

Systematic Review

Effectiveness of Physiotherapy Techniques in Sacroiliac Joint Dysfunction: A Systematic Review

Patrycja Kowalczyk, Maciej Niewodniczy, Bartosz Szmyd , Karol Zaczkowski, Karol Wiśniewski and Dariusz J. Jaskólski * 

Department of Neurosurgery and Neuro-Oncology, Barlicki University Hospital, Medical University of Lodz, Kopcinskiego St. 22, 90-153 Lodz, Poland; path.kowalczyk@gmail.com (P.K.); maciej.niewodniczy@barlicki.pl (M.N.); bartosz.szmyd@umed.lodz.pl (B.S.); karol.zaczkowski@umed.lodz.pl (K.Z.); karol.wisniewski@umed.lodz.pl (K.W.)

* Correspondence: dariusz.jaskolski@umed.lodz.pl

Abstract

Sacroiliac joint dysfunction (SIJD) is an under-recognized source of lumbopelvic pain and disability. Physiotherapy management commonly includes manipulation, mobilization, muscle energy technique (MET), exercise therapy, and adjuncts such as electrotherapy or shock wave therapy, but their relative effectiveness remains unclear. Here, we systematically searched PubMed, Scopus, and Web of Science (up to 19 July 2025) for randomized and pilot trials in adults with SIJD. Most included studies compared one active physiotherapy intervention with another and reported within-group reductions in pain and disability. Some individual trials reported greater improvements in selected outcomes with specific manual therapy approaches than with exercise-only or electrotherapy comparators. In an exploratory meta-analysis of three eligible trials ($n = 125$), the pooled effect for MET versus mobilization on disability was $SMD = -0.11$ (95% CI -2.49 to 2.27), with high heterogeneity ($I^2 \approx 86\%$). Given the small evidence base, high risk of bias, and substantial imprecision and heterogeneity, this estimate should be considered hypothesis-generating and does not establish superiority, equivalence, or the absence of a clinically meaningful difference between the approaches. Because sham, placebo, no-treatment, or usual-care comparators were uncommon, the available evidence primarily informs the comparative effectiveness of physiotherapy approaches and does not establish the absolute effectiveness of manual therapy. No single technique demonstrated consistent superiority. Larger, well-reported randomized controlled trials using standardized SIJD criteria, appropriate control groups, and longer follow-up are required.

Keywords: sacroiliac joint dysfunction; manual therapy; mobilization; manipulation; muscle energy technique; physiotherapy; exercise therapy; electrotherapy; shock wave therapy



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1. Introduction

Low back pain (LBP) is one of the most common reasons for medical and physiotherapy consultations, as well as sick leave, worldwide. It represents a significant social and economic burden, affecting individuals regardless of sex and age. LBP is associated with reduced functional capacity, prolonged absence from work, and increased risk of depressive episodes. It is estimated that approximately 70–80% of adults experience at least one episode of low back pain during their lifetime [1]. The Global Burden of Diseases (GBD) study, which analyzed morbidity, prevalence, and years lived with disability (YLDs)

for 354 diseases in 195 countries between 1990 and 2017, demonstrated that low back pain, depression, and headaches are among the chronic, non-communicable conditions with the highest YLD indices [2].

A variety of factors predispose individuals to LBP, including lack of physical activity, sedentary lifestyle, overweight and obesity ($\text{BMI} > 24$), age above 65 years, previous episodes of LBP, leg length discrepancy, abnormal spinal anatomy, and postural defects [1,3,4]. Additional risk factors include smoking, sleep disorders, chronic stress, and depression [1,4]. It is estimated that up to 37% of LBP episodes are work-related, particularly in occupations involving prolonged forward flexion or rotation of the spine, heavy lifting, or sedentary work [1]. Degenerative spinal changes remain the most common cause of LBP, but other etiologies include spondylolisthesis, scoliosis, osteoporotic vertebral compression fractures, hip osteoarthritis, urogenital disorders, inflammatory conditions of the spine and pelvis, and primary or metastatic spinal tumors [5]. Increasing attention has also been directed toward the sacroiliac joint (SIJ) as a potential pain generator [6].

Current evidence suggests that dysfunction of the SIJ may account for 10–30% of cases of lumbosacral pain [7–10]. The SIJs play a critical role in load transfer from the upper body, shock absorption, gait function, and, in women, they play a role during pregnancy and childbirth. Functionally, the sacroiliac joints may be viewed as a pair of load-transferring bridges between the spine and the lower limbs. They must remain sufficiently stable to transmit the weight of the upper body, while allowing a small degree of movement to absorb and redistribute forces during standing, walking, and changes in body position. In this sense, the SIJs function both as stabilizing links and as shock-absorbing interfaces within the lumbopelvic complex. Their stability relies on two complementary mechanisms: form closure (structural stability) and force closure (dynamic muscular and ligamentous stability). Together, these mechanisms allow limited translational and rotational mobility while maintaining stability and energy efficiency [3,11]. SIJ dysfunctions can manifest as hypermobility/instability or hypomobility/blockage, with or without pain [3,12]. Joint blockage represents a reversible functional impairment characterized by limited accessory joint motion, often treated using manual therapy techniques such as mobilization and manipulation [13].

Pain associated with SIJ dysfunction (SIJD) may mimic that caused by degenerative intervertebral disc disease or lumbar disc herniation [3,14]. Symptoms are typically localized to the SIJ region, posterior superior iliac spine, lower lumbar spine, or buttocks, but may radiate to the groin, hip, thigh, calf, or even the foot [10,15–18]. Anatomical studies suggest that SIJ innervation most commonly arises from the lateral branches of L2–S3, with variations involving L5 or S4 [14,19,20]. Despite its clinical relevance, the SIJ is often overlooked in the differential diagnosis of low back pain, leading to delayed management and unnecessary costs [6,19–21].

Clinical assessment relies on both palpatory and provocation tests. However, palpatory tests have been criticized for poor reliability due to individual anatomical variation and minimal joint excursion [22]. Provocation tests, such as distraction, compression, Patrick's sign, sacral thrust, Yeoman's, thigh thrust, and Gaenslen's test, are considered more reliable. Laslett et al. [23] demonstrated that three or more positive provocation tests yield a sensitivity of 94% and specificity of 78% for SIJ dysfunction.

Currently, no standardized physiotherapeutic protocols exist for SIJD. Image-guided intra- and peri-articular injections are often regarded as the diagnostic and therapeutic gold standard [6,24–26], but they are invasive, costly, and difficult to interpret. Conservative management strategies include strengthening and stretching exercises, pelvic belts, massage, self-mobilization, soft-tissue therapy, and manual techniques (mobilization

and manipulation). For patients with chronic refractory pain, radiofrequency ablation or surgical stabilization may be considered [3,4,25].

The aim of this systematic review was to synthesize evidence on changes in pain, disability, and functional outcomes observed after physiotherapeutic interventions for sacroiliac joint dysfunction, with particular emphasis on the comparative effects of manual therapy techniques, exercise-based approaches, and adjunctive modalities. A secondary objective was to conduct an exploratory, hypothesis-generating quantitative synthesis comparing post-treatment disability after muscle energy technique and mobilization-based interventions.

2. Materials and Methods

Using the predefined search strategy on 19 July 2025, we conducted a comprehensive literature search across three electronic databases: PubMed (“Sacroiliac joint” OR “SI joint”) AND (“manipulation” OR “mobilization” OR “mobilisation” OR “manual therapy” OR “adjustment” OR “high-velocity low-amplitude thrust” OR “HVLA thrust” OR “passive movement techniques” OR “joint mobilization techniques”), Web of Science (the same query), and Scopus (the same search query was applied to the Article title, Abstract, and Keywords fields).

The study selection process followed PRISMA guidelines and is presented in the flow diagram (Figure 1 and Table S1) [27]. Titles, abstracts, and full texts of papers published in English were independently screened by two reviewers (PK and MN). Any disagreements were resolved through discussion with the senior author (DJ). Although a formal preregistered protocol was not available, eligibility criteria were structured post hoc using a PICO framework to improve transparency and consistency of study selection and synthesis:

- P (Population): Adults diagnosed with sacroiliac joint dysfunction (SIJD) based on clinical diagnostic criteria and/or provocation testing.
- I (Intervention): Muscle energy technique (MET) targeting the sacroiliac joint.
- C (Comparator): Manual therapy interventions, including mobilization techniques (e.g., Maitland and Mulligan) and manipulation techniques (e.g., HVLA, osteopathic manipulation, and MFMA techniques).
- (Outcomes): Primary outcomes were pain intensity in Visual Analog Scale/Numeric Pain Rating Scale (VAS/NPRS) and disability in Oswestry Disability Index/Modified Oswestry Disability Index/Roland-Morris Disability Questionnaire (ODI/MODI/RMDQ). Secondary outcomes included functional performance measures, range of motion, and clinical provocation tests.

Given the small number of eligible studies and the anticipated clinical and methodological heterogeneity, the quantitative synthesis was treated as exploratory and hypothesis-generating. It was intended to provide a descriptive summary of the available comparative data rather than confirmatory evidence regarding the superiority, equivalence, or comparative effectiveness of MET and mobilization-based interventions.

After removal of duplicates, 818 records were screened, 53 full-text articles were assessed for eligibility, and 34 studies met the inclusion criteria and were included in the systematic review [8,19,28–59].

This systematic review included RCTs and pilot studies evaluating clinical outcomes after physiotherapy interventions for SIJD. A total of 34 studies were analyzed. They compared manipulation with muscle energy technique (MET); manipulation with exercise therapy; different mobilization techniques; sacroiliac joint manipulation with hip joint mobilization; manipulation with myofascial release; manipulation with electrotherapy; manual therapy with extracorporeal shock wave therapy (ESWT); and high-velocity low-amplitude (HVLA) manipulation with mechanical-force manually assisted (MFMA) manipulation.

Other evaluated SIJD in the context of lumbar disc herniation or investigated other combined or multimodal interventions. All included studies assessed outcomes related to pain, disability, and functional performance using validated scales and clinical tests.

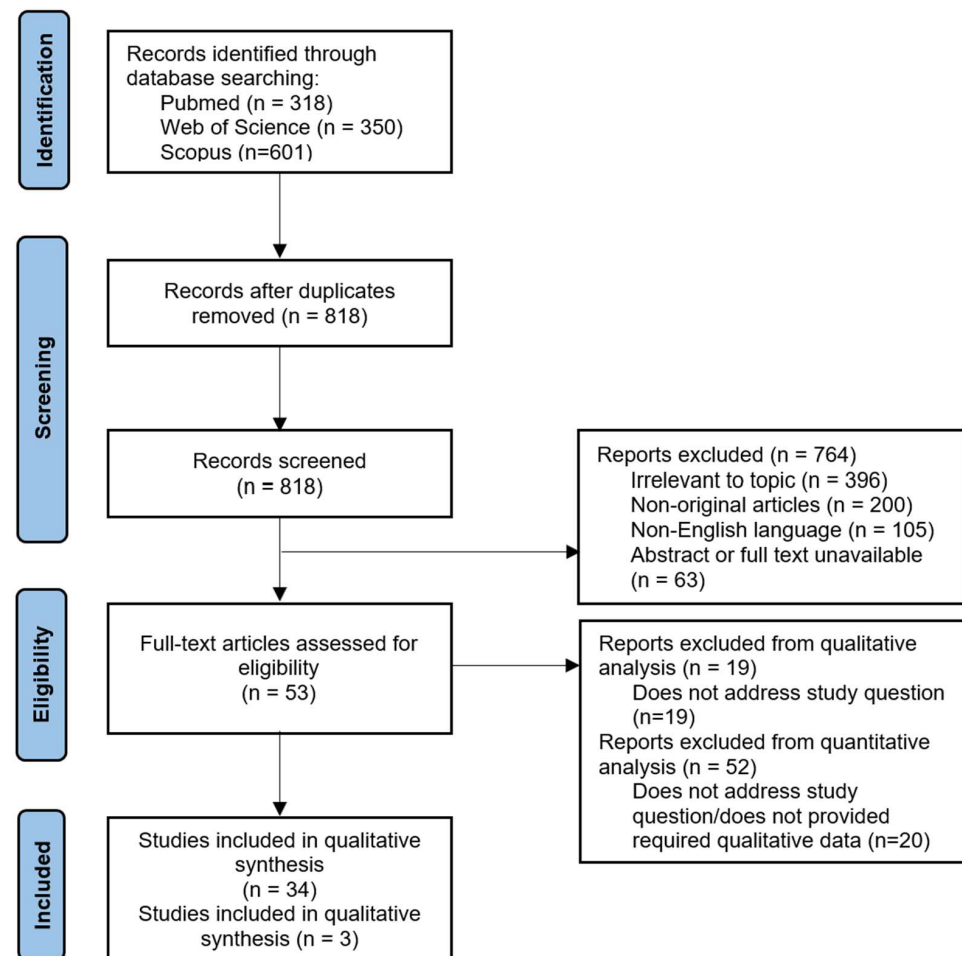


Figure 1. The flow-chart showing the process of including publications in this study.

Additionally, an exploratory meta-analysis was conducted to provide a descriptive, hypothesis-generating comparison of post-treatment disability after MET and mobilization-based interventions in patients with sacroiliac joint dysfunction. The primary outcome of interest was post-treatment functional disability, assessed using the MODI. We decided to use standardized mean difference (SMD; Hedges' g) rather than the raw mean difference. We included randomized or quasi-randomized clinical trials that directly compared MET with a mobilization-based intervention (e.g., Mobilization With Movement, Maitland mobilization, or manual mobilization/manipulation) and reported post-treatment mean and standard deviation of disability scores for both groups. Studies that did not provide complete post-treatment mean $\pm$ standard deviation data for each group could not be entered into the quantitative model and were instead summarized narratively. For each eligible study, we calculated the effect size as $SMD = \text{mean_MET} - \text{mean_mobilization} / \text{pooled standard deviation}$, such that negative values indicate lower disability after MET (i.e., a benefit of MET), and positive values indicate a benefit of mobilization.

Study-specific SMDs were pooled using a random-effects model with restricted maximum likelihood (REML) estimation of the between-study variance (τ^2) and Hartung–Knapp adjustment for confidence intervals. Heterogeneity was quantified using I^2 . We also calculated a random-effects prediction interval. All analyses were performed in R (version ≥ 4.0) using the meta package (metacont, forest.meta).

3. Results

3.1. Comparative Evidence on Muscle Energy Technique in Sacroiliac Joint Dysfunction

Several trials have evaluated MET in patients with SIJD, predominantly in comparison with other active manual or exercise-based interventions. These studies frequently reported within-group reductions in pain and disability, but generally provided limited evidence regarding the absolute effectiveness of MET. Several randomized controlled trials have compared MET with other manual therapy approaches.

Zaidi and Ahmed [28] reported within-group reductions in pain intensity and disability after both MET and Maitland mobilization, with no significant between-group differences. Similarly, Srivastava et al. [29] reported significant short-term improvements in pain and pressure pain threshold with MET and Mechanical Diagnosis and Therapy (MDT), but without between-group differences, in a pilot randomized controlled trial (RCT).

Other studies have explored comparisons with mobilization and manipulation. García-Peñalver et al. [30] found that both MET and osteopathic manipulation improved SIJ-related dysfunction in athletes; however, manipulation produced superior effects at one-month follow-up compared to MET. Alkady et al. [31] and Sivakumar et al. [32] compared Mulligan mobilization with MET, showing that both groups improved, although mobilization tended to yield greater benefits in terms of pelvic tilt correction and function. Another recent RCT among students also confirmed improvements with both methods, but again mobilization showed larger reductions in disability scores compared to MET [33].

Several investigations specifically highlight the pain-relieving effects of MET. Selkow et al. [34] reported a significant within-group reduction in lumbopelvic pain 24 h after a single MET session. Akram et al. [35] further demonstrated that MET produced greater improvements in pain in NPRS and disability (MODI) compared to Mulligan mobilization with movement (MWM) in anterior innominate SIJD, indicating greater improvements with MET than with MWM in this specific study population.

Adjunctive strategies have also been investigated. Sadiq et al. [36] evaluated piriformis stretching combined with mobilization and found no additional pain benefit but observed a greater improvement in ODI in the experimental group.

Overall, within-group reductions in pain and disability were commonly reported after MET, mobilization, and MDT. However, most studies used active comparators, and between-group findings were inconsistent. Therefore, the available evidence does not establish the absolute effectiveness of MET or its consistent superiority over other active approaches.

An exploratory quantitative synthesis was possible for only three randomized or quasi-randomized trials involving 125 participants (Figure 2). All three studies were judged to be at high overall risk of bias and differed in the mobilization-based comparator used. Accordingly, the pooled estimate should be interpreted as a descriptive and hypothesis-generating summary rather than as confirmatory comparative evidence. Individual study effects were expressed as standardized mean difference (SMD, Hedges g), where negative values favour MET (i.e., lower disability after treatment).

Effects were inconsistent across studies. Akram et al. [35] reported a large effect in favour of MET (SMD = −1.22; 95% CI −1.95 to −0.48), indicating substantially lower disability scores after MET compared with Mobilization With Movement. Zaidi and Ahmed [28] showed only a small, non-significant difference between MET and Maitland mobilization (SMD = 0.26; 95% CI −0.25 to 0.77). Sivakumar et al. [33] favoured mobilization numerically (SMD = 0.60; 95% CI −0.12 to 1.32), although the confidence interval crossed zero.

When pooled using a random-effects model with REML estimation and Hartung–Knapp adjustment, the exploratory overall effect estimate was SMD = −0.11 (95% CI −2.49 to 2.27). Although the point estimate was close to zero, the confidence interval was

extremely wide and encompassed potentially important effects in favour of either MET or mobilization. It should therefore not be interpreted as evidence of no difference or equivalence between the interventions. Between-study heterogeneity was high ($I^2 \approx 86\%$; $\tau^2 = 0.78$), indicating substantial inconsistency in the direction and magnitude of the individual effects. Differences in the mobilization-based comparators, including Mobilization With Movement and Maitland mobilization, further limit the interpretability of the pooled class-level estimate. The prediction interval ranged from approximately -4.57 to 4.35 , further illustrating the profound uncertainty surrounding the expected effect. Given that this interval was derived from only three heterogeneous, high-risk-of-bias studies, the quantitative synthesis should be regarded as descriptive and hypothesis-generating rather than confirmatory.

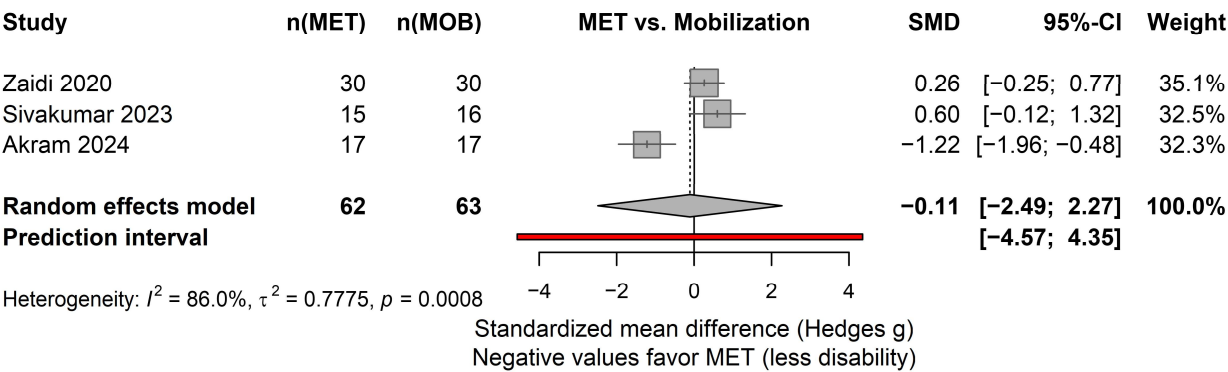


Figure 2. Exploratory forest plot of the standardized mean difference (Hedges’ g) in post-treatment disability (MODI/ODI) comparing muscle energy technique (MET) with mobilization-based interventions in sacroiliac joint dysfunction [28,33,35]. Negative values favour MET, whereas positive values favour mobilization. The synthesis included only three studies, all judged to be at high overall risk of bias. The pooled estimate was highly imprecise, with substantial heterogeneity and a very wide prediction interval. Accordingly, the analysis should be interpreted as descriptive and hypothesis-generating and does not establish superiority, equivalence, or the absence of a clinically meaningful difference between the approaches.

Leave-one-out sensitivity analysis demonstrated substantial instability of the pooled estimate. After excluding Zaidi and Ahmed [28], the pooled SMD was -0.31 (95% CI -11.87 to 11.25); after excluding Sivakumar et al., it was -0.46 (95% CI -9.85 to 8.94); and after excluding Akram et al. [35], it was 0.37 (95% CI -1.66 to 2.41). Although all estimates remained statistically non-significant, the confidence intervals were extremely wide, and the direction of the pooled effect changed after exclusion of Akram et al.’s [35] trial. These findings indicate that the pooled result is highly dependent on individual studies and should be regarded as hypothesis-generating only. The extremely wide confidence intervals reflect the very small number of available studies and indicate that the pooled result is not robust to the inclusion or exclusion of individual trials.

The observed inconsistency across individual study effects is further supported by the methodological quality assessment (Table 1), which indicates that all included trials were judged to be at overall high risk of bias, primarily due to limitations in randomization procedures and lack of blinding, as well as concerns regarding performance and detection bias. This methodological profile likely contributes to the substantial between-study heterogeneity observed in the pooled analysis and should be considered when interpreting the robustness of the overall effect estimate.

Table 1. Risk-of-bias assessment using RoB 2 for studies included in the exploratory meta-analysis of muscle energy technique versus mobilization-based interventions.

Study	Randomization	Deviations	Missing Data	Measurement	Reporting	Overall
Zaidi 2020 [28]	Some concerns	High	Some concerns	Some concerns	Some concerns	High
Sivakumar 2023 [33]	Some concerns	High	Low	Some concerns	Some concerns	High
Akram 2024 [35]	Some concerns	High	Low	Some concerns	Some concerns	High

3.2. Evidence from Randomized and Pilot Trials on Manual Therapy and Exercise Interventions in Sacroiliac Joint Dysfunction

Ten randomized and pilot studies have investigated the effects of manual therapy (mobilization and manipulation) and exercise-based interventions in patients with SIJD.

Kamali et al. [37] compared manipulation with exercise therapy in 40 adults with SIJD and found significant within-group improvements in pain (VAS) and disability (ODI) in both interventions, but no significant inter-group differences, likely due to low statistical power (type II error). Similarly, Nejati et al. [38] reported that manipulation, exercise, and combined therapy all led to significant improvements after up to 12 weeks, with no between-group differences at 12 weeks, although manual therapy showed earlier benefits at six weeks.

When Mulligan's mobilization was combined with motor control exercises, Sivakumar et al. [39] demonstrated greater improvements in pain and functional outcomes compared with exercises alone, with the largest effect sizes observed in the combined group. Dogan et al. [8] confirmed that both mobilization plus exercise and exercise alone reduced pain and improved quality of life, without significant between-group differences.

Pilot data by Barbosa et al. [40] suggested that manipulation combined with isotonic exercise may reduce anterior pelvic tilt and low back pain and improve muscle activation patterns. Likewise, Yan et al. [41] found that both core stability exercise and Mulligan mobilization improved pain and function, but adding mobilization did not yield additional significant benefits.

In a larger trial, Javadov et al. [19] reported that combined sacroiliac manipulation and targeted sacroiliac exercises produced superior improvements in pain, disability, and quality of life compared with lumbar-focused exercise programs. Visser et al. [42] compared manual therapy, physiotherapy, and intra-articular injections in SIJD patients with leg pain; manual therapy was most effective, achieving significant pain reduction and functional improvement in 72% of cases.

Younes et al. [43] found that both gluteus medius strengthening and sacroiliac mobilization significantly reduced pain and pelvic tilt, without differences between groups. Finally, Ulger et al. [44] reported that both stabilization exercise and manual therapy reduced pain and improved function in chronic low back pain patients, with manual therapy showing superior outcomes in ODI scores.

Across these studies, within-group reductions in pain and disability were commonly observed after both exercise-based and manual therapy interventions. Most trials did not detect clear between-group differences, although selected studies reported larger improvements with combined or targeted interventions in specific outcomes. Because the comparators were generally active treatments, these findings primarily concern comparative rather than absolute treatment effects. Some pilot studies also reported changes in biomechanical measures, such as pelvic tilt, but these findings remain preliminary, and their generalizability is limited by small sample sizes.

3.3. Comparison of Different Mobilization Techniques

Kaur et al. [45] directly compared Maitland and Mulligan mobilization in 60 patients with SIJD. Both approaches reduced pain and disability and improved lumbar mobility ($p < 0.001$), but Mulligan's technique was more effective, with pain decreasing on average from 7 to 0.3 compared with 7 to 1.67 in the Maitland group [45]. Vaseghnia et al. [46] evaluated manipulation in young women with SIJD and showed immediate improvements in lumbar range of motion, hip rotation, pain reduction, and active straight leg raise (ASLR) performance, with effects persisting at 24 h.

One of the earliest randomized studies directly compared SIJ manipulation and hip joint mobilization in patients with hip pain associated with SIJ dysfunction ($n = 20$). Participants were randomly assigned to receive either SIJ manipulation ($n = 10$) or hip joint mobilization ($n = 10$). Outcomes included pain intensity (VAS), the Patrick/FABER test, and passive internal hip rotation [47].

Immediately after the interventions, no significant improvements were observed in either group regarding pain reduction or FABER test outcomes. However, follow-up after several days revealed a marked difference: 9 of 10 patients in the manipulation group showed a negative FABER test (no pain), compared with only 3 of 10 patients in the hip mobilization group.

Although both interventions targeted pain of hip origin with concomitant SIJ dysfunction, sacroiliac joint manipulation appeared more effective in achieving short-term clinical improvements in provocative testing [49].

The role of fascial techniques in SIJD has been investigated alongside manipulative therapy. An RCT compared sacral torsion manipulation with myofascial release in patients clinically diagnosed with posterior pelvic pain ($n = 64$). Both groups received 12 weekly sessions. Significant improvements over time were observed in disability (RMDQ), pain (NPRS), and function (SF-36), but between-group differences were limited. Manipulation yielded greater improvements in disability scores, while myofascial release demonstrated better outcomes in selected SF-36 subscales (general health, social functioning) and flexibility (finger-to-floor test) at one-month follow-up [48].

Complementary findings were reported in a pilot study evaluating fascial manipulation according to Stecco's method ($n = 20$). A single session resulted in a significant reduction in pain intensity (NPRS, $p < 0.0001$) and an increase in pressure pain threshold at the posterior superior iliac spine, with effects persisting at one-month follow-up [49].

Both groups showed improvements over time. In the direct comparison, manipulation was associated with larger improvements in disability, whereas myofascial release was associated with larger changes in selected SF-36 domains and flexibility outcomes. These findings do not establish the absolute effectiveness of either intervention.

The comparative effectiveness of manipulative and electrotherapeutic approaches in SIJD has been explored in several trials. A pilot randomized study compared osteopathic manipulation of the SIJ ($n = 21$) with electrotherapy ($n = 20$) in patients with low back pain associated with SIJD. After six sessions of manipulation or 15 sessions of electrotherapy over three weeks, both groups demonstrated significant improvements in pain (VAS) and disability (ODI). However, the manipulation group achieved superior outcomes in pain reduction (VAS score of 1.60 vs. 4.13), functional disability (ODI score of 10.5 vs. 27.9), and functional limitation (Roland-Morris score of 3.8 vs. 8.2; $p < 0.05$). Improvements in pain threshold at muscular tender points were also more consistent in the manipulation group [50].

Similarly, a single-blinded RCT evaluated sacroiliac joint mobilization versus transcutaneous electrical nerve stimulation (TENS) in pregnant women with posterior pelvic pain ($n = 32$). Both interventions, combined with stabilization exercises, led to significant

reductions in pain (VAS) and disability in Roland-Morris Disability Questionnaire (RMDQ). Nevertheless, mobilization achieved superior outcomes, with complete pain relief in 60% of participants and greater functional improvement compared with TENS (96.9% vs. 83% improvement in RMDQ scores) [51].

In these two trials, manipulation or mobilization groups showed greater improvements in selected pain and disability outcomes than the electrotherapy or TENS comparator groups. These findings suggest a comparative advantage in the specific populations studied but do not establish the absolute effectiveness of manual therapy.

A recent prospective clinical trial investigated the comparative and combined effectiveness of focused extracorporeal shock wave therapy (fESWT) and manual therapy in postpartum women with sacroiliac joint dysfunction ($n = 99$; three groups of 33 each). Over two weeks (five sessions, every other day), participants received fESWT, manual therapy, or a combination of both interventions [52].

Clinical outcomes were measured using the VAS and the ODI. At one week, fESWT resulted in superior functional improvement compared to manual therapy (ODI, $p < 0.001$), although pain reduction did not differ significantly. By contrast, manual therapy achieved higher rates of complete remission (50% vs. 33% in fESWT), whereas fESWT showed a greater proportion of partial responders. The combined intervention produced the most favorable outcomes, with 73% of patients achieving complete recovery after two weeks.

Within-group reductions in pain and disability were observed after both fESWT and manual therapy, while the combined group showed the largest observed improvements. In the absence of an inactive control group, these findings should be interpreted as comparative rather than as evidence of absolute treatment effectiveness [52].

A randomized clinical trial compared the effectiveness of traditional HVLA thrust manipulation and MFMA manipulation using the Activator Adjusting Instrument in patients with sacroiliac joint syndrome ($n = 60$). Participants were randomized to HVLA ($n = 30$) or MFMA ($n = 30$) and received four treatment sessions over two weeks, with follow-up one week after the final session. No control group was included [53].

Both interventions produced statistically significant improvements ($p < 0.001$) in pain (NRS), disability (ODI), and orthopedic test scores (ORS). Pressure pain threshold measured by algometry also increased significantly in both groups. Mean NRS scores decreased from 49.1 to 23.4 in the HVLA group and from 48.9 to 22.5 in the MFMA group, while ODI scores improved from 37.4 to 18.5 and from 36.6 to 15.1, respectively.

No statistically significant differences were found between HVLA and MFMA in any outcome. No statistically significant between-group differences were detected for pain, disability, or orthopedic test scores. However, the study was not designed as an equivalence or non-inferiority trial; therefore, these findings should not be interpreted as demonstrating equal effectiveness [53].

3.4. Sacroiliac Joint Dysfunction in the Context of Lumbar Disc Herniation

Two studies evaluated the interplay between sacroiliac joint dysfunction (SIJD) and lumbar disc herniation (LDH) in patients with LBP and radicular symptoms. Galm et al. [54] assessed the frequency and significance of SIJD in patients with imaging-proven LDH. Participants underwent three weeks of conservative treatment (exercise, traction, back school, and hydrotherapy). In addition, those with SIJD ($n = 46$) received specific mobilization and manipulation of the sacroiliac joint. After one week, 22/46 showed improvement and 3 became pain-free; after three weeks, 34/46 (74%) improved, with 5 becoming completely pain-free. In the LDH-only group ($n = 104$), improvement occurred in 55% after three weeks, with no pain-free cases. Fisher's test ($p = 0.020$) confirmed a significant association between SIJD treatment and favorable outcomes. The study highlighted that SIJD can be

an independent pain generator or coexist with symptomatic LDH, and that LDH alone is not always the cause of LBP with or without leg pain [54].

Shokri et al. [55] (n = 20) investigated the effect of combined lumbar and SIJ manipulation in patients with MRI-confirmed LDH (L4-L5 or L5-S1) and concurrent SIJD. Five manipulation sessions were delivered. Significant reductions in lumbar and radicular pain (NRS) and disability (ODI) were observed after treatment and at one-month follow-up ($p < 0.01$). However, when applying minimal clinically important change (MCIC) thresholds (20 points for NRS, 6 points for ODI), improvements were not clinically significant. Functional SIJ tests (standing/sitting flexion, Gillet's test) showed marked improvements (95% resolution of SIJD signs), while neural tension tests (SLR, SLUMP) improved only marginally.

Overall, these studies suggest that in patients with LDH, concomitant SIJD may represent a distinct therapeutic target, and its treatment with manual therapy can contribute to pain relief and functional improvement, although clinical relevance remains debated.

3.5. Manipulative Therapy in Chronic and Non-Specific Low Back Pain

Several clinical studies have addressed the role of SIJ manipulation in patients with chronic or non-specific low back pain, exploring its clinical effects as well as potential underlying mechanisms. Krstev [56] compared two physiotherapeutic protocols in patients with SIJ dysfunction: a standard program including massage and stabilization exercises versus a multimodal intervention combining cross-friction massage, post-isometric relaxation, trigger point therapy, SIJ mobilization, and stabilization training. Both groups improved in pain and muscle strength, yet the experimental group showed greater reductions in VAS scores and superior outcomes in functional muscle tests [56].

Didehdar et al. [57] conducted a double-blind randomized controlled trial using proton magnetic resonance spectroscopy to explore brain metabolic responses to spinal manipulation in chronic non-specific low back pain. In this study, patients received either manipulative treatment targeting the lumbosacral spine and SIJ or a sham procedure. After five weeks, the manipulation group reported significant reductions in pain intensity (NPRS) and disability (ODI), accompanied by an increase in N-acetylaspartate levels in the anterior cingulate cortex, indicating not only clinical but also neurobiological effects of manipulative therapy [57].

Kamali and Shokri [58] compared manipulation directed solely at the SIJ with a combined approach involving both SIJ and lumbar spine. In their single-blind randomized trial, both interventions produced significant and lasting improvements in pain and disability immediately after treatment, at 48 h, and at one month. However, no additional benefit was observed from including lumbar manipulation, suggesting that SIJ-focused treatment alone may be sufficient in this patient group [58].

Finally, Alt et al. [59] examined strategies aimed at preventing chronification of non-specific low back pain. In their trial, one group underwent a structured exercise program supplemented by cognitive-behavioral consultation, while the comparison group received a multimodal program combining consultation, massage, and mobilization. Although both groups showed improvements in NPRS and ODI scores, the exercise-cognitive approach was associated with larger effect sizes for pain reduction and appeared more effective in preventing chronicity [59].

Taken together, these studies reported within-group improvements and selected between-group differences following SIJ manipulation. However, the heterogeneous comparators and limited use of sham or inactive control groups preclude broad conclusions regarding its absolute clinical effectiveness. One sham-controlled study provided more direct evidence in chronic non-specific low back pain, but its findings should not be generalized to all patients with SIJD.

4. Discussion

This review primarily synthesizes comparative evidence from randomized and pilot trials evaluating manual therapy, exercise interventions, and adjunctive modalities for SIJD. Most included studies compared one active intervention with another, and relatively few incorporated sham, placebo, no-treatment, or usual-care controls. Consequently, the commonly reported within-group reductions in pain and disability cannot be attributed specifically to manual therapy. The findings are more informative about the relative performance of different physiotherapy approaches than about their absolute effectiveness.

A recurring finding was that MET, Mulligan or Maitland mobilization, osteopathic manipulation, and exercise-based approaches were frequently associated with short-term within-group improvements, while many studies did not detect significant between-group differences. The absence of between-group differences should not be interpreted as evidence of equivalence. Moreover, because these trials generally lacked inactive or sham comparators, the observed improvements cannot be separated from natural recovery, regression to the mean, contextual effects, co-interventions, or nonspecific treatment effects [28,29,37].

The quantitative synthesis should be interpreted exclusively as exploratory and hypothesis-generating. It included only three trials involving 125 participants, all of which were judged to be at high overall risk of bias. Although the pooled point estimate was close to zero, the confidence and prediction intervals were extremely wide, heterogeneity was substantial, and the leave-one-out analyses demonstrated marked instability, including a change in the direction of the pooled estimate after exclusion of one study. Furthermore, the studies differed in their mobilization-based comparators, treatment protocols, and patient characteristics. Consequently, the pooled estimate cannot provide confirmatory evidence regarding the comparative effects of MET and mobilization-based interventions and should not be interpreted as demonstrating no difference, comparable effectiveness, or equivalence. Rather, it illustrates the uncertainty and inconsistency of the currently available evidence and may serve only to generate hypotheses for future adequately powered trials.

Some individual trials reported larger improvements with particular interventions in defined populations. García-Peñalver et al. [30] and Alkady et al. [31], for example, reported larger changes after manipulation or Mulligan mobilization than after MET. Similarly, Vaidya et al. [51] and Rodríguez-Pastor et al. [50] reported greater improvements in selected outcomes with mobilization or manipulation than with TENS or electrotherapy. These findings describe comparative differences within individual trials but should not be interpreted as establishing the absolute effectiveness of manual therapy or a general advantage applicable across SIJD populations.

The interaction between SIJD and lumbar pathology further underscores the relevance of targeted SIJ interventions. Studies by Galm et al. [54] and Shokri et al. [55] confirmed that SIJD frequently coexists with lumbar disc herniation and that addressing SIJ dysfunction through manipulation can significantly improve outcomes, even when disc pathology is present. Although the magnitude of improvement did not always reach minimal clinically important thresholds, the consistent trend suggests that the sacroiliac joint may represent an underappreciated pain generator in low back pain syndromes.

The trial by Didehdar et al. [57] demonstrated metabolic changes in the anterior cingulate cortex following manipulation, supporting the hypothesis that manual therapy exerts central modulatory effects in addition to peripheral biomechanical ones. This finding aligns with the broader pain science literature, indicating that spinal manipulation may influence pain processing at multiple levels of the nervous system.

Despite promising results, several limitations temper the strength of the conclusions. Many studies included small samples or were pilot in nature, raising concerns about type II error and limited generalizability. Heterogeneity in diagnostic criteria for SIJD, treatment

frequency, and outcome measures complicates direct comparison across studies. Moreover, few trials reported long-term follow-up, leaving uncertainty regarding the durability of effects beyond one to three months. From a methodological standpoint, a critical barrier to evidence synthesis is incomplete reporting: in several trials, post-treatment means and standard deviations for key outcomes (e.g., MODI/ODI) were either partially reported or replaced with only between-group *p*-values. This prevented full quantitative inclusion and directly limits the certainty around comparative effectiveness.

Clinical implications emerge from these findings. First, manual therapy should be considered a core component in the management of SIJD, particularly when integrated with stabilization or motor control exercises. Second, no single manual technique can be universally recommended; instead, tailoring the intervention to patient presentation, practitioner expertise, and available resources may be the most pragmatic strategy. Third, adjunctive approaches such as myofascial release or fESWT may provide additional benefits, but current evidence suggests that their superiority over manual therapy alone is limited.

Future research should prioritize adequately powered randomized controlled trials with standardized diagnostic criteria and longer follow-up periods. Comparative effectiveness trials directly contrasting manual therapy subtypes, combined approaches, and adjunctive interventions are needed to determine optimal treatment strategies. Incorporating mechanistic outcomes such as neuroimaging, biomechanical assessments, and biomarkers may further elucidate the pathways through which manual therapy exerts its effects.

In summary, studies commonly reported reductions in pain and disability following MET, mobilization, manipulation, exercise, and combined interventions. However, no manual therapy technique demonstrated consistent superiority over other active approaches, and the predominance of active-comparator trials prevents firm conclusions regarding absolute effectiveness. The added value and long-term effects of combining manual therapy with exercise or patient education remain uncertain.

5. Limitations

Several limitations should be considered when interpreting the findings of this systematic review. First, the review protocol was not prospectively registered. Although the eligibility criteria were subsequently clarified using an explicit PICO framework, the absence of preregistration increases the possibility of post hoc methodological decisions and limits the ability to verify deviations from the originally intended review process.

A further central limitation concerns comparator selection. Most included studies compared one active physiotherapy intervention with another rather than with sham treatment, placebo, usual care, or no treatment. Consequently, within-group improvements cannot be interpreted as evidence that an intervention produced effects beyond natural recovery, regression to the mean, contextual or placebo effects, and the effects of co-interventions. The present review should therefore be interpreted primarily as a synthesis of comparative effectiveness between active physiotherapy approaches rather than as evidence of the absolute effectiveness of manual therapy.

Further, the included studies were characterized by substantial clinical and methodological heterogeneity. In particular, the diagnostic definition of sacroiliac joint dysfunction varied considerably across studies. SIJD was identified using different combinations of pain-provocation tests, palpatory or mobility assessments, clinical examination findings, and patient-reported symptoms, generally without confirmation using a uniform reference standard. The reliability and validity of several commonly used SIJ tests remain uncertain, particularly when individual tests are interpreted in isolation. Consequently, studies may have enrolled clinically different patient populations under the same diagnostic label,

including patients with predominantly pain-related presentations, presumed hypomobility or malalignment, and coexisting lumbar or hip pathology. Such variability may have resulted in diagnostic misclassification and influenced the observed treatment effects. Less specific diagnostic criteria may include patients whose symptoms do not primarily originate from the SIJ, potentially diluting the apparent effectiveness of targeted interventions. Conversely, more restrictive test clusters may identify narrower patient subgroups that respond differently to treatment. Therefore, differences in diagnostic criteria may have contributed to both the direction and magnitude of the reported effects and substantially limit direct comparability between studies. The available reporting was insufficient to conduct subgroup or sensitivity analyses according to the diagnostic approach used. Further sources of heterogeneity included differences in patient populations, intervention techniques, treatment intensity and duration, co-interventions, comparator definitions, outcome measures, and follow-up periods. In addition, although the pooled comparators were classified as mobilization-based interventions, Mobilization With Movement and Maitland mobilization differ in their application and proposed mechanisms. Pooling these techniques may therefore have obscured intervention-specific effects and contributed to the considerable statistical heterogeneity observed in the quantitative synthesis.

Moreover, the meta-analysis included only three trials contributing data from 125 participants. Consequently, the pooled estimate was highly imprecise, with very wide confidence and prediction intervals encompassing potentially important effects in favour of either MET or mobilization-based interventions. The leave-one-out sensitivity analysis further demonstrated that the direction and magnitude of the pooled estimate were sensitive to the inclusion of individual studies. Therefore, the absence of a statistically significant pooled effect should not be interpreted as evidence of equivalence or comparable effectiveness between the interventions.

All studies included in the meta-analysis were judged to be at high overall risk of bias. Concerns were related particularly to the randomization process, lack of blinding, measurement of patient-reported outcomes, and incomplete information regarding prespecified analyses and outcome reporting. A sensitivity analysis excluding studies at high risk of bias could not be performed because this would have removed all studies from the quantitative synthesis. Moreover, the formal RoB 2 assessment was limited to studies included in the meta-analysis; therefore, findings derived from the broader narrative synthesis should be interpreted with additional caution.

Incomplete reporting also restricted the quantitative synthesis. Several otherwise relevant studies did not provide group-specific post-treatment means and standard deviations or reported only *p*-values, change scores, or graphical results. These studies could not be incorporated into the pooled model, which may have introduced availability bias. In addition, the small number of included trials prevented a meaningful assessment of publication bias using funnel plots or statistical tests and precluded subgroup analyses or meta-regression.

Finally, most studies included relatively small samples and short follow-up periods. Evidence regarding the long-term durability of treatment effects, recurrence of symptoms, adverse events, and clinically meaningful improvement therefore remains limited. The generalizability of the findings may also be restricted because some studies enrolled selected populations, including students, postpartum women, or patients with specific subtypes of sacroiliac joint dysfunction.

Taken together, these limitations mean that the quantitative synthesis should be regarded solely as exploratory and hypothesis-generating. The pooled estimate represents a descriptive summary of three small, heterogeneous, high-risk-of-bias studies and cannot establish superiority, equivalence, comparable effectiveness, or the absence of a clinically

meaningful difference between MET and mobilization-based interventions. Confirmatory comparative conclusions require substantially larger and methodologically rigorous trials using sufficiently consistent interventions, comparators, diagnostic criteria, and outcome measures.

6. Conclusions

Most included studies reported within-group reductions in pain and disability after manual therapy, exercise-based interventions, or adjunctive physiotherapy modalities. However, because most trials compared active treatments and few incorporated sham, placebo, usual-care, or no-treatment control groups, these improvements cannot be attributed specifically to manual therapy. The available evidence therefore primarily addresses comparative effectiveness rather than absolute treatment effectiveness.

Individual studies reported greater improvements with mobilization or manipulation than with selected active comparators, including MET, exercise, TENS, or electrotherapy. Nevertheless, these findings were inconsistent across studies, and the exploratory meta-analysis was highly imprecise and unstable and could not determine whether a clinically meaningful difference exists between MET and mobilization-based interventions. The current evidence is insufficient to establish the superiority, equivalence, or long-term effectiveness of any single manual therapy approach.

Future research should include adequately powered randomized trials with standardized diagnostic criteria, sham, usual-care, or no-treatment control groups where feasible; clinically meaningful outcome thresholds; and longer follow-up. Such studies are required to distinguish specific treatment effects from nonspecific and natural changes and to clarify the relative and absolute effectiveness of physiotherapy interventions for SIJD.

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Abbreviations

The following abbreviations are used in this manuscript:

ASLR/SLR	active straight leg rise/straight leg rise
fESWT	focused extracorporeal shock wave therapy
HVLA	high velocity low amplitude
LBP	low back pain
LDH	lumbar disc herniation
MCIC	minimal clinically important change
MET	muscle energy technique
MFMA	mechanical-force manually assisted
MODI	modified Oswestry Disability Index
MWM	mobilization with movement
NPRS	Numeric Pain Rating Scale
ODI	Oswestry Disability Index

REML	restricted maximum likelihood
RMDQ	Roland-Morris Disability Questionnaire
SIJ	sacroiliac joint
SIJD	sacroiliac joint dysfunction
SMD	standardized mean difference
TENS	transcutaneous electrical nerve stimulation
VAS	Visual Analog Scale

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