

ARTICLE INFORMATION

Received: January, 9, 2025

Revised: May, 27, 2025

Available online: May, 29, 2025

at : <https://e-jurnal.iphorr.com/index.php/minh>

The effectiveness of isometric knee exercises as a non-pharmacological therapy for pain reduction in knee osteoarthritis: A systematic review

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Abstract

Background: Pain, stiffness, and decreased mobility are the main symptoms of osteoarthritis (OA), a degenerative joint disease that mostly affects the knee. The increasing prevalence of OA worldwide highlights the necessity of efficient non-pharmacological management techniques.

Purpose: To evaluate the effectiveness of isometric knee workouts in enhancing functional results and reducing pain in individuals with osteoarthritis.

Method: A comprehensive search was conducted using Google Scholar, PubMed, ScienceDirect, and ProQuest to find publications published between 2014 and 2024. The inclusion criteria focused on studies that used isometric exercises as an intervention for knee OA. The Critical Appraisal Skills Program of the Joanna Briggs Institute (JBI) was used to assess the quality of the selected publications. Data were analyzed thematically to compile conclusions on pain alleviation and functional enhancement.

Results: Eleven studies totaling 876 participants were included in the review. The treatments, which lasted anywhere from four to twelve weeks, continuously showed notable improvements in joint function and pain reduction. Results were improved by using isometric exercises both on their own and in conjunction with treatments like ultrasound and biofeedback. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Visual Analog Scale (VAS), and the Numerical Rating Scale (NRS) were frequently used to measure pain. Despite certain constraints, such as small sample sizes and brief follow-up periods, the quality assessment showed that the majority of studies had excellent methodological rigor.

Conclusion: For individuals with knee OA, isometric knee exercises are useful in lowering discomfort and enhancing functional results. The effectiveness of these exercises can be further increased by combining them with biofeedback or other therapeutic methods. These results provide a useful, low-risk strategy for enhancing patient quality of life and support the incorporation of isometric exercises into non-pharmacological therapy options for knee OA.

Keywords: Isometric Exercises; Osteoarthritis; Pain; Randomized Controlled Trial.

INTRODUCTION

A common degenerative joint disease that impacts millions of people globally is osteoarthritis (OA). It is typified by the gradual deterioration of articular cartilage, which results in symptoms including joint discomfort, stiffness, edema, and decreased mobility, especially in weight-bearing joints like the knees (World Health Organization, 2023). For many patients, knee OA lowers their

quality of life and limits their daily activities, making it a major cause of disability (Valdes & Stocks, 2018; Di Nicola, 2020). According to the Global Burden of Disease Study, the number of cases of OA has dramatically increased from 247.51 million in 1990 to 527.81 million in 2019, primarily as a result of aging populations (Long et al., 2022). The most frequent type of joint illness in Indonesia, OA, is 7.3%

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prevalent and primarily affects the elderly (Kementerian Kesehatan Republik Indonesia, 2018). The necessity for efficient management techniques that can reduce symptoms and enhance joint function without the long-term adverse consequences linked to pharmaceutical therapies is highlighted by this increasing incidence (Ebrahimzadeh, Makhmalbaf, Birjandinejad, Keshtan, Hoseini, & Mazlumi, 2014).

Pharmaceutical and non-pharmacological methods are frequently combined in today's OA management regimens. It has been demonstrated that non-pharmacological treatments, such as physical therapy, massage, and different types of exercise, can safely and effectively manage pain and enhance joint function (Warsono, Rachmawati, & Fahmi, 2021). Since the quadriceps muscle is essential for stabilizing the knee joint and minimizing pain, isometric workouts have drawn the most attention among them (Sengul, Yavuzer, Keles, Tunali, & Tuncer, 2022). Static muscular contractions that don't significantly alter joint mobility or muscle length are a component of isometric exercises. Because they can develop the quadriceps muscle without placing undue strain on the afflicted joint, these exercises are especially helpful for individuals with knee OA (Anwer & Alghadir, 2014). Prior studies have shown that isometric exercises can effectively reduce pain and improve functional outcomes whether used alone or in conjunction with other therapies like ultrasound and biofeedback (Choi, Kim, Hwang, Moon, & Choi, 2015). This review's significance stems from its capacity to direct clinical practice by providing low-risk, economical tactics that are simple to apply in a range of healthcare environments. This is especially important as the population ages and the prevalence of knee OA is predicted to increase further, presenting a serious problem for healthcare systems around the world (Delgado, Lambert, Boutris, McCulloch, Robbins, Moreno, & Harris, 2018).

RESEARCH METHOD

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were followed in the structured methodology of this systematic review. Studies from 2014–2024 were

included in the review, which was based on information from sources like ProQuest, ScienceDirect, PubMed, and Google Scholar. The following search phrases were used: "Pain," "Isometric Exercise," "Osteoarthritis," and "Randomized Controlled Trial." Criteria for Inclusion and Exclusion: The PICO framework served as the basis for defining the selection criteria: Population: Individuals with osteoarthritis in their knees. Intervention: exercises that are isometric. Comparison: conventional treatment or alternative control methods versus isometric exercises. Result: Joint function improves and pain severity decreases. Observational studies, study methods, and papers written in languages other than English were among the exclusion criteria. Full-text articles were the only ones taken into account. Process of Screening and Selection 3.194 articles were found in the initial search. Duplicate and unnecessary studies were eliminated from the titles and abstracts. 3.171 articles were eliminated after a second relevancy test. A thorough analysis was conducted on eleven articles that satisfied the inclusion criteria.

Extraction of data, with an emphasis on study design, sample size, intervention specifics, duration, and results, data from the chosen studies was methodically retrieved. To guarantee accuracy, the authors worked together to complete the extraction procedure. Evaluation of quality, the chosen articles' quality was evaluated using the Joanna Briggs Institute's (JBI) Critical Appraisal Skills Program. This tool assesses factors like blinding, allocation concealment, randomization, and follow-up completeness. Data analysis, the results were compiled using thematic analysis. Getting to know the data, creating preliminary codes, identifying themes, honing themes, and establishing final themes were all steps in the process. This method made it possible to fully comprehend how isometric workouts affect osteoarthritis in the knee. With the use of this methodology, the evidence regarding the efficacy of isometric exercises in reducing pain and enhancing functional outcomes in patients with osteoarthritis of the knee was rigorously and methodically synthesized.

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DOI: <https://doi.org/10.33024/minh.v8i3.614>

RESEARCH RESULTS

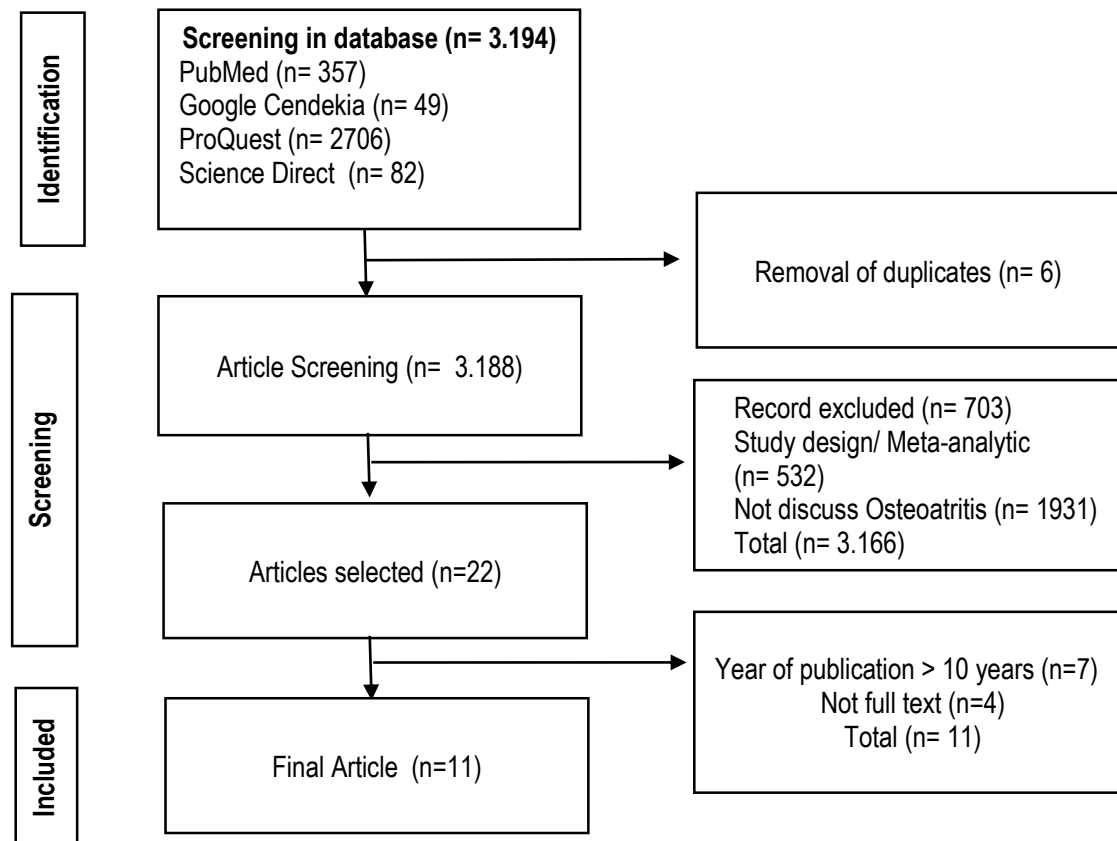


Figure. Diagram Prisma Flow

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Table. Summary of the Articles Review

(Author,Year) (Country)	Purpose	Method	Results
(Anwer & Alghadir, 2014) (India)	To investigate the effects of isometric quadriceps exercise on muscle strength, pain, and function in knee osteoarthritis.	A Randomized Controlled Study.	The experimental group's quadriceps isometric strength values showed a substantial improvement ($p<0.001$) when compared to the baseline at the conclusion of week 5. By the end of week five, there was a significant difference ($p<0.001$) in the groups' quadriceps strength. The experimental group's quadriceps strength increased by an average (SD) of 3.00 (0.18) and the control group's by 0.04 (0.01) during the course of the 5-week treatment period. The baseline NRS scores were statistically insignificant for both groups ($p=0.958$). The experimental group's NRS scores showed a substantial improvement ($p<0.001$) when compared to the baseline at the conclusion of week 5. By the conclusion of week five, there was a substantial ($p<0.001$) difference in the groups' NRS scores. The experimental group's average (SD) increase in NRS scores throughout the course of the 5-week treatment period was 4.81 (0.10), while the control group's was 1.71 (0.23).
(Kangeswari et al., 2021) (India)	To assess the effectiveness of Isometric exercise and counseling on level of pain among patients with KOA.	A Quasi-Experimental Approach.	Pain level reduction after intervention in the study group. The average pre-test was 73.77, and after intervention the average was 59.44. The percentage of the average score was 76.8 in the pre-test and after intervention the percentage of the average score was 61.9, and the average difference was 14.33 in the study group. Pain level reduction after intervention in the control group the average pre-test was 73.60, and after intervention the average

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(Author,Year) (Country)	Purpose	Method	Results
			was 71.59. The percentage of the average score was 76.7 in the pre-test and after intervention the percentage of the average score was 74.6, and the average difference was 2.01. The percentage of pain reduction score, in the study group was 14.9% with a 95% confidence interval, while in the control group it was only 2.1% with a 95% CI. This shows that the reduction in pain levels is higher in the study group than the control group.
(Choi et al., 2015) (South Korea)	To investigate the effects of isometric exercises using electromyographic biofeedback (EMGBF) and ultrasound biofeedback (USBF) on maximum voluntary isometric contraction (MVIC), pain assessed by the Visual Analogue Scale (VAS), and vastus medialis oblique (VMO) thickness in patients with knee osteoarthritis (OA).	Single-Blind, Randomized, and Prospective.	Maximum Voluntary Isometric Contraction (MVIC) showed a statistically significant improvement in the EMGBF training group and the USBF training group compared to the control group ($p<0.05$). When comparing MVIC before and after training, a significant improvement was observed in the EMGBF training group and the USBF training group ($p<0.05$), while MVIC decreased in the control group ($p>0.05$). VAS scores showed a statistically significant decrease in the EMGBF training group and the USBF training group compared to the control group ($p<0.05$). Comparing VAS scores before and after training showed a significant reduction in VAS scores in both the EMGBF training group and the USBF training group ($p<0.05$), while the control group showed no significant reduction in VAS scores ($p>0.05$).
(Onwunzo et al., 2021) (Nigeria)	To investigated the effects of isometric strengthening exercises on pain and disability among patients with knee osteoarthritis.	A Randomized Controlled Trial.	The results of the study showed that isometric quadriceps exercises resulted in an increase in quadriceps strength, reflecting improved functional performance in the exercise group after the six-week exercise program. The experimental group's paired

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			sample t-test results at the start and finish of the trial showed a substantial improvement in range of motion (ROM), functional improvement, and pain intensity reduction ($p = 0.000$). Participants in the control group, however, showed no discernible changes: WOMAC = 0.062, AROM = 0.083, PROM = 0.069, and NPRS = 0.096.
(Senggul et al., 2022) (Turkey)	To compare the effect of quadriceps isometric exercises performed in two different positions in addition to the combined physical therapy program on pain, stiffness, and physical function in patients with knee osteoarthritis (OA).	Prospective and Comparative Study	Both groups showed a statistically significant improvement ($P < 0.05$) in their VAS (rest, activity) and WOMAC (pain, stiffness, physical function, and total score) levels before and after therapy). A significant improvement in VAS scores (rest, activity) and WOMAC scores (pain, stiffness, physical function, and total score) was observed in both groups after the intervention ($P < 0.01$). In the intergroup comparison, a significant improvement was found in the WOMAC stiffness score ($P = 0.035$).
(Bahşi, et al., 2022) (Turkey)	To investigate the effects of different types of exercise on pain, functional capacity, muscle strength measured by an isokinetic dynamometer, and femoral cartilage (FC) thickness measured using ultrasound in patients with knee osteoarthritis (KOA).	A Randomized Controlled Trial.	The Visual Analog Scale (VAS) pain scores after therapy showed a significant decrease in all three groups. There were no discernible variations between the groups' WOMAC scores. Extensor and flexor muscle strength measures at angular velocities of 60°/s and 180°/s showed a substantial increase in the isokinetic group. The maximal torque values of the extensor and flexor muscles at 60°/s showed a statistically significant increase in the isotonic group, but only for the left knee.

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(Author,Year) (Country)	Purpose	Method	Results
(Çokar et al., 2022) (Turkey)	To investigate the effects of various exercises on quadriceps femoris muscle and on pain, strength, function, and balance in female patients with bilateral knee osteoarthritis (OA).	A Randomized Controlled Trial.	Only group 1's activity pain score dropped by week 6, however groups 2 and 3 saw substantial drops in their rest, night, and activity pain levels ($p<0.001$, $p<0.01$, and $p<0.001$, respectively). Each group showed a significant increase in physical function ($p<0.001$). Groups 2 and 3 showed a significant increase in isokinetic muscular strength for the knee extensors ($p<0.001$ and $p<0.01$, respectively). In certain positions, groups 2 and 3's balance scores rose ($p<0.001$ and $p<0.05$, respectively).
(Ding et al., 2024) (China)	To evaluate the efficacy of lower limb strengthening exercises based on different muscle contraction characteristics for KOA patients and provide clinical references.	A Randomized Controlled Trial.	Forty-one studies (2,251 participants) were included. Twenty-eight studies used rigorous randomization; eighteen reported allocation concealment. All had high performance bias risk due to exercise interventions. Regarding efficacy, isokinetic exercise ranked highest in pain relief (SMD = 0.70, 95% CI: 0.50–0.91, SUCRA = 82.6%), function improvement (SMD = 0.75, 95% CI: 0.57–0.92, SUCRA = 96.1%), and enhancement in muscle strength (SMD = 0.56, 95% CI: 0.34–0.78, SUCRA = 90.1%). Isometric exercise ranked highest in improving quality of life (SMD = 0.80, 95% CI: 0.28–1.31, SUCRA = 90.5%). Mixed strengthening exercise ranked lowest across all outcomes. High-frequency interventions (≥ 5 times/week) showed superior pain relief compared with low-frequency (≤ 3 times/week) for isotonic, isometric, and isokinetic exercise.

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(Author,Year) (Country)	Purpose	Method	Results
(Warsono et al., 2021) (Indonesia)	To determine the use of isometric quadriceps exercises for Osteoarthritis (OA) patients.	Quasi-Experimental	According to the Wilcoxon test data analysis, the intervention group received a p-value of $0.00 < 0.05$ while the control group received a p-value of $0.01 < 0.05$. Based on these findings, it can be said that isometric quadriceps workouts help people with grade 1 to 3 osteoarthritis in their knees experience less discomfort.
(Sorour et al., 2022) (Egypt)	To assess the effectiveness of acupressure versus isometric exercise on pain, stiffness, and physical function in knee OA female patients.	Quasi-Experimental	High baseline values for physical dysfunction, pain, and stiffness were found in the study. Following the intervention, stiffness and physical dysfunction scores were considerably lower in the isometric group ($P < 0.001$) than in the other two groups, and pain decreased in both intervention groups when compared to the control group ($P < 0.001$). In comparison to the control group, the decrease in overall WOMAC scores was more noticeable in both intervention groups. Disease duration was a positive predictor of WOMAC scores in multiple linear regression, but the intervention was linked to a decline in scores.
(Ojoawo et al., 2016) (Nigeria)	To compared the effects of isometric quadriceps exercise and proprioceptive exercise on pain, joint stiffness and physical difficulties of patients with knee osteoarthritis.	A Single-Blind Randomized Controlled Trial with Two Active Intervention.	Compared to isometric exercises, proprioceptive exercises significantly decreased physical difficulty ($F = 3.69$; $P < 0.04$) with an effect size of 7.53, and pain intensity ($F = 4.76$; $P = 0.00$) in the sixth week with an effect size of 2.79. Groups A and B showed a substantial decrease in physical difficulty ($F = 3.69$; $P = 0.04$) and pain severity ($F = 12.08$; $P < 0.001$) at pre-treatment, the third week, and the sixth week.

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DISCUSSION

All studies reported significant reductions in pain levels post-intervention. The use of isometric exercises, whether alone or in combination with other therapies, consistently led to improvements in pain intensity and physical function. Demonstrated that a 5-week program of isometric quadriceps exercises significantly increased quadriceps strength and reduced pain levels (Anwer & Alghadir, 2014). Isometric exercises combined with biofeedback enhanced pain reduction and muscle activation. Numerous studies have demonstrated the increased advantages of integrating isometric workouts with other forms of treatment. Compared to isometric exercises alone, electromyographic biofeedback (EMGBF) and ultrasound biofeedback (USBF) significantly raised maximum voluntary isometric contraction (MVIC) and reduced pain. These results imply that biofeedback systems offer useful sensory information that improves pain relief and muscular activation (Khairurizal, Irianto, & Ramba, 2019).

Functional improvements were consistently reported across the studies. Strengthening the quadriceps muscle, a critical stabilizer of the knee joint, was a common outcome (Sorour, Ayoub, & Abd El Aziz, 2014). This strengthening led to increased joint stability, improved mobility, and reduced functional limitations. Following a 6-week isometric training program, participants' joint function and discomfort significantly decreased (Onwunzo, Igwe, Umunnah, Uchenwoke, Ezugwu, Onwunzo, & Ezugwu, 2021). The studies used standardized pain measurement tools such as the Visual Analog Scale (VAS), the Numerical Rating Scale (NRS), and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). These tools consistently indicated significant pain reduction across all studies (Küçük, Taşkıran, Tokgöz, & Meray, 2017). The VAS and NRS provided quantifiable data on pain intensity, while the WOMAC assessed pain, stiffness, and physical function, offering a comprehensive evaluation of the intervention's impact (Long, Liu, Yin, Wang, Diao, Zhang, & Guo, 2022).

The quality evaluation, conducted utilizing the Joanna Briggs Institute (JBI) Critical Appraisal Skills Program, found that eight of the eleven studies had outstanding methodological rigor. Three studies,

however, had mediocre validity because of flaws like incomplete follow-up and a lack of blinding (Pati, & Lorusso, 2018). Notwithstanding these drawbacks, the overall caliber of the evidence was strong, confirming the validity of the conclusions. Numerous flaws were discovered in the included studies. Short intervention durations, small sample numbers, and little long-term follow-up were common problems (Braun & Clarke, 2006). Furthermore, blinding was absent from certain research, which may have introduced bias. These drawbacks emphasize the necessity of more extensive, reliable research with longer follow-up times to validate the long-term effectiveness of isometric exercises in the treatment of knee OA (Rahmaniyah, Fau, Pradita, 2022).

The presented systematic review offers compelling data in favor of isometric exercises as an effective non-pharmacological treatment for individuals with osteoarthritis (OA) of the knee. Isometric exercises have consistently demonstrated their ability to alleviate pain and enhance function in patients with knee OA, which is why they are used to develop comprehensive therapy plans. It has been demonstrated that isometric workouts considerably lessen the severity of knee OA discomfort. There are multiple mechanisms responsible for this reduction in pain. The quadriceps, which are essential for stabilizing the knee joint, are primarily strengthened via isometric workouts. Stronger quadriceps lessen mechanical stress and joint strain, which in turn lessens articular cartilage attrition and friction—two major causes of OA discomfort (Nugent, Lovejoy, Shull, Dobscha, & Morasco, 2021). Furthermore, brain processes, including exercise-induced hypoalgesia (EIH), modulate the analgesic effects of isometric workouts. EIH is the term used to describe the activation of the pain-inhibitory pathways in the central nervous system during isometric contractions, which may result in a decrease in pain perception. This system offers (Ojoawo, Olaogun, & Hassan, 2016).

In addition to pain relief, significant improvements in functional outcomes are observed in knee OA patients who engage in isometric exercises. Strengthening the quadriceps not only reduces pain but also enhances knee stability and mobility, allowing patients to perform daily activities with less

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discomfort and an improved range of motion. This is particularly beneficial for elderly patients, who often experience substantial limitations in mobility due to knee OA (Raja, Carr, Cohen, Finnerup, Flor, Gibson, & Vader, 2020). The combination of isometric exercises with biofeedback mechanisms has shown even greater benefits. Biofeedback, such as electromyographic biofeedback (EMGBF) or ultrasound biofeedback (USBF), improves muscle activation and coordination, further enhancing the effectiveness of isometric exercises. Real-time sensory feedback has been found to improve muscle activation and facilitate greater engagement in the rehabilitation process, leading to more pronounced improvements in both pain and function (Barker, Stone, Sears, Klugar, Tufanaru, Leonardi-Bee, & Munn, 2023). The review highlights the advantages of multimodal approaches in treating knee OA, with combined therapies such as isometric exercises and ultrasound or biofeedback methods yielding superior outcomes compared to single-modality treatments (Bahşi, Altındağ, Akaltun, Aydeniz, Avcı, & Gür, 2022). This approach addresses multiple aspects of knee OA, offering a more comprehensive treatment strategy. For instance, the synergy between isometric exercises and biofeedback improves muscle activation and helps patients engage more actively in their rehabilitation, thus enhancing adherence and long-term outcomes (Çokar, Yıldız, Şahinkaya, Dinçer, Gözübüyük, & Özgönenel, 2022). Multimodal therapy is increasingly seen as an optimal strategy for knee OA management. By personalizing treatments and integrating various interventions, clinicians can achieve more sustainable and comprehensive improvements in patient health. This personalized care model aligns with current trends in healthcare, which emphasize the importance of individualized and integrative care approaches. Even while the available data is encouraging, there are a few things to keep in mind. The findings' generalizability is constrained by the review's included studies' brief durations and small sample sizes (Ding, Yang, Xing, Jia, Liu, & Zhang, 2024). Additionally, the lack of long-term follow-up in the majority of research raises questions about how long-lasting the advantages of isometric workouts will be. Large-scale, long-term studies evaluating the long-term effectiveness of isometric exercises in the

treatment of knee OA should be the main focus of future research (Wako, 2024). To create more efficient and long-lasting care plans for knee OA, it is crucial to research the ideal length, frequency, and intensity of isometric exercise regimens as well as how they might be combined with other non-pharmacological therapies (Kangeswari, Murali, & Arulappan, 2021).

CONCLUSION

Strong evidence is shown in this systematic review to support the use of isometric knee exercises as a successful intervention for knee OA patients' pain management and functional improvement. These advantages are increased when biofeedback and other complementary therapies are added, suggesting that multimodal techniques can offer more complete answers. Isometric exercises should be included in routine therapy protocols for patients with knee OA because they are low-risk and non-invasive. This approach not only lessens the need for pharmaceutical therapies but also greatly enhances patient outcomes, especially with regard to mobility and pain control.

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A systematic review

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DOI: <https://doi.org/10.33024/minh.v8i3.614>