Power System Technology
ISSN:1000-3673

Received: 16-11-2025 *Revised: 05-12-2025* *Accepted: 28-01-2026*

Conservative Management to Slow Disease Progression in Mild-to-Moderate Knee Osteoarthritis in Older Adults: A Narrative Review

[1]Ibrahim Mohammed E Al Jumaan, [2]Mohammed Saeed Mohammed Al Qahtani [2]Mohammed Theyab D Al Subaie, [2]Mohammed Ghatar M Alshibani, [2]Assaf Fahad Assaf Al Otaibi, [3]Saeed Ali M Al Theeb, [3]Abdulaziz Atiah M. Qaysi, [4]Saeed Awadh A Alasmari, [5]Ahmed Yaseen Al Refaei, [6]Meshal Ahmad Abdullah Al Dhubabian, [7]Rakan Mahdi H Al Dawsari, [8]Omar Mualla Mashan Al Otaibi, [8]Fahad Obaid Matar Al Otaibi, [8]Hamad Dakhilallah M Al Otaibi

[1]King Fahad Military Medical Complex
[2]Prince Sultan Military Medical City
[3]Armed Forces Hospital Southern Region
[4]Alhada Armed Forces Hospital
[5]King Salman Armed Forces Hospital Tabuk
[6]King Fahad Armed Forces Hospital Jeddah
[7]Najran Armed Forced Hospital
[8]Land Force Medical Administration

Abstract

Mild-to-moderate knee osteoarthritis (KOA) in older adults is a contributor to pain, mobility limitation, and healthcare use, and its burden is expected to rise with ageing. Yet "mild-to-moderate" KOA is not uniformly defined: symptoms, physical function, and radiographic change can be discordant, and definitions of early disease yield different probabilities of worsening. This variability matters because progression-oriented conservative care depends on identifying patients likely to deteriorate without timely intervention and tracking outcomes that reflect meaningful change in daily function.

This narrative review synthesizes peer-reviewed evidence published from 2020 to 2025 on conservative strategies intended to slow progression in mild-to-moderate KOA among older adults. The synthesis is anchored to guideline-consistent core care—education and self-management, individualized therapeutic exercise, and weight management when indicated—while viewing symptom-modulating modalities as adjuncts that support participation rather than replace core care. Conservative-care success or failure is framed by two linked domains: physiological determinants that influence capacity to engage and respond, and care-environment determinants that shape access, adherence, and sustainability.

Physiological reserve is a central determinant in later life. Evidence indicates sarcopenia is prevalent in KOA, supporting the rationale for targeting strength and physical performance to

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

improve load distribution, joint stability, and activity tolerance. Frailty adds vulnerability that can constrain intensity and increase safety needs; observational evidence suggests KOA and frailty may reinforce one another over time, implying that programs should identify low reserve early and adapt progression, supervision, and monitoring accordingly.

Weight management is a high-yield lever when excess body mass contributes to mechanical overload and systemic risk. Evidence supports integrated diet-plus-exercise approaches for improving pain and disability in eligible patients, while dietary interventions show overall benefit with heterogeneity across patterns and trial designs. Cohort evidence linking weight fluctuation to symptom progression in radiographic KOA underscores the importance of sustainable change and long-term maintenance.

Exercise therapy remains the most consistently supported non-pharmacologic intervention and can be adapted to heterogeneous reserve. Strengthening-based programs are effective across delivery formats, and meta-analytic evidence supports adding proprioceptive or neuromuscular components to address balance and joint-control deficits relevant to ageing. Delivery context is outcome-relevant: home-based exercise can achieve meaningful improvements when travel, cost, or capacity constraints limit center-based care, and technology-enabled approaches
(telerehabilitation and digital physiotherapy) can extend reach. Evidence suggests consistent pain improvement with remote delivery, whereas functional effects are more variable and may depend on adequate progression and support.

Adjunctive modalities may be justified when symptoms prevent participation. Intra-articular corticosteroid injection provides short-term relief and is best framed as a time-limited "window" to enable exercise uptake. Comparative analyses suggest possible longer-term symptom benefit for selected injectables (including platelet-rich plasma and hyaluronic acid), but heterogeneity limits conclusions about structural modification. Cryotherapy can provide low-cost symptom relief to support adherence during flares.

Overall, the most defensible progression-oriented approach is to define success by sustained function and participation, stratify vulnerability, deliver progressive strengthening with neuromuscular elements, match delivery mode to patient context, and use adjuncts selectively to enable adherence.

Keywords: knee osteoarthritis, older adults, conservative management, disease progression, exercise therapy, weight management, frailty, sarcopenia, telerehabilitation, digital physiotherapy.

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

Introduction

Osteoarthritis (OA) is a chronic musculoskeletal disorder characterized by joint pain, functional limitation, and progressive structural changes over time. When OA primarily affects the
tibiofemoral and/or patellofemoral compartments, it is referred to as KOA. KOA is strongly age- associated and becomes increasingly common and clinically consequential in older adults, in whom mobility, independence, and participation in daily activities are often more vulnerable to relatively small declines in lower-limb capacity. In global terms, OA already represents a major public health burden: in 2020, an estimated 595 million individuals were living with OA
worldwide (7.6% of the global population), and projections suggest that the number of OA cases may exceed 1 billion by 2050, largely reflecting population ageing and growth (Steinmetz et al., 2023).

Beyond its high prevalence, KOA is burdensome because it is a leading contributor to years lived with disability (YLDs), a summary measure that reflects time spent in less-than-full health due to disease (Steinmetz et al., 2023). In older adults, disability related to KOA is rarely "single-cause." Instead, pain-related activity restriction can accelerate deconditioning, which can in turn amplify pain sensitivity, reduce walking confidence, and increase fall risk. These interlocking pathways make KOA particularly disruptive in later life, when baseline muscle mass and physiologic reserve are often reduced. Indeed, recent evidence indicates that sarcopenia (age- and disease-associated loss of skeletal muscle mass and function) is common among people with KOA and is associated with multifactorial risk profiles, underscoring the need to interpret symptoms and functional decline within a broader geriatric context (Chen et al., 2025).

A key challenge for both clinical practice and research is that "mild-to-moderate" KOA is not a single, universally standardized category. In real-world care, the term commonly indicates symptomatic KOA that has not yet reached end-stage structural damage or refractory, pervasive disability—yet studies operationalize this concept using different combinations of clinical features, imaging findings, and risk markers. Radiographic severity is frequently expressed using the Kellgren–Lawrence (KL) grading system (KL grade 0–4), but thresholds for eligibility or stratification vary across trials and cohorts. Importantly, "early" or "less advanced" KOA definitions can yield substantially different study populations and different observed rates of subsequent worsening, which directly affects the feasibility of evaluating progression-slowing interventions within typical follow-up windows (Liew et al., 2025).

These definitional issues matter because the concept of "disease progression" in KOA is multidimensional and can be assessed from at least three complementary angles: structural

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

progression, symptomatic progression, and functional progression. Structural progression refers to worsening joint pathology measured by imaging or other structural endpoints; symptomatic progression reflects persistent or worsening pain and other symptoms over time; and functional progression captures decline in mobility, activities of daily living, and broader participation.

Crucially, these domains do not always move in parallel. Some individuals experience symptom improvement despite measurable structural deterioration, while others have fluctuating symptoms that do not neatly track imaging change. From a mechanistic standpoint, KOA is increasingly understood as involving the whole joint (including cartilage, subchondral bone, synovium, menisci, and periarticular tissues), which helps explain why "progression" may manifest differently across patients and why prediction remains challenging (Martel-Pelletier & Pelletier, 2025).

In addition, the practical meaning of progression depends on the question being asked. For health systems and patients, progression is often framed in terms of disability trajectories and the likelihood of requiring advanced interventions. For researchers, progression must be captured using operational definitions that are sensitive to change within feasible study durations. Liew and colleagues demonstrated that different early-stage KOA definitions identify different proportions of people who exhibit "worsening OA" over 2–5 years, illustrating how endpoint selection and baseline categorization can influence apparent progression rates and, therefore, the ability to test progression-modifying strategies (Liew et al., 2025). This variability is particularly relevant for older adults, in whom competing risks (e.g., comorbidities that limit exercise tolerance or access to care) may shape observed trajectories and treatment response.

Against this background, conservative management is central to KOA care—especially before escalation to surgery. In this review, "conservative management" refers to non-surgical interventions aiming to reduce symptoms, maintain or improve function, and potentially slow decline through modifiable behavioral and biomechanical pathways. Conservative strategies are emphasized in part because joint replacement is typically reserved for advanced disease and, while effective for many, is not universally accessible and may be constrained by cost and system capacity; global analyses highlight that arthroplasty is expensive and unaffordable for many people worldwide (Steinmetz et al., 2023). In older adults, conservative care is also clinically attractive because it can be tailored to frailty, comorbidity burden, and patient priorities (e.g., maintaining independence, preserving walking ability, or avoiding medication harms). Yet conservative management is not a single intervention; it is a set of interacting components whose effectiveness depends on patient-level determinants (e.g., baseline muscle strength, sarcopenia, pain sensitivity, adherence capacity) and care-environment

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

determinants (e.g., access to physiotherapy, multidisciplinary support, and follow-up structures).

Weight management is a salient example of both the promise and complexity of conservative care. Excess body weight increases mechanical load across the knee and can worsen symptoms,
but achieving and sustaining weight loss requires behavioral change, ongoing support, and often multimodal programming. In a systematic review with meta-analysis including OA populations, weight-loss interventions were associated with reductions in pain and disability across common musculoskeletal disorders, supporting weight management as a clinically meaningful
conservative target (Robson et al., 2020). For older adults, however, the "how" of weight management is as important as the "whether," because energy restriction without attention to protein intake and resistance exercise may risk exacerbating sarcopenia—an increasingly recognized comorbidity in KOA (Chen et al., 2025). This highlights the need to consider physiologic reserve and muscle health when evaluating conservative programs intended to slow functional decline.

The care environment can further determine whether evidence-based conservative strategies translate into real-world benefit. Access to in-person rehabilitation is uneven, and adherence to home programs often wanes without feedback and reinforcement. TR—defined here as the remote delivery of rehabilitation interventions using communication technologies—has been proposed as one way to extend reach and continuity of care. However, evidence remains mixed and outcome-dependent. In a systematic review and meta-analysis, TR programs were associated with consistent pain relief, while physical function outcomes were mixed and sometimes non-significant; the authors also emphasized limitations related to the number and quality of available studies (Xiang et al., 2023). These findings suggest that digital delivery may reduce barriers to engagement and support symptom relief, yet functional gains may require specific program features (e.g., adequate loading progression, supervision intensity, or adherence supports) that vary across implementations.

Taken together, the burden of KOA in older adults, the heterogeneity in what constitutes "mild- to-moderate" disease, and the multidimensional nature of progression provide a strong rationale for carefully synthesizing conservative approaches through a progression-oriented
lens. The premise is not that every conservative intervention is disease-modifying in a structural sense, but that earlier-stage, non-surgical management may preserve function, reduce
symptom-driven inactivity, and potentially alter trajectories that culminate in severe disability or surgical escalation—particularly when interventions are tailored to patient physiology

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

(including sarcopenia risk) and delivered within supportive care environments.

Accordingly, the aim of this narrative review is to synthesize recent (2020–2025) peer-reviewed evidence on conservative management strategies intended to slow disease progression in mild- to-moderate KOA among older adults, with explicit attention to determinants of success and failure at two levels: (1) clinical and physiological determinants (e.g., symptom patterns, functional status, sarcopenia-related vulnerability) and (2) care-environment determinants (e.g., accessibility and delivery models such as in-person versus remote rehabilitation support).

Guided by the progression framework outlined above, the review addresses the following questions: How is mild-to-moderate KOA commonly operationalized in contemporary studies, and what are the implications for identifying progression? How should structural, symptomatic, and functional progression be conceptualized when evaluating conservative care? Which
conservative modalities show the most consistent signals for maintaining function and limiting worsening in older adults, and under what delivery conditions? In the subsequent sections, the review focuses on key conservative domains frequently used in practice—weight reduction,
exercise and physical therapy, activity modification, injections, and symptomatic modalities such as cryotherapy—while emphasizing the patient and system factors that shape real-world outcomes.

Literature Review

Conceptual Framework

KOA is a chronic, whole-joint condition in which structural changes in articular cartilage, subchondral bone, synovium, menisci, and periarticular tissues interact with pain processing and movement adaptations to produce symptoms and disability. Contemporary clinical guidance converges on a "core" conservative platform—education/self-management support plus therapeutic exercise (and, when appropriate, weight management)—because these components are consistently associated with improved pain and function and can be delivered across settings. However, when the stated goal is to *slow disease progression* in mild-to-
moderate KOA, the literature becomes more nuanced: "progression" is not a single endpoint, and the evidence base is heterogeneous in (1) how disease stage is defined, (2) which
progression outcomes are selected, and (3) the follow-up duration needed to detect structural change. Major guidance documents reflect this reality by emphasizing patient-centered functional goals, symptom control, and risk-factor modification rather than promising consistent structural disease modification from conservative care alone (American Academy

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

of Orthopaedic Surgeons, 2021; National Institute for Health and Care Excellence, 2022; Australian Commission on Safety and Quality in Health Care, 2024).

In studies labeled "mild-to-moderate" KOA, eligibility often relies on radiographic grading (commonly KL grades 1–3), symptom thresholds, or combinations of imaging and clinical criteria; consequently, the same intervention can appear more or less "progression-modifying" depending on whether the cohort is defined by early symptoms, early imaging, or both. In older adults, additional complexity arises because age-related changes in muscle, connective tissue, and pain modulation can amplify functional decline without parallel radiographic worsening, while comorbidity burden can limit intervention intensity. Therefore, a progression-oriented conservative framework is most defensible when it explicitly separates structural progression (e.g., radiographic joint space narrowing or MRI-based tissue change) from symptomatic progression (e.g., persistent pain escalation, reduced walking capacity, increasing disability, or increased need for pharmacologic escalation) and treats total knee arthroplasty as a downstream, multifactorial endpoint rather than a pure structural proxy (American Academy of Orthopaedic Surgeons, 2021; National Institute for Health and Care Excellence, 2022).

Within that framing, conservative targets can be mapped to progression pathways that are biologically plausible and clinically actionable. First, mechanical load matters: peak and cumulative tibiofemoral loading, altered gait mechanics, and reduced shock absorption can intensify joint tissue stress. Second, low-grade inflammation and metabolic dysregulation—particularly relevant in overweight/obese phenotypes—may contribute to synovitis and symptom persistence, and may correlate with structural change in some cohorts. Third, neuromuscular control influences joint stability and movement efficiency; weakness, impaired proprioception (the sense of joint position and motion), and poor balance can increase aberrant loading and fall risk, thereby worsening functional trajectory. Conservative care is positioned to address these domains through (a) weight reduction and load management, (b) structured exercise and physical activity, (c) neuromuscular and balance retraining, and (d) symptom-modulating adjuncts (e.g., injections or cryotherapy) that may enable engagement with the core platform. Importantly, the *strongest and most consistent* evidence for conservative interventions remains symptomatic and functional improvement, while evidence for slowing structural change is more limited and often indirect—one reason why guidelines prioritize sustained function, safe physical activity, and risk-factor modification rather than claiming structural disease modification as a routine outcome (Huffman et al., 2024; Kitagawa et al., 2025).

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

Patient Age as a Progression Modifier

Age shapes KOA progression through more than elapsed time. Chronological age is the calendar measure, whereas biological age reflects physiological reserve across organ systems (e.g.,
musculoskeletal strength, cardiometabolic status, and inflammatory burden). In older adults, biological vulnerability can dominate functional outcomes: two individuals of the same chronological age can differ greatly in mobility reserve, pain tolerance, balance, and capacity to adhere to exercise or weight-management plans. This distinction is clinically important because conservative management success depends not only on the intervention "dose" but also on the patient's ability to safely perform and sustain it over time (National Institute for Health and Care Excellence, 2022; Huffman et al., 2024).

Frailty—a multidimensional syndrome of reduced physiological reserve and increased vulnerability to stressors—becomes particularly relevant when targeting progression in older adults. An updated review of frailty measurement emphasizes that frailty is common globally in older populations and that frailty assessment can inform clinical decision-making and care planning (Dent et al., 2025). In a longitudinal Chinese cohort of middle-aged and older adults,
KOA and frailty showed a bidirectional relationship, with frailty demonstrating a stronger predictive association with subsequent KOA than the reverse in that analysis (Tian et al., 2025). While causal pathways cannot be assumed from observational data, these findings support a practical interpretation for conservative care: if frailty (and the behaviors and physiologic constraints that accompany it) precedes or accelerates KOA-related decline, then progression- oriented management in older adults should incorporate frailty-informed tailoring—simplifying programs, prioritizing safety, emphasizing gradual progression, and addressing environmental barriers to adherence.

Frailty overlaps with sarcopenia, which can be defined clinically as age-associated loss of muscle mass and muscle function (strength and/or performance). Sarcopenia is relevant to KOA
because muscle weakness and reduced power limit shock absorption and dynamic knee stability. A large cross-sectional analysis of U.S. adults reported an association between sarcopenia and osteoarthritis occurrence, while also underscoring that subgroup effects and definition choices can influence observed relationships (Peng et al., 2024). These data do not establish temporality, but they strengthen the rationale for integrating resistance training and protein-adequate dietary strategies (within individualized medical constraints) when the goal is to slow functional decline in older adults with KOA.

Comorbidity burden further modifies progression risk and intervention feasibility.

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

Cardiometabolic disease, chronic pain comorbidities, vestibular impairment, neuropathy, and polypharmacy can constrain exercise selection and intensity; cognitive impairment and depression can undermine adherence; and social determinants (transportation, caregiving responsibilities, or limited access to supervised care) influence the sustainability of conservative plans. A mixed-method exploratory study of osteoarthritis care implementation identified barriers including misconceptions about osteoarthritis, insurance constraints, insufficient multidisciplinary collaboration, workplace limitations, and low patient adherence—while highlighting facilitators such as telehealth/community delivery pathways and education resources (Wang et al., 2025). For older adults, these "care environment" determinants can be progression-relevant because they govern whether core interventions (exercise, education, weight management) are delivered consistently enough to plausibly influence long-term outcomes.

Weight Reduction (Anthropometric Modification)

The rationale for weight reduction in KOA extends beyond "less weight equals less pain." Weight reduction plausibly modifies progression through joint loading (lower compressive forces across the knee during walking and stair tasks) and through metabolic/inflammatory pathways linked to adiposity. Contemporary clinical guidance consistently identifies weight management as a key conservative strategy, especially for individuals with overweight or obesity, because it can reduce symptoms and enable more effective participation in exercise programs (National Institute for Health and Care Excellence, 2022; Huffman et al., 2024).

Randomized trial evidence in KOA populations with overweight/obesity supports the symptomatic value of combined lifestyle programs but also illustrates realistic effect sizes. In a randomized clinical trial evaluating diet and exercise versus attention control over 18 months, diet-plus-exercise produced a statistically significant yet small difference in knee pain, with the clinical importance of that pain difference described as uncertain (Messier et al., 2022). This finding is still progression-relevant in older adults because (1) even modest symptom improvement can increase daily activity and participation in strengthening, and (2) sustained lifestyle change may reduce repeated flare cycles that drive inactivity, deconditioning, and functional decline.

Dietary approaches vary widely (energy restriction, macronutrient manipulation, "pattern-based" diets), and the evidence suggests that *diet interventions can help* but that no single named pattern consistently dominates across outcomes. A systematic review and meta-analysis of randomized trials concluded that dietary interventions can improve pain, physical function, and weight-related outcomes in osteoarthritis, while noting that specific dietary patterns (e.g., Mediterranean diet) showed inconsistent effects and warrant further study (Asadi et al., 2025).

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

For older adults, the practical implication is not to overpromise any single diet identity but to prioritize feasible, protein-adequate, micronutrient-sufficient caloric reduction strategies that preserve muscle function while achieving weight change—coordinated with medical care when comorbidities (e.g., diabetes, renal disease) require constraints.

Weight management strategies should also consider *weight stability*, not only weight loss. In a longitudinal cohort analysis of radiographic knee osteoarthritis, body-weight fluctuations were associated with symptom progression, and the authors suggested that maintaining stable body weight may help alleviate symptom progression (Fu et al., 2025). Although structural
progression was not the sole endpoint and causality cannot be inferred, these findings align with a pragmatic progression-oriented approach: emphasize sustainable routines and relapse prevention, rather than short bursts of aggressive restriction that trigger rebound weight gain and repeated symptom exacerbations.

Combining weight reduction with exercise is consistently emphasized because weight loss alone does not address neuromuscular deficits and can risk lean mass loss in older adults if not paired with resistance training. Community- and clinic-based self-management interventions highlighted in recent narrative synthesis emphasize pairing physical activity with weight
strategies and offering multiple delivery options (in-person, community programs, and online supports) to improve long-term adherence (Huffman et al., 2024). In progression terms, the target becomes not only symptom relief but also improved movement capacity and daily activity—key mediators of functional reserve in aging.

Physical Therapy and Knee Muscle Strength

Physical therapy (PT) in KOA typically refers to a structured, individualized program of therapeutic exercise, functional training, and education delivered by trained clinicians, often with progression over time. The exercise component is commonly categorized into strengthening (resistance training), aerobic conditioning (walking, cycling, aquatic exercise), and flexibility/range-of-motion work, with additional components such as neuromuscular training and balance/proprioception exercises. Across clinical guidance, exercise is repeatedly positioned as a first-line intervention because it improves pain and function with a generally favorable safety profile when appropriately tailored (American Academy of Orthopaedic Surgeons, 2021; National Institute for Health and Care Excellence, 2022).

An overview of systematic reviews in KOA found that many reviews reported improvement across outcomes with exercise therapy, while also drawing attention to methodological limitations in the review literature (Kitagawa et al., 2025). This matters for progression

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

claims: the consistent symptomatic benefit supports exercise as a foundation, but it also cautions
against overstating structural modification when the evidence base is primarily oriented to pain and function endpoints and often varies in quality. In older adults, conservative progression goals can still be justified because improved strength and mobility plausibly reduce activity restriction, fall risk, and deconditioning—drivers of long-term disability even when radiographic change is slow.

Quadriceps and hip strengthening are commonly emphasized because the quadriceps
contribute to shock absorption and knee stability, while hip abductors and extensors influence lower-limb alignment and gait mechanics. For mild-to-moderate KOA, strengthening is typically progressed from low-load, controlled movements to functional closed-chain tasks (sit-to-stand, step-ups) and, when safe, higher-intensity resistance to rebuild capacity. The progression principle is particularly important in older adults: conservative progression management is less about reaching athletic intensity and more about rebuilding a "minimum effective" strength
reserve that protects daily function.

Neuromuscular training and proprioceptive rehabilitation aim to improve movement coordination, balance, and joint position sense. A systematic review and meta-analysis of randomized trials reported that proprioceptive training improved symptoms, function, and proprioception-related outcomes in people with KOA, while noting that consensus on optimal protocols remains limited (Wang et al., 2021). For progression-oriented care in older adults, the implication is practical: better balance and joint control may reduce maladaptive movement patterns and falls, thereby supporting sustained physical activity—an indirect but clinically meaningful route to slowing functional decline.

Program dose, progression, and supervision influence outcomes and feasibility. A systematic review comparing HBE and CBE reported that, based on limited evidence, HBE can be as
effective as CBE for short-term pain and disability outcomes, and that combining modalities may enhance overall efficacy (Zhang et al., 2024). This finding is particularly relevant to older adults, where transportation barriers, cost, and caregiving responsibilities frequently limit attendance.
It supports a progression-oriented strategy that begins with safe, achievable home routines and uses targeted supervision (periodic PT review, group sessions, or telehealth check-ins) to ensure appropriate progression and technique.

Adherence is a central determinant of conservative success. Barriers to implementing guideline- recommended core interventions include limited insurance coverage, workforce constraints, low patient adherence, and insufficient multidisciplinary integration; facilitators

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

include
telehealth/community delivery pathways and education resources (Wang et al., 2025). In older adults with frailty or multimorbidity, adherence challenges can be magnified by fatigue, fear of pain, fear of falling, and competing medical appointments. Consequently, progression-oriented PT should incorporate pacing strategies, flare plans, and realistic goal-setting, while explicitly linking exercise targets to valued daily functions (stairs, transfers, community mobility).

Activity Modification

Activity modification is often misunderstood as "do less." In progression-oriented KOA care, it is better defined as load management: reducing exposures that repeatedly trigger flares while preserving (or increasing) overall physical activity capacity through safer alternatives. Clinical guidance typically encourages ongoing activity and structured exercise, while advising individualized adjustments for symptom-provocative tasks and high-impact exposures,
particularly in older adults with limited reserve (National Institute for Health and Care Excellence, 2022; Huffman et al., 2024).

Evidence comparing specific activity types often emphasizes symptoms and function rather than structural outcomes, and results can vary by baseline disease severity and activity dose. A pragmatic approach—consistent with guideline logic—is to avoid abrupt transitions into high- load novelty activities (e.g., sudden high-intensity plyometrics or extreme sports) and instead support low-impact options such as cycling, aquatic exercise, or walking with graded progression. Mind–body exercise modalities are also relevant in older adults because they can address strength, flexibility, balance, and psychosocial well-being. In a randomized clinical trial comparing yoga versus strengthening exercises over 12 weeks, both improved knee pain, with yoga described as noninferior to strengthening for pain outcomes (Abafita et al., 2025). While short-term symptom trials cannot prove slowed structural progression, they support expanding the menu of acceptable low-impact exercise options—an important adherence lever in older populations.

A core progression-related concept is pacing: balancing activity and rest to reduce flare cycles that lead to inactivity and deconditioning. This can include step-count targets with flexible adjustment, planned recovery days, avoidance of prolonged kneeling/squatting when
provocative, and gradual return after flares. Such strategies are most credible when framed as enabling sustained participation in strengthening and aerobic conditioning rather than as permanent restriction.

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

Knee Injections (Medical Interventions)

Intra-articular injections (IAIs) are commonly used to manage symptoms in KOA when core measures are insufficient or when pain prevents engagement in exercise. In a progression-oriented conservative plan, the role of injections is best framed as *enabling function*: short-term pain reduction that supports participation in PT and physical activity, rather than a reliable disease-modifying strategy.

IACI can provide short-term symptom relief. A systematic review and meta-analysis of randomized controlled trials concluded that intra-articular glucocorticoid injections reduced pain and improved function early after administration (≤6 weeks) compared with placebo, with benefits less clearly sustained against other comparators over longer time horizons (Najm et al., 2021). For older adults, this pattern supports selective use: consider IACI for short-term flare
control or to facilitate PT initiation, while setting expectations that repeated injections are not a substitute for building strength and activity capacity.

Comparative injection effectiveness is actively debated, particularly for platelet-rich plasma (PRP) and hyaluronic acid (HA). A Bayesian network meta-analysis focusing on mid- to long-term outcomes reported sustained efficacy signals favoring PRP—especially PRP combined with HA— for longer-term pain relief and functional improvement compared with several other
injectables, while acknowledging variation across studies and methodologies (Gupta et al., 2025). These findings are relevant to mild-to-moderate KOA because many injection trials recruit earlier-stage cohorts, yet they do not establish structural modification, and generalizability to frail, multimorbid older adults can be uncertain. Additionally, access and cost constraints may limit use, which is a care environment determinant of "success" in real-world conservative pathways.

Safety considerations remain central. Even when serious adverse events are uncommon, older adults may face higher baseline risks related to comorbidities, anticoagulant/antiplatelet use, or impaired immune function. Consequently, progression-oriented conservative planning should emphasize shared decision-making, clarify anticipated duration of benefit, integrate injections into a broader plan (exercise and load management), and reassess response systematically rather than escalating injections reflexively (American Academy of Orthopaedic Surgeons, 2021; National Institute for Health and Care Excellence, 2022).

Cryotherapy (Symptomatic Modality)

Cryotherapy refers to therapeutic cold application (e.g., ice packs, cold wraps, or localized cooling devices) used to reduce pain and modulate inflammatory symptoms. Mechanistically,

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

cold can decrease local nerve conduction and may reduce perceived pain, which may facilitate movement and exercise participation—particularly during symptomatic flares.

A systematic review with meta-analysis aiming to update evidence on cryotherapy in knee osteoarthritis evaluated outcomes including pain, strength, and function (Dias et al., 2025). Across the available trial literature, protocols and comparators vary, and follow-up is often short; therefore, cryotherapy is best positioned as an adjunct to enable adherence to active rehabilitation rather than as a standalone strategy to slow structural progression. In older adults, safety requires attention to skin integrity, sensation changes (e.g., neuropathy), and cold intolerance; conservative plans should specify practical boundaries (time-limited applications and monitoring for adverse skin responses) and align use with flare plans.

Multimodal Conservative Pathways

Because KOA progression is multidimensional, multimodal conservative care is biologically and clinically rational: combine interventions that address load, neuromuscular capacity, symptom modulation, and behavior change. Major guidance documents align on sequencing that starts with education/self-management and therapeutic exercise, adds weight management for those with overweight/obesity, and considers adjuncts when symptoms impede participation—while emphasizing ongoing reassessment and personalization (American Academy of Orthopaedic Surgeons, 2021; National Institute for Health and Care Excellence, 2022; Australian Commission on Safety and Quality in Health Care, 2024).

A practical progression-oriented pathway in older adults can be summarized as follows:

1. establish baseline symptoms and functional limitations (walking tolerance, stairs, transfers),
2. initiate a tailored strengthening + aerobic program with a simple home core,
3. incorporate balance/proprioceptive elements when instability or fall risk is present,
4. integrate weight management (when indicated) with muscle-preserving strategies,
5. use short-term symptom modulators (e.g., selected injections or cryotherapy) to support engagement in exercise rather than replace it, and
6. Monitor response at prespecified intervals to adjust intensity, address barriers, and prevent relapse.

The care environment strongly influences whether such a pathway is feasible. Implementation research highlights that guideline-based core OA treatments can be underused due to

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

misconceptions, insurance and resource constraints, insufficient interdisciplinary collaboration, and low adherence—while telehealth/community delivery and robust education resources can facilitate uptake (Wang et al., 2025). This evidence implies that "success" or "failure" of
conservative care in older adults may reflect system-level determinants as much as patient biology.

Digital and remote delivery options have become increasingly important for older adults with mobility or transportation barriers. A systematic review and meta-analysis of randomized trials concluded that DP interventions were associated with small improvements in physical function and, in subgroup analyses, reductions in pain and improvements in function for video
conferencing and app/web-based modalities, while noting heterogeneity and limited high-quality trials (Cheung et al., 2025). These results support a pragmatic multimodal strategy: use digital delivery to increase access and continuity while maintaining periodic clinician oversight to ensure safe progression, technique correction, and adaptation to comorbidity constraints.

Finally, monitoring and adjustment should be explicit. Because structural progression is slow and difficult to measure clinically, functional metrics (e.g., chair-rise performance, walking tolerance), symptom trajectories, and adherence measures often provide more actionable feedback in routine care. A progression-oriented conservative plan should treat plateau or worsening as a signal to (1) reassess diagnosis and contributors (lumbar spine, hip OA, neuropathy), (2) intensify or modify the exercise prescription (including proprioceptive components), (3) address weight stability and relapse prevention, and (4) remove environmental barriers (access, coaching, affordability) that commonly determine long-term success.

Discussion

Integrated Synthesis Across Outcomes

Mild-to-moderate KOA is a chronic, degenerative joint disorder in which conservative strategies are typically prioritized to relieve symptoms, maintain mobility, and—when possible—slow measurable disease progression (e.g., radiographic change, worsening function, or escalation to invasive care). In the preceding synthesis, the strongest and most consistent signal across
conservative interventions is improvement in pain and physical function, whereas evidence that any single non-surgical approach reliably modifies structural endpoints remains less consistent and is often limited by outcome heterogeneity and follow-up duration.

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

A key interpretive issue is that "success" depends on which outcome is foregrounded. Patient- reported outcomes (e.g., pain intensity, disability scores) and performance-based outcomes (e.g., walking ability, balance tests) often respond more quickly to exercise, education, and weight-focused programs than structural indices that tend to change slowly and are measured inconsistently across studies. In an overview of systematic reviews of exercise therapy for KOA, outcome tools varied widely (with frequent use of instruments such as the 36-Item Short Form Survey and the Western Ontario and McMaster Universities Osteoarthritis Index), and the authors explicitly noted that heterogeneity across outcome measures prevented pooled meta- analysis in their overview, underscoring a persistent alignment problem between what studies measure and what clinicians mean by "progression" (Kitagawa et al., 2025).

Mapping interventions to outcomes can therefore be approached pragmatically:

- Weight-focused strategies (dietary modification and weight management programs) most directly target symptom burden and functional capacity in overweight or obese populations with KOA, with some observational evidence also linking weight dynamics to radiographic trajectory. A large randomized controlled trial (RCT)—defined as a study that randomly assigns participants to interventions to reduce bias—reported that diet and exercise interventions can improve knee pain in individuals with KOA and overweight/obesity, supporting lifestyle-based programs as core components of conservative care (Messier et al., 2022). In parallel, a recent meta-analysis of RCTs examining dietary interventions across osteoarthritis populations found overall supportive effects on clinical outcomes, but the diversity of dietary approaches and endpoints limits precise matching to structural progression claims (Asadi et al., 2025). Complementing trial evidence, a population-based cohort analysis reported associations between body-weight fluctuation patterns and radiographic progression of KOA, suggesting that "how weight changes over time" may matter—not only baseline body mass index (BMI), defined as weight in kilograms divided by height in meters squared— when considering progression-oriented counseling (Fu et al., 2025).
- Exercise therapy and functional rehabilitation most consistently map to improvements in pain, disability, and quality of life, with smaller and less consistent signals for performance domains depending on program design, supervision, and adherence. The overview of systematic reviews above supports exercise as a reasonable conservative treatment option while also highlighting that much of the secondary evidence base is methodologically fragile (Kitagawa et al., 2025). Proprioceptive training—defined as exercises aimed at improving joint position sense and neuromuscular control—has been evaluated in a meta-analysis of RCTs and is plausibly relevant to balance and functional stability outcomes that matter disproportionately in older adults (Wang et

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

al., 2021).

- Injection-based strategies (intra-articular injections, IAIs) are generally positioned as symptom-modifying modalities rather than disease-modifying therapies. IACI —

  corticosteroids delivered into the joint space to reduce inflammation—have been synthesized in a systematic review and meta-analysis focused on efficacy and safety, supporting short-term analgesic roles while reinforcing the need for careful risk–benefit appraisal in older adults who may have multiple comorbidities (Najm et al., 2021).

  Comparative long-term effectiveness across injectables (including hyaluronic acid [HA] and platelet-rich plasma [PRP]) has also been examined using Bayesian network meta- analysis—an approach that compares multiple treatments simultaneously using direct and indirect evidence—suggesting differential durability across modalities but also reflecting the broader challenge that trials vary in comparators, dosing schedules, and co-interventions (Gupta et al., 2025).

- Cryotherapy—the therapeutic application of cold (e.g., cold packs, ice massage)—maps most clearly to short-term symptom relief. A systematic review with meta-analysis evaluating cryotherapy in KOA found pooled evidence supporting pain reduction, with less definitive findings for function and limited data for strength endpoints, reinforcing its role as an adjunct rather than a standalone progression strategy (Dias et al., 2025).

- Overall, the conservative "portfolio" appears most effective when framed as outcome-specific: lifestyle and exercise interventions for pain/function and mobility preservation; targeted adjuncts (e.g., injections, cryotherapy) for symptom flares or participation-enabling relief; and neuromuscular components (e.g., proprioceptive training) for balance-related vulnerability in later life. However, claims of slowed structural progression must remain cautious unless anchored in designs that explicitly track validated progression endpoints over sufficient time horizons, a gap that remains evident across much of the recent conservative literature

(Kitagawa et al., 2025; Fu et al., 2025).

Clinical Decision-Making in Older Adults

Clinical decision-making in older adults with KOA is inherently heterogenous because chronological age does not capture physiologic reserve, multimorbidity burden, or vulnerability
to adverse effects. A practical approach is to base conservative care intensity and monitoring on risk stratification, defined here as estimating the likelihood of poor outcomes (e.g., rapid

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

functional decline, falls, treatment-related harms, or escalation to invasive procedures) using patient-level features such as frailty, sarcopenia, and comorbidity clustering.

Frailty is a multidimensional syndrome of reduced physiologic reserve and increased vulnerability to stressors; its measurement varies by instrument (e.g., phenotype vs deficit accumulation). An updated review of frailty measurement emphasizes that tool choice has direct implications for clinical interpretation and research comparability, which matters in KOA because frailty may shape both baseline function and response to rehabilitation intensity (Dent et al., 2025). The relevance of frailty to KOA is also supported by longitudinal evidence
indicating a bidirectional relationship between KOA and frailty over time, suggesting that KOA may contribute to frailty trajectories (through pain-related inactivity and deconditioning) while frailty may worsen KOA outcomes (through reduced strength, slower recovery from flares, and heightened adverse-event sensitivity) (Tian et al., 2025).

Sarcopenia—defined as age-associated loss of skeletal muscle mass (and often strength and performance)—is closely tied to functional endpoints in KOA because quadriceps weakness and reduced neuromuscular capacity may limit tolerance of progressive loading programs. A large cross-sectional analysis in US adults reported an association between sarcopenia and osteoarthritis status, reinforcing the plausibility that muscle health is not merely a consequence but also a correlating factor in osteoarthritis-related disability (Peng et al., 2024). While cross- sectional designs cannot establish causality, these findings support integrating muscle-preserving strategies (progressive resistance exercise, adequate protein intake aligned with broader geriatric guidance, and individualized progression pacing) into KOA conservative plans, especially when the care goal includes maintaining independence rather than only reducing pain.

Within this geriatric framing, patient selection is less about “who should get conservative care” (nearly all mild-to-moderate KOA should) and more about how conservative care is packaged:

- For patients with higher physiologic reserve, structured exercise programs can be progressed more assertively, with combined aerobic and strengthening elements and measurable functional goals, consistent with broad exercise evidence (Kitagawa et al., 2025).
- For patients with frailty and/or sarcopenia, the emphasis often shifts to safe, function- first programs: lower initial loads, higher supervision early, balance training, and explicit fall-risk mitigation, leveraging evidence that proprioceptive training can improve
outcomes relevant to stability (Wang et al., 2021).

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

- For patients with overweight/obesity, weight management and dietary intervention become central co-equal components rather than optional add-ons, given RCT and
  meta-analytic evidence supporting pain-related benefits (Messier et al., 2022; Asadi et al., 2025).

Safety monitoring and minimizing harms require explicit attention in older adults, particularly when symptom-modifying therapies are used to enable exercise participation. For IAIs, the clinician must weigh expected symptom benefit against patient-specific risks (e.g., glycemic effects in diabetes when using corticosteroids, local joint risks, and the possibility that short-term relief could inadvertently lead to overuse if activity progression is not guided). Safety considerations are central in evidence syntheses of IACIs and in comparative injectable analyses, even when efficacy is supported for selected endpoints (Najm et al., 2021; Gupta et al., 2025).
Cryotherapy is generally low-risk but should still be monitored for cold intolerance, neuropathy risk, and skin integrity issues in older adults; importantly, the recent meta-analysis suggests the greatest value as part of a broader program (Dias et al., 2025).

In short, geriatric KOA decision-making benefits from reframing "progression management" as maintaining physiologic capacity (muscle, balance, endurance) alongside symptom control,
because capacity preservation is both a target outcome and a determinant of whether conservative care can be delivered safely at a sufficient dose to matter (Dent et al., 2025; Tian et al., 2025; Peng et al., 2024).

Implementation and Real-World Feasibility

Even highly evidence-supported conservative strategies can fail in practice if adherence is poor or if care environments restrict access. Implementation science considerations—how interventions are adopted, delivered, and sustained in real settings—are therefore not secondary; they are determinative.
Adherence and behavior change are persistent bottlenecks. A mixed-methods study examining barriers and facilitators to regular exercise among individuals with KOA highlights multi-level constraints, including symptom flares, motivational factors, knowledge gaps, and contextual
barriers such as time, resources, and support, reinforcing that adherence is not a patient "trait" but a modifiable outcome influenced by the care plan and environment (Wang et al., 2025). This has practical implications: exercise prescriptions should be paired with explicit flare plans,
graded progression, and feedback loops (e.g., symptom tracking, function milestones), rather

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

than delivered as one-time instructions.

Access to physical therapy (PT)—defined as supervised rehabilitation delivered by trained clinicians—is uneven, especially for older adults with transportation or financial barriers. This is where delivery mode becomes outcome-relevant. Evidence comparing HBE versus CBE suggests that, on average, HBE can achieve similar short-term patient-reported outcomes to CBE, while hybrid models (HBE plus periodic supervised CBE) may enhance benefits—an interpretation that aligns with pragmatic expectations: some supervision may improve technique, progression, and confidence, while home delivery supports sustainability (Zhang et al., 2024).

Digital delivery is an expanding implementation pathway. DP (technology-supported rehabilitation delivered via apps, telehealth, sensors, or structured online programs) is attractive for older adults when it reduces travel burden and expands reach, but it also introduces risks
(digital literacy barriers, reduced hands-on assessment, and variable program fidelity). A systematic review and meta-analysis of RCTs evaluating DP interventions in KOA supports clinically relevant improvements in patient outcomes relative to comparators in the included trials, providing a basis for considering digital models as part of conservative care pathways (Cheung et al., 2025). The central implementation question is not whether digital is "better," but for whom and under what support conditions it can deliver adequate dose and safety—especially in frail older adults, where initial supervised calibration may be essential.

Finally, feasibility considerations intersect directly with symptom-modifying adjuncts. For example, cryotherapy may improve willingness to participate in exercise during pain flares, and IAIs may be used to "open a window" for rehabilitation participation—yet both approaches risk becoming substitutes for foundational lifestyle and exercise work if not explicitly integrated into a progression plan (Dias et al., 2025; Najm et al., 2021). Implementation success therefore depends on whether care teams present these modalities as enablers of function-building, rather than endpoints.

In real-world KOA management for older adults, feasibility is optimized when conservative care is delivered as an adaptable pathway: scalable home-based or digital options when access islimited; structured supervision when risk or complexity is high; and ongoing adherence scaffolding that explicitly targets the barriers patients actually face (Wang et al., 2025; Zhang et al., 2024; Cheung et al., 2025).

Evidence Limitations and Gaps

The conservative KOA literature has matured rapidly since 2020, but several limitations constrain confidence in progression-focused claims—particularly in older adults.

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

First, there is substantial heterogeneity in definitions and measures of both intervention "dose" and outcome response. Even within exercise therapy, variability in program type (strengthening, aerobic, neuromuscular), intensity, duration, and co-interventions complicates cross-study
comparisons. At the evidence-synthesis level, an overview of systematic reviews reported that heterogeneity in outcome measures prevented pooling and—critically—judged the
methodological quality of most included systematic reviews as very low, which weakens downstream confidence in effect estimates that appear consistent across reviews (Kitagawa et al., 2025).

Second, follow-up is often short relative to the pace of structural change. This matters because trials may be adequately powered to detect symptom changes over weeks to months but underpowered or under-timed to detect differences in structural progression. As a result, "no difference in progression" is frequently not interpretable as "no effect on progression."
Observational analyses linking weight dynamics to radiographic progression underscore that progression-related signals may emerge over longer windows and may be sensitive to time-varying exposures such as weight change patterns (Fu et al., 2025).

Third, older adults—especially those with frailty, sarcopenia, and multimorbidity—remain under-characterized in many trial datasets, limiting generalizability. While recent work clarifies how frailty can be measured and why it matters clinically (Dent et al., 2025), and longitudinal evidence suggests that KOA and frailty can worsen one another (Tian et al., 2025), many intervention trials still do not stratify outcomes by frailty or muscle status, leaving a gap in actionable tailoring evidence.

Fourth, several adjunct modalities have thin RCT bases. Cryotherapy, for example, shows
promising pooled pain reduction in a recent meta-analysis, but the number of included RCTs is small, and functional and strength endpoints remain less certain (Dias et al., 2025). Similarly, injection studies often vary in product preparation (especially for PRP), dosing schedules, and comparator choices, which complicates synthesis even when network meta-analytic methods are applied (Gupta et al., 2025).

These limitations collectively point to a central gap: the field often has enough evidence to say "this improves pain/function," but less consistent evidence to say "this slows progression,"
partly because progression is defined differently across studies and partly because trial designs are not always optimized for progression endpoints. A progression-oriented narrative review should therefore treat many "progression" conclusions as conditional and emphasize transparency about outcome definitions, time horizons, and subgroup applicability (Kitagawa et al., 2025).

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

Future Directions

Progression-focused conservative KOA research in older adults can advance most efficiently by aligning outcomes, optimizing trial designs for geriatric realities, and integrating long-term care pathways rather than short, isolated interventions.

A practical next step is to implement core outcome sets (COS)—defined as a minimum set of outcomes that all trials in a field should measure and report—to reduce outcome heterogeneity and improve evidence synthesis. The inability to pool outcomes in contemporary evidence overviews is a concrete indicator that standardization is still incomplete, even for common conservative interventions (Kitagawa et al., 2025). A COS approach would not prevent additional outcomes; it would ensure that key domains (pain, function, quality of life, harms, and a clearly defined progression proxy) are consistently captured.

Second, there is a need for pragmatic trials—studies designed to test interventions under real-world conditions—specifically in geriatric populations. Pragmatic KOA trials should routinely capture frailty status (with prespecified measurement tools) and muscle health indicators,
because these features plausibly influence adherence, safety, and functional response. The emerging evidence that KOA and frailty interact over time suggests that trials ignoring frailty may miss clinically important effect modification (Dent et al., 2025; Tian et al., 2025).

Third, future pathways should explicitly integrate muscle and balance preservation as progression-relevant goals. Because sarcopenia is associated with osteoarthritis status in large datasets, and because proprioceptive training targets balance-relevant function, conservative programs may be strengthened by embedding muscle-preserving resistance training and neuromuscular components as default features rather than optional add-ons—particularly for older adults at fall risk (Peng et al., 2024; Wang et al., 2021).

Fourth, implementation research should continue to refine scalable delivery models that do not trade reach for safety. Evidence supports the equivalence of home-based and center-based exercise on several short-term outcomes and supports DP as an effective modality in RCT contexts, but future work must clarify the optimal hybrid “dosage” of supervision, particularly for frail or digitally disadvantaged patients (Zhang et al., 2024; Cheung et al., 2025).

Finally, cost and long-term pathway questions should be treated as primary, not peripheral. Older adults often live with KOA for years, and conservative management is iterative: escalation and de-escalation across exercise, weight management, adjunct modalities, and potentially injections. Research that integrates longer follow-up, consistent outcomes, and real-world delivery constraints will be best positioned to answer the question that matters most for progression-focused care: not merely “what works,” but “what works sustainably,

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

safely, and at scale for older adults with varying physiologic reserve" (Wang et al., 2025; Dent et al., 2025).

Conclusion

"Technology-enabled delivery can extend reach, but benefits should be framed cautiously. In their systematic review and meta-analysis, Xiang et al. (2023) reported that telerehabilitation (TR) relieved pain but did not improve physical function overall; heterogeneity in platforms/protocols and trial-quality limitations constrain certainty and limit conclusions about which components are essential. KOA, a prevalent presentation of OA , is a major contributor to disability worldwide and is projected to impose a growing burden as populations age (Steinmetz et al., 2023). In older adults with mild-to-moderate KOA, "slowing progression" is most defensibly framed as sustaining daily function and reducing recurrent symptom flares that trigger inactivity, deconditioning, and escalating care needs. This framing matters because the structural progression of KOA is often slow, difficult to measure in routine care, and inconsistently captured across trials; therefore, conservative care must be judged primarily by whether it maintains mobility, participation, and quality of life while plausibly reducing exposure to known progression amplifiers (e.g., excess joint load, muscle weakness, and prolonged inactivity).

Across contemporary guidance, there is broad agreement that progression-oriented conservative care should begin with education and self-management and a structured therapeutic exercise program, integrate weight management when indicated, and use adjunct symptom-modifying options selectively to enable participation (American Academy of Orthopaedic Surgeons [AAOS], 2021; National Institute for Health and Care Excellence [NICE], 2022; Australian Commission on Safety and Quality in Health Care [ACSQHC], 2024). A key caveat is that guidance consensus does not eliminate uncertainty about disease modification. Evidence remains strongest for pain and function outcomes, whereas direct evidence for structural modification is limited and inconsistent. Consequently, the most defensible conclusion is not that conservative care "halts" KOA, but that it can meaningfully improve trajectories that matter clinically—function, mobility confidence, and sustained activity—while plausibly reducing the downstream consequences of repeated flare–inactivity cycles.

Methodological constraints are particularly visible in the exercise evidence base. An overview of systematic reviews of exercise therapy highlighted substantial heterogeneity in program type, intensity, duration, and outcome measures, and judged the methodological quality of most included systematic reviews as very low; together, these factors limit confidence in pooled estimates and weaken downstream inferences about progression (Kitagawa et al.,

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

2025). This does not negate the clinical value of exercise; rather, it reinforces a practical implication for older adults: conservative success depends on achieving a safe, sustained "dose" of activity and strengthening under real-world constraints, not on selecting a single "optimal" exercise modality based on uncertain comparative evidence.

Within that pragmatic frame, sustained physical activity and structured exercise remain the most defensible foundations for older adults. A narrative synthesis emphasized that physical activity and weight management are central to KOA care and that adherence through symptom flares is often the key determinant of long-term success (Huffman et al., 2024). In adults with KOA and overweight or obesity, a randomized clinical trial found that a diet-and-exercise strategy improved knee pain over an extended follow-up, although the clinical importance of the between-group pain difference was uncertain, underscoring that "statistical improvement" does not automatically translate into a large perceived benefit for every patient (Messier et al., 2022). This supports a progression-oriented interpretation: even modest symptom improvements can be valuable if they help patients remain active and maintain strength.

Dietary interventions can also contribute when they support sustainable weight trajectories and enable movement. A meta-analysis of randomized trials reported that dietary interventions improved pain and physical function and reduced body weight, while also noting heterogeneity across dietary approaches and a limited number of trials (Asadi et al., 2025). Complementing this, longitudinal cohort evidence linked greater body-weight variability with worse symptom trajectories and highlighted weight stability as a potentially important target for older adults, particularly those prone to cycles of loss and regain (Fu et al., 2025). Because observational findings cannot establish causality, the safest clinical inference is behavioral: weight strategies should prioritize sustainability, relapse prevention, and muscle preservation rather than rapid, unstable weight change.

How conservative care is delivered can determine whether older adults receive an adequate therapeutic "dose," particularly when transportation, cost, or workforce limitations restrict clinic-based options. A systematic review comparing HBE with CBE found that HBE can achieve similar short-term patient-reported outcomes to CBE on average, supporting HBE as a scalable pathway when access barriers are present (Zhang et al., 2024). Remote delivery approaches can further extend reach. A meta-analysis comparing different TR strategies found consistent pain improvement, while functional effects were mixed and sometimes non-significant; heterogeneity in platforms and protocols limits precision about which components are essential (Xiang et al., 2023). DP (technology-supported rehabilitation delivered through apps, telehealth platforms, sensors, or structured online programs) is an increasingly relevant option for older adults when it reduces travel burden and improves continuity. A systematic review and meta- analysis of randomized trials found evidence of improvements in outcomes

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

with DP interventions but also noted heterogeneity and limitations in trial quality, implying that these models should be implemented with attention to safety, calibration, and support needs (Cheung et al., 2025). Taken together, delivery evidence supports a practical implication: older adults
often benefit from hybrid models that combine a simple HBE core with periodic supervision or digital monitoring to support technique, progression, and safety.

Adherence is not a fixed patient trait; it is a modifiable outcome shaped by the care plan and care environment. A mixed-methods study among individuals with KOA identified multi-level barriers to regular exercise—symptom flares, motivational factors, knowledge gaps, and contextual constraints such as time, resources, and social support—supporting the use of graded progression, explicit flare plans, and feedback loops (Wang et al., 2025). For older adults, this finding carries a concrete clinical message: conservative care is more likely to "fail" when it is delivered as one-time advice rather than as a supported pathway with troubleshooting,
monitoring, and adaptive progression. In that context, access to physical therapy (PT), defined here as supervised rehabilitation delivered by trained clinicians, becomes outcome-relevant. When PT access is limited, conservative pathways should compensate by building structured follow-up into other delivery channels (telehealth check-ins, community programs, or digitally supported monitoring) rather than assuming that unsupervised HBE alone will reliably deliver adequate doses and safe progression.

Adjunct modalities can support participation when they are positioned explicitly as enablers rather than endpoints. Cryotherapy has been evaluated in recent meta-analytic work with heterogeneous protocols and typically short follow-up; its most defensible role is time-limited flare support to facilitate ongoing exercise participation, with careful attention to skin integrity and cold intolerance in older adults (Dias et al., 2025). Intra-articular injections (IAIs) are also commonly used when pain blocks engagement in exercise. Evidence synthesis indicates that
IACI provides short-term symptom relief, with less consistent sustained benefit over longer horizons, supporting selective use for flare control or to enable PT initiation rather than as a progression-modifying strategy (Najm et al., 2021). Comparative effectiveness across injectable options remains actively debated. A Bayesian network meta-analysis examining longer-term effectiveness across injectable therapies reported differential outcome patterns among
injectables, but conclusions depend on the underlying evidence base and trial heterogeneity, reinforcing that injections should be integrated as part of a broader conservative plan rather than substituted for foundational exercise and behavior change (Gupta et al., 2025). Practically, adjuncts should be presented to patients as tools that help them "stay in the

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

program," not as standalone solutions.

A feasible, high-level pathway for progression-oriented conservative care in older adults with mild-to-moderate KOA can be summarized stepwise, consistent with guideline logic (AAOS, 2021; NICE, 2022; ACSQHC, 2024). First, establish baseline pain, function, and patient priorities
(e.g., stairs, transfers, walking tolerance) and document meaningful goals that connect exercise targets to valued daily activities. Second, initiate education and self-management that normalizes graded activity, clarifies expectations about symptom fluctuations, and includes a written flare plan. Third, start a tailored strengthening and aerobic program with an HBE core; add supervised PT when risk or complexity is high (frailty, fall risk, multiple comorbidities, marked deconditioning, or uncertainty about technique). Fourth, integrate sustainable weight strategies when indicated, emphasizing maintenance, relapse prevention, and muscle preservation. Fifth, select delivery supports—hybrid follow-up, TR, or DP—based on access constraints and patient capability, ensuring safety calibration for older adults who may need more supervision initially. Sixth, use adjunct symptom modulators (e.g., cryotherapy or IAIs) as short-term enablers of participation, not endpoints. Finally, reassess at prespecified intervals and adjust the plan based on function, flare patterns, adherence barriers, and patient preferences, treating plateau or worsening as a cue to re-engineer the pathway rather than abandon conservative care.

Research priorities follow directly from these conclusions. Progression-oriented conservative care needs better harmonization of outcome measures and intervention dose reporting so that evidence can be synthesized more credibly across trials and settings (Kitagawa et al., 2025). Longer-term pragmatic trials are needed to evaluate multimodal packages (exercise plus weight strategy plus adherence support) that reflect real-world care, including hybrid supervision models and scalable digital pathways, rather than testing single components in isolation. Older adults should be intentionally represented and stratified by multimorbidity burden and functional reserve because these factors likely determine both achievable dose and safety.
Finally, implementation research should examine how care environments—coverage, access to PT, community infrastructure, and digital literacy support—shape the success or failure of conservative pathways, because the evidence suggests that conservative "outcomes" in older adults are often system-determined as much as biologically determined.

References

1. Chen, T. X., Yang, T. J., Cheng, S., Zhang, Z. L., & Liu, T. (2025). High prevalence and multifactorial risks of sarcopenia in knee osteoarthritis: a systematic review and meta-analysis. Journal of Orthopaedic Surgery and Research, 20(1), 1-12.

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

2. Liew, J. W., Petrow, E., Tilley, S., LaValley, M. P., Roemer, F. W., Guermazi, A., ... & Felson, D. (2025). Comparison of definitions of early knee osteoarthritis for likelihood of progression at 2- year and 5-year follow-up: the Multicenter Osteoarthritis Study. Annals of the rheumaticdiseases, 84(1), 115-123.
3. Martel-Pelletier, J., & Pelletier, J. P. (2025). Next-Level Prediction of Structural Progression in Knee Osteoarthritis: A Perspective. International Journal of Molecular Sciences, 26(10), 4748.
4. Robson, E. K., Hodder, R. K., Kamper, S. J., O'Brien, K. M., Williams, A., Lee, H., ... & Williams, C. M. (2020). Effectiveness of weight-loss interventions for reducing pain and disability in people with common musculoskeletal disorders: a systematic review with meta-analysis. journal of orthopaedic & sports physical therapy, 50(6), 319-333.
5. Xiang, W., Wang, J. Y., Ji, B. J., Li, L. J., & Xiang, H. (2023). Effectiveness of different telerehabilitation strategies on pain and physical function in patients with knee osteoarthritis: systematic review and meta-analysis. Journal of medical Internet research, 25, e40735.
6. American Academy of Orthopaedic Surgeons. (2021). Management of osteoarthritis of the knee (non-arthroplasty): Evidence-based clinical practice guideline (3rd ed.).
7. National Institute for Health and Care Excellence. (2022). Osteoarthritis in over 16s: Diagnosis and management (NICE guideline NG226).
8. Australian Commission on Safety and Quality in Health Care. (2024). Osteoarthritis of the knee clinical care standard.
9. Huffman, K. F., Ambrose, K. R., Nelson, A. E., Allen, K. D., Golightly, Y. M., & Callahan, L. F. (2024).
10. The critical role of physical activity and weight management in knee and hip osteoarthritis: A narrative review. The Journal of rheumatology, 51(3), 224-233.
11. Kitagawa, T., Isaji, Y., Sasaki, D., Onishi, K., Hayashi, M., & Okuyama, W. (2025). Effectiveness of exercise therapy in patients with knee osteoarthritis: an overview of systematic reviews. BMJ open, 15(7), e093163.
12. Dent, E., Hanlon, P., Kowal, P., & Hoogendijk, E. O. (2025). Frailty measurement in research and clinical practice: an updated review. European Journal of Internal Medicine, 106595.
13. Tian, Z., Zhao, H., Zhai, Y., & Yang, Z. (2025). The bidirectional relationship between knee osteoarthritis and frailty in China: A longitudinal study. The Journal of Frailty & Aging, 14(5), 100087.
14. Peng, P., Wu, J., Fang, W., Tian, J., He, M., Xiao, F., ... & Wei, Q. (2024). Association

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

between sarcopenia and osteoarthritis among the US adults: A cross-sectional study. Scientific reports, 14(1), 296.

15. Steinmetz, J. D., Culbreth, G. T., Haile, L. M., Rafferty, Q., Lo, J., Fukutaki, K. G., ... & Singh, S. (2023). Global, regional, and national burden of osteoarthritis, 1990–2020 and projections to 2050: a systematic analysis for the Global Burden of Disease Study 2021. The LancetRheumatology, 5(9), e508-e522.

16. Wang, Z., Duan, S., Chen, X., Deng, H., Wang, Y., & Ni, G. (2025). Barriers and facilitators to implementing core osteoarthritis treatments in China: a mixed-method study. medRxiv, 2025- 01.

17. Messier, S. P., Beavers, D. P., Queen, K., Mihalko, S. L., Miller, G. D., Losina, E., ... & Callahan, L. F. (2022). Effect of diet and exercise on knee pain in patients with osteoarthritis and overweight or obesity: a randomized clinical trial. Jama, 328(22), 2242-2251.

18. Asadi, S., Grafenauer, S., Burley, C. V., Fitzgerald, C., Humburg, P., & Parmenter, B. J. (2025). The effectiveness of dietary intervention in osteoarthritis management: a systematic review and meta-analysis of randomized clinical trials. European Journal of Clinical Nutrition, 1-13.

19. Fu, K., Oo, W. M., Pelletier, J. P., Martel-Pelletier, J., Feng, Y., Zhang, C., ... & Hunter, D. J. (2025).

20. Association between body weight fluctuation and progression of radiographic knee osteoarthritis: a longitudinal cohort study. RMD open, 11(3).

21. Wang, Y., Wu, Z., Chen, Z., Ye, X., Chen, G., Yang, J., ... & Xu, X. (2021). Proprioceptive training for knee osteoarthritis: a systematic review and meta-analysis of randomized controlledtrials. Frontiers in Medicine, 8, 699921.

22. Zhang, Z.-Y., Huang, L., Tian, L., Yi, J., Gao, M., Wang, X.-Q., Jiang, J.-J., & Liu, Z.-L. (2024). Home- based vs center-based exercise on patient-reported and performance-based outcomes for knee osteoarthritis: A systematic review with meta-analysis. Frontiers in Public Health, 12, Article 1360824

23. Abafita, B. J., Singh, A., Aitken, D., Ding, C., Moonaz, S., Palmer, A. J., ... & Antony, B. (2025). Yoga or Strengthening Exercise for Knee Osteoarthritis: A Randomized Clinical Trial. JAMA Network Open, 8(4), e253698-e253698.

24. Najm, A., Alunno, A., Gwinnutt, J. M., Weill, C., & Berenbaum, F. (2021). Efficacy of intra- articular corticosteroid injections in knee osteoarthritis: A systematic review

Power System Technology
ISSN:1000-3673
Received: 16-11-2025 Revised: 05-12-2025 Accepted: 28-01-2026

and meta-analysis of randomized controlled trials. Joint bone spine, 88(4), 105198.

25. Gupta, N., Khatri, K., Lakhani, A., Dahuja, A., Randhawa, A., Bansal, V., & Bansal, K. (2025). Long- term effectiveness of intra-articular injectables in patients with knee osteoarthritis: a systematic review and Bayesian network meta-analysis. Journal of orthopaedic surgery and research, 20(1), 227.
26. Dias, R. F., de Lima Silva, S., de Mello, S. P., Flores, L. J. F., Buzanello, M. R., & Bertolini, G. R. F. (2025). Cryotherapy in Knee Osteoarthritis: A Systematic Review With Meta-Analysis. PainPractice, 25(6), e70055.
27. Cheung, T. H. R., Elliott, M. T., Stephens, G., & Mansfield, M. (2025). Effectiveness of digitalphysiotherapy interventions in patients with knee osteoarthritis: a systematic review and meta- analysis of randomised controlled trials. BMJ open, 15(12), e102887.