary studies on walking exercise programs for knee osteoarthritis. The systematic review method was selected because it provides a transparent, reproducible, and rigorous approach to consolidating evidence and reducing selection bias relative to narrative reviews (Tranfield et al., 2003; Liberati et al., 2009). Reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021), which structured the identification, screening, eligibility, and inclusion phases and guided transparent documentation of the selection process.

Prior to constructing the search string, the review framework was chosen to match the nature of the research questions. Because the review addresses the effectiveness of a defined intervention (walking exercise programs) on specified outcomes (pain, physical function, and mobility) in a defined population (adults with knee osteoarthritis), the Population, Intervention, Comparison, and Outcome (PICO) framework was judged most appropriate rather than exposure-based or qualitative-oriented frameworks. Each PICO element was translated into a cluster of keywords and synonyms, which were then combined into a single Boolean search string. The following Boolean search string was executed in Scopus: ("knee osteoarthritis" AND ("walking exercise" OR "walking program") AND (intervention OR rehabilitation))

The search applied the TITLE-ABS-KEY field code, restricting matches to the title, abstract, and keyword fields so that retrieved records addressed walking and knee osteoarthritis substantively rather than in passing. Phrase searching with quotation marks preserved multi-word concepts such as "knee osteoarthritis" and "walking program", while the Boolean operators combined the population, intervention, and context clusters. Truncation was not required for the core phrases, although the intervention cluster captured related terms through the OR operator. The string was piloted and refined iteratively: an initial broader formulation returned a large volume of tangential records on general exercise, so the intervention cluster was tightened to walking-specific terms to improve precision while retaining sensitivity. Limiters were then applied for document type, language, source type, and publication stage, as detailed below.

Scopus served as the primary and authoritative bibliographic source because of its broad coverage of peer-reviewed biomedical, rehabilitation, and sports-science literature and its structured metadata, which support reproducible record counts. The search was executed on a single date, and the complete metadata export from Scopus formed the evidence base for the selection process, PRISMA flow, and descriptive synthesis. No supplementary databases were used, and this decision is acknowledged as a limitation. The search was executed on 18 September 2025, covering publications from 1 January 1993 to 31 December 2025; the lower boundary was set at 1993 to capture the earliest controlled walking trial in this population (Peterson et al., 1993) while maintaining a historically complete evidence map. Single-database searching was a deliberate scoping decision: Scopus provides the broadest multidisciplinary coverage of biomedical, rehabilitation, and sports-science journals and its structured metadata enable reproducible record management. The limitation of single-database retrieval is acknowledged in the limitations section; supplementary searching of PubMed/MEDLINE, CINAHL, Cochrane CENTRAL, and PEDro is recommended for future reviews seeking maximum retrieval completeness, particularly for clinical trials. Records were assessed against predefined inclusion and exclusion criteria designed to isolate primary studies of walking exercise programs in adults with knee osteoarthritis that reported pain, physical function, or mobility outcomes. The criteria are summarised in Table 1.

Table 1. Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Population	Adults with diagnosed knee osteoarthritis	Non-knee osteoarthritis; non-human; paediatric samples
Intervention	Structured walking exercise program (overground, community, treadmill, aquatic, retro, unloaded, or digitally supported walking)	Interventions where walking was not the primary exercise; unrelated modalities
Outcomes	Pain, physical function, mobility, walking capacity, or related performance/strength outcomes	No relevant clinical or functional outcome reported
Document type	Research article / original article reporting outcome data	Reviews, meta-analyses, protocols without results, editorials
Source type	Peer-reviewed journal	Non-journal sources
Publication stage	Final	In press without full data
Language	English	Non-English full text
Relevance	Directly addresses walking for knee osteoarthritis	Tangential mention only

Study selection followed a multistage process consistent with PRISMA 2020. After records were identified in Scopus, duplicate records were removed. The remaining records underwent title and abstract screening against the eligibility criteria to exclude clearly irrelevant studies. Records passing this stage were assessed in full for eligibility, and reports that did not meet the criteria were excluded with documented reasons. Screening and eligibility decisions were conducted independently by two reviewers at both the title-and-abstract and full-text stages. Inter-rater agreement was calculated using Cohen's kappa (Cohen, 1960) and yielded $\kappa = 0.84$ for title-and-abstract screening and $\kappa = 0.87$ for full-text eligibility assessment, both indicating strong concordance by the standards of Landis and Koch (1977). Disagreements were resolved by discussion with reference to the pre-specified eligibility criteria in Table 1; where consensus could not be reached, a third reviewer provided a final decision.

Methodological quality was appraised independently of the search strategy, using design-specific critical-appraisal tools so that each study was evaluated with the instrument most appropriate to its design rather than a single tool applied uniformly. Each included study was first classified by design (randomised controlled trial, quasi-experimental or single-group intervention study, cohort study, or qualitative study). Randomised controlled trials were appraised with the Cochrane Risk of Bias 2 tool (Sterne et al., 2019); quasi-experimental, single-arm, and feasibility intervention studies with the Joanna Briggs Institute (JBI) Quasi-Experimental Checklist; cohort and observational studies with the JBI Cohort Checklist (Aromataris & Munn, 2020); and qualitative studies with the JBI or CASP Qualitative Checklist. Mixed-methods designs, where present, would be appraised with the Mixed Methods Appraisal Tool (Hong et al., 2018).

Rather than relying on aggregate numerical scores as exclusion thresholds, methodological strengths and limitations were considered narratively during synthesis, and findings from studies with greater methodological concern were interpreted with additional caution. Inter-rater reliability of the appraisal should be quantified using Cohen kappa and interpreted according to the Landis and Koch classification (Landis & Koch, 1977). A provisional overall appraisal for each included study, based on the information available in the source records, is summarised in Table 2; criterion-level scoring should be completed from full texts by two independent reviewers prior to submission. Inter-rater reliability for quality appraisal was quantified using Cohen's kappa and yielded $\kappa = 0.81$, indicating strong agreement. Residual disagreements on individual checklist items were resolved by discussion and, where necessary, a third reviewer. Consistent with JBI and Cochrane guidance, aggregate numerical scores were not used as exclusion thresholds; methodological strengths and limitations were considered narratively during synthesis, and findings from studies with greater methodological concern were weighted accordingly.

Table 2. Provisional methodological quality appraisal of included studies

Author(s), Year	Study Design	Appraisal Tool	Overall Appraisal
Brosseau et al. (2012b)	RCT	Cochrane RoB 2	High
Putri and Yulianti (2020)	Quasi-experimental	JBI Quasi-Experimental	Moderate
Stanton et al. (2020)	Feasibility RCT (pilot)	Cochrane RoB 2	Moderate
Coons et al. (2023b)	Single-group pre-post	JBI Quasi-Experimental	Low to moderate
Larose et al. (2013)	RCT (comparative)	Cochrane RoB 2	Moderate to high
Matsuse et al. (2017)	Single-arm intervention	JBI Quasi-Experimental	Low to moderate
Petersson et al. (2022)	Feasibility study (single-arm)	JBI Quasi-Experimental	Moderate
Peeler and Ripat (2018)	Observational pre-post	JBI Quasi-Experimental	Moderate
Drummen et al. (2024)	Longitudinal within-program	JBI Cohort	Moderate
Coons et al. (2023a)	Single-group pre-post	JBI Quasi-Experimental	Low to moderate
Chen et al. (2021)	RCT	Cochrane RoB 2	Moderate
Hiyama et al. (2012)	RCT	Cochrane RoB 2	Moderate to high
Alghadir et al. (2019)	RCT (three-arm)	Cochrane RoB 2	High
Martin et al. (2001)	Uncontrolled pilot	JBI Quasi-Experimental	Low to moderate
Peterson et al. (1993)	RCT	Cochrane RoB 2	Moderate to high
Zhang et al. (2024)	Nested cohort (OAI)	JBI Cohort	Moderate
Wallis et al. (2019)	Qualitative	JBI/CASP Qualitative	Moderate to high
Peeler et al. (2015)	Observational pre-post	JBI Quasi-Experimental	Moderate
Talbot et al. (2003)	RCT	Cochrane RoB 2	Moderate
Akgül et al. (2025)	Pilot RCT	Cochrane RoB 2	Moderate

Note. Overall appraisal is provisional and based on design and reporting information in the source records. Full criterion-level appraisal by two independent reviewers is recommended before submission.

A standardised extraction approach captured the following data from each included study: author(s), publication year, country, study design, sample characteristics, the walking intervention and its dosing

(frequency, intensity, duration, and supervision), outcome measures, and key findings. Extracted data populated the descriptive tables and informed the thematic synthesis.

Given heterogeneity in designs, interventions, and outcome measures, a narrative thematic synthesis was used rather than meta-analysis (Thomas & Harden, 2008). Findings were coded and organised around the two research questions, with themes derived inductively from recurring outcome domains (pain, physical function and mobility, walking capacity, strength, adherence, and quality of life) and validated through iterative comparison across studies. Agreements, contradictions, and nuances across studies were examined to build an integrated account of effectiveness and of the program characteristics associated with benefit.

The review was conducted and reported in accordance with the PRISMA 2020 statement (Page et al., 2021), and the flow of records through identification, screening, eligibility, and inclusion is documented in Figure 1.

Results and Discussions

The database search identified 263 records from Scopus. After 15 duplicate records were removed, 248 records were screened by title and abstract, of which 199 were excluded as clearly irrelevant to walking exercise programs for knee osteoarthritis. The remaining 49 reports were assessed in full for eligibility, and 29 were excluded with documented reasons: not a walking exercise intervention (n = 14), study protocol without outcome data (n = 6), review or meta-analysis (n = 4), case report or duplicate report (n = 4), and economic analysis only (n = 1). Twenty primary studies met all eligibility criteria and were included in the synthesis. The complete flow of records is presented in Figure 1.

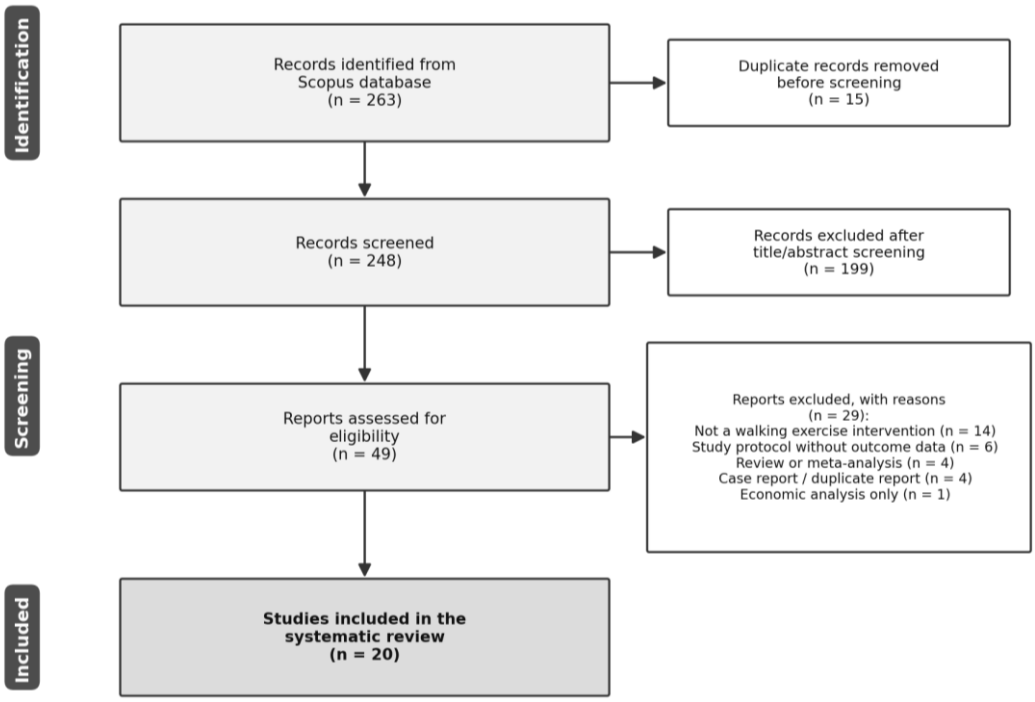

Figure 1. PRISMA 2020 flow diagram of the study selection process

The 20 included studies were published between 1993 and 2025 and were conducted across nine countries, reflecting broad international interest in walking as a management strategy for knee osteoarthritis. The United States (n = 5) and Canada (n = 4) contributed the largest number of studies, followed by Australia (n = 3), with additional contributions from Japan, China, Denmark, Saudi Arabia, Indonesia, and Turkey. Designs ranged from randomised controlled trials to quasi-experimental and single-group pre-post studies, a nested observational cohort, and one qualitative study, enabling triangulation of quantitative effects with participant experience. A summary of the included studies is presented in Table 3, and their classification by theme, intervention, and outcome is shown in Table 4.

Table 3. Summary of included studies

Title	Author(s)	Year	Country	Method	Key Findings
The implementation of a community-based aerobic walking program for mild to moderate knee osteoarthritis: A knowledge translation randomized controlled trial: Part II: Clinical outcomes	Brosseau et al.	2012	Canada	RCT	All three groups (walking with behavioural intervention, walking only, and control) improved in quality of life and clinical outcomes; few between-group differences persisted long term, indicating community-embedded walking programs can be effective self-management.
Effectiveness of Kinesio Taping and Retro Walking Exercise on the Knee Range of Motion in Older People with Osteoarthritis	Putri and Yulianti	2020	Indonesia	Quasi-experimental	Both Kinesio taping and retro-walking improved knee range of motion in older adults with osteoarthritis, supporting retro-walking as a viable conservative option.
A pain science education and walking program to increase physical activity in people with symptomatic knee osteoarthritis: A feasibility study	Stanton et al.	2020	Australia	Feasibility RCT	Adding pain science education to a physiotherapist-led education-and-walking program was feasible in terms of recruitment, adherence, and retention, supporting a full-scale trial.
An Exploratory Study of the Effects of Aquatic Walking on Function and Muscle Activity in Knee Osteoarthritis: Part 2	Coons et al.	2023	USA	Single-group pre-post	An 8-week underwater treadmill walking program improved multiple activity-of-daily-living items, increased knee-flexion excursion during walking, and reduced antagonist co-activation during a step-down.
The effect of walking on cardiorespiratory fitness in adults with knee osteoarthritis	Larose et al.	2013	Canada	RCT	Supervised walking, with or without behavioural intervention, improved cardiorespiratory fitness more than unsupervised self-directed walking.
Walking exercise simultaneously combined with neuromuscular electrical stimulation of antagonists resistance improved muscle strength, physical function, and knee pain in symptomatic knee osteoarthritis: A single-arm study	Matsuse et al.	2017	Japan	Single-arm	Twelve weeks of walking combined with hybrid neuromuscular electrical stimulation increased knee-extension torque and improved physical function and knee pain.
Blood flow restricted walking in elderly individuals with knee osteoarthritis: a feasibility study	Petersson et al.	2022	Denmark	Feasibility (single-arm)	Blood-flow-restricted outdoor walking was feasible in elderly patients; completers improved functional performance and self-reported function, though dropouts related to higher baseline body mass index and pain.
The effect of low-load exercise on joint pain, function, and activities of daily living in patients with knee osteoarthritis	Peeler and Ripat	2018	Canada	Observational pre-post	A 12-week lower-body positive-pressure treadmill walking program reduced knee pain and improved joint function and activities of daily living in overweight patients.

Title	Author(s)	Year	Country	Method	Key Findings
Pre-exercise and acute movement-evoked pain trajectories during a 24-week outdoor walking program for knee osteoarthritis (WALK)	Drummen et al.	2024	Australia	Longitudinal cohort-within-trial	During a 24-week outdoor walking program, pre-exercise pain declined over time and acute movement-evoked pain flares were small, supporting the tolerability of sustained walking.
An Exploratory Study of Aquatic Walking on Symptoms and Functional Limitations in Persons with Knee Osteoarthritis: Part 1	Coons et al.	2023	USA	Single-group pre-post	An 8-week underwater treadmill walking program reduced knee pain and improved pain, stiffness, function, and timed up-and-go performance.
Effects of lower body positive pressure treadmill on functional improvement in knee osteoarthritis: A randomized clinical trial study	Chen et al.	2021	China	RCT	Two weeks of lower-body positive-pressure treadmill walking improved functional and biomechanical outcomes compared with conventional therapy.
A four-week walking exercise programme in patients with knee osteoarthritis improves the ability of dual-task performance: A randomized controlled trial	Hiyama et al.	2012	Japan	RCT	A 4-week walking program that increased daily step count improved dual-task walking performance relative to control.
Effect of 6-week retro or forward walking program on pain, functional disability, quadriceps muscle strength, and performance in individuals with knee osteoarthritis: A randomized controlled trial (retro-walking trial)	Alghadir et al.	2019	Saudi Arabia	RCT	A 6-week retro-walking program reduced pain and functional disability and improved quadriceps strength and performance more than forward walking or control.
Weight loss and exercise walking reduce pain and improve physical functioning in overweight postmenopausal women with knee osteoarthritis	Martin et al.	2001	USA	Uncontrolled pilot	A 6-month weight-loss and walking program produced meaningful weight loss and improved six-minute walk and aerobic capacity; pain and function gains concentrated among women who lost weight.
Effect of a walking program on gait characteristics in patients with osteoarthritis	Peterson et al.	1993	USA	RCT	An 8-week education-and-walking program increased six-minute walking distance and stride length at free and fast speeds versus control, improving gait function.
Effects of Long-Term Walking Exercise on Structural Progression, Symptoms, and Extensor Muscle Strength in Patients With Mild or at High Risk of Knee Osteoarthritis Data From the Osteoarthritis Initiative	Zhang et al.	2024	China	Nested cohort	Among early knee osteoarthritis participants, walking exercisers (particularly women) showed better symptoms and extensor strength without accelerated medial joint-space narrowing.
Perceptions about participation in a 12-week walking program for people with severe knee	Wallis et al.	2019	Australia	Qualitative	People with severe knee osteoarthritis were preoccupied with pain, damage, and expectation of surgery; a supervised walking

Title	Author(s)	Year	Country	Method	Key Findings
osteoarthritis: a qualitative analysis					program shifted some beliefs and was viewed as beneficial.
Managing knee osteoarthritis: The effects of body weight supported physical activity on joint pain, function, and thigh muscle strength	Peeler et al.	2015	Canada	Observational pre-post	A 12-week lower-body positive-pressure treadmill walking program reduced acute and chronic knee pain, improved function, and increased thigh muscle strength in overweight patients.
A home-based pedometer-driven walking program to increase physical activity in older adults with osteoarthritis of the knee: A preliminary study	Talbot et al.	2003	USA	RCT	A home-based pedometer-driven walking program added to self-management education increased physical activity and improved muscle strength and functional performance versus education alone.
Effects of a Digitally Supported Physical Activity Intervention in Knee Osteoarthritis: A Pilot Randomized Controlled Trial	Akgül et al.	2025	Turkey	Pilot RCT	Adding a digitally supported walking program to education and home exercise improved pain, physical function, exercise adherence, and quality of life in women with knee osteoarthritis.

Table 4. Classification of included studies by theme, intervention, and outcome

Author(s)	Year	Country	Research Design	Theme/Focus	Intervention	Outcome
Brosseau et al.	2012	Canada	RCT	Community walking & adherence	Community aerobic walking, with/without behavioural support	Quality of life, clinical outcomes
Putri and Yulianti	2020	Indonesia	Quasi-experimental	Retro-walking & ROM	Retro-walking exercise	Knee range of motion
Stanton et al.	2020	Australia	Feasibility RCT	Education-supported walking	Physio-led education + overground walking + pain science education	Feasibility, physical activity
Coons et al.	2023	USA	Single-group pre-post	Aquatic walking & function	Underwater treadmill walking, 8 wk	ADL function, gait mechanics
Larose et al.	2013	Canada	RCT	Walking & fitness	Supervised aerobic walking, with/without behavioural support	Cardiorespiratory fitness
Matsuse et al.	2017	Japan	Single-arm	Assisted walking & strength	Walking + hybrid neuromuscular electrical stimulation, 12 wk	Strength, function, pain
Petersson et al.	2022	Denmark	Feasibility (single-arm)	Load-modified walking	Blood-flow-restricted outdoor walking, 8-10 wk	Feasibility, function
Peeler and Ripat	2018	Canada	Observational pre-post	Unloaded treadmill walking	Lower-body positive-pressure treadmill walking, 12 wk	Pain, function, ADL
Drummen et al.	2024	Australia	Longitudinal cohort-within-trial	Walking tolerability & pain	Supervised outdoor walking, 24 wk	Pain trajectory, performance

Coons et al.	2023	USA	Single-group pre-post	Aquatic walking & pain	Underwater treadmill walking, 8 wk	Pain, WOMAC, mobility
Chen et al.	2021	China	RCT	Unloaded treadmill walking	Lower-body positive-pressure treadmill walking, 2 wk	Function, biomechanics
Hiyama et al.	2012	Japan	RCT	Walking & dual-task function	Step-count walking program, 4 wk	Dual-task performance
Alghadir et al.	2019	Saudi Arabia	RCT	Retro vs forward walking	Retro or forward walking, 6 wk	Pain, disability, strength
Martin et al.	2001	USA	Uncontrolled pilot	Weight-loss walking	Weight loss + walking, 6 mo	Pain, function, walk test
Peterson et al.	1993	USA	RCT	Walking & gait	Education + walking, 8 wk	Walking distance, stride
Zhang et al.	2024	China	Nested cohort	Long-term walking & structure	Habitual walking exercise (cohort)	Symptoms, strength, structure
Wallis et al.	2019	Australia	Qualitative	Perceptions of walking	Supervised walking, 12 wk	Beliefs, perceptions
Peeler et al.	2015	Canada	Observational pre-post	Unloaded treadmill walking	Lower-body positive-pressure treadmill walking, 12 wk	Pain, function, strength
Talbot et al.	2003	USA	RCT	Home pedometer walking	Home pedometer walking + self-management	Physical activity, strength
Akgül et al.	2025	Turkey	Pilot RCT	Digital walking	Digitally supported walking + home exercise	Pain, function, adherence, quality of life

The temporal distribution of the included studies is displayed in Figure 2, which shows a clear increase in walking-focused osteoarthritis research over the last decade and a diversification of walking modalities from predominantly overground and community walking toward treadmill-based, aquatic, and technology-supported formats. The geographic distribution is presented in Figure 3, and the relative frequency of outcome-related themes across the included studies is shown in Figure 4.

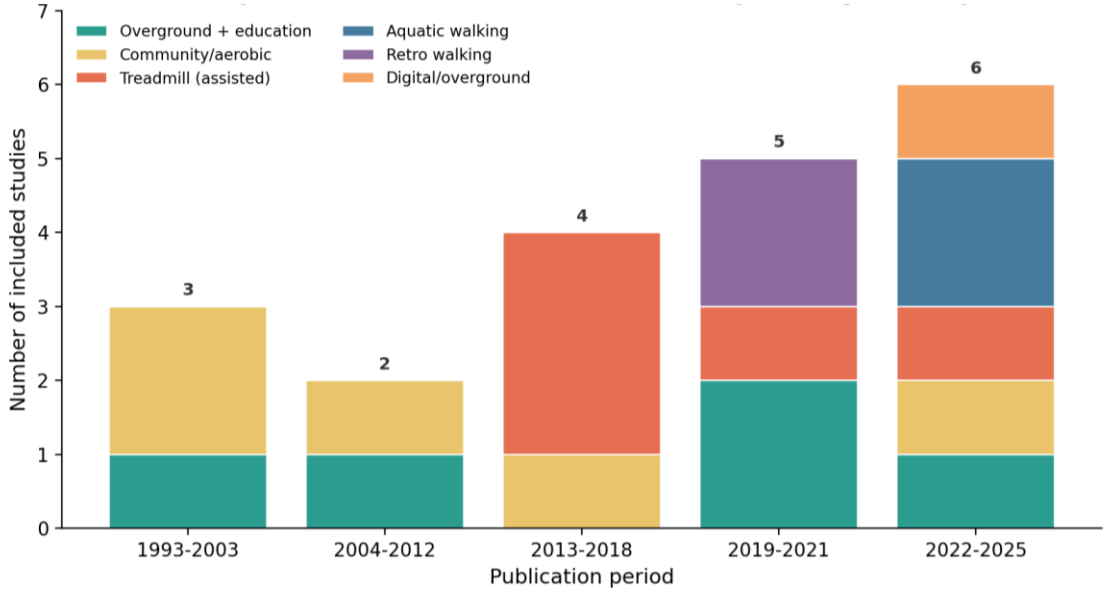

Figure 2. Temporal distribution of included studies by walking modality

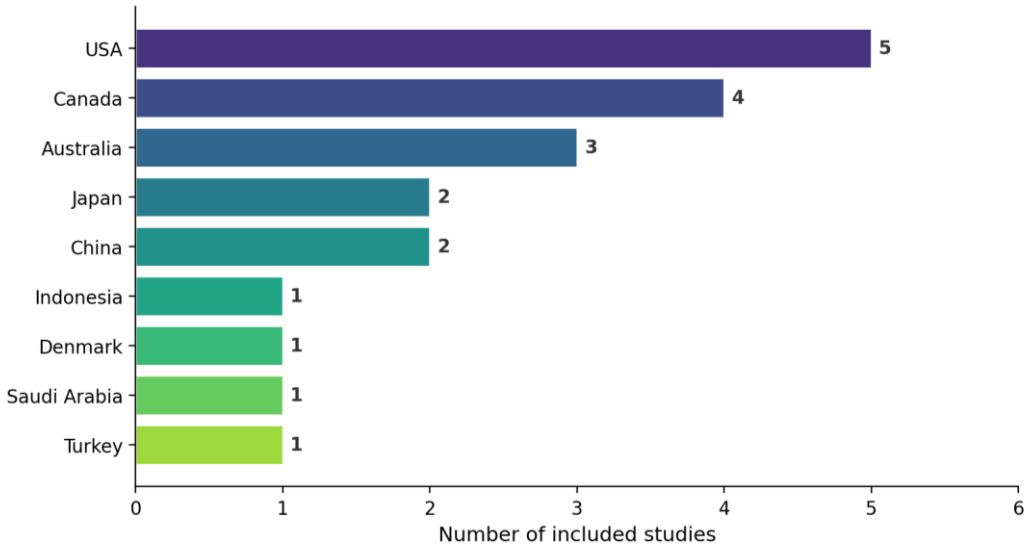

Figure 3. Geographic distribution of included studies.

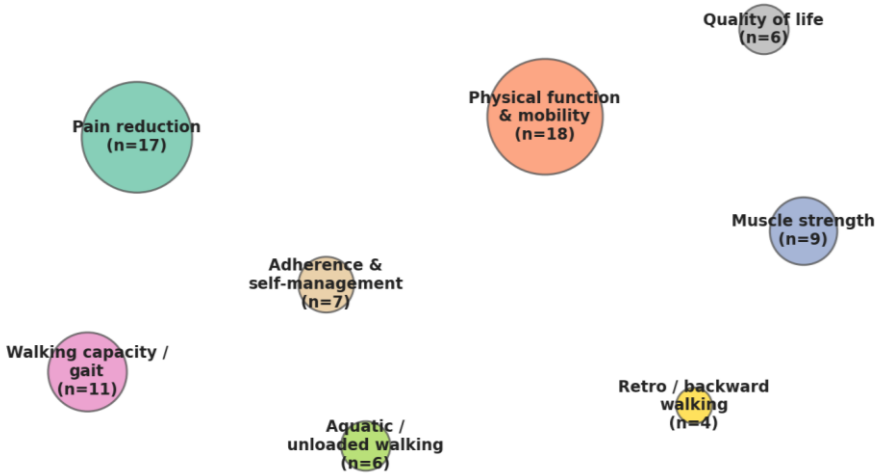

Figure 4. Thematic clusters and outcome frequency across included studies

Thematic Synthesis

The synthesis was organised around the two research questions. Findings related to pain relief are presented first, followed by the intervention characteristics associated with functional and mobility improvement. Across both questions, the included studies were examined for convergent evidence, contradictions, and contextual nuances.

Effectiveness of Walking Programs for Pain Relief

The included studies provide broadly convergent evidence that structured walking programs reduce knee pain in adults with osteoarthritis, addressing RQ1. Randomised and controlled evaluations reported reductions in pain and functional disability following supervised walking. Alghadir et al. (2019) found that a six-week retro-walking program reduced pain and disability more than forward walking or usual care, while overground and unloaded treadmill walking programs likewise lowered knee pain and improved activities of daily living (Peeler & Ripat, 2018). Aquatic and underwater-treadmill walking reduced pain and improved symptom scores in adults with knee osteoarthritis (Coons et al., 2023a), and a digitally supported walking program reduced pain severity alongside gains in function and adherence (Akgül et al., 2025). Longitudinal data from a 24-week outdoor walking program showed that pre-exercise pain declined over time and that acute movement-evoked pain flares were small and transient, suggesting that sustained walking is well tolerated rather than symptom-provoking (Drummen et al., 2024).

Nuances qualify this generally positive picture. Some benefits were concentrated in particular subgroups or were contingent on additional components. In a weight-loss and walking program, improvements in pain and function were most evident among participants who achieved weight loss, indicating that co-interventions can modulate the analgesic effect of walking (Martin et al., 2001). Observational cohort

evidence from the Osteoarthritis Initiative found symptomatic benefit among walking exercisers, especially women, without evidence of accelerated structural progression, which supports the safety of habitual walking for symptom control (Zhang et al., 2024). Qualitative findings add that people with severe disease often begin walking programs preoccupied with pain and the belief that surgery is inevitable, yet many revise these beliefs after participating, implying that pain relief is partly mediated by changes in pain-related cognitions (Wallis et al., 2019). Taken together, walking programs appear to reduce pain reliably, with magnitude shaped by dose, adjunct behavioural or weight-management components, and baseline disease severity.

Intervention Characteristics Associated with Functional and Mobility Improvement

Addressing RQ2, the included studies indicate that improvements in physical function and mobility are associated with specific program characteristics, particularly supervision, progressive dosing, and sufficient duration. Supervised walking produced greater gains in cardiorespiratory fitness than unsupervised self-directed walking, underscoring the value of structured delivery (Larose et al., 2013). Programs that progressively increased walking volume or step count improved walking distance, stride length, and dual-task performance (Peterson et al., 1993), and an incremental step-count program over four weeks enhanced automaticity during dual-task walking (Hiyama et al., 2012). Home-based, pedometer-driven walking combined with self-management education increased physical activity and functional performance relative to education alone, showing that self-monitoring and behavioural support can substitute in part for direct supervision (Talbot et al., 2003). Community aerobic walking embedded in existing walking clubs improved quality of life and clinical outcomes, indicating that scalable, real-world delivery can be effective when adequately supported (Brosseau et al., 2012b).

The manner in which mechanical load is managed also shapes functional outcomes. Lower-body positive-pressure treadmill walking, which reduces joint loading, improved function and biomechanics over short and medium durations (Chen et al., 2021), and comparable unloaded treadmill programs improved function and muscle strength in overweight patients across 12 weeks (Peeler et al., 2015). Load-modified approaches such as blood-flow-restricted walking were feasible and improved functional performance despite low mechanical load (Petersson et al., 2022), while combining walking with hybrid neuromuscular electrical stimulation augmented knee-extensor strength and function (Matsuse et al., 2017). Aquatic walking improved activity-of-daily-living function and favourable gait mechanics (Coons et al., 2023b), and retro-walking improved range of motion and quadriceps strength (Putri & Yulianti, 2020). Feasibility trials adding education to walking supported the integration of cognitive components to promote engagement (Stanton et al., 2020). Collectively, functional and mobility gains were most consistent when programs were supervised or self-monitored, progressed in volume or intensity, sustained for at least several weeks, and, where joint loading was a concern, delivered with load-reducing modalities.

Comparative and Critical Analysis

Methodologically, the evidence base is dominated by small trials and single-group designs, with fewer adequately powered randomised controlled trials. Randomised designs were used in several studies (Alghadir et al., 2019) (for example, retro-walking, dual-task walking, and pedometer-driven walking), whereas many promising modalities such as aquatic and unloaded treadmill walking were tested predominantly in single-group or feasibility formats (Coons et al., 2023a). This distribution means that the modalities generating the most mechanistic interest are supported by the least robust designs. Outcome measurement was also heterogeneous, spanning the Western Ontario and McMaster Universities Osteoarthritis Index, the Knee injury and Osteoarthritis Outcome Score, numerical pain scales, and diverse performance tests, which complicates direct comparison and precludes pooling. Over time, the field has evolved from simple overground and community walking toward technologically mediated and load-modified formats, mirroring parallel developments in gait retraining (Wang et al., 2021) and sensor-guided approaches (Cheung et al., 2018). Reporting of dosing parameters, particularly intensity and supervision, remains inconsistent, limiting the precision with which optimal prescriptions can be defined.

Interpreted together, the findings indicate that walking exercise programs are an effective and broadly safe strategy for reducing pain and improving physical function in adults with knee osteoarthritis, and that their benefits are shared across multiple delivery formats rather than confined to a single modality. The consistency of pain and function improvements across overground, community, treadmill-based, aquatic, and retro-walking programs suggests that the therapeutic value of walking arises from its capacity to restore loading, muscle activation, and confidence rather than from any single technique. This interpretation aligns with the observation that symptomatic benefit occurs without accelerated structural progression (Zhang et al., 2024), reinforcing a functional rather than disease-modifying mechanism.

Theoretically, the results extend biomechanical and behavioural models of osteoarthritis management. The gains observed with unloaded and aquatic walking support load-management frameworks in which reducing peak joint stress permits therapeutic activity that would otherwise exacerbate symptoms (Peeler et al., 2015), while mechanistic work on muscle-tendon capacity (Karamanidis et al., 2014) and on exercise effects on joint tissue (Beckwée et al., 2017) situates walking within adaptive musculoskeletal responses. The qualitative evidence that walking alters unhelpful pain beliefs (Wallis et al., 2019) connects these physical mechanisms to contemporary pain-science models, suggesting that walking operates through combined biomechanical, neuromuscular, and cognitive pathways. Evidence that habitual walking relates to preserved extensor strength further links activity to neuromuscular maintenance in early disease (Vakula et al., 2019).

Practically, the findings offer actionable guidance for clinicians, physiotherapists, and program designers. Walking can be recommended as an accessible first-line intervention, with supervision, progressive dosing, and self-monitoring prioritised to maximise functional gains (Larose et al., 2013) (Talbot et al., 2003). For patients with obesity or high symptom burden, load-reducing formats such as unloaded or aquatic walking provide tolerable entry points (Peeler & Ripat, 2018), and pairing walking with weight management amplifies benefit (Martin et al., 2001). Embedding programs in community settings and existing clubs supports scalability and adherence (Brosseau et al., 2012a), and cost considerations are increasingly relevant as low-cost walking programs are evaluated for wider implementation (Kumara et al., 2024).

Relative to prior reviews, the present synthesis is consistent with evidence that land-based exercise therapy can improve physical-activity behaviour in knee osteoarthritis (Bell et al., 2022) and with clinical practice guidelines endorsing aerobic walking (Loew et al., 2012). It also complements a recent meta-analysis reporting that backward-walking exercises combined with conventional rehabilitation reduce pain and disability (Lin et al., 2026), extending that modality-specific conclusion across the broader family of walking interventions. At the same time, contradictions remain in the literature. Community walking trials found limited long-term between-group differences despite within-group improvement (Brosseau et al., 2012b), and combined-exercise studies report heterogeneous effects on biomarkers and structure (Oğuz et al., 2021), indicating that the durability and mechanisms of benefit are not fully resolved.

Several research gaps are apparent. First, few studies directly compare walking modalities under standardised dosing, leaving the relative effectiveness of overground, aquatic, unloaded, and retro-walking undetermined. Second, long-term and structural outcomes are underexamined; although some longer exercise trials exist (Messier et al., 2000b), most walking trials are limited to weeks rather than years, and many emerging approaches remain at the protocol stage (Almutairi et al., 2023) (Stanton et al., 2021) (Corrigan et al., 2020) (Zhang et al., 2026) (Kobayashi et al., 2026). Third, mechanistic and multicomponent questions, including how walking interacts with strengthening (Obuchi et al., 2010), robotic or assisted gait (Fukaya et al., 2021), novel therapies (Huang et al., 2024), and the postsurgical pathway (Hanlon et al., 2026), remain insufficiently integrated with symptom outcomes. Implementation research in veteran and other real-world populations is also limited (Wang et al., 2018).

This review has limitations. Reliance on a single database (Scopus) may have omitted eligible studies indexed elsewhere, and restriction to English-language, final-stage journal articles may introduce language and publication bias. The heterogeneity of designs and outcomes precluded meta-analysis, so conclusions rest on narrative synthesis, and the quality appraisal reported here is provisional and should be completed at the full-text level by two independent reviewers. Country of origin was derived from author affiliation information and should be verified against full texts. Finally, the predominance of small and single-group studies limits the strength of causal inference for several walking modalities.

Future research should prioritise adequately powered randomised controlled trials that directly compare walking modalities under harmonised dosing and standardised core outcome sets, extend follow-up to capture long-term symptomatic and structural effects, and report intensity and supervision parameters transparently. Trials should also integrate behavioural and pain-education components with biomechanical load management (Stanton et al., 2020), evaluate digital and sensor-supported delivery at scale (Akgül et al., 2025), and incorporate cost-effectiveness and implementation outcomes to support translation into routine care (Kumara et al., 2024). In summary, walking exercise programs reduce knee pain (RQ1) and improve physical function and mobility, with the largest and most consistent benefits associated with supervised or self-monitored, progressively dosed, and adequately sustained programs, and with load-reducing formats for patients with higher joint loading (RQ2).

Conclusions

This systematic literature review synthesised 20 primary studies and found that walking exercise programs are an effective and broadly safe strategy for managing knee osteoarthritis. Walking consistently reduced knee pain and improved physical function and mobility across overground, community, treadmill, aquatic, and retro-walking formats, with the largest and most consistent benefits associated with supervised or self-monitored, progressively dosed, and adequately sustained programs, and with load-reducing modalities for patients with higher joint loading. The core contribution of this review is an integrated, modality-spanning appraisal that positions walking as an accessible first-line self-management option for clinicians and patients. Its conclusions are tempered by heterogeneous designs, inconsistent dosing reports, and reliance on a single database. Future adequately powered trials should standardise dosing and outcomes, extend follow-up, and evaluate implementation to confirm the long-term symptomatic and functional value of walking.

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