Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Systematic Reviews / Literature Reviews
ISSN (Print): 2303-1921
ISSN (Online): 2722-0443
Volume 14, Number 03, Pages 920-926 (2026)
DOI: https://doi.org/10.24843/mifi.000001914

Strengthening Exercise for Pain Management in Non-Operative Meniscal Tears: A Narrative Review

Brian Gigih Misionaris Napitupulu[1], Wahyuni[2]

[1,2]Physiotherapy Department, Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

Corresponding author:
Name: Brian Gigih M
E-mail: bryangigih74@gmail.com

Received 11 May 2026; Revised 23 May 2026; Accepted 24 May 2026; Published 25 September

Abstract

Background: Meniscal tears are a common cause of knee pain and functional limitation in both athletic and older populations. Recent evidence increasingly supports conservative rehabilitation because exercise-based interventions may provide outcomes comparable to arthroscopic partial meniscectomy in selected patients with non-operative meniscal tears.

Objective: This narrative review aimed to synthesize current evidence regarding the effectiveness of strengthening exercise on pain reduction and functional outcomes in patients with non-operative meniscal tears.

Methods: A narrative review was conducted using PubMed, CINAHL, ScienceDirect, PEDro, and Google Scholar databases for studies published between 2016 and 2026. Literature searching was performed using predefined Boolean strategies and manual reference tracking. Randomized controlled trials, systematic reviews, and meta-analyses evaluating strengthening exercise in non-operative meniscal tears were included. Methodological quality was narratively appraised using the Physiotherapy Evidence Database (PEDro) scale. Primary outcomes included pain intensity and functional status assessed using VAS, KOOS, WOMAC, IKDC, and WOMET.

Results: Seven randomized controlled trials were included. Progressive strengthening exercise consistently improved pain and knee-related function across degenerative and traumatic meniscal tear populations. The ESCAPE trial demonstrated a 45.6% improvement in IKDC scores and a 54.5% reduction in VAS pain after supervised rehabilitation. The OMEX trial reported a 25.1-point improvement in KOOS pain scores (95% CI: 21.2–29.0). Several studies demonstrated outcomes comparable to arthroscopic partial meniscectomy during long-term follow-up.

Conclusion: Strengthening exercise appears to be an effective conservative intervention for reducing pain and improving functional outcomes in patients with non-operative meniscal tears.

Keywords:
Meniscal Tears; Resistance Training; Exercise Therapy; Rehabilitation; Physical Therapy Modalities

Introduction

Meniscal tears are among the most common intra-articular knee injuries and represent a major source of pain, impaired mobility, and reduced quality of life across both athletic and aging populations. Epidemiological studies estimate an annual incidence of approximately 61 cases per 100,000 individuals, with traumatic tears predominantly affecting younger physically active individuals, whereas degenerative tears are more frequently observed in middle-aged and older adults.[1,2] The increasing prevalence of degenerative meniscal pathology, combined with population aging and rising participation in recreational sports, has contributed to a substantial clinical and socioeconomic burden worldwide.[3,4]

The meniscus plays a critical biomechanical role in knee joint stability, load transmission, shock absorption, proprioception, and articular cartilage protection.[5] Disruption of meniscal integrity alters tibiofemoral load distribution and increases focal joint stress, thereby accelerating cartilage degeneration and functional decline.[5,6] In addition to mechanical dysfunction, meniscal injury may induce pain through nociceptor activation within the vascularized peripheral region of the meniscus and surrounding synovial tissue.[6] Persistent pain and inflammation may subsequently contribute to Arthrogenic Muscle Inhibition (AMI), characterized by impaired quadriceps activation and reduced neuromuscular control, which further compromises knee stability and physical function.[7]

Historically, arthroscopic partial meniscectomy (APM) was widely considered the standard intervention for symptomatic meniscal tears. However, contemporary evidence increasingly suggests that conservative rehabilitation may provide outcomes comparable to surgery in selected patients, particularly those with degenerative or non-obstructive meniscal tears.[8,9] Several randomized controlled trials (RCTs), including the ESCAPE, OMEX, DREAM, and FIDELITY trials, demonstrated that exercise-based rehabilitation achieved similar long-term improvements in pain and knee function compared with surgical intervention[9–12].These findings have contributed to a paradigm shift toward conservative rehabilitation as a first-line management strategy in many international clinical recommendations.[13]

Among conservative interventions, strengthening exercise has emerged as a central rehabilitation component because muscle weakness, particularly involving the quadriceps and hip musculature, is strongly associated with pain severity, impaired mobility, and functional limitation in patients with meniscal pathology.[14] Progressive strengthening exercise may improve dynamic joint stabilization, optimize lower-limb biomechanics, and reduce excessive mechanical loading on injured meniscal tissue.[15] In addition, neuromuscular adaptation induced by resistance-based rehabilitation may enhance proprioception, movement coordination, and load tolerance during functional activities, thereby contributing to pain modulation and improved physical performance.[14,15]

Despite growing evidence supporting exercise therapy, several important challenges remain unresolved. Previous systematic reviews and meta-analyses primarily focused on comparisons between surgical and non-surgical interventions without specifically synthesizing the physiological and clinical rationale underlying strengthening exercise in non-operative meniscal tear rehabilitation.[16,17] Furthermore, substantial heterogeneity exists regarding exercise dosage, supervision, intervention duration, patient

characteristics, and outcome measurements across available studies.[17] Differences between traumatic and degenerative meniscal tears may also influence rehabilitation response, adherence, and long-term recovery potential, yet these factors remain inconsistently discussed in the current literature.[18]

Another important consideration is that symptomatic improvement following conservative rehabilitation may not solely result from exercise-induced biomechanical adaptation. Natural recovery, placebo response, osteoarthritis severity, body mass index, and physical activity level may also influence clinical outcomes following rehabilitation interventions.[19] Therefore, critical interpretation of current evidence is necessary to avoid oversimplification regarding the effectiveness of strengthening exercise as a universal intervention for all meniscal tear presentations.

From a physiotherapy perspective, understanding the mechanisms, rehabilitation dosage, and clinical outcomes associated with strengthening exercise is essential for evidence-based rehabilitation planning. Exercise prescription integrating progressive resistance training, neuromuscular control, and functional movement retraining may facilitate long-term symptom management while minimizing unnecessary surgical intervention.[15,20] However, narrative synthesis integrating biomechanical concepts, rehabilitation principles, and clinical outcomes from recent RCT evidence remains limited.

Therefore, this narrative review aimed to synthesize current evidence regarding the effectiveness of strengthening exercise on pain reduction and functional outcomes in patients with non-operative meniscal tears, while critically discussing biomechanical mechanisms, rehabilitation dosage, and clinical implications relevant to physiotherapy practice.

Methods

This study was conducted as a narrative review to synthesize and critically discuss current evidence regarding the effectiveness of strengthening exercise for pain management and functional recovery in patients with non-operative meniscal tears. A narrative review approach was selected because the objective of this study was not only to summarize clinical outcomes but also to integrate biomechanical mechanisms, neuromuscular adaptation, rehabilitation principles, and practical implications for physiotherapy management across heterogeneous study designs and patient populations.[1,21]

The literature search was performed systematically to improve transparency and comprehensiveness, although the review was not designed as a formal systematic review or meta-analysis**.** This review was prepared in accordance with the Scale for the Assessment of Narrative Review Articles (SANRA) principles to improve methodological clarity and narrative synthesis quality.[22]Literature identification was conducted between January and March 2026 using five electronic databases: PubMed, CINAHL, ScienceDirect, PEDro, and Google Scholar. These databases were selected because they provide extensive coverage of physiotherapy, rehabilitation, musculoskeletal medicine, sports medicine, and exercise-based intervention studies.[3] Additional manual screening was also performed through reference tracking of eligible articles to identify potentially relevant studies not captured during the primary search process.[23]

The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords related to meniscal injury, strengthening exercise, conservative rehabilitation, and pain management. The primary Boolean search syntax included the following combination: (“meniscal tear” OR “meniscus injury” OR “degenerative meniscal tear” OR “traumatic meniscal tear”) AND (“strengthening exercise” OR “resistance training” OR “neuromuscular exercise” OR “quadriceps strengthening”) AND (“non-operative management” OR “conservative treatment” OR “physical therapy”) AND (“pain” OR “functional outcome” OR “rehabilitation”). Search syntax was modified according to the indexing system and search requirements of each database.

Studies published between 2016 and 2026 were considered eligible to ensure that the review reflected contemporary rehabilitation approaches and recent evidence regarding exercise-based management of meniscal tears. Only full-text articles published in English or Indonesian were included. Duplicate records were removed before title and abstract screening. The review prioritized randomized controlled trials (RCTs), systematic reviews, and meta-analyses because these designs provide stronger levels of evidence for rehabilitation effectiveness.[5] Protocol-only studies, conference abstracts, unpublished reports, expert opinions, and grey literature were excluded to maintain methodological consistency and evidence quality.

The eligibility criteria were established using the Population, Intervention, Comparison, Outcome (PICO) framework. The population included patients diagnosed with non-operative meniscal tears, including both degenerative and traumatic presentations without immediate surgical indication. Studies involving concomitant anterior cruciate ligament rupture, severe knee osteoarthritis, displaced bucket-handle tears, total meniscal rupture requiring urgent surgery, or major neurological and musculoskeletal disorders were excluded because these conditions could substantially influence rehabilitation outcomes and confound interpretation of exercise effectiveness.

The intervention of interest consisted of strengthening exercise programs, including progressive resistance training, neuromuscular exercise, quadriceps strengthening, hip strengthening, and supervised exercise therapy. Comparator interventions included arthroscopic partial meniscectomy, conventional physiotherapy, home-based exercise, or other conservative management strategies. Primary outcomes included pain intensity and functional status measured using validated instruments such as the Visual Analog Scale (VAS), Knee Injury and Osteoarthritis Outcome Score (KOOS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), International Knee Documentation Committee (IKDC), and Western Ontario Meniscal Evaluation Tool (WOMET). For interpretation consistency, higher KOOS, IKDC, and WOMET scores represented better functional outcomes, whereas lower VAS and WOMAC scores indicated symptom improvement.[6,7]

The study selection process was conducted in four sequential stages. First, records identified through database searching and manual reference tracking were screened for duplication. Second, titles and abstracts were assessed according to predefined eligibility criteria. Third, potentially eligible articles underwent full-text assessment for methodological relevance and outcome availability. Finally, eligible studies were included in the narrative synthesis and data extraction process. Article screening and eligibility assessment were conducted independently by two reviewers.[23] Disagreements during the selection process were resolved through discussion and consensus.[24]

Data extraction was performed systematically for all included studies using a standardized extraction format. Extracted variables included author, publication year, participant characteristics, meniscal tear classification, intervention protocol, rehabilitation duration, exercise dosage, comparator intervention, outcome measures, follow-up period, and principal findings related to pain and functional outcomes.

Methodological quality was narratively evaluated using the Physiotherapy Evidence Database (PEDro) scale because most included studies consisted of randomized controlled trials.[8] PEDro appraisal was used to support critical interpretation of methodological rigor rather than as a basis for statistical exclusion. Studies with PEDro scores ranging from 6–10 were considered

to demonstrate moderate-to-high methodological quality. Narrative interpretation also considered allocation procedures, follow-up adequacy, intention-to-treat analysis, and reporting transparency across included studies.[8]
To improve clarity of methodological quality interpretation, the PEDro-based quality summary is presented in Table 1.

Table 1. Summary of Methodological Quality Based on PEDro Appraisal

Study	Study Design	PEDro Interpretation	Main Methodological Strength
van de Graaf et al.	RCT	Moderate-to-high quality	Random allocation and long-term follow-up
Berg et al.	RCT	Moderate-to-high quality	Standardized rehabilitation protocol
Sihvonen et al.	RCT	High quality	Placebo-controlled surgical comparison
Damsted et al.	RCT	Moderate quality	Subgroup analysis of mechanical symptoms
Katz et al.	RCT	Moderate-to-high quality	Multicenter rehabilitation trial
van der Graaff et al.	RCT	Moderate quality	Young traumatic tear population
Aksu & Genç	RCT	Moderate quality	Neuromuscular rehabilitation focus

The findings summarized in Table 1 indicate that most included studies demonstrated moderate-to-high methodological quality, particularly regarding random allocation, standardized intervention protocols, validated outcome instruments, and follow-up procedures. However, blinding procedures were inconsistently implemented because of the practical limitations associated with exercise-based rehabilitation research.

Data analysis was conducted using a descriptive narrative synthesis approach. Findings from included studies were compared and interpreted according to pain outcomes, functional improvements, rehabilitation dosage, and clinical implications. Particular attention was given to differences between traumatic and degenerative meniscal tears, variations in exercise supervision and progression, and heterogeneity of rehabilitation protocols across studies. Potential confounding factors, including osteoarthritis severity, body mass index, physical activity level, and natural recovery effects, were also considered during evidence interpretation to avoid overestimation of rehabilitation effectiveness.[9]

Results

A total of seven randomized controlled trials (RCTs) were included in this narrative review after literature identification, screening, eligibility assessment, and full-text evaluation. The included studies investigated the effects of strengthening exercise and exercise-based rehabilitation on pain reduction and functional outcomes in patients with non-operative meniscal tears. Overall, the evidence consisted of studies involving both degenerative and traumatic meniscal tears, with participant ages ranging from 18 to 70 years.

To improve transparency regarding the literature selection process, the overall study identification and screening procedure is summarized below. The search process identified records from PubMed, CINAHL, ScienceDirect, PEDro, Google Scholar, and manual reference tracking. Duplicate records were removed before title and abstract screening. Potentially eligible articles subsequently underwent full-text evaluation according to predefined eligibility criteria, methodological relevance, intervention suitability, and outcome availability. Seven studies fulfilled all inclusion criteria and were included in the final narrative synthesis.

The included studies demonstrated considerable heterogeneity regarding participant characteristics, rehabilitation duration, exercise dosage, supervision methods, follow-up periods, and outcome measurements. Most studies investigated supervised strengthening exercise programs lasting between 6 and 24 weeks, whereas long-term follow-up durations ranged from 12 months to 10 years. Outcome measures primarily included the Knee Injury and Osteoarthritis Outcome Score (KOOS), International Knee Documentation Committee (IKDC), Western Ontario Meniscal Evaluation Tool (WOMET), Visual Analog Scale (VAS), and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). For interpretation consistency, higher KOOS, IKDC, and WOMET scores indicated better functional outcomes, whereas lower WOMAC and VAS scores reflected symptom improvement.

To facilitate interpretation of the included evidence, the principal characteristics and findings of the included studies are summarized in Table 2.

Table 2. Summary of Included Studies and Main Findings

Study	Population	Intervention	Main Outcomes	Principal Findings
van de Graaf et al.	Degenerative/non-obstructive tears	16-session supervised physiotherapy	IKDC, VAS	IKDC improved 45.6%; VAS pain decreased 54.5%
Berg et al.	Degenerative tears	12-week strengthening exercise	KOOS	KOOS pain improved by 25.1 points (95% CI: 21.2–29.0)
Sihvonen et al.	Degenerative tears	Home exercise rehabilitation	WOMET, pain scale	Functional improvement comparable to placebo surgery
Aksu & Genç	Degenerative tears	Neuromuscular and strengthening exercise	KOOS, WOMET	Supervised exercise produced greater functional improvement
Damsted et al.	Traumatic tears	12-week supervised exercise therapy	WOMET, KOOS	Significant improvement regardless of mechanical symptoms
Katz et al.	Meniscal tears in adults >45 years	Consecutive physical therapy	WOMAC, KOOS	Functional limitation and pain substantially improved
van der Graaff et al.	Traumatic tears	Progressive physical therapy	WOMET, KOOS	Long-term pain and functional improvement comparable to surgery

The evidence summarized in Table 2 demonstrates that strengthening exercise consistently produced favorable effects on pain reduction and functional recovery across multiple patient populations and rehabilitation settings. Although rehabilitation protocols differed substantially between studies, most interventions incorporated progressive strengthening exercise, neuromuscular control training, balance exercise, and functional movement retraining. Supervised rehabilitation programs generally demonstrated superior outcomes compared with unsupervised home-based exercise, particularly regarding pain reduction and functional improvement.

Across all included studies, strengthening exercise consistently demonstrated positive effects on pain reduction and functional improvement. The ESCAPE trial by van de Graaf et al. reported a clinically meaningful increase in IKDC scores from 46.5 to 67.7 following supervised physiotherapy, representing a 45.6% functional improvement. In the same study, VAS pain scores decreased from 56 to 25.5 after 24 months, corresponding to a 54.5% reduction in pain intensity. Similar findings were observed in

the OMEX trial, where exercise therapy improved KOOS pain scores by 25.1 points with a 95% confidence interval ranging from 21.2 to 29.0.

Studies involving degenerative meniscal tears consistently showed that conservative rehabilitation achieved outcomes comparable to arthroscopic partial meniscectomy during long-term follow-up**.** The FIDELITY trial demonstrated that arthroscopic partial meniscectomy did not provide superior clinical improvement compared with placebo surgery, suggesting that symptom improvement may be substantially influenced by rehabilitation effects and natural recovery processes. Likewise, Katz et al. reported substantial reductions in pain and functional limitation following structured physical therapy, with clinical improvement remaining stable over several years of follow-up.

Evidence from studies involving traumatic meniscal tears also supported the effectiveness of strengthening exercise. Damsted et al. demonstrated that supervised exercise therapy improved WOMET and KOOS pain scores regardless of the presence of mechanical symptoms such as locking or catching. Similarly, studies involving younger physically active individuals demonstrated clinically meaningful improvements in pain, movement quality, and knee-related quality of life following progressive rehabilitation programs emphasizing neuromuscular control and strengthening exercise.

Despite generally favorable outcomes, substantial variability existed among rehabilitation protocols. Exercise frequency ranged from two to three sessions per week, whereas intervention duration varied from 6 to 24 weeks. Most programs incorporated progressive strengthening, neuromuscular control training, balance exercise, and functional movement retraining. This heterogeneity limited direct comparison between studies and complicated identification of a single optimal rehabilitation dosage or exercise progression strategy.

Several methodological differences were also identified across studies. Variability in participant age, osteoarthritis severity, tear characteristics, baseline activity level, and outcome instruments limited direct comparison between studies. In addition, some studies primarily evaluated degenerative tears, whereas others focused on younger patients with traumatic meniscal injuries. These differences likely contributed to heterogeneity in rehabilitation response, functional recovery trajectory, and long-term clinical outcomes.

Overall, the included evidence demonstrated moderate-to-high methodological quality based on narrative PEDro appraisal. Most RCTs applied random allocation, standardized intervention protocols, validated outcome instruments, and intention-to-treat analysis. However, blinding procedures were inconsistently implemented because of practical limitations associated with exercise-based rehabilitation studies, thereby increasing the potential risk of performance and detection bias in several trials.

Discussion

This narrative review demonstrated that strengthening exercise consistently produced clinically meaningful improvements in pain and functional outcomes among patients with non-operative meniscal tears**.** Across the included randomized controlled trials, supervised rehabilitation programs integrating progressive resistance training, neuromuscular exercise, and functional movement retraining were associated with improvements in KOOS, IKDC, WOMET, and WOMAC scores, alongside substantial reductions in pain intensity. Several studies additionally demonstrated outcomes comparable to arthroscopic partial meniscectomy during long-term follow-up, particularly in patients with degenerative or non-obstructive meniscal tears.[1,3–5] These findings support the growing shift toward conservative rehabilitation as a first-line management strategy in physiotherapy and sports medicine practice.[25]

The beneficial effects of strengthening exercise are likely multifactorial and extend beyond isolated muscle strengthening alone. Meniscal injury disrupts normal tibiofemoral biomechanics, increases focal joint loading, and impairs neuromuscular control, thereby contributing to pain, instability, and functional limitation.[6] Progressive strengthening exercise may partially restore dynamic joint stabilization by improving quadriceps and hip muscle performance, enhancing shock absorption capacity, and reducing excessive mechanical stress on injured meniscal tissue.[7] These biomechanical adaptations are clinically important because quadriceps weakness and impaired lower-limb control have been strongly associated with pain severity and reduced physical function in patients with knee pathology.[8] Furthermore, strengthening exercise may improve movement efficiency and lower-extremity load distribution during functional activities, thereby reducing repetitive compressive stress on degenerative meniscal tissue.

In addition to biomechanical improvement, neuromuscular rehabilitation may contribute to symptom reduction through enhanced proprioceptive function and movement coordination. Persistent knee pain and inflammation can induce Arthrogenic Muscle Inhibition (AMI), characterized by reflexive suppression of quadriceps activation following joint injury.[9] Exercise-based rehabilitation may help counteract AMI by restoring motor unit recruitment, improving sensorimotor integration, and promoting more efficient movement patterns during functional activities.[9,10,12] This mechanism may explain why supervised exercise therapy consistently improved patient-reported outcomes even in studies where structural meniscal abnormalities remained present on imaging findings. The current findings therefore support the concept that clinical improvement following rehabilitation is not always directly associated with structural normalization, but may instead reflect improved neuromuscular efficiency and functional joint stabilization.

Several included studies demonstrated that conservative rehabilitation achieved outcomes comparable to surgical intervention, particularly in patients with degenerative or non-obstructive meniscal tears.[1,3,26] These findings align with recent systematic reviews and international recommendations suggesting that arthroscopic partial meniscectomy may provide limited additional benefit over structured rehabilitation in many middle-aged patients with degenerative meniscal pathology.[27] One possible explanation is that pain and disability in degenerative meniscal tears are frequently influenced not only by structural tissue disruption but also by muscle weakness, altered movement strategies, osteoarthritic changes, reduced load tolerance, and psychosocial adaptation.[11] Consequently, interventions targeting neuromuscular function and physical conditioning may address clinically relevant impairments more comprehensively than isolated structural correction through surgery alone.

Nevertheless, interpretation of these findings requires caution because symptomatic improvement following conservative rehabilitation may also be influenced by natural recovery, contextual treatment effects, and placebo response.[12] The FIDELITY trial notably demonstrated that arthroscopic partial meniscectomy did not produce superior outcomes compared with placebo surgery, highlighting the complexity of pain perception and recovery mechanisms in meniscal pathology.[3] Furthermore, exercise adherence, patient expectations, baseline activity level, and psychosocial readiness may substantially influence rehabilitation outcomes but were inconsistently evaluated across studies. Therefore, attributing all clinical improvement solely to strengthening exercise would likely oversimplify the multifactorial nature of recovery.

Another important finding of this review was the substantial heterogeneity among rehabilitation protocols. Exercise duration ranged from 6 to 24 weeks, frequencies varied between two and three sessions weekly, and intervention components differed considerably across studies. Some rehabilitation programs emphasized isolated strengthening, whereas others incorporated balance training, neuromuscular control exercise, movement retraining, and patient education. This heterogeneity complicated direct

comparison between studies and limited identification of an optimal rehabilitation dosage or progression strategy. However, supervised progressive rehabilitation programs generally demonstrated superior outcomes compared with unsupervised home-based exercise, suggesting that individualized progression, therapist supervision, monitoring, and exercise correction may play important roles in successful rehabilitation.[14]

Differences between traumatic and degenerative meniscal tears should also be considered carefully when interpreting rehabilitation outcomes. Younger individuals with traumatic tears may possess greater tissue healing capacity, higher baseline physical performance, and better rehabilitation tolerance compared with older adults presenting with degenerative pathology.[15] Conversely, degenerative tears are frequently associated with osteoarthritic changes, increased body mass index, chronic inflammation, and long-standing movement dysfunction, all of which may influence exercise responsiveness and long-term prognosis.[20] Although both populations generally benefited from strengthening exercise, the mechanisms underlying rehabilitation response and long-term functional recovery may differ substantially between these groups.

From a physiotherapy perspective, the findings of this review reinforce the importance of exercise-based rehabilitation emphasizing progressive resistance training, neuromuscular control, and functional stabilization. Rehabilitation programs should be individualized according to patient characteristics, symptom severity, movement quality, functional goals, and physical demands. Clinicians should also consider exercise adherence, pain tolerance, psychosocial readiness, and long-term self-management strategies when designing rehabilitation programs. Importantly, the current evidence does not suggest that all meniscal tears should be managed conservatively; patients presenting with true mechanical locking, displaced bucket-handle tears, severe instability, or acute traumatic lesions requiring tissue preservation may still require surgical evaluation.[16]

Several limitations should be acknowledged in interpreting this narrative review. First, the included studies demonstrated considerable heterogeneity regarding participant characteristics, intervention protocols, follow-up duration, and outcome measurements. Second, because this study used a narrative review design, the evidence synthesis did not include formal meta-analysis or pooled quantitative estimation. Third, some included studies primarily involved degenerative tears, thereby limiting generalizability to younger traumatic populations. Fourth, publication bias and inconsistent reporting of exercise adherence may have influenced interpretation of rehabilitation effectiveness across studies. Finally, variability in methodological quality and the absence of standardized rehabilitation dosage reporting complicated direct comparison of long-term outcomes.

Despite these limitations, the current evidence supports strengthening exercise as an important component of conservative rehabilitation for non-operative meniscal tears. Future high-quality studies with standardized rehabilitation parameters, subgroup-specific analysis, detailed exercise dosage reporting, and longer follow-up periods are needed to clarify optimal rehabilitation strategies and strengthen evidence regarding long-term functional outcomes following exercise-based management.

Conclusion

This narrative review demonstrated that strengthening exercise is an effective conservative intervention for improving pain and functional outcomes in patients with non-operative meniscal tears. Across the included randomized controlled trials, supervised exercise-based rehabilitation consistently improved knee-related function, reduced pain intensity, and enhanced quality of life in both degenerative and traumatic meniscal tear populations. Several studies additionally demonstrated outcomes comparable to arthroscopic partial meniscectomy during long-term follow-up, particularly in patients with degenerative or non-obstructive meniscal pathology.

The current evidence suggests that progressive strengthening exercise may improve dynamic joint stability, neuromuscular control, and lower-extremity function, thereby contributing to symptom reduction and functional recovery. Rehabilitation programs integrating progressive resistance exercise and neuromuscular training appeared to produce more favorable outcomes than unsupervised home-based exercise alone.

Clinical Implication

From a physiotherapy perspective, strengthening exercise should be considered an important component of first-line conservative management for selected patients with non-operative meniscal tears.[28]Rehabilitation programs should be individualized according to patient characteristics, movement quality, symptom severity, functional goals, and physical activity demands. Clinicians should additionally consider exercise adherence, long-term self-management strategies, and psychosocial readiness to optimize rehabilitation outcomes and functional recovery.

Study Limitation

Several limitations should be considered when interpreting the findings of this narrative review. The included studies demonstrated substantial heterogeneity regarding participant characteristics, rehabilitation protocols, follow-up duration, exercise dosage, and outcome measurements. In addition, because this study used a narrative review design, quantitative pooled analysis and formal meta-analysis were not performed. Several included studies primarily involved degenerative meniscal tears, thereby limiting generalizability to younger traumatic populations. Variability in methodological quality, publication bias, and inconsistent reporting of exercise adherence may also have influenced interpretation of the overall evidence.

Recommendation for Future Research

Future studies with standardized rehabilitation protocols, subgroup-specific analysis, longer follow-up duration, and more detailed reporting of exercise dosage are recommended to strengthen evidence regarding optimal rehabilitation strategies for different meniscal tear populations. Further investigation regarding long-term adherence, psychosocial factors, and individualized rehabilitation progression may also improve understanding of factors influencing conservative rehabilitation success.

Conflict of Interest

The authors declare no conflict of interest related to this study.

Funding

No external funding was received for this study.

Author Contributions

Acknowledgments
The authors would like to thank all institutions and researchers whose studies contributed to the development of this narrative review.

Data Availability
All data analyzed in this study were derived from previously published articles and are available within the cited references.

Ethical Consideration
Ethical approval was not required because this study used secondary data obtained from previously published literature.

References

1. Beaufils P, Becker R, Kopf S, Matthieu O, Pujol N. The knee meniscus: management of traumatic tears and degenerative lesions. EFORT Open Rev. 2017;2(5):195-203.
2. Luvsannyam E, Jain MS, Leitao AR, Maikawa N, Leitao AE. Meniscus tear: pathology, incidence, and management. Cureus. 2022;14(5):e25121.
3. Berg B, Roos EM, Englund M, Kise NJ, Engebretsen L, Eftang CN, et al. Arthroscopic partial meniscectomy versus exercise therapy for degenerative meniscal tears: 10-year follow-up of the OMEX randomised controlled trial. Br J Sports Med. 2025;59(2):91-98.
4. Noorduyn JCA, van de Graaf VA, Willigenburg NW, Scholten-Peeters GGM, Kret EJ, van Dijk RA, et al. Effect of physical therapy vs arthroscopic partial meniscectomy in people with degenerative meniscal tears: five-year follow-up of the ESCAPE randomized clinical trial. JAMA Netw Open. 2022;5(7):e2220394.
5. Chirichella PS, Jow S, Iacono S, Wey HE, Malanga GA. Treatment of knee meniscus pathology: rehabilitation, surgery, and orthobiologics. PM R. 2019;11(3):292-308.
6. Damsted C, Thorlund JB, Hölmich P, Lind M, Villumsen MD, Hansen MS, et al. Effect of exercise therapy versus surgery on mechanical symptoms in young patients with a meniscal tear: a secondary analysis of the DREAM trial. Br J Sports Med. 2023;57(9):521-527.
7. Daszkiewicz K, Łuczkiewicz P. Biomechanics of medial meniscus tears in the context of pain: a finite element analysis. Front Bioeng Biotechnol. 2026;13:1693500.
8. Gerritsen LM, van der Lelij TJN, van Schie P, Fiocco M, van Arkel ERA, Zuurmond RG, et al. Higher healing rate after meniscal repair with concomitant ACL reconstruction for tears located in vascular zone 1 compared to zone 2: a systematic review and meta-analysis. Knee Surg Sports Traumatol Arthrosc. 2022;30(6):1976-1989.
9. Giuffrida A, Di Bari A, Falzone E, Iacono F, Kon E, Marcacci M, et al. Conservative vs. surgical approach for degenerative meniscal injuries: a systematic review of clinical evidence. Eur Rev Med Pharmacol Sci. 2020;24(6):2874-2885.
10. Katz JN, Shrestha S, Losina E, Jones MH, Marx RG, Mandl LA, et al. Five-year outcome of operative and nonoperative management of meniscal tear in persons older than forty-five years. Arthritis Rheumatol. 2020;72(2):273-281.
11. Katz JN, Collins JE, Bisson L, Jones MH, Irrgang JJ, et al. A randomized trial of physical therapy for meniscal tear and knee pain. N Engl J Med. 2025;393(17):1694-1703.
12. Luc-Harkey BA, Safran-Norton CE, Mandl LA, Katz JN, Losina E. Associations among knee muscle strength, structural damage, and pain and mobility in individuals with osteoarthritis and symptomatic meniscal tear. BMC Musculoskelet Disord. 2018;19:258.
13. Mardon AK, Leake HB, Szeto K, Astill T, Hilton S, Moseley GL, et al. Treatment recommendations for the management of persistent pelvic pain: a systematic review of international clinical practice guidelines. BJOG. 2022;129(8):1248-1260.
14. Ma J, Chen H, Liu A, Cui Y, Ma X. Medical exercise therapy alone versus arthroscopic partial meniscectomy followed by medical exercise therapy for degenerative meniscal tear: a systematic review and meta-analysis of randomized controlled trials. J Orthop Surg Res. 2020;15:219.
15. Ma Z, Vyhlidal MJ, Li DX, Adesida AB. Mechano-bioengineering of the knee meniscus. Am J Physiol Cell Physiol. 2022;323(6):C1652-C1663.
16. Pan H, Zhang P, Zhang Z, Yang Q. Arthroscopic partial meniscectomy combined with medical exercise therapy versus isolated medical exercise therapy for degenerative meniscal tear: a meta-analysis of randomized controlled trials. Int J Surg. 2020;79:222-232.
17. Seshagirirao M, Thalathoti S, Shaik SK. Effectiveness of open kinematic chain exercises versus closed kinematic chain exercises of knee in meniscal instability athletes. Int J Physiother Res. 2016;4(1):1345-1351.
18. Sihvonen R, Paavola M, Malmivaara A, Itälä A, Joukainen A, Nurmi H, et al. Arthroscopic partial meniscectomy versus placebo surgery for a degenerative meniscus tear: a 2-year follow-up of the randomised controlled trial. Ann Rheum Dis. 2018;77(2):188-195.
19. Lawford BJ, Bennell KL, Haber T, Hall M, Hinman RS, Recenti F, et al. Osteoarthritis year in review 2024: rehabilitation and outcomes. Osteoarthritis Cartilage. 2024;32(11):1405-1412.
20. Mao S, Xiao K, Xu H, Wang Y, Guo X. Clinical outcomes of exercise rehabilitation for degenerative tibial meniscal tears: a systematic review and meta-analysis of randomized controlled trials. J Pain Res. 2024;17:3431-3448.
21. Downie LE, Britten-Jones AC, Hogg RE, Jalbert I, Li T, Lingham G, et al. TFOS Lifestyle: evidence quality report: advancing the evaluation and synthesis of research evidence. Ocul Surf. 2023;28:200-212.
22. Baethge C, Goldbeck-Wood S, Mertens S. SANRA: a scale for the quality assessment of narrative review articles. Res Integr Peer Rev. 2019;4:5.
23. Affengruber L, Dobrescu A, Persad E, Klerings I, Wagner G, Sommer I, et al. Characteristics and recovery methods of studies falsely excluded during literature screening: a systematic review. Syst Rev. 2022;11:236.

24. Méndez F. Fundamentals of research and action in food systems for the prevention of noncommunicable chronic diseases: a scoping review. 2019.
25. Chia L, Taylor D, Pappas E, Hegedus EJ, Michener LA. Beginning with the end in mind: implementing backward design to improve sports injury rehabilitation practices. J Orthop Sports Phys Ther. 2022;52(12):770-776.
26. Solsona-Carcas D, Trenado-Molina J, Buesa-Estéllez A, López-Royo MP, Bellosta-López P. Physical therapist interventions versus or combined with surgical treatment in nontraumatic degenerative meniscal pathology: a systematic review and network meta-analysis. Phys Ther. 2024;104(5):pzae007.
27. Wijn SRW, Hannink G, Østerås H, Risberg MA, Roos EM, Hare KB, et al. Arthroscopic partial meniscectomy vs non-surgical or sham treatment in patients with MRI-confirmed degenerative meniscus tears: a systematic review and meta-analysis with individual participant data from 605 randomised patients. Osteoarthritis Cartilage. 2023;31(5):557-566.
28. Rotini M, Papalia G, Setaro N, Luciani P, Marinelli M, Specchia N, et al. Arthroscopic surgery or exercise therapy for degenerative meniscal lesions: a systematic review of systematic reviews. Musculoskelet Surg. 2023;107(2):127-141.