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ARTICLE

Prognostic Potential of Clinical Factors, Serological Indicators, and Pelvic Floor Ultrasound Parameters in Women With Postpartum Stress Urinary Incontinence

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Abstract

Aims/Background Numerous studies have assessed factors influencing stress urinary incontinence (SUI); however, their findings are somewhat inconsistent. Therefore, this study aimed to explore the predictive potential of clinical characteristics and serological indicators combined with pelvic floor ultrasound parameters for postpartum SUI. Furthermore, the analysis was intended to determine the prevalence and factors affecting postpartum SUI among women in China.

Methods This retrospective analysis included 511 parturient women who underwent prenatal examinations and gave birth at Yongkang Women and Children's Health Hospital between January 2023 and June 2024. Based on the occurrence of SUI within 6 months postpartum, the patients were divided into the SUI (204 cases) and the non-SUI (307 cases) groups. The baseline characteristics, serological indicators, and pelvic floor ultrasound parameters were comparatively analyzed between the two groups. Multivariable logistic regression analysis was applied to assess the factors affecting postpartum SUI. Furthermore, receiver operating characteristic (ROC) curves were drawn to determine the predictive efficacy of indicators that demonstrated statistically significant differences concerning postpartum SUI.

Results The two study groups demonstrated statistically significant differences in mode of delivery and constipation during pregnancy ($p < 0.05$). The SUI group had significantly lower serum estradiol, progesterone, and 25-hydroxyvitamin [25(OH)D] than the non-SUI group ($p < 0.05$). Furthermore, the SUI group showed substantially higher bladder neck descent, urethral rotation angle, posterior urethrovesical angle, levator hiatus area, and urethral funnel formation than the non-SUI group ($p < 0.05$). The bladder neck descent, urethral rotation angle, posterior urethrovesical angle, levator hiatus area, and urethral funnel formation were identified as significant risk factors for postpartum SUI ($p < 0.05$). However, serum progesterone and 25(OH)D levels served as protective factors against SUI ($p < 0.05$). ROC analysis revealed that a combination of progesterone, 25(OH)D, bladder neck descent, urethral rotation angle, posterior urethrovesical angle, levator hiatus area, and urethral funnel formation significantly increased the area under the curve (AUC) to 0.975 ($p < 0.001$, 95% CI: 0.964–0.985), with a sensitivity of 0.946 and specificity of 0.860.

Conclusion The study observed a relatively higher incidence of postpartum SUI among Chinese women, affected by various contributing factors. Combining serological indicators with pelvic floor ultrasound parameters indicated strong predictive efficacy for postpartum SUI.

Key words: postpartum period; stress urinary incontinence; risk factors; ultrasonography; biological markers

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Introduction

Pregnancy and childbirth can cause damage or rupture to the pelvic floor muscle fibers, resulting in pelvic organ prolapse, urinary incontinence, sexual dysfunction, and discomfort during urination in the pregnant and lying-in women (Hage-Fransen et al, 2021; Tunn et al, 2023). Stress urinary incontinence (SUI) is one of the most common postpartum pelvic floor dysfunctions, significantly affecting women's quality of life for a long time. As the disease progresses, treatment costs tend to increase, elevating the financial burden on families and healthcare systems (Jefferson and Linder, 2024; Kobashi et al, 2023; Tabei et al, 2024). Therefore, early identification of pregnant women at risk for SUI and prompt interventions during pregnancy are not only crucial for reducing the occurrence of postpartum SUI and improving their quality of life, but also for maximizing the use of medical resources.

At present, numerous studies have investigated factors affecting SUI; however, their findings remain somewhat inconsistent. For example, a retrospective analysis by Liu and Qian (2024) identified age, vaginal delivery, and parity as independent risk factors for postpartum SUI. In contrast, Wang et al (2020) associated SUI with age, maternal body mass index (BMI), and gestational weight gain, but not with parity. Gao et al (2021) observed no significant association between SUI and age, instead reporting pre-pregnancy BMI, diabetes, neonatal overweight, and abortion history as risk factors for the occurrence of SUI in primiparous women. Furthermore, Chang et al (2023) conducted a retrospective analysis involving 6302 postpartum women and found that weight, constipation, parity, gestational age, and mode of delivery were independent risk factors for postpartum SUI. Kristiansson et al (2001) investigated an association between hormones and SUI during pregnancy and postpartum period and found that progesterone levels were significantly linked to SUI, while estradiol showed no substantial correlation. You et al (2023) conducted pelvic floor ultrasound testing on 103 primiparous women and reported its potential in predicting postpartum SUI.

Due to population heterogeneity across different countries and regions, the prevalence and risk factors of postpartum SUI vary to some extent. Even within the same region, the prevalence of postpartum SUI can change over time. Furthermore, most studies have focused on specific indicators, such as "clinical factors", "serological indicators" or "pelvic floor ultrasound parameters", rather than combining these three dimensions. Consequently, there remained a significant gap in studies assessing the integrated predictive value of clinical, biochemical, and imaging markers for postpartum SUI.

To address this knowledge gap, we conducted a comprehensive retrospective analysis of clinical factors, serological indicators, and pelvic floor ultrasound parameters in 511 parturient women who underwent treatment and delivery at Yongkang Women and Children's Health Hospital. This analysis aimed to determine the prevalence and potential influencing factors of postpartum SUI among Chinese women, improve the accuracy of its prediction, and help in developing more targeted and effective preventive interventions.

Methods

Study Participants

A retrospective analysis was conducted on the clinical data of 511 parturient women who underwent prenatal examinations and gave birth at Yongkang Women and Children's Health Hospital between January 2023 and June 2024. Based on the occurrence of SUI within 6 months postpartum, the individuals were divided into the SUI (204 cases) and the non-SUI (307 cases) groups. Diagnosis of SUI followed previously established criteria (Deutchman and Wulster-Radcliffe, 2005), which include involuntary urine outflow from the external urethral opening during an episode of elevated abdominal pressure caused by sneezing, laughing, coughing, or lifting heavy objects on one or more occasions.

Inclusion and Exclusion Criteria

The inclusion criteria for study participant selection were set as follows: (1) patients aged 20–35 years who delivered at Yongkang Women and Children's Health Hospital and had complete clinical data; (2) patients with singleton full-term pregnancy; (3) patients with no previous history of incontinence; and (4) patients with clear consciousness, normal cognitive ability, no history of mental illness.

Exclusion criteria included (1) a history of urinary tract infection or recent pelvic inflammation, (2) a history of genitourinary surgery during pregnancy, (3) the presence of malignant tumors or vital organ dysfunction, (4) diagnosis of pelvic floor dysfunction, (5) other complications such as pre-eclampsia or retained postpartum placenta, and (6) postpartum hemorrhage. A flow chart of patient selection is summarized in Fig. 1.

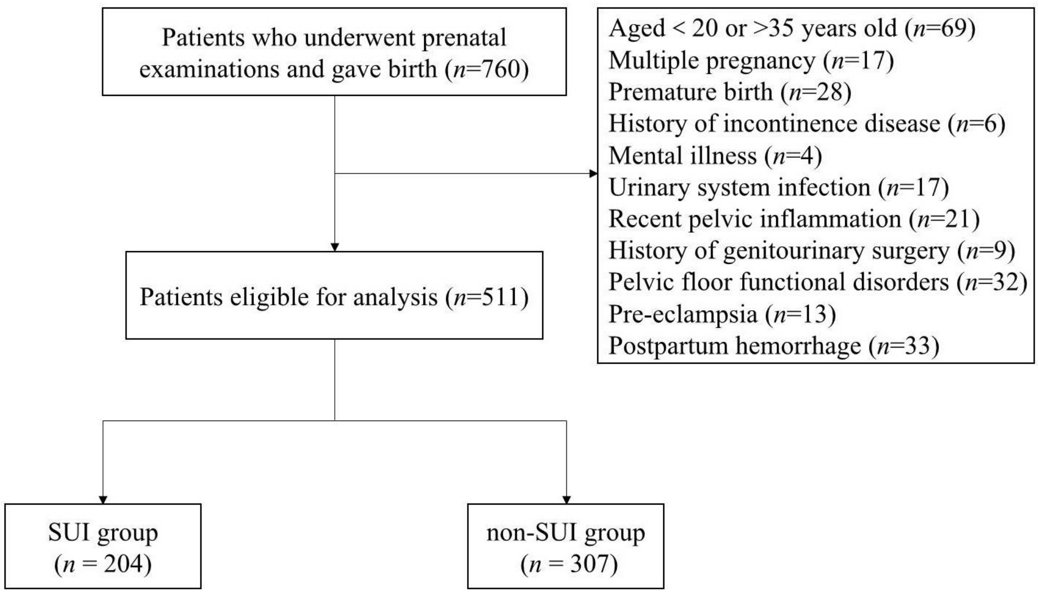

Fig. 1. A flowchart of patient recruitment. SUI, stress urinary incontinence.

Data Collection and Observational Indicators

Upon admission, patients were comprehensively examined, and data regarding their baseline characteristics, serological indicators, and pelvic floor ultrasonic parameters were collected for subsequent analysis.

Baseline characteristics were recorded during patient's assessment and included various factors such as number of pregnancies, number of deliveries, age at delivery, mode of delivery, gestational age at delivery, body mass index (BMI) before delivery, the height of uterine fundus, abdominal circumference, neonatal birth weight, gestational hypertension, gestational diabetes mellitus, and constipation during pregnancy.

Serological indicators documented during the late pregnancy included total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglycerides, all analyzed using a fully automated biochemical analyzer (LABOSPECT 008 α, Shanghai Hitachi Diagnostic Products Co., Ltd., Shanghai, China). Furthermore, hormonal markers, include estradiol (Estradiol determination kit, Beckman Coulter Trading, China, item number: 33540, Shanghai, China), progesterone (Progesterone diagnostic kit, Beckman Coulter Trading, China, item number: 33550, Shanghai, China). Moreover, the levels of 25 hydroxyvitamin D (25(OH)D (detection kit, Zhengzhou Antu Bioengineering Co., Ltd., Yuxiang Zhuzhun 20192400270, Zhengzhou, China)) were measured using the magnetic particle chemiluminescence method.

Pelvic floor ultrasonic assessments were performed by a team of experienced sonographers using a color Doppler ultrasound system (Voluson E8, General Electric Company, Milwaukee, WI, USA) equipped with a RIC5-9D vaginal probe (General Electric Company, Boston, MA, USA). Individuals were advised to empty their bladder 10 minutes before the examination. The assessment was conducted in the lithotomy position, with knees bent and heels close to the buttocks. After guidance on pelvic floor muscle contraction training, the surface of the volumetric probe was coated with a sufficient amount of coupling gel, covered with a disposable probe cover, and the air was expelled. Then, the probe was placed on the perineum with the central axis kept perpendicular to the assessment plane. During the examination, the following parameters were measured: detrusor muscle thickness, post-void residual urine volume, bladder neck descent, urethral rotation angle, posterior urethrovesical angle, levator hiatus area, and urethral funnel formation.

Statistical Analysis

Statistical analysis was performed using SPSS 27.0 software (IBM Corp, Armonk, NY, USA). Continuous variables were assessed for normality using the Kolmogorov-Smirnov test. Variables conforming to normal distribution were expressed as mean $\pm$ standard deviation (SD) and compared using the *t*-test. Categorical variables were expressed as counts and percentages [n (%)], with comparisons made using the chi-square test. The factors affecting postpartum SUI were determined through Multivariable logistic regression models. Receiver operating characteristic (ROC) curves were drawn to assess the predictive efficacy of indica-

Table 1. Comparison of clinical baseline characteristics between the two groups.

Characteristics	SUI group (n = 204)	Non-SUI group (n = 307)	Univariate tests	p-value
Number of pregnancies [n (%)]			0.192	0.662
1–2 times	49 (24.02)	79 (25.73)		
≥3 times	155 (75.98)	228 (74.27)		
Number of deliveries [n (%)]			0.610	0.435
1 time	159 (77.94)	248 (80.78)		
≥2 times	45 (22.06)	59 (19.22)		
Age at delivery (years)	28.46 ± 4.05	27.90 ± 3.06	1.769	0.077
Mode of delivery [n (%)]			7.213	0.007
Natural birth	161 (78.92)	209 (68.08)		
Caesarean section	43 (21.08)	98 (31.92)		
Gestational age at delivery (weeks)	39.08 ± 1.66	39.16 ± 1.72	–0.535	0.593
BMI before delivery (kg/m^2)	27.52 ± 1.71	27.75 ± 1.62	–1.547	0.122
Height of uterine fundus (cm)	34.21 ± 3.67	34.44 ± 3.77	–0.689	0.491
Abdominal circumference (cm)	91.62 ± 4.46	92.07 ± 5.53	–0.979	0.328
Neonatal birth weight (g)	3130.11 ± 409.42	3118.09 ± 366.41	0.347	0.729
Gestational hypertension [n (%)]			0.017	0.897
Yes	22 (10.78)	32 (10.42)		
No	182 (89.22)	275 (89.58)		
Gestational diabetes mellitus [n (%)]			0.395	0.530
Yes	48 (23.53)	65 (21.17)		
No	156 (76.47)	242 (78.83)		
Constipation during pregnancy [n (%)]			8.829	0.003
Yes	77 (37.75)	78 (25.41)		
No	127 (62.25)	229 (74.59)		

Notes: SUI, stress urinary incontinence; BMI, body mass index.

tors that demonstrated statistically significant differences in concerning postpartum SUI. A p-value < 0.05 was considered statistically significant.

Results

Comparison of Clinical Baseline Characteristics Between the Two Groups

Among the 511 postpartum women analyzed in this study, 204 developed SUI at 6 months postpartum, with an incidence rate of 39.92%. No significant differences were observed between the two groups regarding clinical baseline characteristics, such as number of pregnancies, number of deliveries, age at delivery, gestational age at delivery, BMI before delivery, the height of uterine fundus, abdominal circumference, neonatal birth weight, gestational hypertension, and gestational diabetes mellitus ($p > 0.05$). However, there were significant differences regarding the mode of delivery and constipation during pregnancy ($p < 0.05$). A comparison of baseline characteristics between the two groups is shown in Table 1.

Table 2. Comparison of serological indicators between the two groups.

Variables	SUI group (n = 204)	Non-SUI group (n = 307)	t-value	p-value
Total cholesterol (mmol/L)	5.14 ± 0.82	5.16 ± 0.71	–0.369	0.713
High-density lipoprotein cholesterol (mmol/L)	1.77 ± 0.28	1.74 ± 0.28	1.174	0.241
Low-density lipoprotein cholesterol (mmol/L)	3.22 ± 0.48	3.22 ± 0.44	0.076	0.939
Triglyceride (mmol/L)	3.36 ± 1.09	3.25 ± 1.03	1.085	0.279
Estradiol (μg/L)	64.80 ± 10.63	68.45 ± 11.56	–3.610	<0.001
Progesterone (μg/L)	190.83 ± 27.18	214.38 ± 22.55	–10.640	<0.001
25(OH)D (nmol/L)	52.15 ± 7.24	60.70 ± 7.75	–12.537	<0.001

Notes: SUI, stress urinary incontinence; 25(OH)D, 25-hydroxyvitamin D.

Table 3. Comparison of pelvic floor ultrasound parameters between the two groups.

Variables	SUI group (n = 204)	Non-SUI group (n = 307)	χ^2/t	p-value
Detrusor muscle thickness (mm)	3.33 ± 0.38	3.36 ± 0.35	–0.822	0.412
Residual urine volume (mL)	16.09 ± 2.50	15.65 ± 2.57	1.904	0.058
Bladder neck descent (mm)	24.80 ± 6.62	18.73 ± 5.82	10.929	<0.001
Urethral rotation angle (°)	49.16 ± 7.22	40.65 ± 7.40	12.842	<0.001
Posterior urethrovesical angle (°)	143.39 ± 18.79	127.36 ± 16.89	10.040	<0.001
Levator hiatus area (cm^2)	28.98 ± 3.29	25.75 ± 3.49	10.483	<0.001
Urethral funnel formation [n (%)]			61.436	<0.001
Yes	120 (58.82)	75 (24.43)		
No	84 (41.18)	232 (75.57)		

Notes: SUI, stress urinary incontinence.

Comparison of Serological Indicators Between the Two Groups

No significant differences were observed between the two groups in serum total cholesterol, HDL-C, LDL-C, or triglyceride ($p > 0.05$). However, the SUI group exhibited significantly lower serum estradiol, progesterone, and 25(OH)D levels compared to the non-SUI group ($p < 0.05$, Table 2).

Comparison of Pelvic Floor Ultrasound Parameters Between the Two Groups

There were no statistically significant differences between the two groups in detrusor muscle thickness and residual urine volume ($p > 0.05$). However, the SUI group showed significantly higher bladder neck descent, urethral rotation angle, posterior urethrovesical angle, levator hiatus area, urethral funnel formation than the non-SUI group ($p < 0.05$, Table 3).

Multivariable Logistic Regression Models of Postpartum SUI

Using the occurrence of postpartum SUI as the dependent variable (1 = yes, 0 = no), a multivariate logistic regression analysis was conducted with statistically

Table 4. Multivariable logistic regression models of postpartum SUI.

Variables	β	SE	Wald χ^2	p-value	OR	95% CI
Mode of delivery	–0.251	0.418	0.360	0.549	0.778	0.343–1.766
Constipation during pregnancy	0.766	0.416	3.397	0.065	2.152	0.953–4.860
Estradiol	–0.022	0.016	1.787	0.181	0.979	0.948–1.010
Progesterone	–0.046	0.009	25.556	<0.001	0.955	0.938–0.972
25(OH)D	–0.168	0.027	37.772	<0.001	0.845	0.801–0.892
Bladder neck descent	0.221	0.034	41.029	<0.001	1.247	1.166–1.334
Urethral rotation angle	0.198	0.030	42.405	<0.001	1.220	1.149–1.295
Posterior urethrovesical angle	0.053	0.011	22.243	<0.001	1.054	1.031–1.078
Levator hiatus area	0.420	0.070	35.735	<0.001	1.522	1.326–1.746
Urethral funnel formation	1.311	0.391	11.232	0.001	3.712	1.724–7.992
Constant	–13.088	3.614	13.115	<0.001		

significant indicators from Tables 1,2,3 as independent variables. These variables included mode of delivery (1 = natural birth, 0 = caesarean section), constipation during pregnancy (1 = yes, 0 = no), serum estradiol (actual value), serum progesterone (actual value), 25(OH)D (actual value), bladder neck descent (actual value), urethral rotation angle (actual value), posterior urethrovesical angle (actual value), levator hiatus area (actual value), and urethral funnel formation (1 = yes, 0 = no). The analysis identified bladder neck descent ($p < 0.001$, OR = 1.247, 95% CI: 1.166–1.334), urethral rotation angle ($p < 0.001$, OR = 1.220, 95% CI: 1.149–1.295), posterior urethrovesical angle ($p < 0.001$, OR = 1.054, 95% CI: 1.031–1.078), levator hiatus area ($p < 0.001$, OR = 1.522, 95% CI: 1.326–1.746), and urethral funnel formation ($p = 0.001$, OR = 3.712, 95% CI: 1.724–7.992) as significant risk factors for postpartum SUI. However, serum progesterone ($p < 0.001$, OR = 0.955, 95% CI: 0.938–0.972) and 25(OH)D ($p < 0.001$, OR = 0.845, 95% CI: 0.801–0.892) were observed as protective factors. Multivariate logistic analysis is summarized in Table 4.

Prediction Efficacy of Serological Indicators Combined With Pelvic Floor Ultrasound Parameters for Postpartum SUI

ROC analysis showed that when progesterone levels were ≤196.45 µg/L, the area under the curve (AUC) for predicting postpartum SUI was 0.728 ($p < 0.001$, 95% CI: 0.684–0.772), with a sensitivity of 0.549 and specificity of 0.782. For 25(OH)D levels ≤54.81 nmol/L, the predicted AUC was 0.771 ($p < 0.001$, 95% CI: 0.731–0.811), with a sensitivity of 0.632 and specificity of 0.743. Furthermore, a bladder neck descent ≥21.50 mm demonstrated an AUC of 0.765 ($p < 0.001$, 95% CI: 0.722–0.808), with sensitivity and specificity of 0.637 and 0.736, respectively. A urethral rotation angle ≥43.50° yielded an AUC of 0.792 ($p < 0.001$, 95% CI: 0.754–0.830), with sensitivity of 0.789 and specificity of 0.707. A posterior urethrovesical angle ≥144.50° demonstrated an AUC of 0.725 ($p < 0.001$, 95% CI: 0.681–0.770), with a sensitivity of 0.632 and specificity of 0.684. When the levator hiatus area was ≥27.07 cm^2, the AUC was 0.729 ($p < 0.001$, 95% CI: 0.685–0.772), with a sensitivity of 0.730 and specificity of 0.632. For urethral

Table 5. Prediction efficacy of serological indicators combined with pelvic floor ultrasound parameters for postpartum SUI.

Variables	AUC	*p*-value	Cut-off	Sensitivity	Specificity	Youden index	95% CI
Progesterone	0.728	<0.001	196.45	0.549	0.782	0.331	0.684–0.772
25(OH)D	0.771	<0.001	54.81	0.632	0.743	0.375	0.731–0.811
Bladder neck descent	0.765	<0.001	21.50	0.637	0.736	0.373	0.722–0.808
Urethral rotation angle	0.792	<0.001	43.50	0.789	0.707	0.496	0.754–0.830
Posterior urethrovesical angle	0.725	<0.001	144.50	0.632	0.684	0.316	0.681–0.770
Levator hiatus area	0.729	<0.001	27.07	0.730	0.632	0.362	0.685–0.772
Urethral funnel formation	0.672	<0.001	-	0.588	0.756	0.344	0.623–0.721
Combined	0.975	<0.001	-	0.946	0.860	0.806	0.964–0.985

Notes: AUC, area under the curve.

funnel formation, the AUC was 0.672 ($p < 0.001$, 95% CI: 0.623–0.721), with sensitivity and specificity of 0.588 and 0.756, respectively. When all seven indicators were combined, the AUC elevated considerably to 0.975 ($p < 0.001$, 95% CI: 0.964–0.985), with a sensitivity of 0.946 and specificity of 0.860. Prediction efficacy of these seven indicators is shown in Table 5 and Fig. 2.

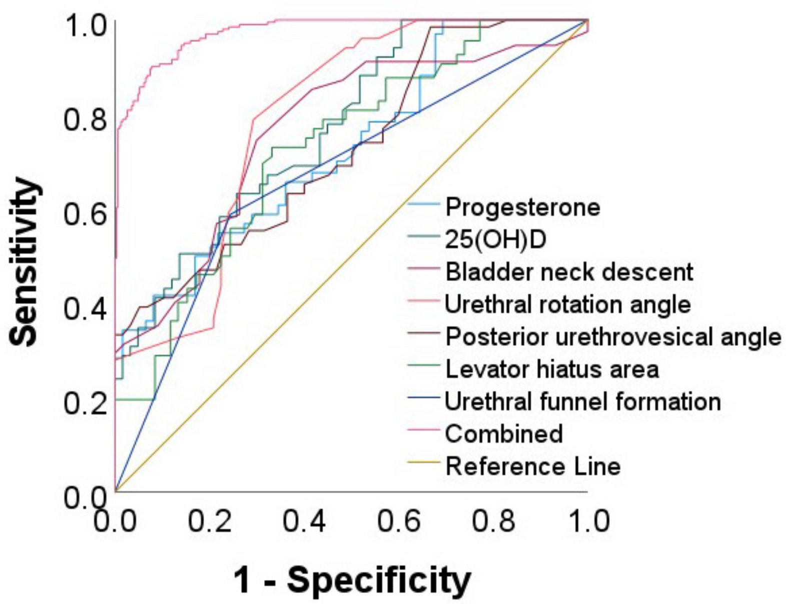

Fig. 2. ROC curve of serum indicators combined with pelvic floor ultrasound parameters for predicting postpartum SUI in women. ROC, receiver operating characteristic.

Discussion

Our study found that the incidence of SUI at 6 months among 511 postpartum women was 39.92% (204/511). Multivariable logistic regression models identified serum progesterone, 25(OH)D levels, bladder neck descent, urethral rotation angle, posterior urethrovesical angle, levator hiatus area, and urethral funnel formation as independent indicators of postpartum SUI. When combined, these factors demonstrated a predictive sensitivity and specificity of 0.946 and 0.860, respectively.

At present, numerous studies have investigated the incidence of postpartum SUI, but reported rates vary significantly due to differences in country, region, sample characteristics, and assessment time. Chang et al (2021) reported SUI rates of 42.5% in the third trimester and 10.4% within 3–5 days postpartum. Liu et al (2023) observed 29.5% (89/301) incidence at 6–8 weeks postpartum. Leroy et al (2016) investigated 344 women at 90 days postpartum and found an SUI incidence of 45.5%. Similarly, Wei et al (2022) conducted a pelvic floor function screening of 5013 women and reported an incidence of 19.33%. Mutaguchi et al (2022) observed an incidence of 22.8% within 3 months after delivery among 228 women. The incidence of postpartum SUI in our survey was 39.92%, which is relatively high. Several factors may contribute to this high rate. First, with the implementation of the second and third child policy in China, our study sample included both primiparous and about 20% multiparous women. Second, the six-month follow-up period allowed adequate time to recruit more cases, resulting in a higher observed incidence. These observations underscore the need for early risk assessment and targeted intervention for postpartum SUI among Chinese women during pregnancy.

Analyzing clinical factors, we found that postpartum SUI women had a high proportion of vaginal delivery and pregnancy-related constipation, which was consistent with the findings reported by Chang et al (2023). However, these variables were not included as significant predictors in our subsequent Multivariable logistic regression models. This finding is consistent with Wlaźlak et al (2015), who reported that demographic and clinical features are relatively weak predictors of SUI. Furthermore, this study assessed routinely monitored pregnancy indicators, such as blood lipid profile and estrogen levels. Notably, serum progesterone levels were observed as a protective factor against postpartum SUI. This may be due to progesterone's crucial role in maintaining pelvic floor function during pregnancy and the postpartum period (Farag et al, 2022; Molinet Coll et al, 2022; Reddy et al, 2020). As early as 1993, Ekström et al (1993) observed in rabbit models that progesterone improves bladder contraction, indicating its therapeutic potential in SUI. Moreover, Bai et al (2004) suggested that progesterone receptors may play a crucial role in the development of SUI.

Pelvic floor ultrasound allows for clear assessment of the thickness, shape, and contraction ability of pelvic floor muscles, as well as the position and structural integrity of pelvic organs such as bladder, uterus, and rectum. It is primarily used to examine the degree of pelvic organ prolapse and anatomical changes, offering several advantages including non-invasiveness, real-time imaging, and high reproducibility, which contributed to its widespread clinical adoption (Anzböck and Koensgen, 2023; Bahrami et al, 2021; Lima et al, 2022). Fani et al (2020) reported significant differences in pelvic floor ultrasound parameters between women with and without SUI. Hu et al (2023) found that both pelvic floor ultrasound and urodynamic parameters are effective in assessing SUI, with ultrasound offering the advantages of being cost-effective and highly comfortable for patients. Furthermore, a study by Chen et al (2018) demonstrated the significance of pelvic floor ultrasound parameters in identifying and calibrating SUI, recommending their combination with clinical factors for risk prediction. Several studies, such as those by Chen et al (2018) focused on identifying SUI during early pregnancy, and our study assessed postpartum SUI. Furthermore, Hagovska et al (2022) investigated the potential of pelvic floor ultrasound not only for diagnosis but also for predicting therapeutic outcomes in SUI women. The underlying mechanism may involve impaired urethral support, weak pelvic floor support structure, and overall pelvic floor relaxation. These changes alleviate the urethral closure pressure, and when abdominal pressure rises suddenly, such as during coughing or lifting, bladder pressure can exceed urethral resistance, leading to urine leakage (Hagovska et al, 2022; Wu et al, 2024; Zhuo et al, 2023).

Currently, the relationship between vitamin D and urinary incontinence remains controversial. A study by Stafne et al (2020) revealed that reduced serum 25(OH)D levels are associated with an increased risk of all types of urinary incontinence, especially SUI. Similarly, studies by Shahraki et al (2022) and Aydogmus et al (2023) proposed that vitamin D supplementation can help treat premenopausal SUI and gestational urinary incontinence. Conversely, Markland et al (2020) observed no significant link between vitamin D levels and the risk of SUI. The findings of our study align with the majority of current research (Aydogmus et al, 2023; Shahraki et al, 2022; Stafne et al, 2020), supporting the perspective that serum 25(OH)D levels serve as a protective factor against postpartum SUI.

Despite its promising outcomes, we acknowledge some limitations in this study: Firstly, all individuals were selected from a single hospital in China, which may limit the generalizability of the results due to small sample size. Secondly, due to certain constraints like limited manpower, our study only investigated the incidence of SUI within 6 months postpartum. Additionally, the analysis of serological indicators was limited to data collected during the third trimester, without including data from the first or second trimester. Similarly, other relevant hormones and biomarkers were also not examined. Therefore, future studies should expand the sample size, extend follow-up period, and include serological data from different pregnancy stages to validate these findings.

We assessed the incidence rate of postpartum SUI among women in China following the full implementation of the two-child and three-child policies. Unlike previous studies, this investigation was not limited to primiparous women and also included about 20% multiparous women. Additionally, our study integrated a broad range of variables, including clinical factors, related hormones and biomarkers, as well as pelvic floor ultrasound parameters, providing a more comprehensive assessment of the factors influencing postpartum SUI.

Conclusion

We observed a relatively high incidence of postpartum SUI among Chinese women, influenced by multiple contributing factors. The combination of serological indicators and pelvic floor ultrasound parameters showed strong predictive efficacy for postpartum SUI. These indicators can be used in clinical practice to predict women at risk, enabling early interventions and prompt preventive measures to reduce the incidence of postpartum SUI.

Key Points

- The incidence of SUI within 6 months postpartum was 39.92%, which was at a relatively high level.
- The SUI and non-SUI groups demonstrated significant differences in mode of delivery, constipation during pregnancy, serum progesterone, estradiol, 25(OH)D, bladder neck descent, urethral rotation angle, posterior urethrovesical angle, levator hiatus area, and urethral funnel formation.
- Multivariable logistic regression analysis identified serum progesterone, 25(OH)D levels, bladder neck descent, urethral rotation angle, posterior urethrovesical angle, levator hiatus area, and urethral funnel formation as significant influencing factors for postpartum SUI.
- A combination of these observed indicators showed a high predictive potential for SUI in women within 6 months postpartum.

Availability of Data and Materials

The data used to support the findings of this study are available from the corresponding author upon request.

Author Contributions

LMS and JHZ designed the research study and wrote the first draft. SYL and BW performed the research. YWD, BW and SYL analyzed the data. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was approved by Yongkang Women and Children's Health Hospital (YFB2024LS017) and complied with the basic principles of medical ethics outlined in the Declaration of Helsinki. All parturient women in this study signed informed consent forms.

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Conflict of Interest

The authors declare no conflict of interest.

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