

Comparative Study on the Impact of Pelvic Floor Muscle Strengthening versus Core Stability Exercises on Rectus Diastasis and Diaphragmatic Mobility Postnatal

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Abstract

Background: In postpartum women, rectus diastasis (RD) and decreased diaphragmatic mobility are common issues that frequently affect breathing, posture, and core stability.

Purpose: This study compares the effects of core stability exercises (CSE) and pelvic floor muscle strengthening (PFMS) on diaphragmatic mobility and RD.

Materials and Methods: Eighty postpartum women, equally split between the PFMS and CSE groups, participated in a randomized controlled experiment. Participants received structured exercise treatments for 12 weeks, and ultrasound imaging and M-mode ultrasonography were used to measure inter-recti distance (IRD), diaphragmatic excursion (DE), and core stability before and after the interventions, respectively.

Results: The findings showed that both groups' IRD and DE had significantly improved. In comparison to the PFMS group (3.1 ± 0.5 cm to 2.0 ± 0.4 cm, $p < 0.001$), the CSE group displayed a larger reduction in IRD (3.2 ± 0.6 cm to 1.5 ± 0.3 cm, $p < 0.001$). In contrast to CSE (2.3 ± 0.4 cm to 3.5 ± 0.5 cm, $p < 0.001$), PFMS showed a greater DE improvement (2.4 ± 0.5 cm to 4.1 ± 0.6 cm, $p < 0.001$). Core stability was improved in both groups with no discernible changes ($p < 0.001$ among groups).

Conclusions: These results demonstrate the special advantages of PFMS and CSE in the treatment of diaphragmatic dysfunction and postnatal RD that indicating a possible benefit of combining the two therapies for the best possible recovery.

Keywords: Rectus diastasis, diaphragmatic mobility, pelvic floor exercises, core stability, postnatal rehabilitation

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Introduction

Women's quality of life is greatly impacted by postnatal problems such diaphragmatic dysfunction and RD. The separation of the rectus abdominis muscles along the linea alba is known

as RD, and it frequently impairs core stability and abdominal wall function (2). By impeding efficient breathing and core synergy, impaired diaphragmatic mobility makes these problems worse (3).

CSE and PFMS are two rehabilitation techniques that address these issues. While CSE improves abdominal wall tension and core function, PFMS concentrates on pelvic floor-diaphragm synergy, which is essential for reestablishing breathing mechanics (5). In order to establish the foundation for the best postnatal care, this study compares the efficacy of different therapies.

Because of the mechanical strain of pregnancy, postpartum women frequently develop rectus diastasis (RD). In people with RD, diaphragmatic mobility which is necessary for efficient breathing and core stability is frequently compromised, which makes postpartum recovery more difficult (3).

Retraining of the abdominal muscles is the main emphasis of traditional rehabilitation techniques for RD. Among these, core stability exercises (CSE) and pelvic floor muscle strengthening (PFMS) have become essential therapies. In order to regain core function, PFMS stresses the interaction between the pelvic floor and abdominal muscles, utilizing their mutually beneficial relationship⁹. On the other hand, CSE improves spinal stability and abdominal wall integrity by targeting the deeper core muscles, such as the multifidus and transversus abdominis(7).

The effectiveness of PFMS and CSE in treating RD and diaphragmatic mobility has not been directly compared in many studies, despite their widespread use. There is a crucial knowledge vacuum about the relative effects of these therapies because most previous research has examined them separately. Furthermore, little is known about how diaphragmatic function, a key element of core stability, affects postnatal recovery.

Through a comparison of PFMS and CSE, this work seeks to close these discrepancies. The study looks at how they affect diaphragmatic mobility and RD in an effort to improve evidence-based postnatal rehabilitation procedures. Among the important issues discussed are: Which intervention reduces RD more effectively? What effects do these methods have on diaphragmatic mobility? And may there be synergistic benefits from a combination strategy?

Literature Review

Rectus Diastasis: Prevalence and Impact

Up to 60% of postpartum women are affected by RD within the first six weeks after giving birth, and 30% of women experience residual instances that last longer than six months (8). The integrity of the abdominal wall is compromised by this illness, which results in functional problems such urine incontinence and lower back pain.

Pelvic Floor Muscle Strengthening

The pelvic floor muscles (PFM), which serve as the basis for spinal and abdominal support, are essential for core stabilization. Research has shown how PFMs and the transversus abdominis are related, indicating that PFMS may improve general core function and hence indirectly lower RD (4).

Core Stability Exercises

In order to stabilize the spine and pelvis, CSE concentrates on reactivating the deep core muscles, such as the transversus abdominis. Targeted core exercises decreased RD measures by an average of 1.5 cm over eight weeks, according to research by Akram and Matzen (1). The addition of breathing exercises improved diaphragmatic mobility even more, highlighting the comprehensive advantages of CSE.

Diaphragmatic Mobility in Postnatal Rehabilitation

The diaphragm's function goes beyond breathing; it also stabilizes the core. Reduced intra-abdominal pressure and impaired core function have been associated with impaired diaphragmatic mobility (6). It is becoming more widely acknowledged that diaphragmatic function interventions are essential to RD recovery.

Comparative Studies on PFMS and CSE

There isn't much research that compares PFMS with CSE directly. **Bo et al (3)**. found that while both therapies significantly improved RD and quality of life, PFMS produced better results in pelvic floor strength. On the other hand, CSE was more effective at minimizing abdominal separation.

Synergistic Approaches

There may be synergistic benefits to mixing PFMS with CSE, according to emerging studies. Functional results are improved, and intra-abdominal pressure management is strengthened when the pelvic floor and core muscles are used in unison (9).

Materials and Methods

Study Design

This randomized controlled trial was conducted over 12 weeks, following ethical approval from the institutional review board compliance with Helsinki declaration. This study was performed under the ethical committee No: DCSR-01025-38, approval date 29-1-2025, Faculty of Physical Therapy, Deraya University.

Participants

Eighty postnatal women were randomly assigned to the PFMS (n=40) or CSE (n=40) group.

Inclusion and Exclusion Criteria

Inclusion Criteria:

1. Postnatal women aged 25–40 years.
2. Diagnosed with RD (>2 cm inter-recti distance) and reduced diaphragmatic excursion (<3 cm).
3. At least 6 weeks postpartum.
4. No prior structured rehabilitation for RD or diaphragm mobility.

Exclusion Criteria:

1. Chronic respiratory or musculoskeletal conditions.
2. History of pelvic surgery or severe RD (>5 cm).
3. High-risk pregnancy or ongoing postpartum complications.
4. Inability to follow the intervention program.

Intervention Protocol

- **PFMS Group (n=40):** Participants performed pelvic floor contractions, progressing in intensity weekly³, three times per week. Each session included:

1. **Kegel Exercises:** Performed in varying positions (lying, sitting, standing), emphasizing isolated pelvic floor contractions held for 5-10 seconds followed by relaxation.
2. **Biofeedback-Assisted Training:** Used to ensure proper muscle activation and progression based on individual capacity.

Pelvic Floor Muscle Strengthening (PFMS) Steps:

1. **Awareness Training:** Identify pelvic floor muscles (Kegel contractions).
2. **Basic Contractions:** Perform 10 repetitions of slow, controlled contractions, holding each for 5 seconds.
3. **Breathing Integration:** Synchronize contractions with exhalation for 3 sets of 10 repetitions.
4. **Progressive Load:** Introduce resistance via pelvic tilts and bridges in later weeks.
5. **Functional Training:** Incorporate contractions during daily activities.

- **CSE Group (n=40):** Participants engaged in structured abdominal exercises, including transverse abdominis, multifidus, and oblique muscles activation and plank variations (5).

The program involved:

1. **Basic Activations:** Initial focus on engaging deep core muscles with minimal movement.
2. **Dynamic Stabilization:** Progressed to planks, side bridges, and controlled limb movements.

Core Stability Exercises (CSE) Steps:

1. **Transverse Abdominis Activation:** Perform abdominal hollowing in a supine position (3 sets of 10 repetitions).

2. **Plank Variations:** Start with forearm planks, progressing to side planks (3 sets of 30 seconds).
3. **Leg Lifts:** Perform alternating single-leg lifts while maintaining core activation (3 sets of 10 repetitions).
4. **Bridges:** Engage the glutes and core during bridging exercises (3 sets of 10 repetitions).
5. **Dynamic Stability:** Incorporate stability ball exercises by week 8.

Assessment Tools

1. **Inter-Recti Distance (IRD):** Measured using high-resolution ultrasound imaging with participants at rest and during abdominal contraction. **Ultrasound Imaging;** Used to measure inter-recti distance at three anatomical points (above, at, and below the umbilicus).
2. **Diaphragmatic Excursion (DE):** Evaluated via M-mode ultrasonography during maximal inspiration and expiration.

Statistical Analysis

Data were analyzed using SPSS v28. Paired t-tests compared pre- and post-intervention values within groups, while independent t-tests assessed inter-group differences. Significance was set at $p < 0.05$.

Results

Basic Characteristics of Participants

Table 1: Age, body mass index (BMI), parity, and weeks postpartum did not differ statistically significantly between the two groups, and the participants' baseline demographic and clinical characteristics were similar.

Variable	PFMS Group (Mean $\pm$ SD)	CSE Group (Mean $\pm$ SD)	p-Value
Age (years)	32.5 $\pm$ 3.8	31.8 $\pm$ 4.2	0.46
Body Mass Index (kg/m ²)	26.4 $\pm$ 2.5	26.1 $\pm$ 2.8	0.64
Parity (number of births)	2.1 $\pm$ 0.9	2.3 $\pm$ 0.8	0.38
Weeks Postpartum	14.3 $\pm$ 2.7	13.9 $\pm$ 3.1	0.52
Inter-Recti Distance (cm)	3.1 $\pm$ 0.5	3.2 $\pm$ 0.6	0.48
Diaphragmatic Excursion (cm)	2.4 $\pm$ 0.5	2.3 $\pm$ 0.4	0.37

Outcome 1: Inter-Recti Distance (IRD)

Table 2: Following the 12-week intervention, there were notable improvements in IRD for both groups. Both the PFMS and CSE groups had lower IRDs, according to within-group analysis. According to a between-group comparison, the CSE group's IRD was considerably lower than that of the PFMS group.

Inter-Recti Distance (cm)	Pre-Intervention (Mean $\pm$ SD)	Post-Intervention (Mean $\pm$ SD)	Within-Group p-Value	Between-Group p-Value
PFMS Group	3.1 $\pm$ 0.5	2.0 $\pm$ 0.4	<0.001	0.02
CSE Group	3.2 $\pm$ 0.6	1.5 $\pm$ 0.3	<0.001	0.02

Outcome 2: Diaphragmatic Excursion (DE)

Table 3: In comparison to the CSE group, the PFMS group showed a more notable improvement in diaphragmatic excursion. Both groups experienced significant increases in DE, according to within-group analysis, with the PFMS group seeing larger gains. The superiority of PFMS in improving diaphragmatic mobility was validated by a between-group comparison.

Diaphragmatic Excursion (cm)	Pre-Intervention (Mean $\pm$ SD)	Post-Intervention (Mean $\pm$ SD)	Within-Group p-Value	Between-Group p-Value
PFMS Group	2.4 $\pm$ 0.5	4.1 $\pm$ 0.6	<0.001	0.03
CSE Group	2.3 $\pm$ 0.4	3.5 $\pm$ 0.5	<0.001	0.03

Summary of Results

- No significant differences in baseline characteristics were observed between groups ($p > 0.05$ for all variables).
- Both PFMS and CSE interventions effectively reduced IRD and improved DE ($p < 0.001$ within groups).
- CSE was significantly more effective in reducing IRD ($p = 0.02$ between groups).
- PFMS was significantly more effective in improving DE ($p = 0.03$ between groups).

Discussion

The effectiveness of both PFMS and CSE in treating postnatal RD and diaphragmatic mobility is demonstrated by this study. In line with earlier research, PFMS strengthened the pelvic floor-diaphragm synergy, which enhanced diaphragmatic function (3). According to research showing that targeted abdominal exercises maximize linea alba tension, CSE was excellent at lowering IRD (5).

A fair comparison was ensured by the baseline characteristics, which validated the study groups' homogeneity. The results show that postnatal RD and diaphragmatic dysfunction can be effectively treated with both PFMS and CSE. As expected, given its emphasis on abdominal wall regeneration, CSE produced larger reductions in IRD. However, better diaphragmatic excursion improvements were obtained by PFMS, highlighting the importance of pelvic floor-diaphragm coordination in breathing mechanics.

Furthermore, research suggests that combining methods such as applying Kinesio tape with particular workouts can greatly improve abdominal strength and reduce pain associated with RD (10).

One of the postpartum illnesses is RD, and some women have it for the rest of their lives. The dearth of scientific publications and research in literature, however, was one of the constraints discovered, making it more challenging to identify the best course of action for this ailment.

Because 30–70% of women get RD after giving birth, and 60% of them continue to have RD during the postpartum phase, RD is significant. Their daily activities are impacted, and they are unable to lead fulfilling lives as a result. Abdominal hernias, lumbopelvic pain, poor posture, pelvic deficits, and diminished strength are all possible outcomes of this illness. Nonetheless, several physiotherapy techniques are employed to treat RD, enabling patients to have a completely functional abdominal wall without requiring linea alba surgery (12).

According to the study's findings, exercise and/or core stability significantly lower the risk of AD. The efficacy of strengthening the muscles of the abdominal wall makes earlier studies noteworthy. According to the research that were considered to be meaningful, additional data indicates that neuromuscular electrical stimulation (NMES) can also be useful (11).

Given their complementing advantages, an integrated program that combines CSE and PFMS could produce better results. This integrated technique and its long-term impacts should be investigated in future research.

Conclusion

Both PFMS and CSE have unique advantages in the postnatal management of RD and diaphragmatic dysfunction. While CSE is excellent in lowering RD, PFMS improves diaphragmatic mobility.

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