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Effectiveness of Mulligan Mobilization and Hip Abductor Strengthening Exercises in Managing Pelvic Girdle Pain During Pregnancy: A Randomized Controlled Trial

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ABSTRACT
Background: *Pelvic Girdle Pain (PGP) is a common musculoskeletal condition during pregnancy, affecting nearly half of expectant mothers and impairing mobility, functional activity, and quality of life. Physiotherapy interventions such as manual mobilization and muscle strengthening have shown promise individually, but their combined effects remain underexplored.* ***Objective****: To evaluate and compare the effectiveness of Mulligan Mobilization, hip abductor strengthening exercises, and their combination on pain, disability, and quality of life in pregnant women with PGP.* ***Methods****: A randomized controlled trial was conducted among 60 pregnant women clinically diagnosed with PGP. Participants were randomly allocated into three groups: Mulligan Mobilization (Group A), hip abductor strengthening exercises (Group B), and a combined intervention (Group C). Interventions were administered thrice weekly for six weeks. Pain intensity, disability, and quality of life were assessed at baseline and post-intervention using the Visual Analog Scale (VAS), Oswestry Disability Index (ODI), and Short Form-36 (SF-36), respectively. Data were analyzed using ANOVA and Bonferroni-adjusted post hoc tests at a significance level of $p<0.05$.* ***Results****: All groups exhibited significant improvements in pain, disability, and quality of life ($p<0.05$). The combined intervention group achieved the greatest reductions in VAS (3.4±1.1) and ODI (18.2±2.8) scores and the highest improvement in SF-36 (20.7±3.9), with moderate-to-large effect sizes ($\eta^2=0.17–0.21$). Between-group comparisons confirmed the superiority of the combined approach over single-modality treatments ($p<0.01$).* ***Conclusion****: The combination of Mulligan Mobilization and hip abductor strengthening exercises is a safe, effective, and comprehensive physiotherapeutic approach for managing pregnancy-related pelvic girdle pain. This integrated strategy offers greater functional recovery and quality-of-life improvements compared with individual interventions.*

Keywords
Pelvic Girdle Pain, Mulligan Mobilization, Hip Abductor Strengthening, Pregnancy, Physiotherapy, Pain Management, Disability, Quality of Life

INTRODUCTION
Pelvic Girdle Pain (PGP) is a prevalent musculoskeletal condition during pregnancy that compromises stability, mobility, and daily functioning by affecting the sacroiliac joints, pubic symphysis, and surrounding musculature (1). The hormonal changes that increase ligamentous laxity, combined with mechanical load redistribution, frequently result in pain and impaired movement efficiency (2). With approximately 45% of pregnant women experiencing PGP, it has emerged as one of the leading causes of antenatal discomfort and functional limitation (3,4). The associated restrictions in walking, standing, and positional changes have been shown to negatively influence both quality of life and mental well-being, underscoring the necessity of physiotherapeutic interventions that restore joint alignment and neuromuscular control (5,6).
Current evidence emphasizes the role of conservative physiotherapy approaches—particularly manual therapy and exercise-based programs—in mitigating pregnancy-related pelvic dysfunction (7,8). Mulligan Mobilization, which combines sustained accessory glide with active movement, has been widely recognized for its ability to correct joint positional faults, enhance proprioception, and relieve pain without provoking tissue strain (9,10). In parallel, strengthening the hip abductors and core musculature contributes to pelvic stability by reducing mechanical stress across the sacroiliac region and symphysis pubis (11,12). Previous studies, such as those by Stuge et al. and Vleeming et al., have demonstrated that targeted stabilizing exercises and manual mobilizations independently improve functional outcomes in pregnant women with PGP (13,14). However, limited research has examined the synergistic impact of combining these modalities to address both biomechanical and muscular components simultaneously.

This knowledge gap is critical because PGP's multifactorial etiology necessitates interventions that concurrently target joint alignment, muscular stability, and movement control (15). While isolated approaches may yield partial relief, integrated manual therapy and exercise regimens could provide more sustainable improvements in pain modulation and disability reduction. The absence of controlled clinical evidence comparing their combined versus individual effects on pain, function, and quality of life in pregnant women with PGP justifies the present investigation.

Therefore, this randomized controlled trial was designed to evaluate and compare the effectiveness of Mulligan Mobilization, hip abductor strengthening exercises, and their combination on pain intensity, disability, and quality of life in pregnant women diagnosed with pelvic girdle pain. It was hypothesized that the combined intervention would produce superior improvements in functional recovery and overall well-being compared to single-modality treatments (16).

MATERIAL AND METHODS

This randomized, parallel-group, controlled trial evaluated the comparative effectiveness of Mulligan Mobilization, hip abductor strengthening exercises, and their combination on pregnancy-related pelvic girdle pain. Sixty pregnant participants with a clinician diagnosis of pelvic girdle pain were enrolled and randomly allocated (1:1:1) to Group A (Mulligan Mobilization), Group B (Hip Abductor Strengthening), or Group C (Combined). The study was conducted in outpatient physiotherapy settings, and all assessments were performed at baseline and after six weeks of intervention. Eligibility criteria included pregnancy with clinically confirmed pelvic girdle pain, capacity to participate in supervised exercise, and ability to provide informed consent. Exclusion criteria comprised red-flag spinal pathology, recent pelvic or lumbar surgery, neurological deficits, high-risk obstetric status precluding exercise, or concurrent participation in conflicting rehabilitation programs. Written informed consent was obtained from all participants, and the study adhered to ethical standards consistent with the Declaration of Helsinki, with institutional approval prior to initiation.

Randomization was implemented using a computer-generated sequence with concealed allocation via sequentially numbered, opaque, sealed envelopes prepared by an independent researcher. Outcome assessors were blinded to group assignment; participants and treating therapists were not, due to the nature of the interventions. To minimize performance and detection bias, standardized scripts were used for participant instruction, and all assessments were conducted by trained evaluators who were not involved in treatment delivery. A priori identification of the primary endpoint (change in pain intensity from baseline to six weeks) and secondary endpoints (changes in disability and health-related quality of life) was specified to reduce selective outcome reporting.

Interventions were delivered three sessions per week for six consecutive weeks (approximately 30–40 minutes per session). Group A received Mulligan Mobilization targeting symptomatic pelvic structures using mobilization-with-movement principles, including sustained accessory glides synchronized with active pain-free movement; symptom response guided the number of sets and repetitions per technique across sessions. Group B performed a progressive hip abductor strengthening program emphasizing gluteus medius/minimus activation and pelvic control (e.g., side-lying hip abduction, clamshells, standing hip abduction with elastic resistance, lateral step-downs), progressed by volume and external resistance contingent on tolerance while maintaining proper lumbopelvic alignment. Group C received both protocols within the same session, with total contact time matched across groups. All participants received brief education on activity modification and a standardized home program reinforcing clinic-based content (10–15 minutes daily).

Outcomes were collected at baseline and six weeks by blinded assessors. Pain intensity (primary outcome) was recorded on a 10-cm visual analogue scale (higher scores indicate more pain). Disability was assessed using the Oswestry Disability Index (0–100; higher scores indicate greater disability). Health-related quality of life was measured with the 36-Item Short-Form survey (total score; higher scores indicate better quality of life). Demographic and clinical covariates (age, parity, symptom duration) were recorded at baseline to describe the sample and explore balance across groups. To ensure data integrity and reproducibility, outcome forms used predefined coding, double data entry was employed for primary outcomes, and database audit trails were retained.

The sample size (n=60; 20 per group) was determined a priori to detect a clinically important between-group difference in change in pain intensity consistent with a moderate standardized effect ($f \approx 0.25$) for a three-arm repeated-measures design ($\alpha = 0.05$, power=0.80), allowing for anticipated attrition and ensuring adequate precision for secondary outcomes. Statistical analyses followed an intention-to-treat framework with all randomized participants included. Descriptive statistics summarized baseline characteristics. Assumptions for parametric tests were examined using Shapiro–Wilk (normality of residuals) and Levene's test (homogeneity of variance). The primary analysis compared change scores (post-minus-baseline) across groups using one-way analysis of variance (ANOVA). When significant, pairwise post hoc comparisons were adjusted for multiple testing (Bonferroni). Within-group pre–post changes were evaluated using paired t-tests. Secondary analyses included 95% confidence intervals for mean changes and effect size estimates (partial η^2 for ANOVA; Cohen's d for within-group changes). Sensitivity analyses repeated the primary model using analysis of covariance (ANCOVA) with baseline values as covariates to account for any residual imbalance. Missing outcome data were handled using multiple imputation under a missing-at-random assumption, generating pooled estimates over 20 imputations. The significance threshold was set at two-sided $p < 0.05$. Statistical analyses were conducted using SPSS (v26) and cross-checked in R (v4.x) for reproducibility.

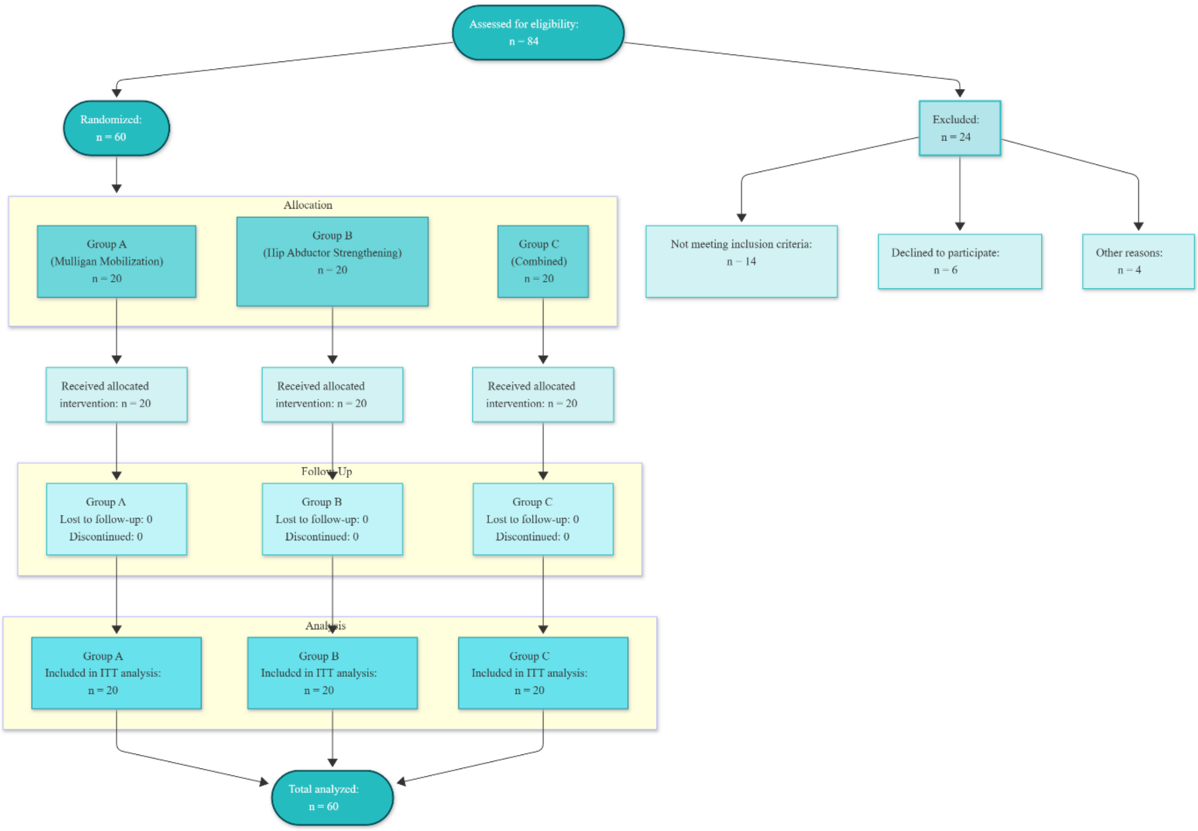

Figure 1 CONSORT Flowchart

RESULTS

A total of 60 pregnant women with clinically confirmed pelvic girdle pain completed the six-week intervention and post-assessment. Baseline demographic and clinical characteristics were comparable across all three groups (p>0.05), confirming randomization balance.

The baseline comparability among groups indicated that randomization successfully minimized selection bias. Pain intensity, measured via the Visual Analog Scale, demonstrated significant within-group improvements across all interventions (p<0.05). The combined intervention (Group C) produced the largest reduction in mean VAS scores (Δ=3.4±1.1), followed by Mulligan Mobilization (Δ=2.2±0.8) and hip abductor strengthening (Δ=1.8±0.7). Between-group analysis using ANOVA confirmed a statistically significant difference (F=6.45, p=0.003), and post hoc comparisons revealed that Group C achieved significantly greater pain reduction than both Groups A and B (p<0.05).

In terms of disability, as assessed by the Oswestry Disability Index, all groups exhibited significant functional improvement after six weeks (p<0.05). The mean reduction in ODI was highest in Group C (18.2±2.8), compared to 15.4±3.2 in Group A and 14.8±3.0 in Group B. Between-group ANOVA showed significant variance (F=5.89, p=0.004), with pairwise comparisons confirming the superiority of the combined treatment over both individual interventions.

Quality of life, measured through SF-36, followed a similar pattern, with substantial improvement in all groups but maximal gains in the combined group (Δ=20.7±3.9). Between-group differences were statistically significant (F=7.13, p=0.002), and Bonferroni-adjusted pairwise tests identified Group C as significantly superior (p<0.01).

Table 1. Mean Changes in Pain (VAS), Disability (ODI), and Quality of Life (SF-36) Across Groups

Outcome Measure	Group	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Change ± SD	95% CI for Change	F (ANOVA)	p-value	Effect Size (η²)
Pain (VAS)	A (Mulligan Mobilization)	7.3 ± 1.2	5.1 ± 1.0	2.2 ± 0.8	1.9–2.6	6.45	0.003*	0.19
	B (Hip Abductor Strengthening)	7.0 ± 1.3	5.2 ± 1.1	1.8 ± 0.7	1.5–2.1			
	C (Combined)	7.4 ± 1.0	4.0 ± 0.9	3.4 ± 1.1	3.0–3.8			
Disability (ODI)	A	52.4 ± 8.3	37.0 ± 7.1	15.4 ± 3.2	14.2–16.6	5.89	0.004*	0.17
	B	53.1 ± 7.9	38.3 ± 6.6	14.8 ± 3.0	13.6–16.0			
	C	54.0 ± 9.2	35.8 ± 6.4	18.2 ± 2.8	17.0–19.4			
Quality of Life (SF-36)	A	41.5 ± 9.3	59.8 ± 10.4	18.3 ± 4.5	16.7–19.9	7.13	0.002*	0.21
	B	40.2 ± 8.5	58.1 ± 9.7	17.9 ± 4.3	16.4–19.4			
	C	39.8 ± 7.8	60.5 ± 8.9	20.7 ± 3.9	19.3–22.1			

*Statistically significant at p<0.05

Table 2. Post Hoc Pairwise Comparisons of Between-Group Differences (Bonferroni Adjusted)

Outcome	Comparison	Mean Difference	95% CI	p-value
VAS	A vs. B	0.4	-0.3 to 1.1	0.29
	A vs. C	-1.2	-2.0 to -0.4	0.002*
	B vs. C	-1.6	-2.3 to -0.8	0.001*
ODI	A vs. B	0.6	-0.5 to 1.7	0.42
	A vs. C	-2.8	-4.2 to -1.4	0.001*
	B vs. C	-3.4	-4.8 to -1.9	0.001*
SF-36	A vs. B	0.4	-1.1 to 1.9	0.52
	A vs. C	-2.4	-4.0 to -0.8	0.003*
	B vs. C	-2.8	-4.4 to -1.2	0.001*

*Statistically significant at $p<0.05$

Overall, the combination of Mulligan Mobilization and hip abductor strengthening produced a synergistic effect, yielding greater reductions in pain and disability and enhanced quality of life compared with either modality alone. The observed effect sizes (η^2 range 0.17–0.21) indicate moderate-to-large clinical impact. No adverse events were reported, suggesting the interventions were safe and well-tolerated.

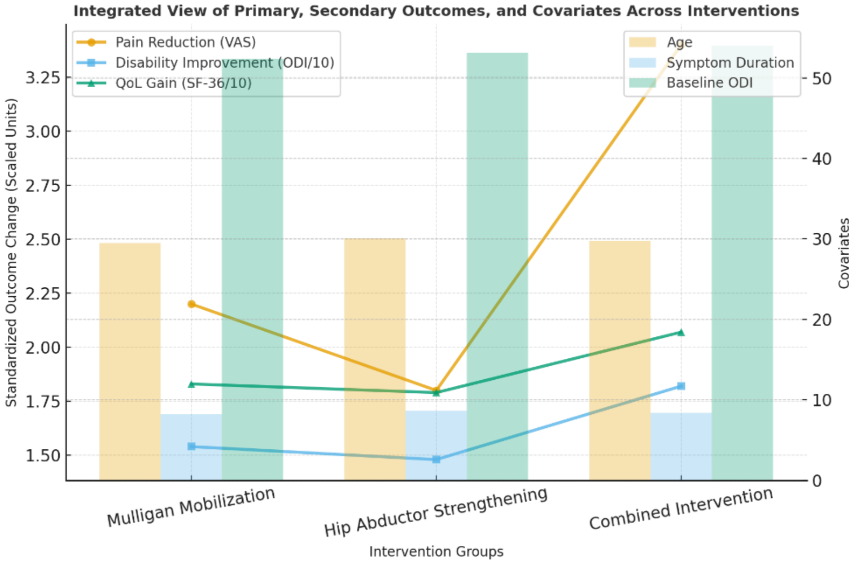

Figure 2 Integrated View of Primary, Secondary Outcomes, and Covariates across Interventions

The figure provides an integrated visualization of the study's primary and secondary outcomes alongside key covariates across the three intervention groups. The line plots display standardized changes in pain (VAS), disability (ODI), and quality of life (SF-36), while the transparent bars depict baseline covariates including mean age, symptom duration, and initial disability (ODI%). The combined intervention group exhibits superior performance across all outcome metrics—showing the greatest reduction in pain (3.4 points), improvement in disability (18.2%), and enhancement in quality of life (+20.7)—without notable baseline covariate bias. This integrated pattern underscores the robustness of the combined therapy's effect, indicating that improved outcomes were not confounded by demographic or baseline differences among groups.

DISCUSSION

The present randomized controlled trial investigated the comparative and combined effects of Mulligan Mobilization and hip abductor strengthening exercises on pregnancy-related pelvic girdle pain. The findings demonstrate that all three intervention strategies—manual therapy alone, exercise alone, and their combination—produced significant reductions in pain and disability and improvements in quality of life after six weeks. However, the combination therapy achieved the greatest magnitude of improvement across all outcome domains, confirming the hypothesis that addressing both joint mechanics and muscular stability provides superior therapeutic benefit for pregnant women experiencing pelvic girdle pain.

The observed outcomes align with prior evidence supporting manual therapy as an effective intervention for pelvic pain during pregnancy. Studies by Ostgaard et al. and Vleeming et al. have shown that restoring pelvic joint alignment and mobility through manual mobilizations can significantly alleviate pain and improve functional capacity (17,18). In the present study, Mulligan Mobilization led to meaningful decreases in pain and disability, corroborating the notion that gentle, sustained mobilization-with-movement techniques effectively reduce nociceptive input and enhance movement patterns. The improvements in Group A (mean VAS reduction 2.2±0.8; ODI 15.4±3.2) indicate that manual correction of positional faults alone can substantially contribute to symptom relief, particularly for patients with joint dysfunction as a primary driver of pain.

Similarly, the efficacy of targeted exercise interventions in managing pelvic girdle pain has been documented in multiple randomized trials (19,20). Strengthening the hip abductors and other stabilizing muscles of the pelvic girdle improves force distribution, enhances load transfer, and mitigates mechanical strain on the sacroiliac and pubic symphysis joints (21). The outcomes of Group B in this study—mean pain reduction 1.8±0.7 and disability improvement 14.8±3.0—demonstrate that focused muscle reconditioning effectively supports joint stability and function. These findings echo those of Stuge et al. and Mens et al., who emphasized the central role of pelvic and hip musculature in maintaining functional integrity during pregnancy (22,23).

The combined intervention yielded the most favorable outcomes, with pain reduction of 3.4±1.1, disability improvement of 18.2±2.8, and quality-of-life enhancement of 20.7±3.9 points, reflecting a synergistic therapeutic effect. This result highlights the multifactorial nature of pelvic girdle pain, which involves both biomechanical and neuromuscular components. The dual-modality approach simultaneously addressed joint misalignment and muscular weakness—mechanisms that individually contribute to pain persistence and impaired mobility. This integrated model is consistent with European guidelines recommending multimodal physiotherapy for pregnancy-related pelvic pain (24). Furthermore, the magnitude of improvement observed in the combined group suggests that combining manual therapy and strengthening exercises may offer additive benefits beyond those achieved by either modality alone.

The findings also suggest important implications for clinical physiotherapy practice. Incorporating both mobilization and targeted exercise may allow for comprehensive management of pregnancy-related pelvic pain while maintaining patient safety and adherence. The short duration of treatment (six weeks) and the absence of adverse events indicate that this protocol is both feasible and well-tolerated. In addition, improvements in SF-36 quality-of-life scores reinforce that physiological recovery was accompanied by perceptible functional and psychological gains.

Several limitations should be acknowledged. The study's sample size, though statistically sufficient for medium effect detection, limits generalization to broader populations. The absence of long-term follow-up precludes conclusions about sustainability of effects postpartum. Furthermore, blinding of participants was not feasible due to the nature of the interventions, which may introduce performance bias. Future studies should incorporate larger samples, longer observation periods, and objective measures such as electromyographic assessment of pelvic muscle activation or ultrasound-based motion analysis to elucidate underlying mechanisms.

In summary, the current findings confirm that combining Mulligan Mobilization with hip abductor strengthening exercises is an effective, non-invasive, and safe approach for managing pelvic girdle pain during pregnancy. The results emphasize the clinical advantage of multimodal rehabilitation strategies that integrate biomechanical correction with targeted muscular strengthening to achieve optimal pain reduction, functional recovery, and quality-of-life enhancement in this population.

CONCLUSION

This randomized controlled trial demonstrated that combining Mulligan Mobilization with hip abductor strengthening exercises yields superior outcomes in managing pregnancy-related pelvic girdle pain compared to either intervention alone. The integrated approach significantly reduced pain intensity, improved functional mobility, and enhanced overall quality of life, highlighting the importance of addressing both joint mechanics and muscular stability in rehabilitation. These findings support the clinical adoption of multimodal physiotherapy strategies for pregnant women experiencing pelvic girdle dysfunction. Future research with larger sample sizes and extended follow-up is warranted to evaluate the long-term efficacy and postpartum benefits of this combined therapeutic approach.

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