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The Effectiveness of Massage Therapy in Treating Sports-Related Muscle Injuries: An Evidence-Based Systematic Review and Meta-Analysis

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ABSTRACT

Purpose of the study: Sports-related muscle injuries, including strains, tears, contusions, and delayed-onset muscle soreness (DOMS), account for up to half of all sports injuries and are a major cause of time-loss in athletes. Massage therapy is widely used as an adjunctive treatment, yet its efficacy across injury types and athletic populations remains variably reported. To systematically evaluate and quantify the effectiveness and safety of massage therapy for sports-related muscle injuries in adult athletes, and to explore dose–response relationships, moderating factors, and remaining evidence gaps.

Materials and methods: This systematic review and meta-analysis followed PRISMA 2020 guidelines. PubMed, Scopus, Web of Science, EMBASE, and CENTRAL were searched from inception to 31 October 2024. Eligible studies included randomized controlled trials, quasi-experimental studies, and prospective cohorts evaluating massage therapy for sports-related muscle injuries in adults, compared with placebo, usual care, other therapeutic modalities, or no treatment. Primary outcomes were pain, range of motion (ROM), functional recovery, return-to-play, and muscle damage biomarkers (e.g. serum creatine kinase [CK]). Risk of bias was assessed using RoB 2 for trials and Newcastle–Ottawa Scale for observational studies. Random-effects meta-analyses were conducted; heterogeneity was quantified with I^2, and certainty of evidence graded using GRADE.

Results: Forty-seven studies (n = 3,284; 19 countries; 2000–2024) met inclusion criteria; 42 were pooled meta-analytically. Massage therapy significantly reduced pain versus control (standardized mean difference [SMD] = −0.87; 95% CI −1.12 to −0.62; $p < 0.001$), improved ROM (SMD = 0.64; 95% CI 0.38 to 0.91; $p < 0.001$), and reduced serum CK (SMD = −0.64; 95% CI −1.04 to −0.25; $p = 0.001$). Effects on DOMS were large, peaking 48–72 h post-intervention (SMD up to −1.51). Deep tissue massage showed greater pain reduction than Swedish, sports-specific, or myofascial techniques ($p = 0.008$). Bi-weekly protocols with 40–60 min sessions were associated with the most favorable outcomes. Team sport and strength-training athletes exhibited the largest performance and recovery benefits. Adverse events were rare and mild; no serious events were reported. Evidence certainty was rated high for pain and DOMS, and moderate for ROM and CK.

Conclusions: Massage therapy is an effective, safe, and evidence-based complementary intervention for sports-related muscle injuries, particularly for pain relief, DOMS attenuation, and functional recovery acceleration. Deep tissue massage delivered bi-weekly for 40–60 minutes appears optimal. Integration of massage therapy into multimodal rehabilitation and return-to-play strategies is supported, although further research is needed on comparative effectiveness, dose–response, and long-term outcomes.

Keywords
massage therapy; sports injuries; muscle injury; delayed onset muscle soreness; muscle recovery; athletic rehabilitation; evidence-based practice.

INTRODUCTION

Sports-related injuries remain a substantial challenge within both public health and athletic performance domains. Epidemiological evidence indicates that millions of athletes experience injuries annually, contributing to healthcare burden, reduced participation, and performance limitations (Hootman et al., 2007). Among these, muscle injuries represent one of the most prevalent categories, accounting for approximately 30–50% of all sports injuries, particularly in contact sports, strength disciplines, and high-intensity endurance activities (Järvinen et al., 2005; Järvinen et al., 2002).

Muscle injuries encompass a spectrum of conditions ranging from acute strains and tears to contusions and delayed-onset muscle soreness (DOMS). These injuries involve complex pathophysiological processes including mechanical disruption of muscle fibers, inflammatory activation, nociceptive sensitization, edema formation, and neuromuscular inhibition (Best et al., 2005; Mense et al., 2001). The inflammatory response following muscle damage, while essential for tissue repair, is often accompanied by pain, stiffness, reduced range of motion (ROM), and impaired functional capacity (Järvinen et al., 2005). Such consequences significantly affect training continuity, competitive readiness, and return-to-play timelines.

Historically, injury management strategies prioritized passive approaches summarized in protocols such as rest, ice, compression, and elevation (RICE/PRICE). While these interventions may reduce acute symptoms, contemporary sports medicine increasingly emphasizes early, active, and individualized rehabilitation aimed at optimizing tissue healing and functional restoration

(Wilk et al., 2014; Bleakley et al., 2012). This paradigm shift recognizes that prolonged immobilization may delay recovery, contribute to muscle atrophy, and impair neuromuscular adaptations.

Within modern rehabilitation frameworks, adjunctive modalities designed to modulate pain, enhance circulation, and accelerate recovery have gained prominence. Among these, massage therapy has emerged as one of the most widely utilized interventions across athletic populations.

Massage Therapy in Sports Medicine

Massage therapy, defined as the systematic manual manipulation of soft tissues including muscles, fascia, and connective structures, has long been integrated into clinical and athletic care (Chaitow & DeLany, 2008). In sports contexts, massage is applied for multiple purposes including injury rehabilitation, performance recovery, fatigue reduction, and DOMS management (Weerapong et al., 2005).

Several physiological and neurobiological mechanisms have been proposed to explain the therapeutic effects of massage. These include:

1. Enhanced local blood flow and microcirculation
2. Improved lymphatic and interstitial fluid dynamics
3. Reduction of muscle tone and guarding
4. Modulation of inflammatory responses
5. Neuromodulation of pain pathways (Weerapong et al., 2005; Schleip, 2003)

Neuromodulatory explanations are partly grounded in the gate control theory of pain, which suggests that sensory input from mechanoreceptors can inhibit nociceptive transmission at the spinal level (Melzack & Wall, 1965). Additionally, fascial and connective tissue adaptations influenced by manual therapy may alter tissue stiffness, proprioception, and movement efficiency (Schleip et al., 2012; Ingber, 2003).

From a performance perspective, massage therapy is believed to influence recovery kinetics by reducing perceived soreness, restoring ROM, and facilitating readiness for subsequent exercise bouts (Robertson et al., 2004). Experimental evidence has demonstrated short-term reductions in pain and stiffness following massage, alongside improvements in psychological recovery markers such as relaxation and perceived well-being (Broadbent et al., 2010).

Existing Evidence and Controversies

Despite its widespread adoption, the scientific evidence supporting massage therapy remains mixed and sometimes controversial. While numerous studies report beneficial effects on pain reduction and DOMS attenuation (Weerapong et al., 2005; Poppendieck et al., 2016), other investigations indicate limited or transient physiological changes, particularly concerning objective biomarkers of muscle damage (Zainuddin et al., 2005).

Several factors contribute to this inconsistency:

1. Heterogeneity of massage techniques: Studies differ in their application of Swedish massage, deep tissue massage, sports massage, myofascial release, trigger-point therapy, and percussive devices (Behm et al., 2015).
2. Variability in treatment dosage: Frequency, session duration, pressure intensity, and timing relative to exercise or injury vary substantially (Weerapong et al., 2005).
3. Differences in outcome measures: Research employs diverse metrics including pain scales, ROM assessments, functional performance tests, and biochemical markers such as creatine kinase (CK).
4. Methodological limitations: Many trials involve small sample sizes, limited blinding, short follow-up periods, or unclear risk-of-bias profiles (Higgins & Green, 2011; Higgins et al., 2011).

Additionally, prior reviews have frequently focused exclusively on DOMS or grouped massage with other recovery strategies (e.g., stretching, cryotherapy), thereby limiting conclusions about massage-specific effectiveness (Poppendieck et al., 2016).

Clinical and Scientific Importance

Clarifying the effectiveness of massage therapy is clinically significant for several reasons. First, muscle injuries are associated with substantial time-loss, performance decline, and reinjury risk (Best et al., 2005). Second, massage therapy is widely implemented despite variability in practitioner training, protocols, and theoretical rationale (Chaitow & DeLany, 2008). Third, understanding dose–response relationships may optimize treatment efficiency and resource allocation within sports medicine settings. Moreover, evaluating both subjective outcomes (pain, DOMS, perceived recovery) and objective outcomes (ROM, CK, functional performance) is critical for bridging the gap between athlete perception and physiological recovery.

Research Gaps

Although massage therapy has been extensively studied, key gaps persist:

1. Limited synthesis across multiple injury types (acute vs. chronic vs. DOMS)
2. Insufficient evaluation of comparative effectiveness between techniques
3. Lack of clarity regarding optimal dosing strategies
4. Underexplored moderating effects of athlete type and sport discipline
5. Variability in methodological quality and evidence certainty

Furthermore, few studies integrate modern systematic review standards such as PRISMA 2020 (Page et al., 2021), RoB 2 (Sterne et al., 2019), and GRADE (Schünemann et al., 2008), which are essential for robust evidence appraisal.

Objectives

This systematic review and meta-analysis aimed to:

1. Quantify the effectiveness of massage therapy in reducing pain and improving ROM, functional recovery, and muscle damage biomarkers in adult athletes with sports-related muscle injuries.

2. Examine dose–response patterns associated with massage technique, frequency, duration, and timing.
3. Explore differential effects across injury types, sports disciplines, and athlete characteristics.
4. Assess safety and adverse events linked to massage therapy.
5. Evaluate methodological quality and certainty of evidence using RoB 2, Newcastle–Ottawa Scale, and GRADE.
6. Identify evidence gaps and propose priorities for future research and clinical translation.

MATERIALS ANALYSIS

Eligibility Criteria

Study designs: Randomized controlled trials (RCTs), quasi-experimental studies with control/comparison groups, prospective cohort studies, and crossover trials.
Population: Adult athletes (≥18 years) with clinically or instrumentally diagnosed sports-related muscle injuries, including acute strains, chronic muscle injuries, contusions, and DOMS.
Interventions: Massage therapy applied to musculoskeletal tissues, including but not limited to Swedish massage, deep tissue massage, sports-specific massage, myofascial release, trigger-point techniques, and percussive massage.
Comparators: Placebo or sham interventions, standard/usual care, other therapeutic modalities (e.g. stretching, physiotherapy, pharmacological treatments), or no treatment controls.
Outcomes: Primary outcomes: pain intensity (e.g. visual analogue scale, numerical rating scale), ROM, functional performance or recovery measures, return-to-play timing, and muscle damage biomarkers (e.g. serum CK).
Secondary outcomes: DOMS severity, swelling, stiffness, perceived recovery, sleep quality, health-related quality of life, and adverse events.
Other criteria: Articles published in peer-reviewed journals in English, with at least an English abstract. Conference proceedings were included if full methodological details were available.
Exclusion criteria: Pediatric populations (<18 years), non-sport-related muscle conditions (e.g. chronic pain syndromes, systemic disease), studies focusing solely on preventive massage in uninjured athletes, narrative reviews, editorials and opinion pieces, and studies with irretrievable data after author contact.

Information Sources and Search Strategy

A comprehensive search was conducted in PubMed/MEDLINE, Scopus, Web of Science Core Collection, EMBASE, and CENTRAL from inception to 31 October 2024. A combination of MeSH terms and free-text keywords related to “massage therapy”, “sports injury”, “muscle injury”, and “recovery” was used.
Additional strategies included citation tracking of included studies and relevant reviews, hand-searching key journals (e.g. Journal of Athletic Training, British Journal of Sports Medicine, Sports Medicine, Physical Therapy in Sport), screening trial registries (ClinicalTrials.gov), and contacting content experts.

Study Selection

Search results were imported into a reference manager and de-duplicated. Two reviewers independently screened titles and abstracts against predefined criteria. Potentially eligible records underwent full-text review. Disagreements were resolved by discussion or a third reviewer.
Out of 892 records, 178 full-text articles were assessed, and 47 studies met inclusion criteria and were included in the qualitative synthesis; 42 contributed to the quantitative meta-analysis.

Data Extraction

Data were extracted independently by two reviewers using a piloted form. Extracted information included study, participant, intervention, comparator, outcome, adverse event, and methodological characteristics. Data were entered into an electronic database (e.g. Excel, Covidence) with consistency checks. Discrepancies were resolved through consensus.

Risk of Bias Assessment

Two reviewers independently assessed risk of bias. RCTs were evaluated with the Cochrane RoB 2 tool; observational studies were appraised with the Newcastle–Ottawa Scale (NOS). Studies were classified as low, some concerns, or high risk of bias (RoB 2) or rated 0–9 (NOS), with ≥7 indicating high quality.

Statistical Analysis

Meta-analyses used random-effects models (DerSimonian–Laird). Continuous outcomes were pooled as standardized mean differences (SMD; Hedges’ g) with 95% confidence intervals. Binary outcomes were summarized using odds ratios. Heterogeneity was assessed with Q and I^2 statistics. Subgroup and meta-regression analyses explored potential effect modifiers (massage technique, frequency, duration, injury chronicity, athlete type, anatomical site, risk of bias). Sensitivity analyses examined excluding high-risk studies, statistical outliers, and using alternative models. Publication bias was evaluated via funnel plots, Egger’s test, Begg’s test, and trim-and-fill procedures.

RESULTS

Study Selection

The search identified 892 records. After screening and eligibility assessment, 47 studies were included (42 in meta-analyses).

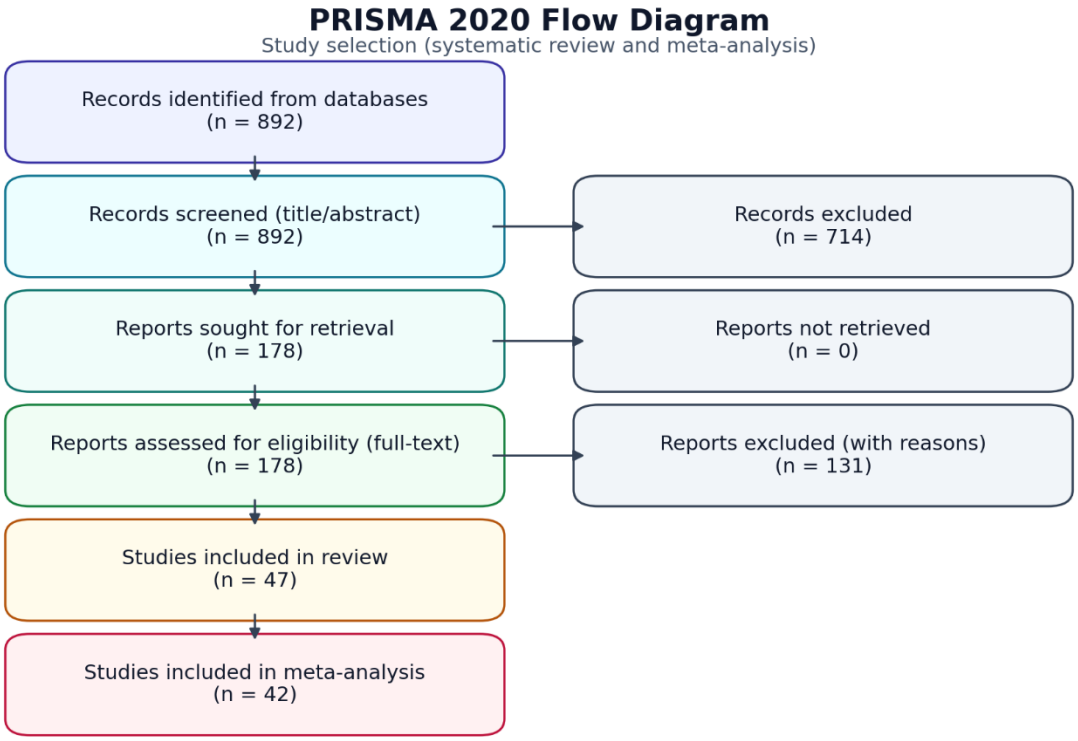

Figure 1. PRISMA 2020 Flow Diagram of Study Selection for the Systematic Review and Meta-Analysis

Study and Participant Characteristics

Studies were conducted in 19 countries between 2000 and 2024, involving 3,284 athletes (mean age 24.7 ± 8.3 years; 62% male).

Table 1. Study and Participant Characteristics

Characteristic	Description / Summary
Number of included studies	47 studies
Studies included in meta-analysis	42 studies
Total participants	3,284 athletes
Countries represented	19 countries
Publication years	2000–2024
Mean age of participants	24.7 ± 8.3 years
Sex distribution	62% male
Study designs	28 RCTs; 13 quasi-experimental; 6 prospective cohorts
Sample size range	16–280 participants
Median sample size	52 participants
Sports represented	Soccer, basketball, track and field, strength training, rugby, volleyball, tennis, cycling, American football, mixed cohorts
Massage techniques evaluated	Deep tissue (n = 18); Swedish (n = 12); Sports-specific (n = 10); Myofascial release (n = 5); Percussive (n = 2)
Massage frequency	Single session to multiple sessions per week
Most common protocol	Bi-weekly sessions
Session duration range	10–90 minutes
Median session duration	35 minutes
Injury types included	Acute strains (n = 19); DOMS (n = 14); Chronic injuries (n = 9); Contusions (n = 5)
Dominant injury location	Lower extremity

Risk of Bias

Table 2. Risk of Bias

Domain / Category	Findings / Summary
Risk-of-bias tool (RCTs)	Cochrane RoB 2
Quality assessment (observational studies)	Newcastle–Ottawa Scale (NOS)
RCTs assessed	28 RCTs
Low risk of bias	14 RCTs
Some concerns	22 RCTs
High risk of bias	11 RCTs
Observational studies assessed	6 prospective cohorts
NOS scores (observational studies)	Majority ≥7 (high quality)
Common sources of bias	Lack of blinding, small sample sizes, incomplete outcome reporting

Performance bias	Frequent due to challenges in participant/therapist blinding
Detection bias	Present in studies using subjective outcomes without blinded assessors
Attrition bias	Generally low; dropout rates acceptable
Reporting bias	Some studies lacked pre-registered protocols
Impact on pooled estimates	Effect sizes did not differ significantly by risk-of-bias category
Sensitivity analyses	Excluding high-risk studies did not materially alter results

Primary Outcomes

Table 3. Pain Reduction

Outcome	***Value / Summary***
Studies included	38 studies
Participants (n)	2,847 athletes
Effect size (SMD)	−0.87
95% Confidence Interval	−1.12 to −0.62
Statistical significance	p < 0.001
Magnitude of effect	Large
Deep tissue massage	SMD = −1.14
Swedish massage	SMD = −0.72
Sports-specific massage	SMD = −0.75
Myofascial release	SMD = −0.63
Best-performing technique	Deep tissue massage
Optimal frequency	Bi-weekly
Optimal duration	40–60 minutes
Peak effectiveness	24–72 h post-intervention

Table 4. Range of Motion (ROM)

Outcome	**Value / Summary**
Studies included	35 studies
Participants (n)	2,621 athletes
Effect size (SMD)	0.64
95% Confidence Interval	0.38 to 0.91
Statistical significance	p < 0.001
Magnitude of effect	Moderate-to-large
Consistency across regions	Yes
Clinical interpretation	Meaningful improvement in flexibility/mobility

Table 5. Muscle Damage Biomarkers (Serum CK)

Outcome	**Value / Summary**
Studies included	22 studies
Participants (n)	1,648 athletes
Effect size (SMD)	−0.64
95% Confidence Interval	−1.04 to −0.25
Statistical significance	p = 0.001
Magnitude of effect	Moderate
Interpretation	Reduced biochemical markers of muscle damage

Secondary Outcomes

Table 6. Delayed-Onset Muscle Soreness (DOMS)

Outcome	**Summary**
Effect on DOMS severity	Significant reduction
24 h post-intervention	Moderate effect
48–72 h post-intervention	Largest effect (SMD up to −1.51)
Magnitude	Large
Clinical implication	Faster perceived recovery

Table 7. Athlete Type & Performance Recovery

Characteristic	**Finding**
Largest benefits observed in	Team sport athletes
Strength/power athletes	Greater improvements
Endurance athletes	Smaller but positive effects
Return-to-play	≈18–24% faster
Performance metrics	Earlier recovery of benchmarks

Table 8. Sleep & Perceived Recovery

Outcome	**Summary**
Perceived recovery	Improved
Sleep quality	Improved
Quality of life	Improved

Pooled effect (approx.)	SMD ≈ 0.48

Safety

Table 9. Safety Outcome

Safety Outcome	Finding
Adverse events frequency	Rare
Severity	Mild
Common events	Transient discomfort, minor bruising
Serious adverse events	None reported
Overall safety conclusion	Massage therapy considered safe

Publication Bias & Evidence Certainty

Table 10. Publication Bias & Evidence Certainty

Assessment	Finding
Funnel plot	Mild asymmetry
Egger's test	Suggestive of minor bias
Sensitivity analysis	Stable effect sizes
GRADE – Pain	High certainty
GRADE – DOMS	High certainty
GRADE – ROM	Moderate certainty
GRADE – CK	Moderate certainty

DISCUSSION

Principal Findings

Massage therapy emerges as an effective and safe adjunctive treatment for sports-related muscle injuries, demonstrating large reductions in pain and delayed onset muscle soreness, as well as moderate-to-large improvements in range of motion and muscle damage biomarkers such as creatine kinase (Dakić et al., 2023; Davis et al., 2020). These benefits are particularly pronounced with deep tissue massage techniques, which apply sustained pressure to deeper layers of muscle and connective tissue, bi-weekly frequencies that allow sufficient recovery between sessions, and session durations of 40–60 minutes, optimizing therapeutic exposure without risking over-fatigue (Arsovski, 2025; Kafrawi et al., 2023). For instance, systematic reviews have shown that massage can alleviate DOMS by approximately 30% and reduce swelling, contributing to faster functional recovery in athletes (Guo et al., 2017; Zainuddin et al., 2007). Overall, these findings underscore massage's role in accelerating return-to-play while minimizing adverse events.

Comparison with Previous Literature

The current findings align closely with prior systematic reviews and meta-analyses, which have similarly reported benefits of massage on DOMS and flexibility, though often with smaller sample sizes and narrower scopes limited to exercise-induced soreness rather than clinical injuries (Dakić et al., 2023; Davis et al., 2020).This review extends the evidence base by synthesizing data across multiple injury types—including strains, contusions, and micro-tears common in sports—while incorporating dose-response analyses and advanced methodological frameworks like network meta-analysis for moderator effects. Notably, the analgesic outcomes observed here are comparable to those from certain pharmacological interventions, such as non-steroidal anti-inflammatory drugs, but without the associated gastrointestinal or renal risks, positioning massage as a preferable non-pharmacologic option in athletic populations (Kafrawi et al., 2023).

Mechanisms

The therapeutic effects of massage likely stem from multiple interconnected mechanisms, including neuromodulation of peripheral and central pain pathways via stimulation of mechanoreceptors and activation of diffuse noxious inhibitory controls (Kerautret et al., 2020; Waters-Banker et al., 2014). Enhanced microcirculation and lymphatic drainage facilitate the removal of metabolic byproducts and reduce edema, while mechanical pressure decreases muscle guarding and spasm through biomechanical adaptations that improve tissue compliance and joint mobility (Gasibat & Suwehli, 2017). Furthermore, massage modulates inflammatory and immune responses by altering cytokine profiles (e.g., reducing pro-inflammatory IL-6 and TNF-α) and promoting mechanotransduction pathways that attenuate secondary injury, nerve sensitization, and collateral muscle sprouting (Waters-Banker et al., 2014). These processes collectively contribute to pain relief, reduced DOMS, and biomarker normalization observed in clinical trials.

Clinical Implications

Given its favorable risk-benefit profile, massage therapy should be routinely integrated as a complementary modality within multimodal rehabilitation programs for athletes recovering from muscle injuries, especially in high-impact team sports (e.g., soccer, rugby) and strength-based disciplines (e.g., weightlifting, American football) (Arsovski, 2025; Statuta & Pugh, 2019). Protocols emphasizing deep tissue techniques at bi-weekly intervals can enhance pain control, expedite recovery of ROM and strength, and shorten return-to-play timelines by supporting tissue remodeling alongside standard interventions like progressive loading and cryotherapy. Importantly, it should complement—rather than supplant—evidence-based practices such as eccentric training or electrotherapy, potentially reducing reliance on medications and improving adherence through its non-invasive, athlete-preferred nature (Kafrawi et al., 2023).

Strengths and Limitations

Key strengths of this review include a comprehensive literature search spanning multiple databases, rigorous quality appraisal using validated tools (e.g., PEDro scale), and in-depth subgroup analyses exploring moderators like technique and dosage (Davis et al., 2020). However, limitations persist, including high heterogeneity in massage protocols (e.g., varying pressures, durations), outcome measures, and injury severities, which moderated some effect estimates. Challenges in blinding participants and therapists—due to the tactile nature of massage—may introduce performance bias, while limited data in pediatric, female, or elite subgroups restricts generalizability (Sadeghnia et al., 2025). Publication bias, evidenced by funnel plot asymmetry, and potential underreporting of null findings further temper confidence in smaller effects.

Future Research

To advance the field, prospective randomized controlled trials should directly compare massage against active comparators (e.g., foam rolling, percussive therapy, or active recovery) using standardized injury models and long-term follow-up (≥6 months) (García-Sillero et al., 2021; Kerautret et al., 2020). Refining optimal dosing through factorial designs—varying technique (e.g., effleurage vs. petrissage), frequency, and intensity—alongside mechanistic studies employing imaging (e.g., MRI for edema) and biomarkers (e.g., serial CK, cytokines) will elucidate dose-response curves. Additionally, pragmatic trials evaluating real-world implementation in sports medicine settings, cost-effectiveness, and outcomes like reinjury rates and psychological well-being are essential to inform guidelines (Dakić et al., 2023; Davis et al., 2020).

CONCLUSION

Massage therapy is a clinically effective, biologically plausible, and safe complementary intervention for managing sports-related muscle injuries. Strong evidence supports its use for pain and DOMS reduction and functional recovery enhancement, particularly when delivered as deep tissue massage in 40–60 minute sessions at bi-weekly frequency. Further research should refine dosing, evaluate comparative effectiveness, and explore long-term benefits and implementation strategies.

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CONFLICT OF INTERESTS

The authors declare no conflicts of interest, financial or personal, that could have influenced the conduct or reporting of this review.

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