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The Effect of Pelvic Floor Muscle Strengthening on Tidal Volume Capacity in Postnatal Women: A Comparative Study

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Abstract

Background: Postnatal women often experience reduced tidal volume due to physiological changes during pregnancy and childbirth, including the weakening of pelvic floor muscles (PFMs). The postnatal period is marked by various physiological and mechanical alterations. These alterations may result in diminished tidal volume, dyspnea, and reduced exercise tolerance, thereby impacting overall quality of life

Purpose: This study investigates the effect of pelvic floor muscle strengthening, specifically through Kegel exercises, on tidal volume in postnatal women.

Methods: A randomized controlled trial was conducted with 100 postnatal women divided into an intervention group (n=50) performing supervised Kegel exercises and a control group (n=50) receiving standard postnatal care. Tidal volume was assessed using spirometry at baseline and after an eight-week intervention.

Results: The intervention group showed a statistically significant improvement in tidal volume (mean increase of 20%, $p<0.01$) compared to the control group (mean increase of 5%, $p=0.12$).

Conclusion: These findings highlight the potential role of PFM exercises in enhancing respiratory function and overall recovery in postnatal women.

Keywords: Pelvic floor muscles, tidal volume, Kegel exercises, postnatal respiratory function, postpartum recovery.

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Introduction

Although the postpartum phase is an important time for recuperation and adjustment, many women continue to have physical difficulties, such as weak pelvic floor muscles (PFMs) and breathing restrictions. These difficulties might affect day-to-day functioning and quality of life, which emphasizes the necessity of efficient solutions **(8)**.

Pelvic Floor Muscles and Their Functions: At the base of the pelvis, the pelvic floor muscles provide a supportive sling that is essential for preserving continence, supporting the pelvic

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organs, and enhancing core stability. These muscles experience a great deal of tension throughout pregnancy and delivery, which frequently results in dysfunction that lasts into the postpartum phase **(1)**.

Pelvic Floor Exercises: Strengthening these muscles is the goal of pelvic floor exercises, especially Kegel exercises. Kegel exercises, which date back to the 1940s, entail deliberately contracting and relaxing PFMs. Although they are frequently recommended to treat urine incontinence, they also help with respiratory mechanics and core stability **(4).**

Tidal Volume: The amount of air exchanged during a typical respiratory cycle is referred to as the tidal volume. It is a crucial indicator of pulmonary function and shows how well the breathing muscles work. Due to physiological changes that occur during pregnancy, such as diaphragmatic elevation and weakening of the abdominal and pelvic muscles, postpartum women frequently have decreased tidal volume **(3).**

Respiratory Limitations in the Postnatal Period: The postnatal period is marked by various physiological and mechanical alterations. Pregnancy-related diaphragmatic elevation decreases lung compliance, and the concomitant weakening of pelvic floor muscles and abdominal muscles further compromises respiratory mechanics. These alterations may result in diminished tidal volume, dyspnea, and reduced exercise tolerance, thereby impacting overall quality of life **(9).**

Pregnancy-related respiratory changes, such as reduced lung capacity and elevated diaphragm positioning, may last after delivery **(2).** In particular, impaired diaphragm movement and abdominal musculature have an impact on tidal volume, which is a measurement of the air displaced between inhalation and exhalation **(7).** Research indicates that by stabilizing the core and increasing diaphragm efficiency, strengthening PFMs can indirectly improve respiratory performance **(5).**

The Role of Pelvic Floor Strengthening in Respiratory Function: It has been suggested that strengthening PFMs will enhance respiratory mechanics and core stability. Targeted treatments for PFMs may improve tidal volume and overall pulmonary function because the pelvic floor, diaphragm, and abdominal muscles are interrelated **(6).**

Rationale for the Study:

Although pelvic floor strengthening is recognized to improve urogenital health, less is known about how it affects respiratory metrics like tidal volume. By comparing an intervention

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group to a control group getting normal care, this study attempts to close this gap by assessing the impact of Kegel exercises on tidal volume in postnatal women.

Methods

Study Design A randomized controlled trial was conducted to evaluate the effects of PFM strengthening on tidal volume in postnatal women. Ethical approval was obtained, and participants provided written informed consent. This study was performed under the ethical committee No: DCSR-01025-37, approval date 29-1-2025, Faculty of Physical Therapy, Deraya University.

Participants A total of 100 postnatal women, aged 25-40 years and 6-24 weeks postpartum, were recruited.

Inclusion Criteria:

1. Women aged 25-40 years.
2. 6-24 weeks postpartum.
3. Mild to moderate pelvic floor weakness.
4. No history of chronic respiratory or pelvic conditions.

Exclusion Criteria:

1. High-risk pregnancy.
2. Recent abdominal surgery.
3. Pre-existing respiratory disorders.

Intervention and Control Groups

- **Intervention Group:**
  50 postnatal women perform:
  1. Supervised Kegel exercises over an eight-week period.
  2. **Steps of Kegel Exercises:**
     - **Warm-Up:** Diaphragmatic breathing and light stretching (5 minutes).
     - **Exercise Routine:**
       - Week 1-2: Three sets of 10 contractions, each held for 5 seconds with a 5-second rest.
       - Week 3-4: Progressed to 15 contractions per set with 7-second holds.
       - Week 5-8: Included fast flicks (quick contractions) and endurance holds lasting 10 seconds.
     - **Cool-Down:** Relaxation exercises focusing on diaphragmatic breathing (5 minutes).
- **Control Group:** 50 postnatal women follow the following:
  1. Received standard postnatal care.
  2. Provided general advice on physical activity without targeted PFM strengthening.

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Outcome Measures Primary outcome: Tidal volume measured using spirometry at baseline and post-intervention. Secondary outcomes: Pelvic floor muscle strength assessed with a perineometer, self-reported quality of life measured using the SF-36 questionnaire, and diaphragmatic movement assessed using ultrasonography.

Assessment Tools:

1. **Spirometry:** Used to measure tidal volume, ensuring precise and reproducible results.
2. **Perineometer:** Quantified pelvic floor muscle strength by recording intravaginal pressure during contractions.
3. **SF-36 Questionnaire:** Evaluated physical and mental quality of life domains.
4. **Ultrasonography:** Assessed diaphragmatic movement during tidal breathing and maximal inspiration to correlate with respiratory improvements.

Statistical Analysis Data were analyzed using SPSS software. Baseline characteristics were compared using t-tests and chi-square tests. Paired t-tests evaluated within-group changes, while independent t-tests compared between-group differences. Effect sizes were calculated using Cohen's d, and statistical significance was set at $p<0.05$. Missing data were handled using multiple imputation. Regression analysis was performed to adjust for confounding variables such as BMI and parity.

Results

Baseline Characteristics Participant demographics and baseline characteristics were similar across groups (Table 1).

Table 1: Baseline Characteristics

Variable	Intervention Group (n=50)	Control Group (n=50)	p-value
Age (years)	31.8 ± 4.1	32.1 ± 3.9	0.62
BMI (kg/m²)	24.6 ± 2.8	24.9 ± 3.0	0.48
Parity (median)	2	2	0.54

Tidal Volume The intervention group showed a significant increase in tidal volume, from 420 ± 50 mL to 504 ± 60 mL (Δ=84 mL, $p<0.01$), compared to the control group, which showed a smaller and non-significant increase from 428 ± 52 mL to 449 ± 55 mL (Δ=21 mL, $p=0.12$).

Table 2: Changes in Tidal Volume

Group	Baseline (mL)	Post-Intervention (mL)	Mean Change (mL)	p-value
Intervention	420 ± 50	504 ± 60	+84	<0.01
Control	428 ± 52	449 ± 55	+21	0.12

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Pelvic Floor Muscle Strength Pelvic floor strength increased significantly in the intervention group (mean increase of 35%, $p<0.01$) compared to the control group (mean increase of 7%, $p=0.09$).

Table 3: Pelvic Floor Muscle Strength

Group	Baseline Strength (cm H_2O)	Post-Intervention Strength (cm H_2O)	Mean Change (%)	p-value
Intervention	20.5 ± 3.2	27.7 ± 4.1	+35	<0.01
Control	21.0 ± 3.5	22.5 ± 3.8	+7	0.09

Diaphragmatic Movement Enhanced diaphragmatic movement was observed in the intervention group compared to the control group. Baseline diaphragmatic excursion during tidal breathing improved significantly in the intervention group (mean increase of 0.8 cm, $p<0.01$).

Table 4: Diaphragmatic Movement

Group	Baseline Excursion (cm)	Post-Intervention Excursion (cm)	Mean Change (cm)	p-value
Intervention	3.4 ± 0.5	4.2 ± 0.6	+0.8	<0.01
Control	3.5 ± 0.6	3.6 ± 0.5	+0.1	0.21

Quality of Life The intervention group reported significant improvements in quality of life scores, particularly in domains related to physical functioning and vitality ($p<0.05$).

Table 5: Quality of Life Scores

Domain	Intervention Group	Control Group	p-value
Physical Health	+18%	+5%	<0.01
Vitality	+22%	+6%	<0.01

Discussion

This study shows that postpartum women's tidal volume is greatly increased by strengthening their pelvic floor muscles, particularly through Kegel exercises. These results support the idea that strengthening the pelvic floor improves respiratory mechanics because the pelvic floor cooperates with the abdominal and diaphragm muscles.

The results of this study unequivocally show that strengthening the pelvic floor muscle (PFM) has a major effect on postpartum women's respiratory and general health indices. Tidal

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volume improved significantly in the intervention group, which engaged in supervised Kegel exercises, with a mean rise of 84 mL as opposed to the control group's insignificant 21 mL gain. This improvement was statistically significant ($p < 0.01$), reinforcing the hypothesis that PFM strengthening positively affects respiratory function by enhancing diaphragmatic coordination and core stability.

Furthermore, perineometry showed that the intervention group's pelvic floor muscle strength increased by 35%, while the control group's improvement was only 7% ($p < 0.01$). The improvement in diaphragmatic movement, which is demonstrated by an increase of 0.8 cm in diaphragmatic excursion during tidal breathing, supports the idea that the diaphragm and pelvic floor work together to optimize respiratory mechanics. The intervention group's quality of life scores also showed a significant improvement in the physical health and vitality areas, underscoring the all-encompassing advantages of PFM strengthening activities. All of these findings highlight how important it is to include structured PFM exercises in postnatal care in order to address respiratory restrictions, pelvic health concerns, and general wellbeing.

PFM training by PFES significantly increased PFM strength and diaphragm excursion during tidal and forceful breathing and coughing in women with SUI. In addition, there were significant differences in X-axis translation in the upper rib cage during tidal and forceful breathing and Z-axis translation at this location during forceful breathing between pre-and post-PFM training by PFES. Although the cause-and-effect relationship between altered breathing pattern and PFM weakness is controversial, PFM training by PFES could affect diaphragm excursion and breathing patterns in women with SUI. Also, although we did not measure expiratory function, such as forced vital capacity and forced expiratory flows, and gas change, increasing diaphragm excursion and decreasing elevation of upper ribcage movement may help improve to optimal breathing pattern in women with SUI **(10).**

Kegel exercises are effective, as evidenced by the intervention group's statistically significant increases in tidal volume. In addition to improving pelvic health, these workouts also improved pulmonary function. This dual advantage emphasizes how crucial it is to include these workouts in routine postpartum care regimens.

Previous research on the same subject revealed that there was no significant difference between the groups in terms of the type of delivery that occurred when PFM training was performed or not performed during pregnancy **(11).**

Due to the narrative character of this article, the authors have neither intended to cite all recent and relevant publications nor to evaluate or qualify established diagnostic or therapeutic measures and recommendations regarding PFM function and dysfunction or PFM training.

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However, they believe that the consideration of respiratory mechanics may serve to open different perspectives and to enhance the effects of many of such interventions **(12).**

The connection of respiratory and pelvic floor mechanics is further supported by the noted improvements in diaphragmatic mobility as determined by ultrasonography. The higher tidal volume seen in the intervention group was probably caused by improved diaphragmatic function. This research emphasizes the necessity of a comprehensive strategy for postpartum rehabilitation that takes pelvic and respiratory health into account **(6).**

In addition to supporting urine continence, the intervention group's increased pelvic floor muscle strength also indicates better core stability. Because it lessens the strain on the diaphragm when breathing, core stability is crucial for effective respiratory mechanics **(1).** Furthermore, the intervention group's reported improvements in quality of life highlight the all-encompassing advantages of pelvic floor strengthening. Both better respiratory function and greater self-assurance in controlling pelvic floor symptoms probably contributed to improved physical functioning and vitality.

Lastly, the evaluation of respiratory function in postnatal women gains a new dimension with the use of ultrasonography to measure diaphragmatic movement. The beneficial alterations in diaphragmatic excursion demonstrate how pelvic floor therapy improves respiratory mechanics in a number of ways.

Conclusion

The results of this study demonstrate the important advantages of strengthening the pelvic floor muscles, especially with Kegel exercises, in enhancing postpartum women's diaphragmatic movement, pelvic floor strength, and tidal volume. The significance of adding specific pelvic floor exercises to routine postnatal care is shown by these benefits, which are both statistically significant and clinically useful. To confirm these results and investigate their implications for long-term postpartum healing, more studies with bigger sample sizes and longer follow-up times are advised.

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