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ORIGINAL RESEARCH

Ultrasound Characteristics of Trunk Muscles in Postpartum Women, and Their Correlation with Symptoms of Stress Urinary Incontinence

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Purpose: The aim of this cross-sectional study was to compare the ultrasound characteristics of the trunk muscles in postpartum women with or without stress urinary incontinence (SUI), and to determine correlations between the trunk muscle thickness and the urinary incontinence symptoms.

Methods: In 60 individuals, musculoskeletal ultrasound was used to measure the right-diaphragm thickness (at end-inspiration/end-expiration), diaphragm thickness change, rectus abdominis diastasis (RAD), and the thickness of rectus abdominis (RA), transversus abdominis (TrA) and lumbar multifidus (LM). The symptoms of urinary incontinence (SUI) were assessed by the International Consultation on Incontinence Questionnaire Short Form (ICIQ-SF).

Results: Compared to the control group, the postpartum SUI (PSUI) group demonstrated a significant reduction in right-diaphragm thickness at both end-inspiration and end-expiration ($p < 0.05$). However, there were no significant differences in diaphragm thickness change, RAD, and the thickness of RA, TrA, and LM between the two groups ($p > 0.05$). In the PSUI group, the right diaphragm thickness at end-inspiration was negatively correlated with the severity of SUI symptoms as measured by the ICIQ-SF. A negative correlation was also detected between diaphragm thickness change and the severity of SUI symptoms in the ICIQ-SF.

Conclusion: Postpartum women with PSUI had decreased diaphragm thickness (at end-inspiration and end-expiration) when compared to those without SUI. A negative correlation was observed between diaphragm thickness and SUI. These findings could serve as a theoretical basis for the potential role of coordinated diaphragm and pelvic floor muscle training in postpartum women with SUI, as well as for the prevention of SUI.

Keywords: trunk muscle, musculoskeletal ultrasound, postpartum stress urinary incontinence

Introduction

The International Continence Society (ICS) defines urinary incontinence (UI) as the complaint of involuntary loss of urine.[1] According to the literature, the prevalence of UI varies, with estimates ranging from 1.5% to 36.4% in different populations.[2] Stress urinary incontinence (SUI) is the most common type, primarily attributed to pregnancy and childbirth. Postpartum stress urinary incontinence (PSUI) specifically refers to the impairment of pelvic floor structures including nerves, fascia, ligaments, and muscles due to pregnancy or childbirth.[3] In an observational cohort study, among 560 women who gave birth to their newborns in a hospital via vaginal delivery, 70 (12.5%) suffered from SUI 12 months after childbirth. Out of the 306 women who underwent Cesarean delivery, 22 (7.2%) experienced SUI 12 months postpartum.[4] This leads to insufficient pelvic-floor muscle (PFM) strength and deficits in urethral and bladder-neck structure and support, resulting in involuntary urine leakage during activities such as coughing, sneezing, exercising, laughing, or other physical movements that increase intra-abdominal pressure. Consequently, this impacts the daily lives of postpartum women.[5,6]

Currently, treatments for PSUI mainly include PFM training, biofeedback, and electrical stimulation. PFM training, recognized for its simplicity and effectiveness, has been incorporated into the guidelines for the treatment of SUI in

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China.[7–10] Another main treatment for SUI is surgical, although it may not be applicable in the immediate postpartum period. The PFMs and the endopelvic fascia act like a suspension bridge to provide support to the lower abdominal cavity, playing a crucial role in maintaining continence and pelvic support.[11] However, recent research has suggested that PFMs do not operate in isolation.[11,12] Together with the diaphragm, transverse abdominis, and multifidus muscles, they form the deep core of the abdomen, contributing as part of a closure mechanism to regulate intra-abdominal pressure (IAP).[13] Additionally, they help maintain trunk stability during postural changes, walking, limb movements, and the coughing processes.[5] For instance, during coughing, the levator ani muscles contract simultaneously with the diaphragm and abdominal muscles to increase intra-abdominal pressure. This sudden rise in abdominal pressure forces the contents of the lower abdomen to move downward. When the PFMs are damaged or insufficiently supported, such as after childbirth or due to age-related degeneration, the risk of UI is further increased.[11] Imaging studies using ultrasound and dynamic MRI videos have also confirmed synergistic interactions between PFMs and the diaphragm, transverse abdominis, and internal oblique muscles in healthy nulliparous women during breathing.[14,15] During inhalation, the diaphragm contracts and moves downward to draw air into the lungs, while the anterior-lateral abdominal wall slightly expands to make room for displaced abdominal viscera, causing relaxation of the pelvic floor. During exhalation, before the diaphragm relaxes, the PFMs and anterior-lateral abdominal muscles contract to shift IAP from the abdominal cavity to the thoracic cavity.[16] Because of the postulated synergistic co-activation of PFM and trunk muscles, we hypothesize that trunk muscle thickness may differ in postpartum women with and without SUI and that there is an association between SUI symptoms and trunk muscle ultrasound parameters.

The rectus abdominis, as a superficial core muscle group of the abdomen, serves various physiological functions and is easily measurable. Diastasis recti abdominis (DRA) refers to an increase in the distance between the bilateral rectus abdominis muscles at the midline of the abdomen to more than 2 cm; this condition can occur during pregnancy and the postpartum period. Studies indicate that postpartum DRA can weaken the abdominal muscles, reduce the stability of the lumbar spine and pelvis, and lead to lower back and pelvic pain, often associated with pelvic floor dysfunction.[17] Harada et al established a predictive model using questionnaires and found that participants with DRA were 2.6 times more likely to have PFD than participants without DRA, although the predictive accuracy was poor.[18]

Only a few studies have taken into account the ultrasound-based measurement of core muscles, specifically regarding the thickness changes of these muscles and DRA in patients with PSUI, as well as their role in the manifestation of SUI symptoms. Consequently, this study is centered around discerning the variations in trunk muscle groups between PSUI patients and the postpartum population without SUI. Additionally, it aims to explore the correlation between core muscle groups and the symptoms of PSUI. The findings of this study could potentially provide a theoretical foundation for the development of precise and comprehensive rehabilitation strategies tailored to PSUI in the future.

Materials and Methods

Participants

This study adopted a cross-sectional design. Participants were recruited from August 2023 to August 2024, targeting postpartum women diagnosed with or without SUI. The inclusion criteria of PSUI group refer to: (1) female aged 20–40 year between 6 weeks and 6 months after their first or second delivery; (2) no history of pelvic surgery or urinary system diseases; (3) full-term singleton delivery; (4) voluntary participation and signed informed consent by participants. Normal controls had normal functional activity without PSUI. SUI was diagnosed if the participants responded “yes” to the question “Did you leak urine with activities, such as coughing, sneezing, or running?”.[19] Exclusion criteria for participants: (1) diagnosed with organic urinary incontinence such as detrusor dysfunction, mixed incontinence, prolapse, or urgency incontinence; (2) history of urinary incontinence before pregnancy, prior pelvic surgery, pelvic organ prolapse, acute inflammation of the urogenital system, including clinically diagnosed acute urinary tract infections or other acute urogenital inflammatory conditions at the time of enrollment; (3) with severe other systemic diseases unable to cooperate with assessment.

Participants’ basic information was collected through questionnaire and consulted their medical charts, including age, height, weight, body mass index (BMI), newborn weight, and exercise habits.

The individuals were a sample of convenience recruited from the outpatient clinics and posters advertisement. The sample size was calculated using the G*power 3.1.9.2 software with an α value of 0.05 and test power of 0.80, based on mean difference variables between two independent groups and considering the thickness of the right hemidiaphragm of a pilot study with two groups (mean ± SD), ten individuals with SUI (2.79 ± 0.77) and ten healthy controls (3.53± 0.70). Indeed, 2-tailed hypothesis, effect size of 1.01, and allocation ratio (N2/ N1) of 1 were used for calculating the sample size. In this regard, 17 subjects were determined per group.

Ethics Statement

The protocol for this study adhered to the Declaration of Helsinki (1964 and later revisions) and received approval from the Ethics Committee of the First Affiliated Hospital of Sun Yat-Sen University, which also provided ongoing supervision. The ethical approval number is [2025]397. All participants voluntarily took part in the study and provided written informed consent prior to study enrollment.

Ultrasound Imaging

The assessments for each participants were completed by two experienced doctors that were blinded to participants' division for both groups to reduce potential bias. Both doctors followed a standardized protocol, and each parameter was measured twice by each doctors. Each doctor performed twice and calculated their mean. The two doctors' means were then averaged to obtain the final value. The diaphragm, RA, RAD, and TrA were imaged in B-mode using a portable ultrasound system (SonoSite M-Turbo, Seattle, USA). A 2–5 MHz curvilinear-array transducer was employed for the LM, while a 6–13 MHz linear-array transducer was used for the TrA, with the scanning depth automatically adjusted.

Assessment of Diaphragm Thickness

Regarding the assessment of diaphragm thickness, a 7.5 MHz linear array transducer was manipulated in a perpendicular orientation to the chest wall. This was carried out between the mid and anterior axillary lines on both the right and left sides, usually within the 8th and 10th intercostal spaces, in order to obtain the most distinct image of the zone where the diaphragm makes contact. The transducer was positioned such that it extended across two ribs. Measurements were taken at end-inspiration (Tins) and end-expiration (Texp) during deep breathing. The thickness of the right and left diaphragms as tested by ultrasound exhibited high intra-rater reliability, and the right diaphragm was notably more significant for detection.[16,17] The change in diaphragm thickness was calculated using the following formula: (Tins − Texp) / Texp * 100.[18] A greater thickness change implies a more pronounced contraction of the diaphragm from the end of deep inspiration to deep expiration. The thickness of the diaphragm was ascertained through the identification of two outer echogenic layers corresponding to the margins of the pleura and peritoneum. At these margins, the muscle fibers exhibited a parallel orientation (Figure 1).

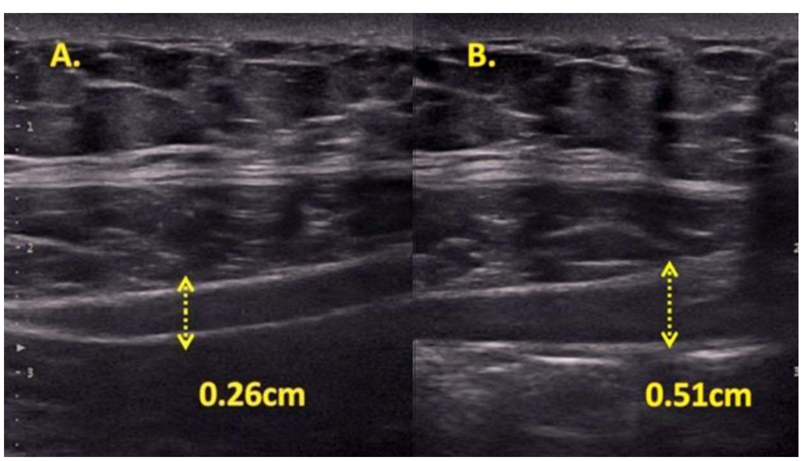

Figure 1 Ultrasound imaging of the hemidiaphragm (**A**) hemidiaphragm thickness at deep expiration, (**B**) hemidiaphragm thickness at deep inspiration.

Assessment of RA Thickness and DRA

The ultrasound image presented a symmetrical, elongated configuration with faintly hypoechoic regions, which corresponded to the thickness between two layers of linear hyperechoic fascia when assess the rectus abdominis muscle thickness (Figure 2). The thicknesses of both the right and left RAs were gauged three times, and the average of these measurements was taken as the final data. In the case of DRA, the subjects were directed to void their bladders and assume a supine position. The probe was positioned horizontally 2 centimeters above the umbilicus to identify the medial border of the rectus abdominis muscle (Figure 2). Subsequently, the distance between the medial borders of the rectus abdominis muscles was determined while the subject was at rest.

Assessment of TrA thickness

Left and right TrA thickness of the subject were scanned with M-mode at rest and during the Abdominal Drawing-in Maneuver (ADIM) maneuver with subject in a supine hook-lying position with arms crossed over the chest. US images could be clearly collected with the transducer placed transversely just along the midaxillary line at the level of the umbilicus.[20] The ADIM is commonly used to train the TrA muscle and may activate the TrA muscle contraction in comparison with the more superficial abdominal muscles.[21] In this study, the ADIM was used to assess the contracted thickness. The thickness of the transversus abdominis muscle was measured in centimeters, from the superior fascial border to the inferior fascial border (Figure 3).

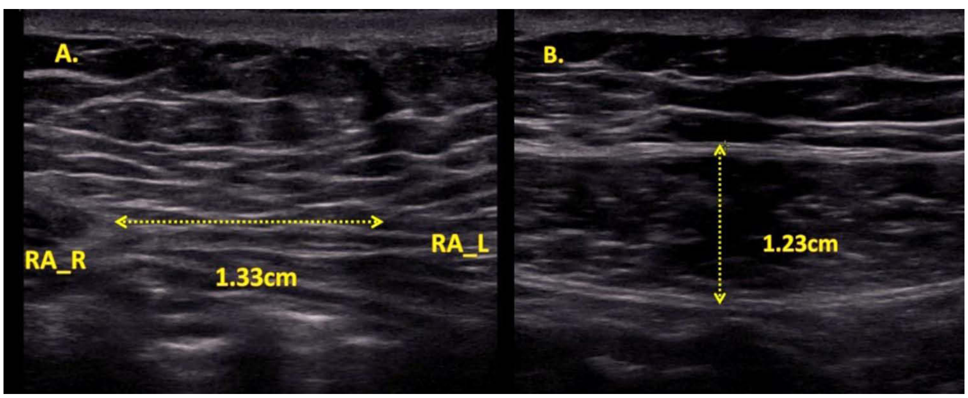

Figure 2 Ultrasound imaging of the rectus abdominis diastasis and the thickness of rectus abdominis (**A**) the rectus abdominis diastasis, RA_R: the right rectus abdominis, RA_L: the left rectus abdominis, (**B**) thickness of rectus abdominis.

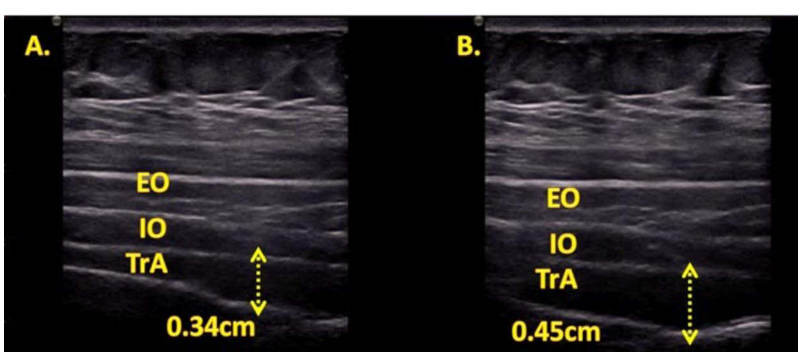

Figure 3 Ultrasound imaging of the transversus abdominis (**A**) thickness of transversus abdominis at rest state, (**B**) thickness of transversus abdominis during ADIM. EO: External oblique muscle, IO: Internal oblique muscle, TrA: transversus abdominis.

Thickness of LM Muscle

Subjects were positioned prone with arms naturally positioned alongside the trunk and a pillow placed under the abdomen to avoid excessive lumbar lordosis. US images were collected in a longitudinal section at the L4–5 level. Following the procedure mentioned in the previous study, images of the right LM at rest and during maximum isometric contraction (MIC) were acquired.[22] In all subjects, linear measurements of the LM thickness were obtained. On-screen calipers were utilized to measure from the superior border of the LM to the tip of the L4–5 zygapophyseal joint. (Figure 4).

Assessment of the Symptoms of PSUI

International Consultation on Incontinence Questionnaire – Short Form (ICIQ-SF) assesses SUI including frequency, causes, and impact on quality of life. ICIQ-SF consists of 3 scoring items grouped into 1 dimension, evaluating frequency of urinary leakage, amount of leakage, and impact on daily life. Additional questions assess when leakage occurs. Scores range from 0 to 21, with higher scores indicating more severe symptoms. Cronbach's α coefficient for the scale is 0.92.[23] Severity levels are categorized as mild (1–5 points), moderate (6–12 points), severe (13–18 points), and very severe (19–21 points).

Statistical Methods

Statistical Analysis Data were analyzed using SPSS 25.0 software. A significance level of $P < 0.05$ was considered statistically significant. For continuous variables, we performed exploratory data analysis and Shapiro–Wilk tests in order to determine the normality of our data distributions first.

When the results fit a normal curve, we used an independent *t* test; when the results did not fit a normal curve, we used a nonparametric test (Mann–Whitney U). Normally distributed continuous variables are presented as mean ± standard deviation (x ± s), while categorical variables are presented as percentages. Independent samples *t*-test and chi-square test were used to analyze group differences in basic characteristics such as maternal age, height, weight, neonatal weight, gestational weeks, delivery mode, exercise habits, and time after delivery to ensure comparability between the two groups. Independent samples *t*-test was used to analyze differences in ultrasound parameters between the groups. The data which was not normally distributed were explored using the nonparametric test (Mann–Whitney U), mean and interquartile range (IQR) were presented. Pearson or Spearman correlation analysis was performed within the PSUI group to explore correlations between ultrasound parameters of core muscles and ICIQ-SF scores, assessing the relationship between core muscle ultrasound parameters and PSUI.

Result

Comparison of General Information Between Two Groups

There were 30 subjects in the PSUI group and 30 healthy controls in the control group. There were no statistically significant differences in between the two groups in demographic characteristics such as age, height, weight, BMI, neonatal weight, gestational week, time after delivery, delivery mode and regular sporting activity. ($p > 0.05$). The data between the two groups are comparable (see Table 1).

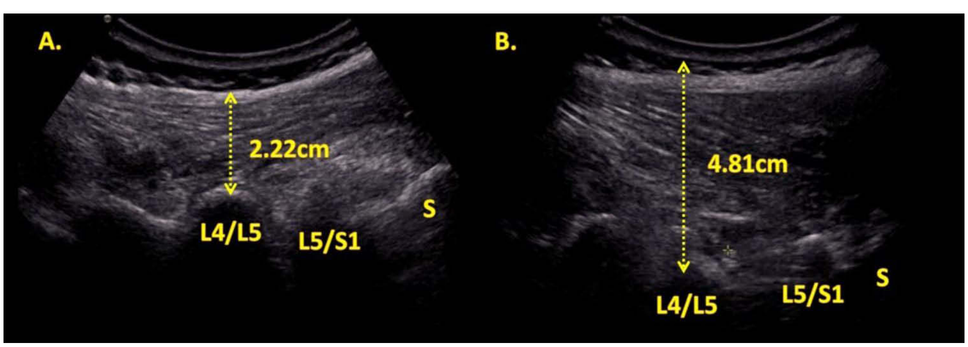

Figure 4 Ultrasound imaging of the multifidus muscle (**A**) thickness of multifidus muscle at rest state, (**B**) thickness of multifidus muscle during ADIM.

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Table 1 Participants' characteristics(mean±SD)

Item	PSUI Group (n=30)	Control Group (n=30)	*p*
Age/years	33.87±3.01	34.17±2.98	0.70
Height/cm	159.65±4.33	159.93±4.52	0.83
Weight/kg	51.47±7.49	52.04±7.76	0.80
BMI/kg/m^2	20.98±2.96	20.29±2.46	0.34
Neonatal weight/kg	3.43±0.39	3.40±0.65	0.86
Gestational week/week	38.90±1.45	38.00±1.41	0.89
Delivery mode			0.26
Vaginal n(%)	23(76.7%)	7(23.3%)	
Cesarean n(%)	19(63.3%)	11(36.7%)	
After delivery/week	7.69±1.96	7.71±1.96	0.97
Regular sporting activities n(%)	12(40%)	14(46.7%)	0.60

Abbreviations: PSUI, Pelvic floor muscle dysfunction with stress urinary incontinence; BMI, Body Mass Index; SD, Standard deviation.

Comparison of Two Groups of Trunk Muscles Measurement

After Shapiro–Wilk tests, we found that the thickness change of diaphragm and right RA thickness do not fit a normal distribution, the Mann–Whitney *U*-test was used to perform our comparisons and independent *t*-test was used to compare the difference of other parameters. At end-inspiration, the right-diaphragm thickness was 0.35 ± 0.10cm in the healthy control group and 0.30 ± 0.09 cm in the PSUI group. At end-expiration, the right-diaphragm thickness was 0.20 ± 0.06 cm in the healthy control group and 0.17 ± 0.04 cm in the PSUI group. Compared to the healthy control group, the right-diaphragm thickness in the PSUI group was significantly reduced at both end-inspiration and end-expiration ($p < 0.05$). The degree of rectus abdominis muscle separation was greater in the PSUI group compared to the healthy control group, but this difference was not statistically significant ($p > 0.05$). There were no significant differences in the thickness of the right-rectus abdominis muscle or the cross-sectional area of the right oblique muscle compared between the two groups ($p > 0.05$). Detailed data are shown in Table 2.

Table 2 Comparison of the trunk muscles measurements in both groups. [mean(SD), median(IQR)]

Variables (cm)	PSUI Group (n=30)	CG (n=30)	t/Z	*p*
T_{ins} R	0.30(0.09)	0.35(0.10)	-2.08	<0.05*
T_{exp} R	0.17(0.04)	0.20(0.06)	-2.47	<0.05*
Thickness Change R	58.03(45.77)	62.09(67.84)	-0.70	0.49
RAD	1.77(0.55)	1.59(0.71)	0.89	0.38
RA R	0.84(0.34)	0.80(0.19)	-0.42	0.68
RA L	0.87(0.19)	0.82(0.14)	0.35	0.35
TrA_{rest} R	0.26(0.09)	0.27(0.07)	-0.48	0.63
TrA_{max} R	0.37(0.08)	0.38(0.12)	-0.25	0.81
TrA_{rest} L	0.25(0.09)	0.27(0.07)	-0.91	0.37
TrA_{max} L	0.37(0.08)	0.38(0.10)	-0.57	0.57
LM_{rest} R	2.47(0.91)	2.65(0.73)	-0.68	0.50
LM_{max} R	2.91(1.27)	2.96(0.71)	-0.15	0.88
LM_{rest} L	2.47(0.94)	2.55(0.70)	-0.29	0.78
LM_{max} L	3.20(1.13)	3.12(0.69)	0.29	0.08

Note: *p < 0.05; For all analyses, p < .05 (for a confidence interval of 95%) was considered as statistically significant (*).

Abbreviations: CG, Control group; T ins, Thickness at inspiration; T exp, Thickness at expiration; R, Right; L, left; RAD, rectus abdominis diastasisand; RA, the thickness of rectus abdominis, TrA_{rest}, transversus abdominis muscle thickness at rest state; TrA_{max}, transversus abdominis muscle thickness with maximum contraction; LM_{rest}, lumbar multifidus muscle thickness at rest state; LM_{max}, lumbar multifidus muscle thickness with maximum contraction.

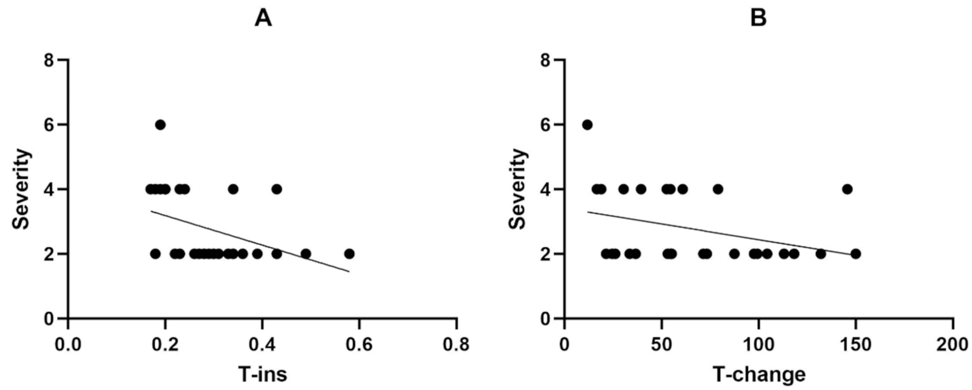

Figure 5 (**A**) Correlation between In-expiration diaphragm thickness and severity of the UI symptom, (**B**) Correlation between hemidiaphragm change and severity of the UI symptom.

Correlation Analysis Between Ultrasound Indices and Symptoms of PSUI

In the PSUI group, urinary incontinence frequency, severity of the PSUI symptoms, quality of life and ICIQ-SF total score did not follow a normal distribution. Spearman correlation analysis was used to analyze the correlation between ultrasound indices and symptoms of PSUI.

In-expiration diaphragm thickness was negatively correlated with urinary incontinence severity (r = −0.48) with statistical significance ($p < 0.05$). Negatively correlation was found between right hemidiaphragm change and severity of the UI symptom (r = −0.39, $p < 0.05$) (see Figure 5). The symptoms of PSUI showed no significant correlations with other ultrasound indices ($p > 0.05$).

Discussion

Ultrasound imaging technology provides highly reliable quantitative assessment of muscle morphology and function, enabling real-time identification of muscle thickness, cross-sectional area, and other information which was easily accepted by participants.[24] A larger cross-sectional area of a muscle is generally associated with greater strength. Muscles with a greater cross-sectional area have more contractile proteins (actin and myosin), which can generate more force during contraction.[25] Therefore, this study compares trunk muscle group ultrasound indicators between postpartum women with and without SUI, aiming to explore more effective strategies for treating PSUI.

The study found that the thickness of the diaphragm (end-inspiration/end-expiration) is significantly reduced in patients with PSUI compared to healthy individuals without incontinence. Limited studies compare the diaphragm thickness between the healthy control and patients with PSUI. However, a meta-analysis including a total of 720 participants demonstrated that core stabilization exercises are effective and safe in alleviating UI symptoms, improving quality of life, strengthening PFMs, and enhancing diaphragmatic function in postpartum women.[26] In addition, Yagli, M.D. et al reported that, among women with SUI, those who performed combined core stability exercises in addition to conventional Kegel training showed more pronounced long-term improvements in UI symptoms, with sustained enhancements in PFMs strength and endurance.[27] Therefore, based on the clinical effects, further research is warranted to investigate specific changes in core muscle groups among postpartum women with urinary incontinence. Previous study found that the diaphragm excursions of subjects with were smaller than healthy subjects among women with SUI.[28] Previous research has shown that the diaphragm and PFMs coordinate movement to regulate intra-abdominal /pressure, and lung function indicators such as FEV1, vital capacity, and maximum voluntary ventilation are positively correlated with PFM function.[5,14] Additionally, PFM contraction can effectively activate respiratory muscles and lung capacity.[29] The reduced diaphragm thickness (end-inspiration/end-expiration) in patients with PSUI may be due to weakened diaphragm muscle contraction resulting from decreased PFM strength during coordinated movement.

In the PSUI group, the in-expiration diaphragm thickness was negatively correlated with urinary incontinence severity of the UI symptom. Negatively correlation was also found between right hemidiaphragm change and severity of the UI symptom. The association may be explained by the synergistic reaction of the PFM and diaphragm, which can maintain trunk stability and control and respond to changes in intra-abdominal pressure (IAP).[30] Diaphragm training can improve this coordination by optimizing the IAP-related load on the PFM. Previous research found PFM contracts eccentrically during inspiration and contracts concentrically together with the abdominal muscles during forced expiratory maneuvers, thereby forcing the diaphragm upwards and increases expiratory effort.[5,14,31,32] Based on our findings, it could be proposed that the main focus might be placed on diaphragm retraining for the rehabilitation of people with PSUI. This is supported by the increasing number of research which incorporated muscle group training or respiratory training into SUI rehabilitation programs, all of which have shown superior efficacy for treating PSUI.[33–35] Through repeated practice of diaphragm-focused exercises, individuals can learn to better coordinate the activation of the diaphragm with the PFM. This improved co - activation can lead to enhanced PFM strength over time.

In this study, no significant difference in the degree of rectus abdominis diastasis was observed between postpartum women with and without stress urinary incontinence, which is consistent with the findings of a large-scale cross-sectional population-based study conducted by Q. Wang et al and a large-scale prospective cohort study by Kari Bø et al[36,37] However, another study suggested a possible association between rectus abdominis diastasis and stress urinary incontinence as well as pelvic floor muscle dysfunction, although the observed relationship was relatively weak.[38] Currently, there is limited literature on the correlation between RA muscle and PFMs, with controversial results. This study analyzed the differences in RA muscle thickness and DRA between the PSUI group and control groups. There was no statistically significant difference between the two groups, which aligns with earlier related research findings.[36,39] In this study, there was no significant difference in multifidus muscle thickness and TrA thickness between the experimental and control groups. Moreover, in the experimental group, multifidus muscle thickness and TrA thickness showed no significant correlation with symptoms of urinary incontinence. In contrast, Mahnaz Tavahomi et al assessed changes in muscle thickness at end-deep inspiration, end-expiration, and voluntary coughing, which found that the percentage change in transversus abdominis thickness was significantly reduced in SUI during deep expiration and coughing, while the internal and external oblique muscles exhibited greater changes during deep breathing.[40] The discrepancies between their findings and our study may be attributable to differences in movement paradigms employed during ultrasound assessment. In addition to the acknowledged influence of movement paradigms and participant instruction, technical differences in ultrasound machine performance, transducer selection, and imaging depth may also contribute to inconsistent results. Thus, comprehensive reporting of methodological details is essential for the accurate interpretation of ultrasonographic data.

Limitations

This study still has some limitations. For example, the sample size is small, which limits its ability to reflect characteristics of a broader population. Results of musculoskeletal ultrasound testing can be influenced by subject cooperation and the experience of the examiner, introducing a degree of subjectivity to the data. Although ultrasound imaging offers a non-invasive and relatively convenient way to directly visualize the diaphragm and trunk muscles, other functional parameters may be used in future studies to gain more in-depth findings. This study is limited by its cross-sectional observational and single-center design. While significant associations were identified, it remains unclear whether the observed alterations in abdominal muscle morphology precede the development of urinary incontinence or result from it. Future studies employing more rigorous longitudinal or interventional designs would help to clarify the direction of causality. Furthermore, other factors that may influence abdominal muscle mass, such as nutritional status, should be taken into consideration in future research.

Conclusion

This cross-sectional study assessed ultrasound characteristics of trunk muscles in 60 postpartum women, with and without SUI. Compared with women without PSUI, those with SUI demonstrated reduced right diaphragmatic thickness at both end-inspiration and end-expiration. However, no significant differences were observed between the two groups in other trunk muscles. In addition, end-inspiration diaphragmatic thickness and change of diaphragmatic thickness were negatively correlated with the severity of the stress urinary incontinence. These findings suggest that the thickness of the diaphragm, rather than the other assessed trunk muscles, may be specifically associated with postpartum SUI. This provides a new perspective for the rehabilitation and prevention of postpartum SUI, indicating that coordinated training targeting the diaphragm and pelvic floor muscles may hold potential application value.

Disclosure

The authors report no conflicts of interest in this work.

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