DOI: https://doi.org/10.54393/pbmj.v9i4.1355

PAKISTAN BIOMEDICAL JOURNAL
https://www.pakistanbmj.com/journal/index.php/pbmj/index
ISSN (E): 2709-2798, (P): 2709-278X
Volume 9, Issue 04 (April 2026)

Original Article

OPEN ACCESS

Association of Diastasis Recti with Abdominal Muscle Strength, Endurance, Postural Control, and Pelvic Girdle Pain in Postpartum Women

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ARTICLE INFO

Keywords:
Diastasis Recti, Inter-Recti Distance, Muscular Endurance, Postural Control, Pelvic Girdle Pain, Postpartum

How to Cite:
Ghaffar, E., Ishfaq, S., Umar, M., Mazhar, F., Tariq, R., Samad, M., Batool, U., & Irshad, U. (2026). Association of Diastasis Recti with Abdominal Muscle Strength, Endurance, Postural Control, and Pelvic Girdle Pain in Postpartum Women: Diastasis Recti with Abdominal Muscle Strength, and Pelvic Girdle Pain in Postpartum Women. Pakistan BioMedical Journal, 9(4), 11-15. https://doi.org/10.54393/pbmj.v9i4.1355

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Received Date: 10th March, 2026
1st Revision Received: 21st April, 2026
Acceptance Date: 27th April, 2026
Published Date: 30th April, 2026

ABSTRACT

DRA or diastasis recti abdominis is a postpartum complication where the rectus abdominis muscles are separated, leading to impaired abdominal muscle function, reduced core stability, and functional limitations. However, its relationship with muscle strength, endurance, postural control, and pelvic girdle pain remains unclear. **Objectives:** To determine whether the severity of inter-recti distance (IRD) within women already diagnosed with DRA is associated with abdominal muscle strength, endurance, postural control, and pelvic girdle pain in postpartum women. **Methods:** A total of 60 postpartum women with DRA were included. IRD was assessed using the fingerbreadth method. Abdominal muscle strength was measured through manual muscle testing (MMT), endurance by curl-up test, postural control using the Balance Error Scoring Scale (BESS), and pelvic girdle pain through the Pelvic Girdle Questionnaire (PGQ). Spearman correlation was applied to assess associations, and linear regression was used to identify predictors of IRD. **Results:** IRD showed a strong negative correlation with abdominal muscle strength (ρ = -0.938, p<0.001) and endurance (ρ = -0.970, p<0.001), and a moderate positive correlation with BESS score (ρ = 0.436, p=0.001). The relationship with PGQ was weak and not significant (ρ = 0.234, p=0.072). Mode of delivery was the only significant predictor of IRD (p<0.001). **Conclusions:** Increased IRD is associated with reduced abdominal strength, endurance, and impaired postural control, but not significantly with pelvic girdle pain. Mode of delivery is the only significant predictor of IRD.

INTRODUCTION

Diastasis recti abdominis (DRA) is characterized by a separation of the two rectus abdominis muscles along the linea alba [1]. Its prevalence is reported to be approximately 60% at 6 weeks postpartum, decreasing to 45% at 6 months and 33% at 12 months [2]. DRA severity can be categorized as mild (25–35 mm or visible protrusion with <25 mm separation), moderate (35–50 mm), and severe (>50 mm) [3]. Commonly examined variables included in risk factors are maternal age, pre- and post-pregnancy BMI, parity, newborn birth weight, abdominal circumference in late pregnancy, mode of delivery, joint hypermobility, heavy lifting, and exercise patterns [4, 5]. The body's core system plays a central role in trunk stabilization and in supporting the spine and pelvis [6]. Given these biomechanical relationships and principles of pelvic dynamics, it is proposed that DRA may influence abdominal and pelvic floor muscle strength, alter body mechanics, and compromise core function [7]. Pelvic girdle pain (PGP) refers to discomfort occurring between the posterior iliac crest and the gluteal folds, typically around the sacroiliac joints and/or pubic symphysis [8]. Key factors include pubic symphysis separation and diastasis recti abdominis (DRA),

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both of which can contribute to altered load transfer and persistent PGP [9-11]. These anatomical changes in the distance between the two rectus abdominis muscles are associated with reduced abdominal muscle performance [12, 13]. Effective coordination among the lumbopelvic region, abdominal muscles, and fascial structures is essential for maintaining postural stability [14, 15]. DRA is a common postpartum condition that can impair abdominal muscle function, reduce core stability, and negatively affect strength, endurance, and pelvic girdle function, ultimately impacting daily activities and quality of life.

Despite its clinical importance, existing evidence on the relationship between DRA and functional outcomes remains limited and inconsistent, with most studies examining these factors in isolation. Therefore, there is a need for comprehensive research to investigate the combined association of DRA with muscle strength, endurance, postural control, and pelvic girdle pain in postpartum women. This study aimed to determine the association of diastasis recti with abdominal muscle strength, endurance, postural control, and pelvic girdle pain in postpartum women

METHODS

This analytical cross-sectional study was conducted at Hijaz Hospital and Services Hospital, Lahore, from October 1, 2025, to March 1, 2026. Data were collected from Hijaz Hospital and Services Hospital, Lahore. A consecutive sampling technique was used. All eligible postpartum women attending Hijaz Hospital and Services Hospital, Lahore, during the study period who met the inclusion criteria were invited to participate consecutively until the target sample size of 60 was achieved. The ethical approval was taken from the Institutional Review Board of Hajvery University (HU/FAHS/ECRB/25/74, date: 1 Oct 2025). Sixty postpartum women (aged 20–40 years, at 6 weeks postpartum) diagnosed with DRA (IRD ≥2 cm) were included. Seven Women aged 20–40 years, at 6 to 8 weeks postpartum (single recruitment window), diagnosed with DRA (IRD ≥2 cm). Data were collected after informed consent, including demographic details (age, height, weight, BMI, parity, and time since delivery). IRD, abdominal muscle strength, endurance, postural control, and pelvic girdle pain were assessed using standardized methods. Inter-recti distance (IRD) was assessed using the fingerbreadth palpation method in a hook-lying position, with ≥2 fingerbreadths indicating diastasis recti abdominis [16]. Severity was categorized as mild (<3 cm), moderate (3–5 cm), and severe (>5 cm) [17]. Sample size was calculated by G*Power software (version 3.1.9.7). The statistical test family was "exact" – "correlation: bivariate normal model". Based on a two-tailed test, an expected effect size ρ = 0.40 (moderate correlation, derived from a pilot study), α = 0.05, and power (1-β) = 0.80, the calculated required sample size was 46. Accounting for a potential 20% dropout/incomplete data rate, the final target sample was set at 60 participants. Abdominal muscle endurance was measured using a static flexion test [18], and strength was assessed through manual muscle testing graded 0–5 [19]. Postural control was evaluated using BESS [9], while pelvic girdle pain was measured using the Pelvic Girdle Questionnaire(PGQ)[20].

The analysis of the data was done through SPSS version 27.0. The Kolmogorov-Smirnov test with Lilliefors correction was used to test normality. The results showed that IRD (p=0.003), MMT grade (p=0.002), curl-up endurance (p=0.001), and BESS score (p=0.004) were not normally distributed. PGQ percentage (p=0.120) was normally distributed. Because the majority of key variables violated normality, non-parametric Spearman's rank correlation coefficient (ρ) was used for all bivariate associations to ensure consistency and avoid bias. Multiple linear regression analysis was performed with IRD as the dependent variable. Independent variables included age (years, continuous), BMI (kg/m^2, continuous), parity (number of deliveries, continuous), and mode of delivery. Mode of delivery was dummy-coded as: 0 = vaginal delivery (reference category), 1 = cesarean section. This coding allows interpretation of the unstandardized coefficient (B = 1.556, β = 0.759) as the mean increase in IRD (in cm) for cesarean section compared to vaginal delivery, holding all other variables constant. At least sixty subjects were required to achieve the statistical power of 80% with a significance level <0.005.

RESULTS

A total of 67 postpartum women with suspected DRA were screened for eligibility. Seven of them were eliminated as they didn't fit the requirements for inclusion: inter-recti distance <2 cm (n=5), vestibular diseases (n=1), or knee pain (n=1). The age range of women was between 20 and 40 years, consistent with the inclusion criteria. The mean BMI with the range of 25.6 to 3.4 kg/m^2 indicates that the majority of participants fell within the overweight category. Vaginal delivery was reported in 31 participants (51.7%), while cesarean section was reported in 29 participants (48.3%); the distribution was relatively balanced. The parity distribution confirms that primiparous women constituted the largest group (58.3%), multiparous women (33.3%), and twin pregnancies (8.3%) (Table 1).

Table 1: The Demographic and Clinical Characteristics of the Subjects

Demographic Characteristics	n (%) / Mean ± SD
Age	28.3 ± 4.3
BMI	27.1 ± 0.9

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Primiparous	35 (58.3%)
Multiparous	20 (33.3%)
Twin Pregnancy	5 (8.3%)
Vaginal Deliveries	31 (51.7%)
Cesarean	29 (48.3%)
IRD Severity	
Mild	25 (41.7%)
Moderate	25 (41.7%)
Sever	10 (16.7%)

Correlations with IRD were also shown in Mean ± SD. The Spearman's ρ of IRD, MMT, Curl-Up Endurance, PGQ Percentage, and Bess Score were analyzed (Table 2).

Table 2: Correlations with IRD

Clinical Characteristics	Mean ± SD	Spearman's ρ	p-value
IRD	3.35 ± 1.03	–	–
MMT	2.43 ± 1.015	-0.938	<0.001
Curl-Up Endurance	6.10 ± 2.69	-0.970	<0.001
PGQ Percentage	36.98 ± 15.32	0.234	0.072
Bess Score	17.2 ± 6.2	0.436	0.001

Multiple linear regression analysis revealed that mode of delivery was the only significant independent predictor of inter-recti distance (β = 0.759, p<0.001). Age (β = 0.001, p=0.992), BMI (β = 0.004, p=0.970), and parity (β = -0.197, p=0.104) were not found to be significant predictors. IRD demonstrated statistically significant strong negative correlations with abdominal muscle strength (ρ = -0.938, p<0.001) and curl-up endurance (ρ = -0.970, p<0.001), and a moderate positive correlation with BESS score (ρ = 0.436, p=0.001). The correlation with PGQ percentage was weak and not significant (ρ = 0.234, p=0.072) (Table 3).

Table 3: Multiple Linear Regression Analysis Identifying Independent Predictors of IRD

Variables	B	Std. Error	Beta (β)	t	p-value	95% CI (Lower)	95% CI (Upper)
Constant	1.385	3.297	–	0.420	0.676	-5.222	7.991
Age (Years)	0.000	0.027	0.001	0.011	0.992	-0.053	0.054
BMI	0.004	0.114	0.004	0.038	0.970	-0.223	0.232
Parity Status	-0.312	0.189	-0.197	-1.653	0.104	-0.691	0.066
Mode of Delivery	1.556	0.224	0.759	6.937	<0.001	1.106	2.005

DISCUSSION

This study found that increased inter-recti distance (IRD) (mean 3.35 ± 1.03 cm) in postpartum women is significantly linked to decreased abdominal muscle strength (MMT grade 2.43 ± 1.02, ρ = -0.938, p<0.001) and endurance (curl-up repetitions 6.10 ± 2.69, ρ = -0.970, p<0.001), and moderately related to poorer postural control (BESS score 17.2 ± 6.2, ρ = 0.436, p=0.001), but not significantly associated with pelvic girdle pain (PGQ percentage 36.98 ± 15.32, ρ = 0.234, p=0.072). Mode of delivery (cesarean section) was the only significant predictor of IRD (β = 0.759, p<0.001), while age, BMI, and parity showed no significant effect. The separation of the rectus abdominis muscles alters abdominal wall mechanics and reduces force generation capacity. A study measured abdominal muscle strength using the same manual muscle testing (MMT) scale (0-5) in women with DRA at 6-8 weeks postpartum [8]. They reported a mean MMT grade of 2.8 ± 0.9 and found a significant negative correlation with IRD (ρ = -0.82, p=0.01). In comparison, the current study observed a slightly lower mean MMT grade (2.43 ± 1.02) and a stronger correlation (ρ = -0.938, p<0.001). The difference may be attributed to a higher proportion of cesarean deliveries in the current sample (48.3% vs. 32%), which is associated with greater IRD. Similarly, the present study found a significant relationship between IRD and decreased abdominal muscle endurance. This aligns with Hills et al. who reported that women with increased IRD exhibited reduced endurance during functional abdominal tasks [17]. The disruption in the linea alba may impair efficient load transfer and lead to early muscle fatigue. In terms of postural control, a moderate association with IRD was observed, indicating its impact on functional stability. This is supported by the study conducted by Sperstad et al. which reported impaired balance and reduced limits of stability in women with increased IRD [21]. Conversely, this research discovered a low and statistically insignificant relationship between IRD and pelvic girdle pain. This observation is in line with Benjamin et al. who found that there is a lack of evidence to support a strong relationship between diastasis recti and lumbopelvic pain [19]. The discrepancy can be attributed to the multifactorial nature of pain that includes biomechanical, hormonal, and psychosocial factors. On the predictors of IRD, mode of delivery was found to be the only significant predictor of IRD in this study. This observation is confirmed by Turan et al. who recorded a greater prevalence of diastasis recti in women who undergo cesarean section, which could be due to post-operative trauma and slow muscle recovery [20]. The current study found no significant association of IRD with age (p=0.992), BMI (p=0.970), or parity (p=0.104). According to Sperstad et al. the age >35 years was statistically connected with a higher prevalence of DRA at 6

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weeks postpartum (odds ratio 1.8, p=0.003), but both BMI and parity had no significant effect (p>0.005 for both) [21]. In contrast, Werner and Dayan have found that multiparity (p=0.001) and pre-pregnancy BMI >25 kg/m 2 (p=0.02) were both significant predictors [5]. The discrepancy in the studies could have been caused by changes in the sample characteristics, method of measurement, and the time of measurement.

The study was limited by the lack of a control group, small subgroups, and incomplete assessment of multifactorial factors affecting pelvic girdle pain and postural control. Future research should include larger, well-balanced samples and use ultrasound for more accurate IRD measurement, alongside palpation.

CONCLUSIONS

Inter-recti distance (IRD) is significantly associated with reduced abdominal muscle strength and endurance, and moderately linked to impaired postural control in postpartum women. It shows a weak, non-significant relationship with pelvic girdle pain. Mode of delivery is the only significant predictor of IRD, while age, BMI, and parity are not influential. These findings emphasize focusing on abdominal function and postural stability in postpartum rehabilitation.

Authors' Contribution

Conceptualization: EG
Methodology: MU, FM, UI
Formal analysis: EG
Writing and Drafting: SI, RT, MS, UB
Review and Editing: EG, SI, MU, FM, RT, MS, UB, UI

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

The authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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