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The effects of fascial manipulation on pain: a systematic review with meta-analysis

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ABSTRACT

Objectives: This systematic review and meta-analysis aimed to summarize the effects of fascial manipulation (FM) on pain alleviation in adults, providing valuable insights for future research and practitioners by addressing a significant gap in the existing literature.

Methods: Systematic review with meta-analysis. Key databases, including PubMed, Scopus, and Web of Science, were searched for relevant studies. The eligibility criteria required randomized clinical trials involving adults (>18 years) with musculoskeletal pain, who participated in FM, and included either true control or active control groups as comparators. To assess the risk of bias, the PEDro scale was used, while the certainty of the evidence was evaluated using the GRADE scale. Out of the initial pool of 138 studies, 15 were determined to be eligible for inclusion in this systematic review.

Results: Results showed significant favoring effect for the FM compared to the active-control group in pain-related outcomes (ES = -0.80, 95% CI -1.30 to -0.29, $p = 0.002$, $I^2 = 85\%$). The certainty of evidence, as determined by the GRADE assessment, was rated as very low.

Conclusions: Although the included studies provide evidence of very low certainty – given the small sample sizes, lack of blinding, and significant limitations in the intervention – the meta-analysis suggests that FM may potentially be beneficial in reducing pain associated with various musculoskeletal conditions. However, more robust research is needed to strengthen these findings, with a focus on increasing the number of blinded studies, reducing methodological heterogeneity, and further exploring the underlying mechanisms that may explain the observed trends in the evidence.

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musculoskeletal pain;
myofascial pain; fascial
system; manual technique

1. Introduction

Fascial Manipulation (FM) is a hands-on/manual therapy [1,2] that focuses on assessing and treating dysfunctions in the fascial system to restore movement and alleviate pain [3]. It is based on the model developed by Luigi Stecco and involves deep tissue manipulation of specific densified areas within the fascia to improve mobility and function [4] (Figure 1). FM (Stecco Method) claims to differ from other soft tissue techniques by using a structured, movement-based assessment to identify specific fascial densifications, applying deep, sustained pressure at precise points within the fascia, and targeting the global fascial system for long-lasting functional improvement [5]. Thus, the fundamental premise of FM is to eliminate fascial densification, aiming to restore the physiological tension of the fascial tissue and promote proper sliding

between its layers [6]. While comprehensive research on this concept is limited, preliminary findings suggest that improving the viscoelastic properties of hyaluronic acid within the fascia plays a key role [7]. Consequently, the therapist’s movements should be directed in alignment with the sensed dysfunction in fascial sliding [8].

First introduced as ‘neuroconnective manipulation’ [9], FM operates on the premise that fascia is not a passive structure, but an active tissue with contractile properties [10], containing cells such as myofibroblasts that influence its mechanical behavior [11]. The fascia forms a continuous network connecting muscles, bones, and organs [12]. Disruptions due to trauma, overuse, or pathological changes may contribute to movement dysfunction and pain. FM targets specific ‘myofascial units’ – areas of the body where fascial

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Figure 1. Examples of fascial manipulation.

dysfunction is believed to cause or contribute to musculoskeletal pain and discomfort [13].

The theoretical assumption of FM suggests that applying FM to dysfunctional or stiff areas may reduce fascial tension, improve sliding between fascial layers, and potentially restore normal movement patterns while possibly reducing mechanical stress on muscles, joints, and tissues [14]. However, fundamental research to substantiate this claim remains lacking. This potential reduction in mechanical stress is believed to decrease the likelihood of nociceptive input from free nerve endings in the fascia and surrounding tissues, which may be activated in painful conditions [15]. Furthermore, FM assumptions suggest that it may lead to changes in global muscle tone and vasodilation, which could enhance circulation, tissue oxygenation, and the removal of metabolic waste products that may contribute to pain [16]. These potential neurophysiological responses may help alleviate both musculoskeletal pain – such as that caused by myofascial trigger points or joint dysfunction – and nonspecific pain by reducing inflammation, improving tissue flexibility, and facilitating collagen remodeling in damaged fascia [17]. However, these underlying mechanisms remain theoretical and require further research for confirmation.

FM has been shown to be effective in both chronic and acute pain scenarios, making it a versatile treatment for a variety of populations, including workers, athletes, and clinical patients [18–20]. In chronic conditions, such as persistent musculoskeletal pain or myofascial pain syndrome, FM helps restore normal fascial dynamics by reducing tissue stiffness [18]. In acute scenarios, such as injury or inflammation following trauma or overuse, FM can accelerate recovery by promoting tissue healing, enhancing blood flow, reducing edema, and modulating the neural responses associated with pain [21]. For workers, especially those in physically demanding jobs, FM can alleviate pain caused by repetitive strain and poor posture by addressing fascial restrictions that lead to musculoskeletal imbalances [22]. For athletes, FM may aid in recovery from sports-related injuries by restoring optimal

fascial function and preventing further injury through improved biomechanics [20]. In clinical populations, FM is beneficial in managing conditions like low back pain [18], neck pain [23], and temporomandibular [24] disorders by targeting the fascial system's role in stabilizing and transmitting forces across the body, thereby reducing discomfort and enhancing mobility.

With growing evidence in this technique, it became possible to summarize the results and analyze the overall interpretation of its effects on pain. A previous systematic review [25] had delved into the information; however, it only established a foundation of the state of the art without generating quantitative evidence that would allow for proper data interpretation through meta-analysis. To address this, we proposed conducting a systematic review and meta-analysis. Our goal was to consolidate existing evidence, clarify FM's overall effect size, and identify specific conditions and protocols where FM may offer possible benefits. By filling these gaps, our review aims to provide insights for both practitioners and future research, contributing to evidence-based therapeutic interventions. Therefore, this systematic review and meta-analysis sought to summarize the effects of FM on pain alleviation in adults, helping to bridge a significant gap in the existing literature.

2. Methods

The 2020 PRISMA Statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), was followed in our systematic review [26].

2.1. Protocol and registration

Published on 20 November 2024, the protocol for this systematic review is available on the Open Science Framework (registration: osf.io/yk5hu) and can be accessed through DOI: [A0.17605/OSF.IO/ACVHD](https://doi.org/10.17605/OSF.IO/ACVHD).

2.2. Eligibility criteria

Detailed in Table 1, the eligibility criteria adhered to the PICOS framework (Participants, Intervention,

Table 1. Inclusion and exclusion criteria based on PICOS.

	Inclusion criteria	Exclusion criteria
Population	The study will include both men and women aged 18 years and older who have musculoskeletal pain.	Individuals under 18 years of age and those asymptomatic will be excluded from the review.
Intervention	FM will be considered for both single sessions and longitudinal treatments.	To avoid bias in isolating the effects, treatments that combine FM with other techniques will not be considered.
Comparator	True control groups, defined as those not participating in any form of rehabilitation, as well as active control groups, will be included. Active controls may consist of rehabilitation methods such as exercise therapies, other manual therapies, or hands-off approaches like psychological interventions, education, or general practitioner management.	Excluded will be interventions that incorporate FM within a broader training protocol.
Outcomes	Outcomes related to pain intensity, such as scores on the Visual Analog Scale or Numeric Pain Rating Scale, will be included and must be assessed at two time points: pre- and post-intervention.	Excluded will be assessments reporting only one time point, along with other outcomes related to disability, functionality, or health, including mental health (e.g. depression), biomarkers, cognitive measures, and social-related factors (e.g. social interaction or support).
Study design	The review will include two-arm or multi-arm randomized controlled trials.	Non-randomized experimental study designs, descriptive studies, systematic reviews, and gray literature will be excluded.

Comparator, Outcomes, Study Design). Original research articles published in peer-reviewed journals were included, without restrictions on publication year [27] or article language.

2.3. Information sources

On 20 November 2024, in line with the registered protocol, we carried out a thorough search for relevant studies across PubMed, Scopus, and Web of Science (Core Collection) databases. We also manually examined the reference lists of the included studies to identify additional pertinent sources. To enhance the review process, snowball citation tracking was performed via the Web of Science database. For added rigor, we consulted two globally recognized experts, selected through Expertscape for their expertise in Musculoskeletal Manipulations (<https://expertscape.com/ex/musculoskeletal+manipulations>). Additionally, all studies chosen for inclusion were carefully reviewed for any errata or retractions.

2.4. Search strategy

To maximize the retrieval of relevant studies, the search strategy employed a combination of the Boolean operators 'AND' and 'OR.' No filters or limitations were applied regarding publication date, language, or study design, allowing for a broad and comprehensive search. This approach was designed to capture as many relevant studies as possible without narrowing the scope. The specific methodology used for the search is outlined as follows:

[Title/Abstract] 'fascial manipulation' OR 'Stecco method'
AND
[Title/Abstract] 'myofascial pain' OR 'musculoskeletal pain' OR 'musculoskeletal dis*' OR 'pain'

The full search strategy for each database is provided in Supplementary Material 1.

2.5. Selection process

In the research process's first stage, two independent authors (RT and FMC) initially screened studies based on titles and abstracts. These abstracts were evaluated according to the pre-established inclusion criteria, and full-text articles were retrieved when needed. In the next phase, the full texts of studies that passed the initial screening were reviewed separately by the same two authors. Any disagreements that arose were discussed between the reviewers, and if they could not reach an agreement, a third reviewer (AK) was consulted to help resolve the issue. To manage records efficiently and eliminate duplicates, both manual and automated methods were used, supported by EndNoteTM software (version 20.5, Clarivate Analytics, Philadelphia, PA).

2.6. Data collection process

The data extraction process was initiated by one of the authors (FMC) and later reviewed by two additional authors (RT and AK) to ensure both accuracy and completeness. A specialized Microsoft Excel spreadsheet (Microsoft®, USA) was developed to facilitate the capture of all relevant data.

If any data were missing from the full-text articles, FMC contacted the corresponding authors via e-mail or ResearchGate to request the necessary information. Studies from which no response was received within two weeks were excluded from both the review and the meta-analysis.

The key details extracted from each study included: (i) sample size, (ii) participant characteristics such as physical activity status (e.g. active, inactive, athlete status), age, sex, and clinical condition, and (iii) study design aspects, including randomization methods and blinding procedures.

For the training intervention, the following data were collected: (i) training duration and frequency, (ii) total number of sessions, (iii) participant adherence, and (iv) the specific rehabilitation procedures.

2.7. Data items

Pain-related outcomes were extracted when they included evaluations at two time points (baseline and post-intervention), with measures derived from various pain perception tools, such as the Visual Analog Scale, Numeric Pain Rating Scale, and McGill Pain Questionnaire. The exclusion criterion was a single time-point assessment, as without a pre-post assessment, it would not be possible to represent the progression from baseline to post-intervention.

2.8. Risk of bias assessment

The Physiotherapy Evidence Database (PEDro) scale was used to assess the risk of bias in the included studies. This scale, widely utilized in physiotherapy-based randomized clinical trials, has been validated for its effectiveness and reliability. It includes 11 items that evaluate essential aspects of study design and reporting, such as random allocation, concealed allocation, baseline comparability, blinding of both participants and assessors, retention rates, intention-to-treat analysis, and outcome reporting. Each item is scored as either 'yes' (1 point) or 'no' (0 points), with items 1 and 2 excluded from the final score, allowing a maximum possible score of 10.

Two authors (RT and FMC) independently assessed each study using the PEDro scale. If there was disagreement over the score, a third author (AK) was consulted to finalize the decision. Cohen's kappa statistic was used to analyze inter-rater reliability, demonstrating a high level of agreement between the authors ($\kappa = 0.89$).

2.9. Summary measures, synthesis of results, and risk of publications bias

Meta-analyses were carried out when a minimum of three independent studies reported effect size data for the pain reported, regardless of the particular test or variable used to measure it [28,29].

Effect sizes (ES) using Hedges' g , along with 95% confidence intervals (CI) and 95% prediction intervals (PI), were computed for the primary outcomes in both the FM group and comparison groups. These effect sizes were derived from the means and standard deviations of pre- and post-intervention measurements, with standardization based on the post-intervention standard deviations. To address potential small-study effects (SSE) and study variability, the DerSimonian and Laird random-effects model was applied. This

approach helps account for inter-study differences and enhances the robustness of the overall findings [30,31].

Effect sizes (ES) were presented with 95% confidence intervals (CIs) and interpreted using the following scale: 0.0–0.2 as trivial, 0.2–0.6 as small, 0.6–1.2 as moderate, 1.2–2.0 as large, 2.0–4.0 as very large, and greater than 4.0 as extremely large [32]. For studies with more than one intervention group, the sample size of the control group was adjusted proportionally to ensure accurate comparisons across all groups [33]. To examine heterogeneity, the I^2 statistic was calculated, with values categorized as follows: less than 25% for low, between 25% and 75% for moderate, and greater than 75% for high heterogeneity [34].

To assess potential publication bias in continuous variables (with a minimum of 10 studies per outcome), we applied the extended Egger's test [35]. If bias was detected, we conducted a sensitivity analysis using the trim and fill method [36], employing L0 as the default estimator for identifying missing studies [37]. All statistical analyses were carried out using Comprehensive Meta-Analysis Software (Version 4, Biostat, Englewood, NJ, USA), with statistical significance set at $p \leq 0.05$.

2.10. Certainty assessment

The quality of the evidence was independently assessed by two authors (RT and FMC) using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach [38]. When discrepancies arose, the authors reached consensus through discussion. The evaluation focused on four of the five core GRADE criteria [39,40] risk of bias, inconsistency, imprecision, and potential publication bias.

Randomized controlled trials are initially rated as high-certainty evidence. However, the certainty of the evidence can be either downgraded (e.g. due to high risk of bias, inconsistent results, or indirect evidence) or upgraded (e.g. due to a large effect size or a dose-response relationship). The final level of certainty is categorized into one of four groups: high, moderate, low, or very low, reflecting the degree of confidence in the estimated effect.

3. Results

3.1. Study selection

A total of 138 studies were initially identified through a search of the Web of Science, Scopus, and PubMed databases. After removing duplicates ($n = 74$), 64 records remained and were screened based on their titles and abstracts. At this stage, 46 studies were excluded, leaving 18 for full-text review. Following this assessment, 3 studies did not meet the eligibility

criteria and were excluded. Of these, 1 was excluded for not meeting the comparator criteria, and 2 were excluded for failing to have pain-related outcomes. A full list of the included and excluded studies, along with the reasons for exclusion, can be found in Supplementary Material 2. In the end, 15 original studies were included in the systematic review and 14 in the meta-analysis, as shown in Figure 2.

3.2. Study characteristics

Table 2 provides a summary of the main characteristics of the studies included in this analysis. A total of 764 participants took part, all of whom were adults, with a mean age of around 44.9 ± 17.7 years. Eleven studies [6,13,18,21,23,41–43,45,46,48] included both men and women participants, while one study [24] exclusively involved men participants, and another [47] focused solely on women participants. The sex of participants was not reported in two studies [42,44]. In terms of pain-related outcomes, the Visual Analog Scale was the most frequently utilized tool, appearing in 7 of the studies [6,18,21,44–47]. The Numeric Pain Rating Scale was used in 6 studies [13,23,41–43,48], while

the Verbal Numerical Scale was employed in two studies [24,42]. The pre- and post-intervention assessments (baseline and after interventions) lasted an average of 3.4 weeks.

3.3. Risk of bias in studies

The risk of bias assessment for the studies included in this review (Table 3) revealed a range of PEDro scores. One study scored 5 points, while fourteen studies had scores between 6 and 8. None of the studies achieved a score between 9 and 10. The most common biases identified were the lack of blinding for evaluators ($n = 12$), inadequate description of allocation concealment ($n = 12$), and the absence of blinding for the therapists delivering the interventions ($n = 12$).

3.4. Summary of the individual studies

Table 4 summarizes the pre- and post-treatment pain scale values following FM. Among the studies with active controls (defined as controls receiving any form of treatment, either physical or passive – most of which consisted of stretching, manipulation, or

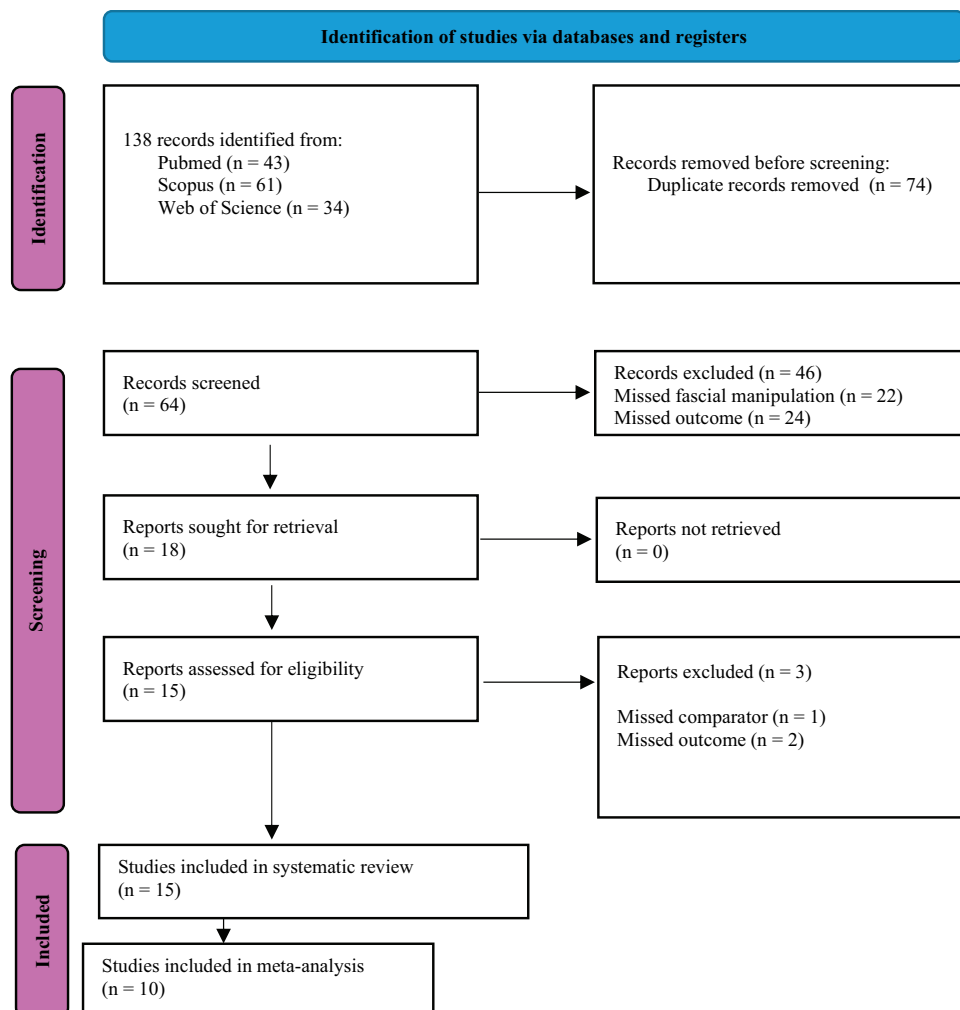


Figure 2. PRISMA 2020 flow diagram.

Table 2. Characteristics of the included studies.

Study	N	Age	Clinical condition	Sex	Duration (weeks)	Standalone FM sessions (n)	Control group	Pain-related tests/outcomes
Batool et al. [41]	45	24.5 ± 2.4	Chronic neck pain	M&W	3	9	Active (fasciotherapy + physical therapy)	Numeric Pain Rating Scale
Bellotti et al. [42]	84	30 to 60	Recurrent shoulder pain	ND	5	2	Active (physical exercise – stretching and strengthening)	Numeric Pain Rating Scale
Branchini et al. [18]	24	45.8 ± 10.3	Low back pain	M&W	4	8	Active (relaxation and stretching)	Visual Analogue Scale
Busato et al. [20]	46	67.8 ± 7.9	Total hip arthroplasty	M&W	1	2	Active (physiotherapy – not described)	Verbal numerical scale
Cotti et al. [43]	71	64.0 ± 9.9	Coxarthrosis	M&W	2	6	True control (passive)	Numeric Pain Rating Scale
Endamlil et al. [44]	55	37.1 ± 11.6	Chronic low back pain	ND	3	5	Active (physiotherapy – not described)	Visual analogue scale
Guarda-Nardini et al. [45]	30	45.5 ± 14.0	Temporomandibular disorders	M&W	2–4	6 ± 2 to 12 ± 4	Active (Botulinum toxin injections)	Visual analogue scale
Harper et al. [13]	102	59.7 ± 11.6	Low back pain	M&W	ND	ND	Active (physiotherapy – mobilization and traction)	Numeric Pain Rating Scale
Pawlukiewicz et al. [6]	52	22.7 ± 2.3	Myofascial pain	M&W	1	3	True control (passive)	Visual analogue scale
Picelli et al. [46]	18	40.5 ± 12.8	Whiplash associated disorders	M&W	2	3	Active (physiotherapy – mobilization and stretching)	Visual analogue scale
Pintucci et al. [47]	14	51.4 ± 10.0	Carpal tunnel syndrome	W	5	5	Active (sham)	Visual analogue scale
Pratelli et al. [21]	42	54.2 ± 9.0	Carpal Tunnel Syndrome	M&W	3	9	Active (Low-Level Laser Therapy)	Visual analogue scale
Priya et al. [48]	60	41.0 ± 10.6	Mechanical low back pain	M&W	2	6	Active (conventional physical exercises)	Numeric Pain Rating Scale
Raja et al. [23]	93	26.9 ± 7.1	Mechanical neck pain	M&W	4	4	Active (standard care)	Numeric Pain Rating Scale
Sekito et al. [24]	28	45.3 ± 13.8	Temporomandibular disorders	M	5	5	Active (conventional temporomandibular disorders treatment)	Verbal Rating Scale

M: men; W: women; FM: fascial manipulation; ND: not described.

Table 3. Risk of bias assessment using the physiotherapy evidence database scale (PEDro).

Study	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Score
Batool et al. [41]	1	1	0	1	1	0	1	1	1	1	1	8
Bellotti et al. [42]	1	1	0	1	1	0	0	1	1	1	0	6
Branchini et al. [18]	1	1	0	0	1	0	0	1	1	1	1	6
Busato et al. [20]	1	1	0	1	1	0	0	1	1	1	1	7
Cotti et al. [43]	1	1	0	1	1	0	0	1	1	1	1	7
Endamli et al. [44]	1	1	0	1	0	0	0	1	1	1	1	6
Guarda-Nardini et al. [45]	1	1	0	1	0	0	0	1	1	1	1	6
Harper et al. [13]	1	0	0	1	0	0	0	1	1	1	1	5
Pawlukiewicz et al. [6]	1	1	0	1	1	1	0	1	1	1	1	8
Picelli et al. [46]	1	1	1	1	1	0	0	1	1	1	1	8
Pintucci et al. [47]	1	1	0	1	1	0	1	1	1	1	1	8
Pratelli et al. [21]	1	1	0	1	0	1	0	1	1	1	1	7
Priya et al. [48]	1	1	1	1	1	0	0	1	1	1	1	8
Raja et al. [23]	1	1	0	1	0	0	1	1	1	1	1	7
Sekito et al. [24]	1	1	1	1	0	1	0	1	1	1	1	8

C1: eligibility criteria were specified; C2: subjects were randomly allocated to groups; C3: allocation was concealed; C4: the groups were similar at baseline regarding the most important prognostic indicators; C5: there was blinding of all subjects; C6: there was blinding of all therapists who administered the therapy; C7: there was blinding of all assessors who measured at least one key outcome; C8: measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; C9: all subjects for whom outcome measures were available received the treatment or control condition as allocated, or, where this was not the case, data for at least one key outcome were analyzed according to 'intention to treat'; C10: the results of between-group statistical comparisons are reported for at least one key outcome; C11: the study provides both point measures and measures of variability for at least one key outcome.

Table 4. Results of the individual studies on pain-related outcomes.

Study	Outcome	N	FM pre (mean)	FM pre (SD)	FM post (mean)	FM post (SD)	mean difference post-pre	N	Control pre (mean)	Control pre (SD)	Control post (mean)	Control post (SD)	mean difference post-pre
vs. true-control													
Cotti et al. [43]	NPRS	31	6.58	1.46	3.16	3.39	-3.4	26	6.40	1.46	5.0	3.16	-1.40
Pawlukiewicz et al. ^{a,b} [6]	VAS	16	5.2	0.8	1.8	0.8	-3.4	10	5.6	1.0	5.0	0.9	-0.60
vs. active control													
Batool et al. [41]	NPRS	23	6.04	0.63	2.89	0.75	-3.2	22	6.09	0.61	2.54	0.67	-3.55
Bellotti et al. ^b [42]	NPRS	46	-	-	-	-	#-2.7	38	-	-	-	-	#-2.7
Branchini et al. [18]	VAS	11	5.45	2.37	0.41	0.54	-5.0	13	2.62	1.91	1.05	1.09	-1.57
Busato et al. [20]	VerNS	23	1.13	2.16	0.5	1.3	-0.6	23	0.7	1.18	0.5	1.1	-0.20
Endamli et al. [44]	VAS	28	6.29	1.76	3.79	1.73	-2.5	27	6.26	1.93	4.85	1.94	-1.41
Guarda-Nardini et al. [45]	VAS	15	6.0	2.0	2.1	1.4	-3.9	15	7.3	1.1	5.2	2.1	-2.10
Harper et al. [13]	NPRS	53	7.0	2.2	2.7	1.8	-4.3	49	6.2	2.5	4.5	2.8	-1.70
Picelli et al. [46]	VAS	9	-	-	-	-	*	9	-	-	-	-	*
Pintucci et al. [47]	VAS	7	7.29	1.78	2.50	2.18	-4.8	7	7.90	1.55	3.71	1.25	-4.19
Pratelli et al. [21]	VAS	35	6.0	2.6	0.8	0.96	-5.2	35	5.51	2.24	5.0	2.07	-0.51
Priya et al. [48]	NPRS	30	6.4	-	3.03	1.13	-3.4	30	6.1	-	4.47	1.17	-1.63
Raja et al. [23]	NPRS	48	6.29	1.97	1.63	1.48	-4.7	45	5.93	1.57	3.33	1.87	-2.60
Sekito et al. ^b [24]	VerNS	14	9.5	1.1	1.25	2.0	-8.3	14	9.3	1.4	2.7	2.5	-6.60

VAS: Visual analogue scale; VerNS: verbal numerical scale; NPRS: Numerical Pain Rating Scale; FM: fascial manipulation; a: data collected from the standard fascial manipulation group; b: data collected after the latest treatment; * the study reported significant within-group differences enhancing the pain levels; #: the authors only provided the mean difference, and did not reported baseline and post-intervention mean and standard-deviations.

traction, as detailed in Table 2), an improvement of -3.77 ± 0.78 A.U. was observed in the Numerical Pain Rating Scale (NPRS) outcomes after FM treatment. In the studies [18,21,44,45,47] with active controls that used the Visual Analogue Scale (VAS), the weighted improvement was -4.15 ± 1.15 A.U. after FM treatment.

3.5. Meta-analysis

Of the 15 studies included, 5 were excluded from the meta-analysis. Two of these studies [6,43] were excluded because they used true control groups, which could influence the heterogeneity of the conditions and comparisons against active comparators. The remaining 3 studies [42,46,48] were excluded because they did not

Table 5. GRADE analysis.

Outcomes (FM vs true-control)	Studies and PSS	Risk of bias in studies	Risk of publication bias	Inconsistency	Imprecision	Certainty of evidence
Pain-related outcomes	10, $n = 507$	Downgrade by two levels (high-risk of bias)	No downgrading (Egger test two-tailed = 0.741)	No downgrading ($I^2 = 85\%$)	Downgrade by two levels: (i) <800 participants; (ii) clear direction of effect.	⊕ , Very low

i) *Risk of bias in studies*: downgraded by one level if some concerns and two levels if high-risk of bias; ii) *Indirectness*: considered low due to eligibility criteria; iii) *Risk of publication bias*: not assessed, as all comparison had < 10 studies available; downgrade one level if Egger's test < 0.05; iv) *Inconsistency*: downgraded by one level when the impact of statistical heterogeneity (I^2) was moderate (>25%) and by two levels when high (>75%); v) *Imprecision*: downgraded by one level when < 800 participants were available for a comparison or if there was no clear direction of the effects [49]; accumulation of both resulted in downgrading by two levels.

GRADE: Grading of Recommendations Assessment, Development and Evaluation; FM: fascial manipulation; PSS: pooled sample size.

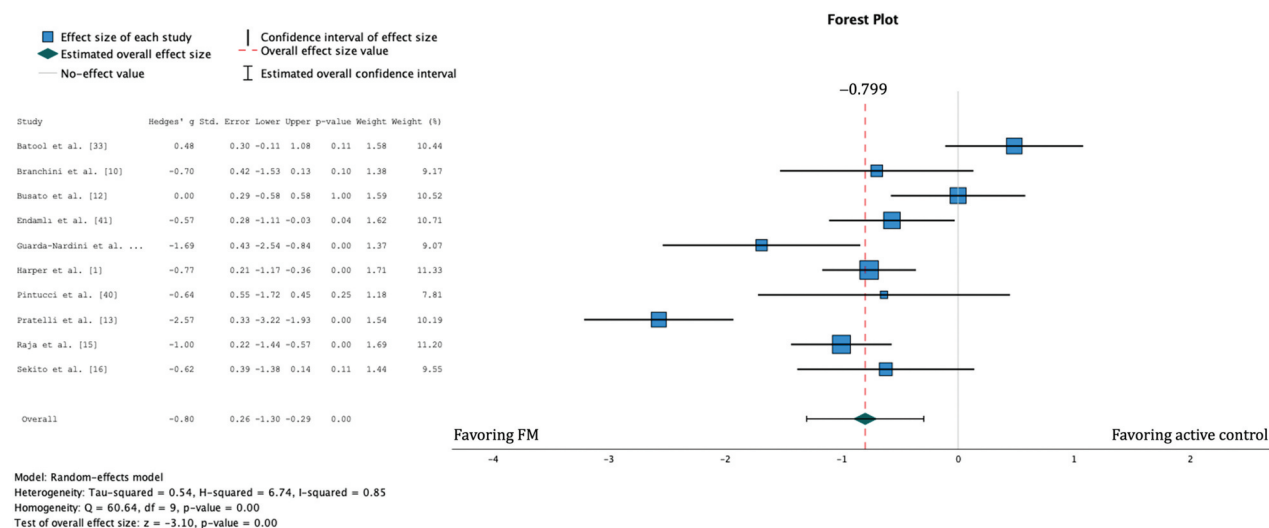


Figure 3. Forest plot illustrating changes in pain-related outcomes after fascial manipulation (FM) in comparison to active-control groups. Forest plot values are shown as effect sizes (ES [Hedges' g]) with 95% confidence intervals (CI). Blue squares: individual studies. Green rhomboid: overall summary value.

report the averages and/or standard deviations necessary for the analysis, and the researchers did not respond in time to data requests for inclusion in the meta-analysis.

Results (Figure 3) showed significant favoring effect for the FM compared to the active-control group in pain-related outcomes (ES = -0.80, 95% CI -1.30 to -0.29, $p = 0.002$, $I^2 = 85\%$, total FM participants $n = 257$, total true-control participants $n = 250$; Egger test two-tailed = 0.741).

3.6. Certainty of evidence

Table 5 summarizes the certainty assessment based on the GRADE. Evidence concerning pain outcomes is judged to have very low certainty. This assessment is mainly due to the substantial risk of bias present in most of the included studies. Moreover, the small participant numbers result, further reducing the reliability of the findings. The very low certainty is compounded by both the limited sample sizes and the risk of bias observed in comparisons between FM and control groups.

4. Discussion

The current findings suggest that FM treatment is effective in alleviating pain-related outcomes in

populations with musculoskeletal conditions, showing significantly better results than active comparators.

In our systematic review, we observed the diverse applications of FM treatment across various conditions, with studies registered for neck pain [23,41], low back pain [13,18,44,48], temporomandibular disorders [24,45], recurrent shoulder pain [42], coxarthrosis [43], carpal tunnel syndrome [21,47], whiplash-associated disorders [46], and total hip arthroplasty [20]. In studies [6,43] comparing FM to true control groups with no treatment, both groups showed improvements in the NPRS and VAS scales of -3.4 A.U. However, in the study by Cotti et al. [43] the control group showed improvements of -1.40 A.U., while in the study by Pawlukiewicz et al. [6] the improvements were -0.60 A.U.

FM targets pain conditions from coxarthrosis [43] or myofascial pain [6], possibly facilitating the release of fascial adhesions and improving tissue mobility [50]. The process can contribute to restore optimal fascial tension, leading to a reduction in nociceptive signals [51]. Additionally, the stimulation of mechanoreceptors within the fascia during manipulation can activate neural pathways that modulate pain perception, potentially influencing the central nervous system's processing of pain [16]. The therapeutic effects may be supported by the release of endogenous analgesic

substances, such as endorphins, which are known to reduce pain [52]. The rapid alleviation of symptoms observed in these treatment sessions, as compared to the control group, suggests the effectiveness of FM in modulating both peripheral and central pain mechanisms possibly through biomechanical and neurophysiological processes [53].

Most of the included studies actually compared FM against other treatments. These treatments include active comparators, which may involve physical modalities and hands-on, as well as other interventions such as sham treatments that do not target the specific regions [47], low-level laser therapy [21], or botulinum toxin injections [45]. The results of the meta-analysis, which compared FM to active control group, revealed that FM was significantly more effective in alleviating pain, with a moderate effect size.

Studies suggest that FM helps to release myofascial restrictions and restore normal tissue movement, thus improving pain thresholds [54]. Unlike active controls, which often targets symptoms through exercises, or stretches, FM addresses the underlying fascial tension and dysfunction, which are often overlooked [55]. Research has shown that fascia is not only a mechanical structure but also an active component in pain signaling, as it contains sensory receptors involved in nociception [56]. By treating the fascial system directly, FM is thought to normalize the mechanical load and reduce nociceptive input, leading to a more profound and lasting reduction in pain [50].

Despite the results observed in this systematic review, some limitations should be considered when interpreting the findings. First, the studies included in the review shows heterogeneity in terms of the conditions treated, and treatment protocols, which may limit the generalizability of the results. For instance, the number of treatment sessions varied significantly across studies, which could influence the observed outcomes. Additionally, the comparison of FM treatment to other interventions, such as active comparators, low-level laser therapy, and botulinum toxin injections, introduces variability in the effectiveness of FM treatment due to differences in the nature of these therapies. Another limitation is the lack of long-term follow-up in some studies, which means the durability of the benefits observed with FM treatment remains unclear. Finally, while the proposed mechanisms of action, including the release of fascial adhesions and modulation of pain perception, are biologically plausible, they remain speculative, as more robust studies are needed to confirm the neurophysiological processes underlying FM's effects on pain.

Despite the limitations, given its effectiveness in alleviating pain and improving tissue mobility, FM could be considered as a valuable adjunct to active comparators for conditions such as neck pain, low

back pain, myofascial pain, and temporomandibular disorders. Clinicians might find FM particularly useful in cases where traditional treatments focusing fail to address underlying fascial dysfunction. The potential for FM to reduce nociceptive input by directly targeting fascial restrictions also offers an opportunity for more lasting pain relief, which may be beneficial for patients with chronic pain conditions. Furthermore, the rapid symptomatic relief observed with FM suggests that it could be a suitable option for patients seeking quicker pain management, particularly in acute or subacute stages of musculoskeletal disorders. However, given the variation in treatment protocols across studies, clinicians should adjust the number of FM sessions to individual patient needs, with consideration for the severity and chronicity of the condition.

5. Conclusions

The findings from this systematic review suggest that FM is an effective treatment for alleviating pain in various musculoskeletal conditions when compared to active comparators, as FM showed superior results compared to active control groups. However, it is important to note that the certainty of the evidence is very low due to the small number of studies included and the risk of bias from the lack of blinding in many of the studies. Therefore, future research is needed, particularly to better describe the treatments and control treatments, as well as to increase sample sizes and employ blinded studies for both participants and therapists.

Abbreviations

FM	Fascial Manipulation
PEDro	The Physiotherapy Evidence Database
VAS	Visual Analogue Scale

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Authors' contributions

RT and FMC conceived the study idea, designed the protocol, conducted searches and screening, handled data analysis, contributed to writing, and approved the document. FMC conducted searches, performed screening, extracted data, authored the article, and provided approval. AK contributed to risk of bias assessment, writing, and approval of the manuscript. GO, MS, and AV contributed to writing and revising the article. All authors read and approved the final version.

Data availability statement

The data is available upon reasonable request to the corresponding author.

Protocol registration

The protocol for this systematic review is available on the Open Science Framework (registration: osf.io/yk5hu) and can be accessed through DOI: 10.17605/OSF.IO/ACVHD.

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