


# Interpregnancy Interval and the Degree of Cystocele Across Two Vaginal Deliveries: A Retrospective Self-Controlled Cohort Study Using Transperineal Ultrasound

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**Objective:** To examine the association between interpregnancy interval (IPI) and the risk of worsening cystocele between two consecutive vaginal deliveries.

**Methods:** In this retrospective cohort study, 314 women who underwent transperineal ultrasound (TPUS) within six months postpartum after each of two consecutive vaginal deliveries were included. Multivariable linear regression was used to assess the association between first-delivery cystocele severity and second-delivery outcomes, with IPI categorized as  $\leq 24$ ,  $>24\text{--}\leq 36$ , and  $>36$  months to evaluate its potential modifying effect.

**Results:** Cystocele severity after the first delivery strongly predicted worsening at the second delivery ( $\beta = 0.5$ ; 95% CI: 0.4–0.6;  $p < 0.001$ ). Longer IPI was associated with less progression of cystocele, showing a significant linear trend across IPI categories ( $p$  for trend = 0.04). After adjusting for obstetric factors, the position of the most dependent point of the posterior bladder wall after the first delivery was independently associated with cystocele severity after the second delivery ( $\beta = 0.5$ ; 95% CI: 0.4–0.6;  $p < 0.001$ ). IPI was negatively associated with cystocele severity. Although the formal test for interaction was not statistically significant ( $p$  for interaction = 0.11), the test for linear trend across IPI strata was significant ( $p$  for trend = 0.04).

**Conclusion:** Cystocele severity after the first vaginal delivery strongly predicts that after the second, and this association weakens with longer IPI. TPUS enables early identification of high-risk women, supporting individualized birth spacing counseling with potential public health implications for the prevention of pelvic floor disorders.

**Keywords:** cystocele, delivery, transperineal ultrasound, interpregnancy intervals, women's health

## Introduction

Pelvic floor dysfunction (PFD), particularly pelvic organ prolapse (POP), represents a significant health burden for postpartum women. Among these, cystocele is the most common, significantly impacting patients' daily activities and mental health.<sup>1</sup> Vaginal delivery is a definite risk factor for POP.<sup>2</sup> Current studies suggest that multiple deliveries may lead to cumulative risks through progressive biomechanical damage to the pelvic floor support tissues.<sup>3</sup> Previous studies<sup>4–6</sup> have often relied on cross-sectional comparisons between women with different parities or obstetric histories. Such study designs are inherently limited by confounding biases arising from individual characteristics that do not change over time—such as innate connective tissue elasticity, pelvic morphology, and biological vulnerability<sup>7</sup>—which may simultaneously influence both obstetric outcomes and pelvic floor integrity.<sup>8</sup>

The interpregnancy interval (IPI) is defined as the period between a previous live birth and the subsequent conception. As a critical modifiable factor, the World Health Organization (WHO) recommends an IPI of at least 24 months to reduce the risk of adverse maternal and perinatal outcomes.<sup>9</sup> In the context of pre-pregnancy clinical counseling, a thorough understanding of IPI is essential, as a short IPI may result in incomplete biological remodelling due to insufficient recovery time for pelvic floor tissues to restore muscle tone and for vaginal micro-tears or birth canal trauma to heal adequately, a process that follows a specific physiological trajectory.<sup>10</sup> Such impaired wound healing significantly compromises the integrity of the anterior compartment support. Although previous studies have associated shorter IPI with adverse maternal and infant outcomes,<sup>9,11</sup> few studies have focused on whether IPI modify the longitudinal trajectory of anterior pelvic floor support status in women following two vaginal deliveries. Transperineal ultrasound (TPUS), particularly through measurement of the displacement of the bladder neck or the lowest point of the posterior bladder wall relative to the symphysis pubis during maximum Valsalva, has been demonstrated to be a repeatable, quantifiable, and clinically effective indicator for assessing anterior pelvic support structures.<sup>12–14</sup> This technology enables objective longitudinal tracking of anatomical changes, yet its potential in elucidating the “modulating effect of IPI on the persistent impact of pelvic floor injury” remains largely unexplored.

Accordingly, this study employed a retrospective, self-controlled cohort design to assess postpartum pelvic floor ultrasound parameters change in the same women following two consecutive vaginal deliveries and to evaluate how IPI moderates the association between the degree of cystocele after the first and second deliveries. This design inherently controls for fixed individual characteristics while further adjusting key obstetric factors, hence more reliably revealing the temporal dynamics of pelvic floor tissue repair and cumulative injury. The findings aim to provide objective evidence for personalized birth spacing counseling and early risk stratification management in women showing signs of pelvic floor injury during their first postpartum period.

## Materials and Methods

### Study Design and Subjects

This is a single-center, retrospective, self-controlled cohort study conducted at Shenzhen Second People’s Hospital. This study included 314 females who had two vaginal deliveries and underwent TPUS examinations within 6 months postpartum between January 2015 and December 2024. This study was reviewed and approved by the Ethics Committee of the First Affiliated Hospital of Shenzhen University (2025–690-02PJ).

### Inclusion Criteria

1. Delivery at term (37–41 weeks of gestation); 2. Birth weight  $\leq 4$  kg.

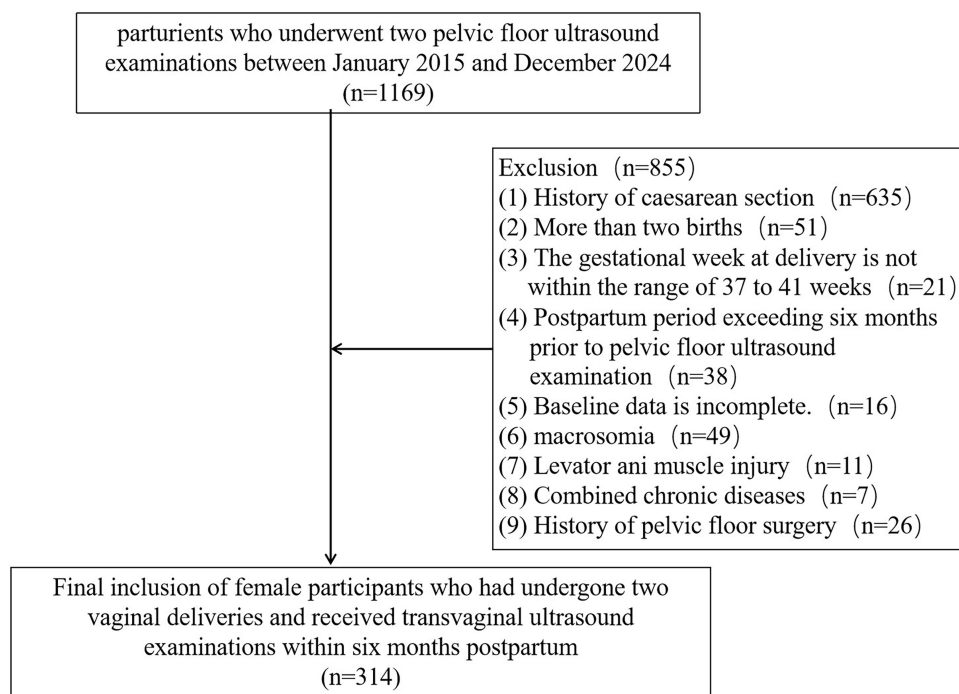
### Exclusion Criteria

1. Delivery assisted by forceps or vacuum extractor; 2. Incomplete baseline data; 3. History of pelvic surgery; 4. Patients with levator ani muscle injury identified by postpartum pelvic floor ultrasound; 5. Chronic conditions affecting pelvic floor structure and function (such as persistent cough, chronic constipation, chronic pulmonary disease, etc).

All participants underwent standardized transperineal 2D pelvic floor ultrasound assessment.<sup>2</sup> All ultrasound examinations are performed by physicians with over 10 years of experience in pelvic floor ultrasound. During the inclusion period, the evaluation protocol underwent no significant changes, consistently employing the same imaging system and methodology (Figure 1).

### Clinical Data

The collected clinical baseline data included: age at both deliveries, pre-pregnancy BMI, post-pregnancy BMI, gestational weight gain, gestational age at delivery, newborn birth weight, presence of episiotomy, and presence of perineal tear, And the IPI was calculated based on the ages at the two deliveries.



**Figure 1** Flowchart of the study population.

## Ultrasonic Data

Use GE Volusion E6/E8/E10 or Mindray ultrasound diagnostic systems, configured with an abdominal probe frequency of 3–5 MHz and a transvaginal probe frequency of 5–9 MHz. After bladder emptying, position the patient in the lithotomy position. Acquire two-dimensional images of the mid-sagittal plane of the pelvic floor during both resting and maximum Valsalva maneuvers.

### Maximum Valsalva Criteria

After taking a deep breath and holding it, exert force downward as if straining to defecate. The monitor displays pelvic organs shifting posteriorly and caudally, with exertion lasting over 6 seconds.

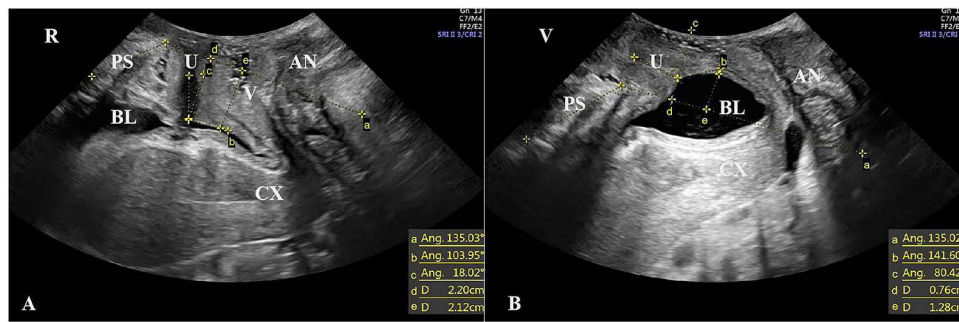
### Parameter Measurement and Diagnostic Criteria

Reference line at the posterior inferior margin of the pubic symphysis: In the mid-sagittal plane of the pelvic floor, establish a Cartesian coordinate system with the posterior inferior margin of the pubic symphysis as the origin and the midline of the pubic symphysis forming a 45° angle with the x-axis passing through the posterior inferior margin of the pubic symphysis. This system is used to estimate the position and movement of the bladder neck and urethra. Treat records above the reference line as positive values and records below the line as negative values.<sup>2</sup>

### Measurement Standards

Measurement standards measure the vertical distance from the bladder neck and the lowest point of the posterior bladder wall to the horizontal reference line at the posterior inferior border of the symphysis pubis on the mid-sagittal plane. Measure the urethral angle (UA) (the angle between the proximal urethra and the body's longitudinal axis) and the posterior bladder angle (PBA) (the angle between the proximal urethra and the tangent line to the posterior bladder wall). Bladder neck displacement (BND): the difference in bladder neck distance from the posterior inferior margin of the symphysis pubis during rest and during maximum Valsalva. Urethral rotation angle (URA): the difference between the UA of inclination at rest and during maximum Valsalva (Figure 2).

Ultrasound diagnostic criteria for cystocele: Mild cystocele is defined as descent of the bladder below the symphysis pubis by <10mm, whereas ≥10mm is defined as significant cystocele.



**Figure 2** Two-dimensional ultrasound image. (A) at rest; (B) At maximum Valsalva. a reference line; b posterior angle of the bladder, c angle of urethral inclination; d distance between the bladder neck and the reference line; e distance between the lowest point of the posterior bladder wall and the reference line.

**Abbreviations:** R, rest; V, valsalva; PS, pubic symphysis; BL, bladder; V, vagina; CX, cervix; AN, anus.

Prior to evaluating the ultrasound images, Dr XY L conducted a series of repeatability tests for bladder descent, UA and BPA, with all measurements demonstrating high repeatability (intraclass correlation coefficients of 0.821 or higher).

## Statistical Analysis

All statistical analyses were performed using EmpowerStats software (version X.Y.Z; Xiamen Enlighten Stats Co., Ltd., China) and R software (version 4.4.1; R Foundation for Statistical Computing, Vienna, Austria). Continuous variables with a normal distribution are presented as mean  $\pm$  standard deviation, while those with a skewed distribution are presented as median (interquartile range). Categorical variables are expressed as frequency (percentage).

To compare the differences in parameters between the two deliveries, comparisons between groups for continuous variables were performed using one-way analysis of variance or the Kruskal–Wallis test according to distribution characteristics. Categorical variables were analysed using the chi-square test or Fisher’s exact test. Pearson’s test or Spearman’s test was used to analyse the impact of various parameters following the first delivery on the severity of cystocele after the second delivery. We then applied multiple regression analyses to estimate the independent relationship between pelvic floor parameters following the first delivery and severity of cystocele after the second delivery, with an adjustment for potential confounders.

To assess whether IPI moderates the association between the degree of cystocele after the first vaginal delivery and after the second delivery, we referred to the WHO report<sup>15</sup> and divided IPI into three groups: < 24 months, 24–36 months, and > 36 months. We fitted linear regression models separately within each delivery interval subgroup to estimate the subgroup-specific associations, and reported the regression coefficients ( $\beta$ ), 95% confidence intervals (CI), and two-sided p-values. To formally examine the effect of the modification, we included the interaction term between the first childbirth cystocele (continuous variable) and IPI (categorical variable) in the combined regression model, and evaluated using an F-test (p for interaction). Given that the interval categories have an order, we further conducted a linear trend test: We assigned the three groups as ordinal scores (1, 2, 3), and incorporating this score into the model for a Wald test to assess linear trends (p for trend). Based on clinical and biological plausibility, we pre-specified a set of potential confounders from the first delivery for adjustment in our analyses. These included: maternal age (years), prepregnancy BMI ( $\text{kg}/\text{m}^2$ ), postpartum BMI (categorized as <25.0, 25.0–29.9, or  $\geq 30.0$   $\text{kg}/\text{m}^2$ ), gestational weight gain (kg), and firstborn birth weight (kg).

This study used two-sided statistical testing, with P values < 0.05 indicating statistical significance.

## Result

A total of 314 parturients meeting the criteria were included in this study. Age, two pre-pregnancy BMI, postpartum BMI, gestational weight gain, newborn birth weight, episiotomy, perineal laceration, postpartum SUI, bladder neck mobility, lowest point of the posterior bladder wall after Valsalva manoeuvre, and both BPA and URA after Valsalva manoeuvre all exhibited statistically significant differences ( $p < 0.05$ ). There were no statistically significant differences in gestational weeks at delivery or pre-pregnancy BMI between the two deliveries (Table 1).

**Table 1** Baseline Characteristics of Participants

Characteristic	First Delivery (n=314)	Second Delivery (n=314)	p
Age (years)	27.7 ± 3.0	30.8 ± 3.8	<0.001
Gestational age (weeks)	39.4± 1.1	39.4± 1.0	0.754
Pre-pregnancy BMI (kg/m <sup>2</sup> )	20.0 ± 2.5	20.9 ± 2.9	<0.001
Pre-delivery BMI (kg/m <sup>2</sup> )	25.4±2.7	25.8±2.9	0.118
Postpartum BMI (kg/m <sup>2</sup> )	22.3±2.7	22.8±2.8	0.019
Gestational weight gain (Kg)	13.9 ± 4.2	12.5 ± 4.0	<0.001
Newborn birth weight (kg)	3.2 ± 0.3	3.3 ± 0.4	0.001
IPI (M)	-	37.8 ± 18.0	
Presence of episiotomy			<0.001
No	88 (28.0%)	246 (78.3%)	
Yes	226 (72.0%)	68 (21.7%)	
Perineal tear			<0.001
No	199 (63.4%)	64 (20.4%)	
Yes	115 (36.6%)	250 (79.6%)	
SUI			<0.001
No	273 (86.9%)	220 (70.1%)	
Yes	41 (13.1%)	94 (29.9%)	
BND (mm)	27.6 ± 8.5	31.1 ±7.8	<0.001
Lowest point of the bladder wall following Valsalva (mm)	-12.4 ± 9.9	-16.0 ± 9.7	<0.001
PBA following valsalva (°)	141.6± 21.8	146.7 ± 21.7	0.010
URA (°)	53.8±26.7	62.1±25.6	0.043

**Abbreviations:** IPI, interpregnancy intervals; SUI, Stress Urinary Incontinence; BND, Bladder neck displacement; URA, Urethral rotation angle; °, degrees.

**Table 2** shows the effect of baseline data after the first delivery on the severity of cystocele after the second delivery. Univariate analysis revealed a positive correlation between the lowest point of the posterior bladder wall after the first delivery and the severity of cystocele after second delivery ( $\beta = 0.5$ , 95% CI 0.4–0.6,  $P < 0.001$ ). Additionally, prenatal/

**Table 2** Univariate Analysis for Severity of Cystocele After the second Delivery

Influencing Factors (First Delivery)	Statistics	Severity of Cystocele following the Second Delivery	p
Age (years)	27.7 ± 3.0	0.3 (-1.0, 1.6)	0.68
Gestational weight gain (kg)	13.9 ± 4.2	-0.3 (-0.5, -0.0)	0.027
Pre-delivery BMI (kg/m <sup>2</sup> )	25.4 ± 2.7	-0.6 (-1.0, -0.2)	0.003
Newborn birth weight (kg)	3.2 ± 0.3	-4.9 (-8.0, -1.8)	0.002
Gestational age (weeks)			
37	11 (3.5%)	0	
38	51 (16.2%)	5.9 (-0.3, 12.1)	0.064
39	98 (31.2%)	5.1 (-0.8, 11.1)	0.093
40	99 (31.5%)	2.7 (-3.2, 8.7)	0.372
41	55 (17.5%)	1.4 (-4.8, 7.6)	0.654
SUI			
No	273 (86.9%)	0	
Yes	41 (13.1%)	-0.1 (-3.3, 3.1)	0.958
Presence of episiotomy			
No	88 (28.0%)	0	
Yes	226 (72.0%)	-1.8 (-4.2, 0.6)	0.143

(Continued)

**Table 2** (Continued).

Influencing Factors (First Delivery)	Statistics	Severity of Cystocele following the Second Delivery	p
Perineal tear			
No	199 (63.4%)	0	
Yes	115 (36.6%)	-0.1 (-2.3, 2.1)	0.943
IPI (months)	37.8 ± 18.0	-0.1 (-0.1, -0.0)	0.036
PBA following valsalva (°)	141.6 ± 21.8	-0.0 (-0.1, 0.0)	0.758
URA (°)	53.8 ± 26.7	-0.1 (-0.1, -0.1)	<0.001
BND (mm)	27.6 ± 8.5	-0.3 (-0.5, -0.2)	<0.001
Lowest point of the bladder wall following Valsalva (mm)	-12.4 ± 9.9	0.5 (0.4, 0.6)	<0.001
Degree of bladder prolapse			
No	26 (8.3%)	0	
Mild	93 (29.6%)	-6.2 (-9.9, -2.5)	0.001
Obvious	195 (62.1%)	-13.7 (-17.2, -10.2)	<0.001

**Abbreviations:** IPI, interpregnancy intervals; SUI, Stress Urinary Incontinence; BND, Bladder neck displacement; URA, Urethral rotation angle; °, degrees.

postnatal BMI, pregnancy weight gain, newborn birth weight, URA, and BND were positive associated with the severity of cystocele following second delivery (greater severity after subsequent deliveries). According to cystocele grading the degree of cystocele after the first delivery was positively associated with greater worsening after the second delivery (mild vs absent: -6.2; marked vs absent: -13.7; both  $P \leq 0.001$ ). The first age, week of gestation at delivery, SUI, episiotomy, and perineal laceration showed no significant association. IPI showed a weak negative correlation with the degree of cystocele following the second delivery ( $\beta = -0.1$ ,  $P = 0.036$ ).

After adjusting for first-pregnancy weight gain, pre-pregnancy and postpartum BMI, and newborn birth weight, the lowest point of the posterior bladder wall after the first delivery was an independent predictor of cystocele severity after the second delivery ( $\beta = 0.5$ , 95% CI 0.4–0.6,  $P < 0.001$ ). After incorporating IPI into the model, the effect size and significance remained unchanged (Table 3).

The sample sizes of the three subgroups after IPI stratification were 80 cases ( $\leq 24$  months), 100 cases (24–36 months), and 134 cases ( $> 36$  months), respectively. The association between the degree of cystocele after the first delivery and that after the second delivery is moderated by the IPI. In the adjusted model (Model I), the regression coefficient ( $\beta$ ) of this association showed a monotonically decreasing trend with increasing IPI: for the  $\leq 24$  months group,  $\beta = 0.70$  (95% CI, 0.50–0.90;  $P < 0.001$ ); for the 24–36 months group,  $\beta = 0.50$  (95% CI, 0.30–0.70;  $P < 0.001$ ); for the  $> 36$  months group,  $\beta = 0.40$  (95% CI, 0.30–0.60;  $P < 0.001$ ). Although the formal interaction test did not reach the traditional statistical significance level ( $p$  for interaction = 0.11), the trend test treating the IPI as an ordinal variable was statistically significant ( $p$  for trend = 0.04), indicating a gradually weakened of the predictive association with longer IPI. The above estimated values are in complete agreement with the crude model, and they are also stable in each subgroup (Table 4, Figure 3).

**Table 3** Relationship Between the Lowest Point of the Posterior Bladder Wall During First and second Deliveries

Outcome	Crude Model		Model I		Model II	
	$\beta$ (95% CI)	p	$\beta$ (95% CI)	p	$\beta$ (95% CI)	p
The lowest point of the bladder wall following the second delivery (mm)	0.5 (0.4, 0.6)	<0.001	0.5 (0.4, 0.6)	<0.001	0.5 (0.4, 0.6)	<0.001

**Notes:** Model I adjusted for postpartum parameters following the first delivery, including gestational weight gain (kg), urinary incontinence, episiotomy, perineal laceration, pre- and postnatal BMI ( $\text{kg}/\text{m}^2$ ), and neonatal birth weight (kg). Model II adjusted for post-first-birth parameters included gestational weight gain (kg), urinary incontinence, episiotomy, perineal laceration, pre- and postnatal BMI ( $\text{kg}/\text{m}^2$ ), neonatal birth weight (kg), and interpregnancy interval (months).

**Abbreviation:** CI, confidence interval.

**Table 4** Association Between First- and second-Delivery Bladder Descent by IPI

IPI (Month)	Crude Model $\beta$ (95% CI)	<i>p</i>	Model I $\beta$ (95% CI)	<i>p</i>
$\leq 24$	0.7 (0.5, 0.9)	<0.0001	0.7 (0.5, 0.9)	<0.0001
>24, $\leq 36$	0.5 (0.3, 0.7)	<0.0001	0.5 (0.3, 0.7)	<0.0001
>36	0.4 (0.3, 0.6)	<0.0001	0.4 (0.3, 0.6)	<0.0001
<i>p</i> for interaction		0.06		0.11
<i>p</i> for trend		0.02		0.04

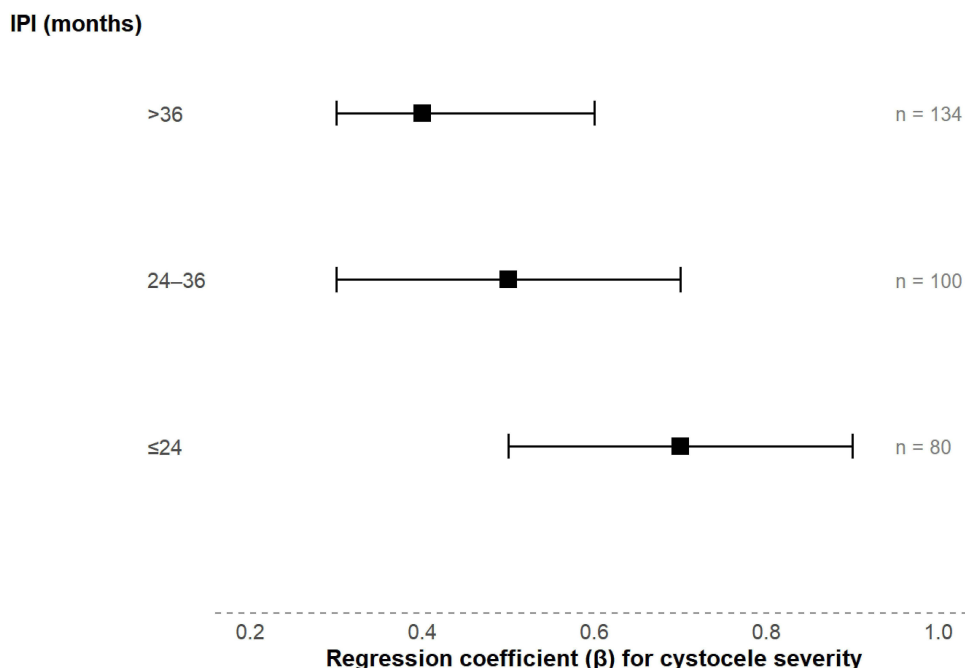
**Notes:** Model I adjusted for postpartum parameters following the first delivery, including gestational weight gain (kg), urinary incontinence, episiotomy, perineal laceration, pre- and postnatal BMI ( $\text{kg}/\text{m}^2$ ), and neonatal birth weight (kg).

**Abbreviations:** CI, confidence interval; IPI, interpregnancy interval.

## Discussion

This retrospective self-controlled cohort study involving 314 women who had undergone two vaginal deliveries demonstrated that the degree of cystocele after the first delivery has a stable predictive effect on the pelvic floor support status during the second delivery, and this predictive strength shows a monotonically decreasing gradient relationship as the IPI lengthens. This study effectively controlled for individual characteristics that do not change over time (such as the baseline of pelvic floor anatomy and genetic factors), and the adjustment of key covariates further enhanced the reliability of the results. This indicates that our study findings can provide important guidance for individualized consultation on the timing of childbirth for women who have already suffered pelvic floor damage after their first delivery in clinical practice.

Our study revealed a strong and nearly linear positive correlation between the lowest point of the posterior bladder wall during the first delivery and that of the second delivery. That is, the more severe the cystocele after the first delivery, the more noticeably it worsens after the second delivery. However, Ditez's earlier study<sup>16</sup> suggested that a second pregnancy and delivery appeared to have no significant impact on bladder support function, which is inconsistent with



**Figure 3** Association between first- and second-delivery cystocele severity by interpregnancy interval (IPI). Forest plot showing the regression coefficient ( $\beta$ ) for cystocele severity after the second delivery, stratified by IPI ( $\leq 24$  months, 24–36 months, >36 months). Sample sizes:  $n = 80$ , 100, and 134, respectively. Adjusted for maternal age, pre- and postpartum BMI, gestational weight gain, and newborn birth weight. *p* for interaction = 0.11; *p* for trend = 0.04.

our findings. This may be due to differences in sample size (65 cases vs 314 cases). Additionally, race and BMI may also be contributing factors. Shek et al<sup>2</sup> suggested that pelvic floor structural damage associated with vaginal delivery—such as levator ani avulsion and enlarged hiatus—exerts a persistent influence on anterior vaginal wall prolapse. They emphasized that TPUS can sensitively capture this “anatomical-functional” relationship, wherein abnormal bladder descent following the first delivery often portends more severe prolapse in the future.<sup>17</sup> Shao et al<sup>3</sup> found that cystocele symptoms were more significant among Chinese female populations who had experienced two vaginal deliveries, indicating that multiple vaginal deliveries exert a cumulative effect on pelvic floor function. Fonseca et al demonstrated through finite element modeling that second delivery—particularly without adequate recovery—may lead to increased accumulation of damage, thereby heightening the risk of pelvic floor dysfunction (PFD). Our research is highly consistent with these conclusions. By using self-comparisons to minimize confounding, we further indicated that vaginal delivery has a persistent impact on the changes in pelvic floor function.

Our further analysis revealed that the linear correlation between the downward displacement of the bladder after the first delivery and that after the second delivery was influenced by IPI, which is consistent with the findings of previous studies.<sup>18,19</sup> On this basis, our study further clarified the role of the IPI as an effect modifier by performing a stratified analysis. The regression coefficients for the subgroups ( $\leq 24$ ,  $>24$ – $36$ , and  $>36$  months) were 0.70, 0.50, and 0.40, respectively. Although the interaction was not significant ( $p = 0.11$ ), the significant linear trend ( $P = 0.04$ ) strongly suggested a moderating effect of IPI: The predictive strength of the degree of cystocele after the first delivery for the severity of cystocele after the second delivery decreases monotonically as the IPI lengthens. Furthermore, our adjustment set incorporated more factors related to the parameters of the first childbirth characteristics, resulting in a more targeted estimate of the association between this risk factor and the outcome. Rynkevicius et al’s study indicates that even in vaginal deliveries without obvious lacerations, the pelvic floor muscles may experience “minor injuries”, resulting in functional decline. This change can persist for up to two years after childbirth.<sup>20</sup> Animal model experiments also confirm this conclusion, likely due to the impact of elastin on soft tissue compliance, preventing the vaginal biomechanical properties from returning to their pre-pregnancy state after gestation.<sup>21</sup> Following the first delivery, pelvic floor tissues that have not fully recovered or are vulnerable may repeatedly endure small to moderate mechanical loads over time (such as inadequate weight restoration), leading to the gradual accumulation of microdamage. This ultimately results in measurable structural descent or functional deterioration. This accumulation is particularly significant during the 2–3-year postpartum remodeling window.<sup>22,23</sup> The existence of this reparative window provides a mechanistic explanation for the strongest cumulative effect observed at intervals of  $\leq 24$  months, where incomplete tissue repair prior to the next delivery leads to additive damage. Conversely, intervals  $>36$  months facilitate near-complete restitution of both collagen architecture and neuromuscular function, thereby attenuating the ability of the initial prolapse to predict subsequent severity. Consequently, while prior research has established the longitudinal persistence of pelvic floor anatomical states, our findings newly show the IPI as a dynamic and modifiable temporal factor capable of altering this trajectory.

Our research also found that following a second delivery, BMI levels were significantly higher than after the first delivery, both during the pre- and postpartum periods, indicating the occurrence of “postpartum weight retention”. This is consistent with previous research.<sup>24</sup> This indicates that following a second delivery, in addition to increased maternal age and reduced metabolic rate, parity may also contribute to cumulative effects leading to persistent weight retention.<sup>25</sup>

This study also has some limitations. First, we did not include women who had cesarean sections, considering that vaginal delivery affects pelvic floor tissues differently during labor compared to cesarean delivery. Future research could compare the differences in pelvic floor function outcomes between the two delivery methods in a second pregnancy. Second, this study is a retrospective study, and some cases were excluded due to incomplete data, which may introduce selection bias. Finally, this study is a single-center study, and its conclusions may not be applicable to other centers. Future studies may include data from multiple centers for validation.

In conclusion, cystocele after the first vaginal delivery strongly predicts severity after a second delivery, with evidence that longer IPI may attenuate this risk. These findings support using TPUS for early risk stratification and individualized counseling on birth spacing and pelvic floor protection to promote long-term women’s health.

## Data Sharing Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

## Ethical Approval

This study was reviewed and approved by the Ethics Committee of The First Affiliated Hospital of Shenzhen University. All activities were carried out in full compliance with the ethical standards outlined in the Declaration of Helsinki.

## Informed Consent

Informed consent was obtained from all subjects involved in the study.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

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