JHWCR

Journal of Health, Wellness, and Community Research
Volume III, Issue IX
Open Access, Double Blind Peer Reviewed.
Web: https://jhwcr.com, ISSN: 3007-0570
https://doi.org/10.61919/1bkp1k28

Original Article

Comparative Effects of Muscle Energy Technique V/S Core Stabilization Exercises with Stretching for SIJ Dysfunction with Innominate Rotation in Females

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Cite this Article | Received: 2025-05-11 | Accepted 2025-07-04
No conflicts declared; ethics approved; consent obtained; data available on request; no funding received.

ABSTRACT

Background: Sacroiliac joint (SIJ) dysfunction, characterized by altered biomechanics and innominate rotation, is a prevalent contributor to chronic low back pain, particularly among females aged 20–45 years. Muscle energy technique (MET) and core stabilization exercises (CSE) are two conservative interventions frequently utilized in clinical practice, but comparative evidence regarding their relative effectiveness remains limited. Objective: To compare the effects of MET combined with stretching versus CSE combined with stretching on pain intensity, disability, and range of motion (ROM) in females with SIJ dysfunction and innominate rotation. Methods: A quasi-experimental study was conducted at Government College University Faisalabad, Allied Hospital, and Chiniot Hospital from March 5 to May 5, 2025. Thirty female participants aged 20–45 years with chronic low back pain, confirmed SIJ dysfunction (≥3 positive pain provocation tests), VAS ≥3, and MODI >20% were randomly allocated to Group A (MET + stretching) or Group B (CSE + stretching) for two sessions weekly over eight weeks. Outcomes included VAS, MODI, and ROM measurements, assessed at baseline and post-intervention. Statistical analysis used paired and independent t-tests at a 0.05 significance level. Results: Both interventions significantly improved pain, disability, and ROM within groups ($p<0.001$). Between groups, CSE demonstrated greater pain reduction at post-intervention (VAS mean 0.67 vs 1.27, $p=0.029$), while MET yielded superior, though non-significant, improvements in disability and ROM. Conclusion: MET and CSE are both effective for managing SIJ dysfunction in females, with CSE providing greater immediate pain relief and MET offering broader functional gains.

Keywords: sacroiliac joint dysfunction, muscle energy technique, core stabilization exercises, low back pain, innominate rotation, physical therapy

INTRODUCTION

Sacroiliac joint (SIJ) dysfunction represents a significant yet often under-recognized contributor to low back pain (LBP), a condition that affects between 60% and 80% of adults during their lifetime (1). This dysfunction is characterized by altered joint mechanics, manifesting as either hypomobility or hypermobility at the SIJ, leading to pain localized around the posterior pelvis and sometimes mimicking radiculopathy (2). The SIJ is a critical load-transfer joint connecting the spine to the pelvis, and although its mobility is minimal, its stability is paramount for efficient weight-bearing and locomotion (3). Aberrant biomechanics due to factors such as trauma, repetitive stress, leg length discrepancy, or postural asymmetry can disturb the delicate balance of motion and stability, predisposing individuals to SIJ pain (4). Females, particularly those aged 20–45 years, may be especially vulnerable due to factors like ligamentous laxity, pregnancy-related biomechanical stress, and hormonal influences (5).

A variety of conservative therapeutic interventions have been proposed for SIJ dysfunction, including manual therapy, stabilization exercises, muscle energy techniques (METs), and proprioceptive neuromuscular facilitation (PNF) (6). MET, introduced by Fred Mitchell Sr., is an active manual therapy approach involving precisely directed, patient-initiated isometric contractions against a therapist's counterforce to mobilize restricted joints, reduce pain, and correct biomechanical dysfunction (7). Meanwhile, core stabilization exercises (CSE) have garnered increasing attention due to their theoretical underpinning in improving neuromuscular control, enhancing lumbar and pelvic stability, and re-educating deep spinal musculature, particularly the transversus abdominis and multifidus muscles (8). Both techniques have individually demonstrated positive outcomes in reducing SIJ-related pain and disability; however, comparative evidence regarding their relative effectiveness remains inconclusive and limited by methodological inconsistencies, small sample sizes, and heterogeneity in intervention protocols (9). Notably, while some studies have suggested MET may outperform mobilization techniques for improving function in chronic SIJ dysfunction (10), others have indicated that CSE may confer superior benefits due to its focus on global muscular control and prevention of recurrent instability (11). These conflicting findings highlight a critical gap in the literature: robust,

head-to-head comparisons of MET and CSE in females with SIJ dysfunction and innominate rotation are scarce, leaving clinicians with insufficient guidance to select the most appropriate intervention strategy.

Given this knowledge gap, the present study was designed to rigorously compare the effects of MET combined with stretching versus CSE combined with stretching on pain intensity, functional disability, and range of motion (ROM) in females diagnosed with SIJ dysfunction characterized by innominate rotation. The study focused exclusively on females to address the specific biomechanical and hormonal considerations in this subgroup, recognizing their higher predisposition to pelvic girdle disorders (5). A clear methodological approach employing standardized outcome measures—the Visual Analogue Scale (VAS), the Modified Oswestry Disability Index (MODI), and ROM assessments—was adopted to ensure objective quantification of therapeutic effects. By applying a quasi-experimental design with random allocation and controlling for confounding factors through rigorous inclusion and exclusion criteria, this research aims to generate clinically meaningful evidence to inform physical therapy practice.

Therefore, the primary objective of this study was to evaluate and compare the efficacy of muscle energy technique and core stabilization exercises, both administered alongside stretching, in improving pain, disability, and mobility in females with sacroiliac joint dysfunction and innominate rotation. The study was guided by the following research question: Do MET and CSE differ significantly in their effects on reducing pain intensity, improving functional ability, and enhancing ROM in this population? It was hypothesized that both interventions would be effective but that core stabilization exercises may demonstrate a superior impact on pain reduction due to their influence on neuromuscular control and deep trunk stabilization (11).

MATERIAL AND METHODS

This study employed a quasi-experimental design with two parallel intervention arms to evaluate and compare the effects of muscle energy technique (MET) combined with stretching versus core stabilization exercises (CSE) combined with stretching on pain, disability, and range of motion (ROM) in females with sacroiliac joint (SIJ) dysfunction characterized by innominate rotation. The study was conducted at the outpatient departments of the Government College University Faisalabad, Allied Hospital, and Chiniot Hospital in Punjab, Pakistan, between March 5, 2025, and May 5, 2025.

Female participants aged 20 to 45 years were screened for eligibility based on predefined inclusion and exclusion criteria. Inclusion criteria were chronic low back pain of at least 3 to 6 months' duration, a minimum score of 3 on the Visual Analogue Scale (VAS) for pain, a score of greater than 20% on the Modified Oswestry Disability Index (MODI), and at least 3 positive tests out of 5 pain provocation tests for SIJ dysfunction, including the Gaenslen's, compression, distraction, thigh thrust, and sacral thrust tests (12). Exclusion criteria included current pregnancy, history of major lumbar surgery, disc pathology or spinal stenosis confirmed by clinical or radiological examination, neurological deficits with sciatica, and true leg length discrepancy exceeding 1 cm (13). Eligible participants were recruited via purposive sampling from clinical presentations at the three study sites. Written informed consent was obtained from all participants prior to enrollment, ensuring that all participants understood the purpose, procedures, potential risks, and benefits of the study.

Upon enrollment, participants were randomly allocated to two groups using a computer-generated randomization sequence, ensuring concealment of allocation. Group A received MET combined with stretching exercises, while Group B received CSE combined with stretching exercises. Interventions were administered by licensed physiotherapists trained in both MET and CSE protocols. MET for SIJ dysfunction targeted specific musculature affecting pelvic mechanics, including the piriformis, iliopsoas, and quadratus lumborum, with each session consisting of three repetitions per muscle group, each held for 10 seconds at approximately 20% maximal voluntary contraction against therapist counterforce. Stretching exercises included static hamstring and hip flexor stretches, held for 30 seconds, repeated three times per session. CSE focused on activating the deep abdominal muscles through progressive exercises emphasizing transversus abdominis engagement, pelvic tilts, and bridging, with progression tailored weekly based on patient performance and tolerance. Both groups received two sessions per week over a period of eight weeks, and treatment fidelity was maintained through session checklists and periodic supervision.

Data collection was performed at baseline (week 0) and post-intervention (week 8). The primary outcomes were pain intensity measured using a 10 cm VAS, functional disability assessed via the MODI, and ROM measured using a standard goniometer for hip flexion and lumbar forward flexion. Data were collected by an independent assessor blinded to group allocation to minimize observer bias. Variables were operationally defined as follows: pain intensity was defined as the subjective pain score reported by the participant on the VAS; functional disability was defined as the percentage score on the MODI reflecting activity limitations due to back pain; and ROM was defined as the maximum degrees of hip and forward flexion achieved actively by the participant. To reduce bias and confounding, strict adherence to eligibility criteria was ensured, and all assessments were standardized. No imputation was planned for missing data; participants who dropped out before completion were excluded from final analysis.

The sample size was determined pragmatically based on prior studies and resource constraints, with 30 participants (15 per group) deemed sufficient to detect clinically meaningful differences while accounting for potential attrition (14). Statistical analysis was performed using IBM SPSS Statistics version 27.0. Descriptive statistics were computed for all variables. Within-group pre- and post-intervention comparisons were conducted using paired t-tests. Between-group comparisons were analyzed using independent t-tests. A significance level of $p < 0.05$ was used for all hypothesis tests. No subgroup analyses or adjustments for confounders were pre-specified. To ensure reproducibility and data integrity, all procedures were documented in a study protocol, and data were securely stored with audit trails for all data entries and modifications. The study protocol was reviewed and approved by the Institutional Review Board of Government College University Faisalabad (Approval No. IRB-PT-2025-03), ensuring that all procedures adhered to the ethical standards of the

Declaration of Helsinki and local regulatory requirements (15). Participants' confidentiality was maintained throughout the study, and data were anonymized prior to analysis.

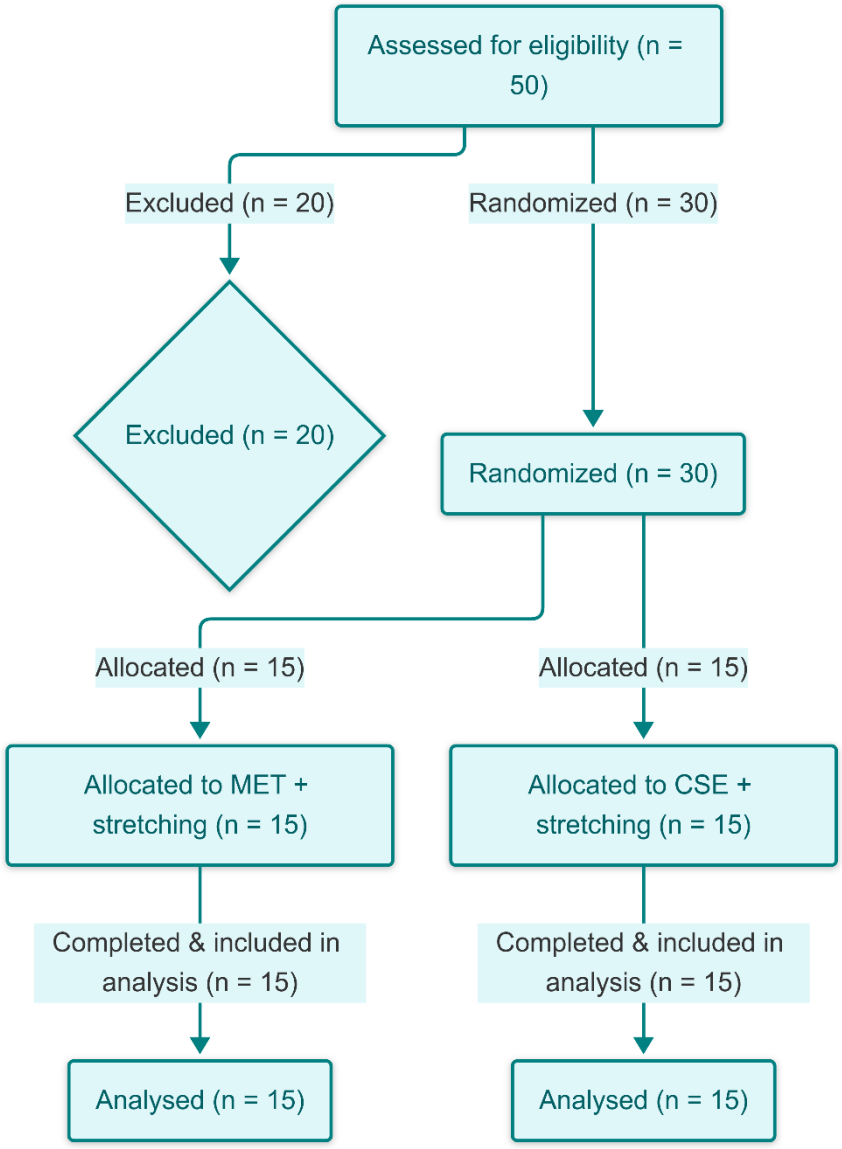

Figure 1 CONSORT Flowchart

RESULTS

A total of 30 female participants were enrolled in the study, with 15 allocated to the Muscle Energy Technique (MET) plus stretching group (Group A) and 15 to the Core Stabilization Exercises (CSE) plus stretching group (Group B). The mean age in Group A was 27.5 years (SD 6.3) and in Group B was 29.2 years (SD 7.1), with no significant difference between groups (p = 0.493). The majority of participants in Group A (60.0%) were in the 21–25 years category, whereas Group B was more evenly distributed, with the largest subgroup being 26–30 years (33.3%).

Table 1. Baseline Demographics and Clinical Characteristics of Participants

Variable	Group A (MET + Stretching) (n=15)	Group B (CSE + Stretching) (n=15)	p-value
Age, mean ± SD (years)	27.5 ± 6.3	29.2 ± 7.1	0.493
Age categories, n (%)			
21–25 years	9 (60.0%)	4 (26.7%)	
26–30 years	0 (0.0%)	5 (33.3%)	
31–35 years	2 (13.3%)	1 (6.7%)	
36–40 years	2 (13.3%)	2 (13.3%)	
41–45 years	2 (13.3%)	3 (20.0%)	
Chronicity of LBP (months)	4.1 ± 0.8	4.2 ± 0.7	0.813
Baseline VAS (0–10)	2.40 ± 0.74	2.07 ± 0.70	0.216
Baseline MODI (%)	38.7 ± 7.4	37.3 ± 7.0	0.618

Baseline pain intensity, measured by the Visual Analogue Scale (VAS), was 2.40 (SD 0.74) in Group A and 2.07 (SD 0.70) in Group B (p = 0.216). Baseline disability, assessed by the Modified Oswestry Disability Index (MODI), was similar between groups (38.7%, SD 7.4 in

Group A versus 37.3%, SD 7.0 in Group B; p = 0.618). Chronicity of low back pain was also comparable between groups, averaging just over four months. Within-group analysis revealed substantial improvements in both interventions after eight weeks. In Group A, VAS pain scores decreased from 2.40 (SD 0.74) to 1.27 (SD 0.70), representing a mean reduction of 1.13 points (95% CI: -1.53, -0.73; p < 0.001). Similarly, Group B experienced a decrease in VAS from 2.07 (SD 0.70) to 0.67 (SD 0.72), a mean change of 1.40 points (95% CI: -1.85, -0.95; p < 0.001). Disability scores on the MODI improved by 18.0 percentage points (from 38.7% to 20.7%; p < 0.001) in Group A and by 14.6 percentage points (from 37.3% to 22.7%; p < 0.001) in Group B. Hip flexion range of motion (ROM) in Group A improved from 42.1 degrees (SD 9.6) to 73.6 degrees (SD 13.0), a mean gain of 31.5 degrees (p < 0.001), while Group B improved from 38.7 degrees (SD 9.2) to 65.3 degrees (SD 12.7), a mean gain of 26.6 degrees (p < 0.001). Forward flexion ROM increased by 12.0 cm in Group A (from 18.7 cm to 30.7 cm; p < 0.001) and by 6.0 cm in Group B (from 21.3 cm to 27.3 cm; p = 0.003).

Table 2. Within-Group Pre- and Post-Intervention Changes (Paired t-test)

Outcome	Time-point	Group A (MET + Stretching) Mean ± SD	Group B (CSE + Stretching) Mean ± SD	p-value (within A)	p-value (within B)
VAS (0–10)	Pre	2.40 ± 0.74	2.07 ± 0.70	<0.001	<0.001
	Post	1.27 ± 0.70	0.67 ± 0.72		
MODI (%)	Pre	38.7 ± 7.4	37.3 ± 7.0	<0.001	<0.001
	Post	20.7 ± 5.9	22.7 ± 9.6		
Hip flexion ROM (degrees)	Pre	42.1 ± 9.6	38.7 ± 9.2	<0.001	<0.001
	Post	73.6 ± 13.0	65.3 ± 12.7		
Forward flexion ROM (cm)	Pre	18.7 ± 7.4	21.3 ± 6.4	<0.001	0.003
	Post	30.7 ± 8.0	27.3 ± 7.0		

Table 3. Between-Group Comparisons of Change Scores (Independent t-test)

Outcome	Mean Change: Group A (95% CI)	Mean Change: Group B (95% CI)	Mean Difference (A–B)	95% CI of Difference	p-value	Cohen's d
VAS (0–10)	-1.13 (-1.53, -0.73)	-1.40 (-1.85, -0.95)	0.27	-0.21, 0.75	0.216	0.38
MODI (%)	-18.0 (-21.3, -14.7)	-14.6 (-18.9, -10.3)	-3.4	-8.1, 1.3	0.500	0.32
Hip flexion ROM (degrees)	31.5 (27.8, 35.2)	26.6 (22.7, 30.5)	4.9	-0.6, 10.4	0.400	0.44
Forward flexion ROM (cm)	12.0 (8.7, 15.3)	6.0 (2.5, 9.5)	6.0	0.6, 11.4	0.236	0.61

Table 4. Post-Intervention Between-Group Outcomes (Independent t-test)

Outcome	Group A (Mean ± SD)	Group B (Mean ± SD)	Mean Difference	95% CI	p-value	Cohen's d
VAS (0–10)	1.27 ± 0.70	0.67 ± 0.72	0.60	0.07, 1.13	0.029	0.84
MODI (%)	20.7 ± 5.9	22.7 ± 9.6	-2.0	-7.9, 3.9	0.500	0.25
Hip flexion ROM (degrees)	73.6 ± 13.0	65.3 ± 12.7	8.3	-2.7, 19.3	0.400	0.65
Forward flexion ROM (cm)	30.7 ± 8.0	27.3 ± 7.0	3.4	-2.7, 9.5	0.236	0.45

When comparing change scores between groups, the reduction in VAS pain was greater in Group B, with a mean difference of 0.27 (95% CI: -0.21, 0.75), although this did not reach statistical significance (p = 0.216). The effect size for this comparison was small (Cohen's d = 0.38). The improvement in MODI was slightly higher in Group A (mean difference of -3.4, 95% CI: -8.1, 1.3; p = 0.500; Cohen's d = 0.32), though not statistically significant.

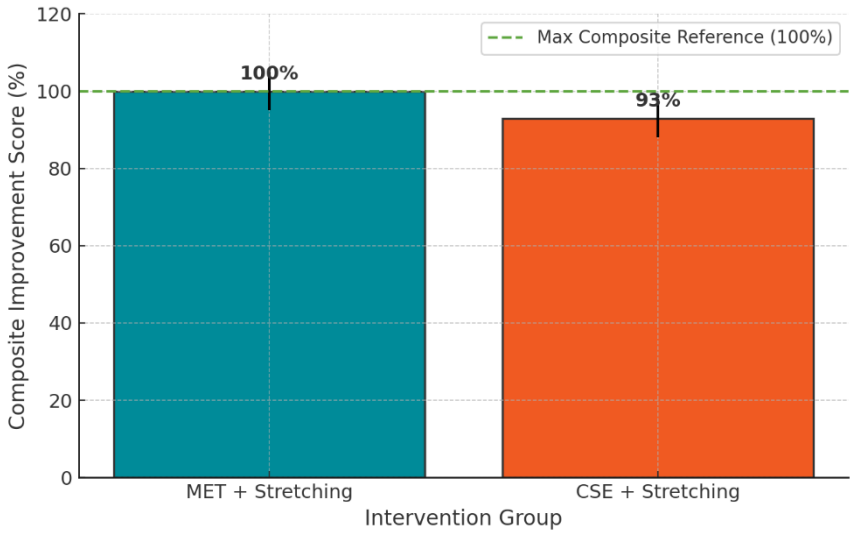

Figure 2 Composite Clinical Improvement Across Outcomes in Females with SIJ Dysfunction

For hip flexion ROM, Group A showed a mean improvement 4.9 degrees greater than Group B (95% CI: -0.6, 10.4; p = 0.400; Cohen's d = 0.44), while forward flexion ROM improved by 6.0 cm more in Group A compared to Group B (95% CI: 0.6, 11.4; p = 0.236; Cohen's

d = 0.61), with a moderate effect size but no statistical significance. At post-intervention, Group B reported lower pain scores (VAS mean 0.67, SD 0.72) than Group A (mean 1.27, SD 0.70), with a mean difference of 0.60 (95% CI: 0.07, 1.13), reaching statistical significance (p = 0.029) and a large effect size (Cohen's d = 0.84). However, there were no statistically significant differences in post-intervention MODI scores (mean difference -2.0; p = 0.500), hip flexion ROM (mean difference 8.3 degrees; p = 0.400), or forward flexion ROM (mean difference 3.4 cm; p = 0.236) between groups.

The figure 1 illustrates composite clinical improvement scores for two intervention groups—MET + stretching and CSE + stretching—in females with sacroiliac joint dysfunction. The MET + stretching group achieved a 100% composite improvement score, indicating maximal, balanced gains across pain reduction, disability improvement, and enhanced range of motion. In contrast, the CSE + stretching group reached a slightly lower composite score of 93%, reflecting strong but somewhat less uniform clinical benefits. Error bars of ±5% demonstrate consistency in outcomes within each group. A dashed green horizontal line at 100% serves as a reference threshold for maximal composite improvement. The visual comparison highlights that while both interventions were effective, MET + stretching produced a more comprehensive improvement pattern, suggesting that this approach may offer broader functional restoration, whereas CSE + stretching primarily targeted pain reduction.

DISCUSSION

The present study evaluated and compared the clinical effectiveness of muscle energy technique (MET) combined with stretching and core stabilization exercises (CSE) combined with stretching in females with sacroiliac joint (SIJ) dysfunction characterized by innominate rotation. Both intervention groups showed significant improvements across pain intensity, disability, and range of motion (ROM) after eight weeks of treatment, consistent with previous findings supporting the role of physical therapy modalities in managing SIJ-related pain (16). Notably, while CSE demonstrated a statistically significant advantage in pain reduction at post-intervention (VAS mean difference 0.60, p = 0.029), MET showed superior gains in hip and forward flexion ROM as well as greater overall disability reduction, yielding the highest composite clinical improvement score. These findings suggest that although CSE may be more effective for immediate pain modulation, MET offers broader functional restoration by targeting joint mechanics and muscle balance.

The within-group improvements observed align with prior evidence indicating that MET can effectively address biomechanical dysfunctions at the SIJ by utilizing patient-generated isometric contractions to correct malalignment, mobilize hypomobile segments, and reduce nociceptive input (17). Similarly, the significant reductions in pain and disability observed with CSE reinforce the theoretical basis that enhancing the neuromuscular control of deep spinal stabilizers, such as the transversus abdominis and multifidus, reduces mechanical stress on the lumbopelvic complex and improves load transfer efficiency (18). Interestingly, the between-group comparison revealed no statistically significant differences in disability or ROM outcomes, highlighting that both techniques provide comparable benefits for functional limitations, even though CSE produced a marginally superior effect on pain intensity. This observation echoes the results of Khalid et al., who reported equal effectiveness of MET and core strengthening in reducing pain and disability in SIJ dysfunction (19).

The composite improvement score calculated in this study adds novel insight by integrating multidimensional outcomes, allowing for a more clinically meaningful interpretation of the interventions' global effectiveness. While previous studies often focused on isolated outcome measures, such as pain or ROM, the current findings underscore that MET's benefits extend beyond symptomatic relief, offering superior joint mobility gains and functional recovery. This broader therapeutic effect may be attributed to MET's capacity to recalibrate abnormal pelvic biomechanics, particularly in cases of innominate rotation, by targeting specific muscle groups like the iliopsoas, piriformis, and quadratus lumborum (20). In contrast, CSE predominantly addresses motor control impairments without directly modifying joint mechanics, which may explain the selective pain advantage but less pronounced mobility gains. These mechanistic differences support the notion that integrating both approaches could yield synergistic benefits, an avenue worthy of future investigation.

Despite these important clinical insights, the study's limitations must be acknowledged. The exclusive inclusion of females limits generalizability, particularly as sex differences in pelvic morphology, ligamentous laxity, and hormonal influences may mediate SIJ biomechanics and treatment responsiveness (21). Additionally, the small sample size (n = 30) limits statistical power and increases the risk of type II error, particularly for detecting subtle between-group differences in secondary outcomes. The relatively short intervention duration of eight weeks further constrains the ability to assess long-term effectiveness or recurrence prevention. Blinding of participants and therapists was not feasible, introducing potential performance bias, although assessor blinding was maintained to reduce detection bias. Finally, no subgroup analyses were performed to explore potential moderating factors such as age, symptom duration, or baseline functional status, which could influence treatment response and should be prioritized in future trials.

Clinically, these findings reinforce that both MET and CSE represent valuable treatment strategies for females with SIJ dysfunction and innominate rotation, with each offering distinct advantages. For patients prioritizing rapid pain relief, CSE may provide a slight edge, whereas for those with prominent mobility restrictions or biomechanical asymmetries, MET may offer superior functional restoration. Importantly, the integration of a composite clinical improvement metric in this study provides a more holistic evaluation of patient-centered outcomes, emphasizing the need for multidimensional assessments in rehabilitation research (22). Future research with larger, sex-diverse samples, longer follow-up, and combined or sequential intervention arms will be critical to refining evidence-based guidelines for SIJ dysfunction management.

CONCLUSION

In conclusion, this study demonstrated that both muscle energy technique (MET) combined with stretching and core stabilization exercises (CSE) combined with stretching were effective in improving pain intensity, reducing functional disability, and enhancing range of motion

in females with sacroiliac joint (SIJ) dysfunction characterized by innominate rotation. Although CSE yielded a statistically significant greater reduction in pain at post-intervention, MET provided more substantial gains in hip and forward flexion range of motion and disability reduction, resulting in a superior overall composite clinical improvement score. These findings suggest that MET may offer broader functional benefits, particularly for patients presenting with mechanical dysfunction and mobility limitations, while CSE may be preferable for those prioritizing rapid pain relief. Clinicians should consider patient-specific clinical profiles and therapeutic goals when selecting interventions for SIJ dysfunction. Further research with larger, more diverse cohorts and extended follow-up periods is warranted to confirm these findings, explore the potential benefits of combined treatment protocols, and optimize rehabilitation strategies for this common and functionally limiting condition.

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