RESEARCH ARTICLE

Correlation of Spinal Curvature in Postpartum Women with and without Diastasis Recti Abdominis: A Cross-sectional Study

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Abstract

Aim and background: Diastasis recti abdominis (DRA) is a disorder that can persist in 35–60% of women postpartum, leading to issues like core function issues, urine incontinence, and low back pain (LBP). Diastasis recti abdominis has been associated with modifications in spinal alignment, notably an elevation in lumbar curvature, potentially affecting the distribution of loads. Diastasis recti abdominis is a potential cause of postural abnormalities, and evaluating the relationship between them will be beneficial for the medical professionals to understand the need for abdominal muscle strengthening in the postpartum period and how it affects quality of life. Thus, this study aims to explore the relationship between postural changes and DRA in the postpartum phase.

Materials and methods: This cross-sectional study design was conducted to find the relationship between spinal curvature and DRA using a bubble inclinometer, and a caliper respectively. A total of 102 patients underwent screening based on inclusion and exclusion criteria. An independent *t*-test and Karl Pearson's correlation method were used to find a comparison and relation of spinal curvature (thoracic kyphosis angle and lumbar lordosis angle) between with and without DRA groups, while a *p*-value < 0.05 was considered statistically significant.

Results: The results of the present study stated that DRA was positively correlated ($p < 0.05$) with kyphosis angle ($r = 0.322$) and lordosis angle ($r = 0.774$). The findings of the current study also indicate a positive correlation between body mass index (BMI) and both DRA and the lordosis angle.

Conclusion: This study revealed a strong positive correlation between DRA and lordosis angle and a weak positive correlation between DRA and kyphosis angle in postpartum women.

Clinical significance: These findings emphasize the importance of holistic postpartum care to address musculoskeletal changes, providing insights for interventions to improve core muscle function and alleviate chronic spinal pain.

Keywords: Bubble inclinometer, Caliper, Diastasis recti abdominis, Postpartum period, Pregnancy, Spinal curvature.

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Introduction

The postpartum period, often referred to as the "fourth stage of labor," lasts from 6 weeks postnatally and consists of three phases: acute, subacute, and delayed.[1] It is a crucial period for reproductive health, involving significant complications like anemia, wound dehiscence, low back pain (LBP), and diastasis recti abdominis (DRA), which can persist if untreated.[2]

Diastasis recti abdominis occurs when the two rectus abdominis muscles separate along the Linea alba, compromising the structural integrity and stability of the abdominal wall and trunk.[3] The abdominal wall helps to maintain posture breathing patterns, provide pelvic stability and protects the abdominal viscera.[4] Diastasis recti abdominis may affect up to 100% of pregnant women and persist in the postpartum period in 35–60% of women.[5] Diastasis recti abdominis is also linked to abdominal deformities, core instability, and functional impairments, affecting core function, urine incontinence, pelvic girdle pain (PGP), LBP and body dissatisfaction.[6,7] Research shows 60% of women experience unresolved DRA, negatively impacting their quality of life.[8]

Gestational weight gain, posture shifts, and joint laxity can alter the static stability of pregnant women, which may persist into the postpartum phase due to increased looseness in connective tissues, posture shifts, and sleep deprivation.[9] An anterior pelvic tilt increases lumbar lordosis and compensatory thoracic kyphosis, with lumbar hyperlordosis being the most prevalent postural change.[10] Relaxin hormone levels are elevated for up to 12 weeks after birth, impacting postural alignment and affecting ligaments and joint supporting structures.[11] Incorrect posture can also contribute to postpartum LBP, which can persist for up to 6 months after childbirth and is associated with muscle weakness, persistent thoracic kyphosis, and lumbar lordosis.[12,13]

Pregnancy-related low back pain (PR-LBP) affects 50.9% of women during pregnancy, and 72% of women experience discomfort in the lumbo-pelvic region after giving birth. This discomfort can persist for up to 3 years postpartum.[14] Pregnancy-related LBP is the primary risk factor for experiencing pain at

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intervals of 1–3 months and 3–6 months postdelivery, and future persistent non-specific LBP.[15] Spinal alterations, particularly an increase in lumbar curvature, can cause back pain.[16] An increase in postpartum breast mass could contribute to lasting changes in the lordotic curvature of the lumbar spine.[17] Postural kyphosis is common in the postpartum period, often caused by slouching while lactating. Other factors like muscle strength, trunk flexibility, and postpartum depression also contribute to altered spinal curvature and posture.[17–20]

The irregular function of the rectus abdominis muscles can impact balance by diminishing spinal stabilization and disrupting body equilibrium.[21] Also, a study carried out by Doubkova et al. revealed a relation between DRA and chronic spinal pain.[22] Various studies have suggested differing anthropometric factors, such as physical activity levels, cultural norms, and environmental and organizational barriers, can all have an impact on postural changes during pregnancy and postpartum.[23–25]

Moreover, the diastasis of the rectus abdominis muscles has been identified as one of the potential causes of postural abnormalities yet relationship between them is still unclear among postpartum women.[21] Evaluating the relationship between them would be advantageous for medical professionals in comprehending the importance of abdominal muscle strengthening during the postpartum period and its impact on quality of life. Therefore, the study's purpose is to examine the relationship between spinal curvature and DRA among postpartum women.

Materials and Methods

A cross-sectional study was conducted at Pediatrics and Obstetrics and Gynecology department of Justice KS Hegde Charitable Hospital, Deralakatte, Mangaluru. Ethical clearance for this study was acquired from the NITTE Institute of Physiotherapy's Institutional Ethics Committee on 09-02-2023. (Ref: NIPT/IEC/Min//22/2022-2023).

Inclusion Criteria

The study included primiparous women aged 18–35 years in postpartum period (6 weeks–6 months).

Exclusion Criteria

The study excluded women with a history of musculoskeletal disorders affecting the spine or lower extremities, previous spinal surgeries such as laminectomy or discectomy, congenital spine deformities, prior abdominal surgeries other than cesarean sections, and any relevant neurological deficits.

Sample Size

The sample size was determined based on the mean ± standard deviation (SD) of the Lordosis Angle in the study group (29.270 ± 11.92) and the control group (33.876 ± 7.49) at a significance level of 5%, with 80% power, and an estimated effect size of 0.49. With these parameters, a sample size of 51 participants was determined for each group. Therefore, a total of 102 participants were included in the study. The sample size calculation was done using G*Power version 3.1.9.4.

Procedure

Verbal as well as written consent was obtained from those respondents who were willing to participate in the study. Demographic data on the subject was collected and recorded. Subjects screened were assessed by a caliper and divided into two groups, one with DRA and another without DRA. Also, spinal curvature, i.e., kyphosis and lordosis angle, were assessed in both groups using the baseline® Bubble Inclinometer.

Table 1: Descriptive statistics for age, BMI, and weight of baby at birth

(N = 102)	*Range*	*Mean*	*SD*
Age (Years)	20–35	26.71	3.13
BMI (kg/m^2)	14.1–33.8	23.17	3.61
Weight of baby at birth (kg)	1.4–4	2.60	0.45

Measurement Procedure of DRA

The participants were instructed to lie supine, with their hips and knees bent, feet flat on the bed, and arms lying alongside their bodies. The midpoint of the umbilicus is marked for measurement. Participants elevate their heads until the spine of the scapula clears the table's surface while maintaining this position. The examiner then palpates the inner edge of both the right and left rectus abdominis muscles at the specified location. Using the inside jaws of a caliper, positioned perpendicular to the muscle direction and adjusted for width, the intrarectal distance is measured at the palpated location. Participants with measurements greater than 2.7 cm at the umbilical region were classified as DRA positive. Participants are allowed to rest if fatigued.[26]

Measurement Procedure of Spinal Curvature

The participants were instructed to stand upright against a flat surface, such as a wall, with their feet shoulder-width apart and their arms relaxed. The spinous processes at the junction of T1/T2, T12/L1, and S2/S3 were located by palpation. The inclinometer comprises a perspex protractor with a pointer that responds to gravity, measuring the tangent angle to the surface under assessment. The average values were computed by applying both linear and triangular methods of angle addition for the measurements taken between T1/T2 and T12/L1, as well as between T12/L1 and S2/S3. This process helped determine the angles for thoracic kyphosis and lumbar lordosis, respectively.[27]

Statistical Analysis

The data were analyzed by using the Statistical Package for the Social Sciences (SPSS) software (SPSS Inc.; Chicago, IL) version 29.0.10. The data collected were summarized using the Descriptive Statistics: frequency, percentage, mean and SD. The Independent sample "*t*" test was used to compare age, body mass index (BMI), weight of baby at birth and DRA score, also kyphosis angle and Lordosis angle, between the groups with DRA and without DRA. To find the relation between: Age, BMI, weight of baby at birth, DRA, kyphosis angle, and Lordosis angle the Pearson correlation coefficient ("*r*") was used. The likelihood ratio or Chi-square test was used to compare occupation and type of delivery between the groups. A p-value < 0.05 was considered as statistically significant.

Results

This study was conducted among 102 postpartum women, in which 51 (50%) women were included in the with DRA group and 51 (50%) women were included in without DRA group. The age of the women ranged from 20 to 35 years, with a mean of 26.71 ± 8.4. The BMI ranged from 14.1 to 33.8, with a mean of 23.17 ± 3.61. Similarly, the weight of the baby at birth ranged from 1.4 to 4, with a mean of 2.60 ± 0.45 (Table 1).

Table 2: Descriptive statistics for DRA, kyphosis angle, and lordosis angle

(N = 102)	*Range*	*Mean*	*SD*
DRA (cm)	0.5–4.4	2.40	0.92
Kyphosis angle (°)	18–38	31.08	4.37
Lordosis angle (°)	15–46	28.48	6.13

Table 3: Comparison of DRA, kyphosis angle, and lordosis angle between the groups

	Mean	*SD*	*"t"*	*p-value*
DRA (cm)				
With DRA	3.18	0.49	16.30	<0.001*
Without DRA	1.62	0.47		
Kyphosis angle (°)				
With DRA	32.67	3.98	3.93	<0.001*
Without DRA	29.49	4.19		
Lordosis angle (°)				
With DRA	33.59	3.33	15.32	<0.001*
Without DRA	23.37	3.41		

p-value is < 0.05

Table 4: Correlation between DRA, kyphosis angle, and lordosis angle

	DRA	*Kyphosis angle*	*Lordosis angle*
DRA (cm)			
"r"	1	0.322	0.774
p-value	–	0.001*	<0.001*
Kyphosis angle (°)			
"r"		1	0.280
p-value		–	0.004*
Lordosis angle (°)			
"r"			1
p-value			–

"r", Pearson correlation coefficient; *Significant

Table 2 demonstrates the descriptive statistics for DRA, kyphosis angle, and lordosis angle using the mean and SD. Diastasis recti abdominis of the participants ranged from 0.5 to 4.4 with mean 2.40 ± 0.92. Kyphosis angle ranged from 18 to 38 degrees with a mean of 31.08 ± 4.37, and lordosis angle ranged from 15 to 46 degrees with the mean 28.48 ± 6.13.

The independent sample "*t*" test was used to compare DRA, kyphosis angle, and lordosis angle between the groups. There was a difference ($p < 0.05$) in DRA, kyphosis angle and lordosis angle between the groups between the groups: With DRA and without DRA (Table 3).

The Pearson correlation coefficient ("*r*") was used to find the relation between DRA, kyphosis angle, and lordosis angle. The DRA was strongly positively correlated ($p < 0.05$) with the lordosis angle and weakly positively correlated ($p < 0.05$) with the kyphosis angle. Also, there was a weak positive correlation ($p < 0.05$) between kyphosis angle and lordosis angle (Table 4).

The Pearson correlation coefficient ("*r*") was used to find the relation between age, BMI, weight of baby, and DRA, kyphosis angle, and lordosis angle. The BMI was weakly positively correlated ($p < 0.05$) with DRA as well as lordosis angle (Table 5).

Table 5: Correlation between age, BMI, weight of baby, and DRA, kyphosis angle, and lordosis angle

	Age (Years)	*BMI (kg/m^2)*	*Weight of baby at birth (kg)*
DRA (cm)			
"r"	–0.095	0.251	–0.096
p-value	0.342	0.011*	0.337
Kyphosis angle (°)			
"r"	0	0.173	0.018
p-value	0.996	0.082	0.858
Lordosis angle (°)			
"r"	–0.035	0.209	–0.165
p-value	0.724	0.035*	0.098

"r", Pearson correlation coefficient; *Significant

Discussion

Postpartum women may experience various complications, including anemia, back pain, sexual difficulties, urinary incontinence, hemorrhoids, postpartum stress, weakened postural control, and DRA. Previous research has highlighted how irregular functioning of the rectus abdominis muscles can impact balance by reducing the stabilization of the spine and disrupting body posture.[21] Back pain often arises from spinal changes, particularly increased lumbar curvature due to altered load distribution. Postural kyphosis, commonly observed during breastfeeding, is a prevalent issue.[11] Although, the relationship between DRA and postural problems is not fully understood, they may mutually exacerbate each other.

The present study revealed DRA was positively correlated ($p < 0.05$) with kyphosis angle as well as lordosis angle. This result is consistent with Anna Zmyślna et al., who found a correlation between the width of linea alba and the level of lumbar lordosis, along with a lesser correlation with thoracic kyphosis degree.[21] Yalfani et al., also reported that there was a significant difference ($p \leq 0.05$) in the lumbar lordosis angle between the two groups, while the kyphosis angle did not show significance ($p \geq 0.05$).[28] This study revealed a connection between lumbar hyperlordosis, postural instability, and DRA. Women with this condition often experience limited improvement after childbirth without intervention. Following delivery, the reduction in uterine volume results in weakened and slackened abdominal muscles, leading to insufficient support in the affected area. As a consequence, the lack of muscular support can exacerbate postural instability in affected women compared to those without the condition, consequently slowing down the recovery process from hyperlordosis.[5,21] Previous research has indicated that vertebral body structure, intervertebral disc and muscle strength shape can influence the angle of kyphosis. Additionally, individuals with a greater thoracic kyphosis angle tend to experience greater impairment in core stability. Also, Bahmanbeglou et al., concluded in their study that even with decreased bone mass density, a strong back extensor can prevent thoracic kyphosis. This underscores the crucial role of a strong core in maintaining optimal body mechanics.[29]

The findings of the current study indicate a positive correlation between BMI and both DRA and the lordosis angle. This finding was in accordance with a study by Wu et al. who suggest that higher BMI increases the risk of DRA due to increased abdominal pressure from excess fat tissue, which can lead to the separation of rectus

abdominis muscles, exacerbated by potential muscle loss in obese individuals.[30] Grossi et al. illustrated that individuals with morbid obesity exhibit reduced collagen content in Linea alba above the umbilical area compared to non-obese counterparts in the same age category. This implies that these factors may play a role in the onset of DRA in obese individuals.[31]

Similarly, the study by Taweetanalarp and Purepong results indicate a significant relationship between BMI and the lower lumbar angle, suggesting that increased body mass may contribute to spinal curvature by potentially exerting excessive pressure on facet joints and intervertebral discs.[32]

One merit of this study was the finding that stated the direct relationship that exists between the DRA incidence and corresponding altered spinal curvature. Similarly, the demerit in this study was that the distribution of participants was not uniform with types of delivery. To sum up, the study findings suggest that DRA impacts thoracic and lumbar curvatures in postpartum women. These findings underscore the importance of holistic postpartum care that addresses musculoskeletal changes, offering valuable insights for interventions aimed at improving core muscle function and reducing chronic spinal pain among women in this crucial phase.

Conclusion

In conclusion, this study unveils a significant correlation between DRA and spinal curvatures among postpartum women. Importantly, DRA was found to impact kyphosis and lordosis angles, indicating its potential influence on postural stability and quality of life postpartum.

Clinical Significance

These findings underscore the importance of holistic postpartum care that addresses musculoskeletal changes, offering valuable insights for interventions aimed at improving core muscle function and reducing chronic spinal pain among women in this crucial phase.

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