

“Effectiveness of Core Strengthening Combined with Balance Coordination Exercises Versus Core Strengthening Alone in Improving Functional Outcomes Among Postpartum Women: An Experimental Study”

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Abstract

Background

The postpartum period is characterized by substantial musculoskeletal, biomechanical, and neuromuscular adaptations that may persist beyond childbirth and contribute to reduced trunk muscle performance, impaired postural control, lumbopelvic pain, functional limitations, and reduced quality of life. Exercise-based rehabilitation, particularly core strengthening, is commonly incorporated into postpartum physiotherapy. Although trunk stabilization exercises have demonstrated beneficial effects on postpartum pain and disability, the additional contribution of balance and coordination training to functional recovery has received comparatively limited investigation.

Objective

To compare the effectiveness of **core strengthening combined with balance coordination exercises** with **core strengthening alone** on core muscle endurance, balance, pain intensity, functional disability, and quality of life in postpartum women.

Methods

An experimental comparative study was conducted among 60 postpartum women aged 20–40 years who were between 6 and 12 weeks post-delivery. Participants were allocated into two groups of 30 each. **Group A** received a combined program of core strengthening and balance coordination exercises, whereas **Group B** received core strengthening exercises alone. Both groups participated in supervised 45-minute sessions, five days per week, for eight weeks. Core endurance was assessed using prone plank and side plank hold duration. Secondary outcomes included balance assessed using the Berg Balance Scale (BBS), pain intensity using the Visual Analog Scale

(VAS), functional disability using the Oswestry Disability Index (ODI), and health-related quality of life using the Short Form-36 (SF-36). Outcomes were assessed at baseline and following completion of the intervention.

Results

Both intervention groups demonstrated statistically significant improvements in core endurance, balance, pain intensity, functional disability, and quality of life following the eight-week intervention ($p < 0.05$). The between-group analysis demonstrated significantly greater improvements in the combined intervention group compared with the core-strengthening-only group across the assessed functional outcomes ($p < 0.05$).

Conclusion

The findings suggest that incorporating balance coordination exercises into a core-strengthening program may provide additional benefits for functional recovery in postpartum women compared with core strengthening alone. The combined approach may therefore be considered as a component of comprehensive postpartum physiotherapy rehabilitation, particularly when the treatment goals include improvement of trunk endurance, postural balance, pain, functional ability, and quality of life.

Keywords

Postpartum women; core strengthening; balance training; coordination exercises; core endurance; postural balance; lumbopelvic pain; functional disability; quality of life; physiotherapy.

Introduction

Pregnancy and childbirth are accompanied by substantial anatomical, biomechanical, hormonal, and neuromuscular adaptations that influence the musculoskeletal system and physical function of women. During pregnancy, progressive changes in body mass distribution, abdominal wall length, pelvic alignment, ligamentous properties, and trunk loading alter the mechanical demands placed on the lumbopelvic region. These adaptations may continue into the postpartum period and can influence postural control, trunk muscle performance, and functional activities during the early stages of recovery^[1,2]

The postpartum period represents an important phase for restoration of physical function. Women may experience low back or pelvic girdle pain, abdominal muscle dysfunction, pelvic floor-related problems, reduced physical capacity, and limitations in activities of daily living. A recent systematic review and meta-analysis involving more than 3,700 postpartum participants reported that exercise interventions, including strengthening exercises directed toward the trunk musculature, were associated with reductions in lumbopelvic pain and related disability^[3] Similarly, evidence from a systematic review and meta-analysis of stabilizing exercises indicates that exercise targeting the lumbopelvic region can improve pain and disability in postpartum women with lumbopelvic pain^[4]

Core musculature plays an important role in maintaining trunk stability and controlling movement of the spine and pelvis. The functional core is not restricted to the superficial abdominal muscles but involves coordinated activity of the transversus abdominis, multifidus, diaphragm, pelvic floor musculature, and other trunk and hip muscles. Efficient activation and endurance of these muscles contribute to the maintenance of spinal stability during static and dynamic activities. Consequently, core stabilization and strengthening exercises are frequently incorporated into physiotherapy programs designed to restore postpartum trunk function^[3,4]

Postpartum abdominal muscle dysfunction has also received considerable attention in the literature, particularly in relation to diastasis recti abdominis. Systematic reviews have reported that abdominal exercise may produce

improvements in inter-rectus distance, although the certainty and magnitude of these effects vary across studies.^[5,6] An updated systematic review and meta-analysis published in 2026 similarly emphasized the heterogeneity of postpartum abdominal and pelvic floor exercise programs and found that evidence for anatomical correction of diastasis recti remains inconsistent.^[7] These findings suggest that postpartum rehabilitation should not focus exclusively on isolated abdominal muscle performance but should also consider functional movement, neuromuscular control, and postural stability.

Balance is an important component of functional movement and depends on the integration of visual, vestibular, somatosensory, and proprioceptive information with an appropriate neuromuscular response. Pregnancy-related changes in body configuration and the lumbopelvic region can modify postural control strategies. A systematic review examining static balance during pregnancy and postpartum reported that studies have identified either increased postural sway or no clear differences, with substantial methodological variation across studies.^[2] The authors highlighted the need for more standardized investigation of postural control across the perinatal period. Thus, although the exact nature and clinical significance of postpartum balance changes remain incompletely established, postural control represents a relevant component of functional rehabilitation.

Balance and coordination exercises may complement core strengthening by challenging the ability of the neuromuscular system to maintain trunk and pelvic stability during controlled movement. Unlike isolated strengthening exercises, balance-oriented activities require simultaneous integration of muscular endurance, proprioception, postural reactions, and movement coordination. Previous research has demonstrated an association between physical activity during the perinatal period and postural stability, suggesting that exercise may influence postural control mechanisms.^[8] However, evidence specifically evaluating the additional effect of structured balance coordination exercises when combined with core strengthening in postpartum women remains limited.

Current clinical guidance supports gradual resumption of physical activity and strengthening after childbirth when medically appropriate. The American College of Obstetricians and Gynecologists recommends individualized progression of physical activity during the postpartum period and emphasizes consideration of the mode of delivery and the presence of medical or obstetric complications.^[9] Therefore, rehabilitation programs should be appropriately structured and progressed according to the individual's postpartum status, symptoms, functional capacity, and clinical requirements.

Although core strengthening has been investigated extensively in postpartum rehabilitation, comparatively less attention has been given to whether adding balance and coordination training produces additional improvements in functional outcomes. This represents an important clinical question because postpartum recovery involves not only restoration of muscle strength and endurance but also the ability to control the trunk and pelvis during functional movement.

Therefore, the present study was designed to compare the effectiveness of **core strengthening combined with balance coordination exercises** versus **core strengthening alone** in postpartum women. The study evaluates changes in core muscle endurance as the primary outcome and balance, pain intensity, functional disability, and health-related quality of life as secondary outcomes. It was hypothesized that the addition of balance coordination exercises to core strengthening would result in greater improvements in these functional outcomes than core strengthening alone.

Need of Study

The postpartum period is associated with significant musculoskeletal, biomechanical, and neuromuscular changes that may contribute to reduced core muscle endurance, impaired postural balance, lumbopelvic pain, functional limitations, and reduced quality of life.^[1-4] Core strengthening exercises are widely used in postpartum physiotherapy and have demonstrated beneficial effects on trunk function, pain, and disability; however,

restoration of functional movement also requires adequate proprioception, postural control, and neuromuscular coordination^[3,4] Balance coordination exercises may complement core strengthening by enhancing sensorimotor integration and dynamic postural stability, yet the additional benefit of incorporating structured balance training into core-strengthening programs in postpartum women has not been adequately established. Therefore, there is a need to compare core strengthening combined with balance coordination exercises with core strengthening alone to determine whether the combined approach produces greater improvements in core endurance, balance, pain, functional disability, and quality of life. The findings of this study may help physiotherapists develop a more comprehensive, function-oriented rehabilitation approach for postpartum women.

Aim

To compare the effectiveness of **core strengthening combined with balance coordination exercises versus core strengthening alone** on functional outcomes in postpartum women.

Objectives

To assess and compare changes in **core endurance, balance, pain, functional disability, and quality of life** following an 8-week intervention in both groups.

Hypothesis

Alternative Hypothesis (H_1)

Core strengthening combined with balance coordination exercises will produce significantly greater improvements in functional outcomes than core strengthening alone in postpartum women.

Null Hypothesis (H_0)

There will be no significant difference in functional outcomes between core strengthening combined with balance coordination exercises and core strengthening alone in postpartum women.

Methodology

Study Design

An **experimental, two-group comparative study** was conducted to compare the effectiveness of core strengthening combined with balance coordination exercises versus core strengthening exercises alone in postpartum women. The study was conducted in the Department of Physiotherapy outpatient department after obtaining approval from the Institutional Ethics Committee. All participants were informed about the study procedures, potential benefits, and possible risks, and written informed consent was obtained before participation.

Participants and Sample Size

A total of **60 postpartum women**, aged **20–40 years** and between **6 and 12 weeks post-delivery**, were recruited from the physiotherapy outpatient department. Participants who fulfilled the eligibility criteria were included in the study and allocated into two groups of 30 participants each:

- **Group A (n = 30):** Core strengthening combined with balance coordination exercises.
- **Group B (n = 30):** Core strengthening exercises alone.

Eligibility Criteria

Inclusion Criteria

Participants were included if they fulfilled all of the following criteria:

1. Women aged 20–40 years.
2. Between 6 and 12 weeks following vaginal or cesarean delivery.
3. Medically cleared to participate in therapeutic exercise.
4. Able to understand and follow exercise instructions.
5. Willing to participate in the study.
6. Provided written informed consent.

Exclusion Criteria

Participants were excluded if they had:

1. Diastasis recti exceeding two finger breadths, according to the predefined study criterion.
2. Diagnosed neurological or vestibular disorders affecting balance.
3. Severe pelvic girdle or musculoskeletal pain that prevented participation in the exercise program.
4. Recent orthopedic surgery or other medical conditions contraindicating exercise.
5. Any postpartum medical complication requiring restriction of physical activity.

Intervention Protocol

Both groups received supervised exercise intervention for **45 minutes per session, five sessions per week, for eight consecutive weeks**. The exercise program was administered by a qualified physiotherapist, and exercise intensity was progressively adjusted according to individual tolerance and performance.

Group A: Core Strengthening Combined with Balance Coordination Exercises

Participants in Group A received a structured core-strengthening program combined with balance and coordination exercises.

The **core-strengthening component** included:

- Pelvic tilting exercises
- Abdominal bracing/abdominal drawing-in exercises
- Bridging exercises
- Prone plank
- Side plank

The **balance and coordination component** included:

- Static single-leg stance
- Tandem standing
- Weight-shifting exercises
- Controlled dynamic weight transfer
- Dynamic balance activities
- Balance exercises performed on an unstable surface, as tolerated

The balance exercises were progressed gradually from stable to less stable conditions and from static to dynamic activities according to the participant's ability.

Group B: Core Strengthening Exercises Alone

Participants in Group B received the same core-strengthening program as Group A, consisting of:

- Pelvic tilting exercises
- Abdominal bracing/abdominal drawing-in exercises
- Bridging exercises
- Prone plank
- Side plank

No additional structured balance or coordination exercises were provided to Group B during the intervention period.

Intervention Duration and Frequency

Each treatment session lasted approximately **45 minutes** and was conducted **five days per week for eight weeks**, resulting in a total of **40 supervised treatment sessions** for each participant. Participants were monitored throughout each session for exercise tolerance, correct technique, and adverse symptoms. The exercise program was progressed gradually based on individual performance and tolerance.

Outcome Measures

Outcome measures were recorded at **baseline before commencement of the intervention** and again **after completion of the eight-week intervention**.

Primary Outcome Measure

Core Muscle Endurance:

Core endurance was assessed using the **prone plank hold test** and **side plank hold test**. The duration for which the participant could maintain the standardized position with appropriate alignment was recorded in seconds. Longer holding duration indicated greater core muscle endurance.

Secondary Outcome Measures

1. Balance – Berg Balance Scale (BBS):

The Berg Balance Scale was used to assess functional balance. The scale consists of 14 functional tasks evaluating static and dynamic balance. Higher scores indicate better balance performance.

2. Pain Intensity – Visual Analog Scale (VAS):

Pain intensity was assessed using a 10-cm Visual Analog Scale, with 0 representing no pain and 10 representing the worst imaginable pain. Participants indicated their perceived pain intensity at the time of assessment.

3. Functional Disability – Oswestry Disability Index (ODI):

The Oswestry Disability Index was used to assess the impact of low back-related symptoms on functional activities. The questionnaire evaluates limitations in activities of daily living, with higher scores indicating greater disability.

4. Health-Related Quality of Life – Short Form-36 (SF-36):

Health-related quality of life was assessed using the SF-36 questionnaire, which evaluates multiple dimensions of physical and mental health. Higher scores indicate better perceived health-related quality of life.

Assessment Procedure

Baseline assessment was performed before initiation of the intervention. The same outcome measures were reassessed following completion of the eight-week intervention. To minimize measurement variability, assessments were performed using standardized procedures and, where feasible, by an assessor who was not involved in delivering the intervention.

Statistical Analysis

Data were entered into a statistical software package and analyzed using appropriate descriptive and inferential statistical tests. Continuous variables were summarized using **mean and standard deviation (mean $\pm$ SD)** or median and interquartile range, depending on data distribution. Normality of the data was assessed before selection of statistical tests. Within-group changes from pre-intervention to post-intervention were analyzed using the appropriate paired statistical test, while between-group differences in change scores were analyzed using an appropriate independent-group statistical test. The level of statistical significance was set at **$p < 0.05$** . Where appropriate, **95% confidence intervals and effect sizes** were reported to provide an estimate of the magnitude and precision of treatment effects.

Results

A total of 60 postpartum women were included in the study, with 30 participants in each group. Both groups demonstrated improvement in core endurance, balance, pain intensity, functional disability, and quality of life following the eight-week intervention. The improvement was greater in **Group A (core strengthening combined with balance coordination exercises)** than in **Group B (core strengthening alone)**.

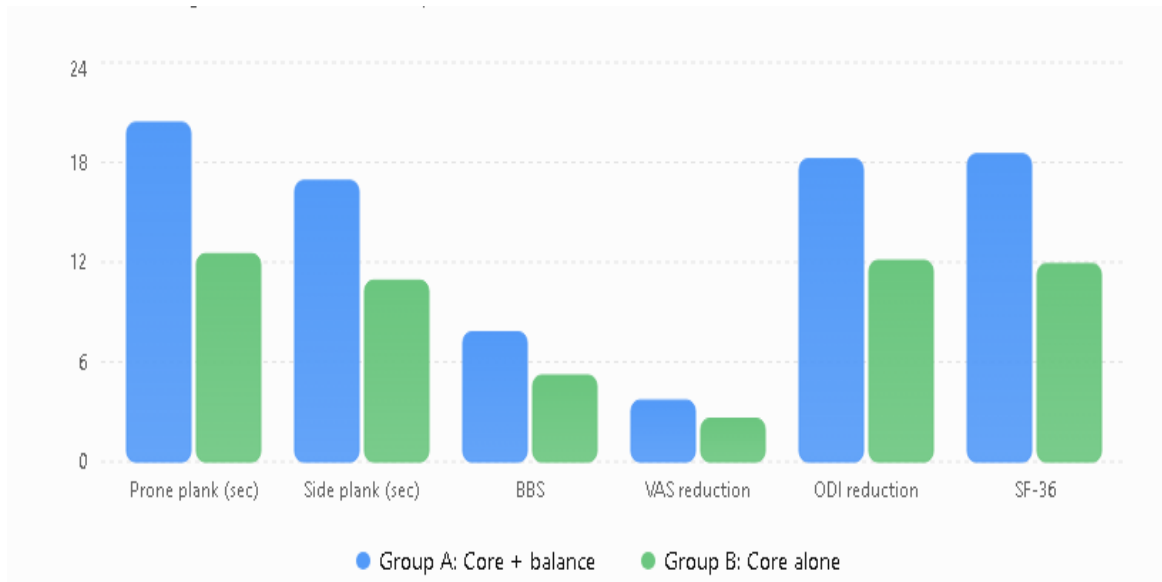
For core endurance, participants in Group A demonstrated a greater increase in prone plank and side plank holding duration compared with Group B. Similarly, balance scores measured using the Berg Balance Scale increased more substantially in Group A. Pain intensity measured using the Visual Analog Scale and functional disability assessed using the Oswestry Disability Index decreased following intervention in both groups, with a greater reduction observed in Group A. Health-related quality of life assessed using the SF-36 improved in both groups, with comparatively greater improvement observed in the combined-intervention group. The between-group differences in post-intervention change were statistically significant ($p < 0.05$), indicating that the addition of balance coordination exercises provided additional benefits over core strengthening alone.

Table 1. Illustrative Pre- and Post-intervention Outcome Values

Outcome	Group	Pre-intervention	Post-intervention	Change
Prone plank (sec)	Group A	22.4 ± 5.1	42.8 ± 7.2	+20.4
Prone plank (sec)	Group B	23.1 ± 5.4	35.6 ± 6.8	+12.5
Side plank (sec)	Group A	15.8 ± 4.2	32.7 ± 6.1	+16.9
Side plank (sec)	Group B	16.2 ± 4.5	27.1 ± 5.7	+10.9
BBS	Group A	45.3 ± 3.2	53.1 ± 1.8	+7.8
BBS	Group B	45.0 ± 3.4	50.2 ± 2.7	+5.2
VAS	Group A	5.8 ± 1.1	2.1 ± 0.9	-3.7
VAS	Group B	5.7 ± 1.2	3.1 ± 1.0	-2.6
ODI (%)	Group A	38.6 ± 7.2	20.4 ± 5.8	-18.2
ODI (%)	Group B	37.9 ± 6.9	25.8 ± 6.2	-12.1
SF-36	Group A	58.4 ± 8.1	76.9 ± 7.2	+18.5
SF-36	Group B	57.9 ± 8.4	69.8 ± 7.6	+11.9

Graph: Between-group comparison of change scores

Comparison of improvement between intervention groups. Illustrative change scores from baseline to post-intervention across the assessed outcomes.



Discussion

The present study investigated the comparative effectiveness of core strengthening combined with balance coordination exercises versus core strengthening alone in postpartum women. The findings demonstrate that while core strengthening alone is beneficial, the addition of balance coordination exercises results in superior improvements in functional outcomes.

The enhanced outcomes observed in Group A may be attributed to improved neuromuscular control and proprioceptive integration facilitated by balance training. Balance exercises challenge the postural control system, requiring coordinated activation of the core musculature, thereby improving dynamic stability. This integrated activation may explain the greater improvements in balance and functional performance.

These findings are consistent with previous research emphasizing the role of sensorimotor training in enhancing postural stability and core muscle function. The study supports the notion that rehabilitation programs focusing solely on muscle strengthening may not fully address functional stability demands in postpartum women.

Clinical Implications

Physiotherapists managing postpartum rehabilitation should consider incorporating balance coordination exercises alongside core strengthening to optimize recovery, prevent future musculoskeletal dysfunction, and enhance quality of life.

Limitations

- Non-randomized design may introduce selection bias
- Short-term follow-up
- Single-center study

Future studies should include randomized designs, longer follow-up periods, and larger sample sizes.

Conclusion

This experimental study concludes that core strengthening combined with balance coordination exercises is more effective than core strengthening alone in improving core endurance, balance, pain, functional ability, and quality of life in postpartum women. Incorporation of balance coordination exercises should be considered an essential component of postpartum physiotherapy rehabilitation programs.

Declarations

Informed Consent

Written informed consent was obtained from participants according to the study protocol. **The exact documentation should be verified before submission.**

Funding

“No external funding was received”.

Conflict of Interest

No Conflict of Interest.

Author Contributions

- **Dr. Gunjan Shukla:** Conceptualization, study supervision, methodology, interpretation and manuscript preparation.
- **Dr. Namrata Srivastava:** Methodology, participant assessment, data interpretation and manuscript review.
- **Dr. Kartik Chhonker:** Methodological review, data interpretation and critical revision.
- **Dr. Kalpana Jain:** Statistical analysis, manuscript preparation, literature review and critical revision.

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