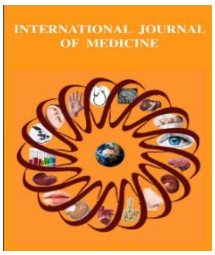

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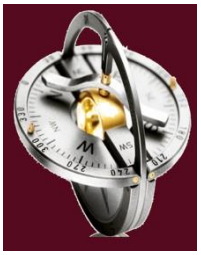

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Original Research

Comparative study of lower urinary tract symptoms among women following vaginal delivery and caesarean section.

Dr. Shridevi

Associate Professor, Department of Obstetrics and gynaecology, MNR College and Hospital, Fasalwadi, Mohd- Shapur, Telangana 502294, India.

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Abstract

Background: Lower urinary tract symptoms are common after childbirth and may adversely affect women's physical, psychological and social well-being. Vaginal delivery can cause pelvic-floor muscular, connective-tissue and neural injury, whereas caesarean section may offer partial protection. This study compared the prevalence, pattern and severity of LUTS among women following vaginal delivery and caesarean section. *Aim:* To compare lower urinary tract symptoms among women following vaginal delivery and caesarean section. *Materials and Methods:* This hospital-based comparative cross-sectional study included 140 postpartum women, with 70 women following vaginal delivery and 70 following caesarean section. Sociodemographic, maternal and obstetric information was collected using a structured proforma. LUTS and their impact were assessed using the International Consultation on Incontinence Questionnaire-Female Lower Urinary Tract Symptoms. Continuous variables were compared using Welch's independent-samples *t*-test, while categorical variables were compared using the chi-square test. Associations were expressed as odds ratios with 95% confidence intervals. A P value <0.05 was considered statistically significant. *Results:* The overall prevalence of LUTS was 35.7%. LUTS were significantly more frequent following vaginal delivery than caesarean section (45.7% versus 25.7%; OR=2.43, 95% CI: 1.19-4.96; P=0.014). The mean ICIQ-FLUTS score [7.8 (5.2) versus 4.9 (4.4); P<0.001] and quality-of-life interference score [3.1 (2.4) versus 1.9 (2.0); P=0.002] were significantly higher after vaginal delivery. Stress urinary incontinence was significantly more common following vaginal delivery (34.3% versus 14.3%; OR=3.13, 95% CI: 1.36-7.19; P=0.006). Differences in urgency, urgency urinary incontinence, frequency, nocturia, voiding symptoms and incomplete emptying were not statistically significant. Age ≥30 years, BMI ≥25 kg/m², parity ≥2, instrumental delivery, prolonged labour and episiotomy or perineal tear were significantly associated with LUTS. *Conclusion:* Women following vaginal delivery had a significantly higher prevalence and greater burden of LUTS, particularly stress urinary incontinence, than women following caesarean section. Screening for LUTS and early pelvic-floor rehabilitation should be integrated into postnatal care, especially for women with additional maternal or obstetric risk factors.

Keywords: *Lower urinary tract symptoms; vaginal delivery; caesarean section.*

Introduction

Lower urinary tract symptoms (LUTS) comprise a spectrum of storage, voiding and post-micturition symptoms, including increased daytime frequency, urgency, nocturia, urinary incontinence, hesitancy, straining, slow urinary stream, incomplete emptying and post-micturition dribbling. These symptoms are common among women and may adversely affect physical activity, emotional well-being, social participation, sexual health and overall quality of life. Pregnancy and childbirth are important periods during which LUTS may develop or worsen because of hormonal changes, increased intra-abdominal pressure, altered bladder function and mechanical stress on the pelvic floor. Vaginal delivery may cause stretching or injury to the pelvic floor muscles, connective tissues and pudendal nerves, particularly after prolonged labour, instrumental delivery, perineal trauma or delivery of a macrosomic baby. Such changes can reduce urethral support and contribute to stress urinary incontinence, urgency and other urinary complaints.

Caesarean delivery avoids direct passage of the fetus through the pelvic floor and may therefore offer some protection against postpartum pelvic floor dysfunction; however, pregnancy itself, labour before caesarean section, bladder catheterisation and operative trauma may still contribute to LUTS. A systematic review and meta-analysis by Tähtinen et al. found that vaginal delivery was associated with a higher long-term risk of stress and urgency urinary incontinence compared with caesarean delivery.[1] Similarly, Blomquist et al. reported lower hazards of stress urinary incontinence and overactive bladder following caesarean delivery than following spontaneous vaginal birth.[2] Nevertheless, the association between delivery mode and urinary symptoms is influenced by maternal age, body mass index, parity, duration of labour, previous urinary symptoms, birth weight, instrumental delivery and obstetric trauma. Some symptoms may also improve during the months following childbirth, making the timing of assessment important.

Address for Correspondence Dr. Shridevi, Associate Professor, Department of Obstetrics and gynaecology, MNR College and Hospital, Fasalwadi, Mohd-Shapur, Telangana 502294, India. Email: k.shriobgy@gmail.com

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Standardised instruments such as the International Consultation on Incontinence Questionnaire-Female Lower Urinary Tract Symptoms (ICIQ-FLUTS) allow systematic assessment of filling, voiding and incontinence symptoms and their effect on quality of life.[3] Postpartum urinary problems are frequently underreported because women may consider them a normal consequence of childbirth or may hesitate to discuss them with healthcare providers. Consequently, opportunities for early counselling, pelvic-floor rehabilitation and appropriate referral may be missed. The World Health Organization emphasises comprehensive postnatal assessment to promote women's short- and long-term health and well-being.[4] Evidence also suggests that caesarean delivery may reduce, but does not eliminate, postpartum urinary incontinence.[5] Comparing LUTS after vaginal and caesarean delivery may therefore help identify high-risk women and support structured urinary-symptom screening during postnatal care.

AIM
To compare lower urinary tract symptoms among women following vaginal delivery and caesarean section.

OBJECTIVES
1. To determine and compare the prevalence, pattern and severity of lower urinary tract symptoms among women following vaginal delivery and caesarean section.
2. To assess the association of delivery mode and selected maternal and obstetric factors with lower urinary tract symptoms.

Materials and Methods
Source of Data
The study participants were recruited from women attending the postnatal clinic and the outpatient departments of Obstetrics and Gynaecology and Urology at the selected tertiary-care teaching hospital. Relevant maternal and obstetric information was obtained through participant interviews, clinical examinations and review of hospital case records, discharge summaries and delivery registers.

Study Design
A hospital-based comparative cross-sectional study was conducted. Eligible women were classified into two groups according to the mode of their most recent delivery:

- Group A: Women who had undergone vaginal delivery,
- Group B: Women who had undergone caesarean section,

Study Location
The study was conducted in the Departments of Obstetrics and Gynaecology and Urology.

Study Duration
The study was conducted over 12 months, including participant recruitment, data collection, verification, analysis and report preparation.

Sample Size
A total of 140 women were included, with 70 participants in each delivery group. The sample size was estimated using the expected difference in the prevalence of postpartum LUTS between women following vaginal and caesarean delivery, with a 95% confidence level, 80% statistical power and a two-sided significance level of 5%. An additional allowance was made for incomplete responses or non-participation. Participants were recruited through consecutive sampling until the required sample size was achieved in each group.

Inclusion Criteria
Women were included when they:
1. Were 18-45 years of age.
2. Had delivered a live, singleton infant at term.
3. Were between six weeks and twelve months postpartum at assessment.
4. Had delivered either vaginally or by caesarean section during the most recent pregnancy.
5. Were able to understand and respond to the study questionnaire.
6. Provided written informed consent to participate.

Exclusion Criteria
Women were excluded when they:
1. Had known urinary incontinence or chronic LUTS before the index pregnancy.
2. Had an active urinary tract infection at assessment.
3. Had congenital urinary tract abnormalities, urinary fistula, urinary calculi or known bladder pathology.
4. Had undergone previous pelvic, bladder or urethral surgery.
5. Had neurological disorders affecting bladder function, including spinal cord injury, multiple sclerosis, stroke or diabetic neuropathy.
6. Had pelvic organ prolapse beyond stage II or a pelvic mass likely to affect urinary function.
7. Had severe uncontrolled diabetes mellitus or another systemic illness affecting bladder function.
8. Had experienced stillbirth, multiple pregnancy or major obstetric complications preventing participation.
9. Were unable to complete the questionnaire reliably.

Procedure and Methodology
After approval from the Institutional Ethics Committee, eligible women attending the selected departments were approached consecutively. The purpose and procedures of the study were explained, and written informed consent was obtained.

Participants were interviewed in a private setting using a predesigned and pretested data-collection form. Information regarding age, residence, education, occupation, socioeconomic status, height, weight, body mass index, parity, previous deliveries and relevant medical history was recorded. Obstetric information included gestational age at delivery, mode of delivery, elective or emergency caesarean section, labour before caesarean section, duration of labour, instrumental delivery, episiotomy, perineal tear and neonatal birth weight.

LUTS were assessed using the validated ICIQ-FLUTS questionnaire or an appropriately translated and validated version. The questionnaire assessed storage symptoms, voiding symptoms and urinary-incontinence symptoms, together with their perceived interference with daily life. Storage symptoms included frequency, nocturia, urgency and urgency urinary incontinence. Voiding symptoms included hesitancy, straining, intermittency and slow urinary stream, while post-micturition symptoms included incomplete emptying and post-micturition dribbling.

Each participant underwent a general and relevant pelvic examination, where clinically indicated. Height and weight were measured using standardised equipment, and body mass index was calculated as weight in kilograms divided by height in metres squared. Women were classified into vaginal-delivery and caesarean-section groups based on delivery records. The prevalence, type and severity of LUTS were compared between the groups. Potential confounders such as age, BMI, parity, birth weight, labour duration and instrumental delivery were recorded for adjusted analysis.

Women found to have clinically important urinary symptoms were counselled and referred to the appropriate department for further evaluation and management.

Sample Processing
No blood, tissue or other biological specimens were routinely collected because the study was questionnaire- and examination-based. When symptoms suggested a urinary tract infection, a clean-catch midstream urine specimen was collected in a sterile container and sent promptly to the microbiology laboratory for routine microscopy and culture according to institutional protocol. Women with confirmed active urinary tract infection were excluded from the comparative analysis because infection could produce transient LUTS.

Data Collection
Data were collected using a predesigned, pretested structured proforma consisting of:
1. Sociodemographic characteristics.
2. Medical, surgical and urinary history.
3. Antenatal and obstetric characteristics.
4. Details of labour and mode of delivery.
5. ICIQ-FLUTS symptom and bother scores.
6. Relevant clinical examination findings.

The questionnaire was administered by a trained investigator to minimise missing information. Case records were reviewed to verify delivery-related variables. Completed forms were checked daily for completeness and consistency. Each participant was assigned a unique study identification number, and personally identifying information was kept confidential.

Statistical Methods
Data were entered into Microsoft Excel and analysed using SPSS version 28.0. Continuous variables were assessed for normality and summarised as mean with standard deviation or median with interquartile range, as appropriate. Categorical variables were presented as frequencies and percentages.

The prevalence of overall and individual LUTS was reported with 95% confidence intervals. Continuous variables between the two delivery groups were compared using the independent-samples *t*-test or Mann-Whitney *U* test. Categorical variables were compared using the chi-square test or Fisher's exact test. Effect estimates were expressed as mean differences, odds ratios or prevalence ratios with 95% confidence intervals.

Binary logistic regression analysis was performed to determine the independent association between mode of delivery and LUTS after controlling for potential confounders such as age, BMI, parity, previous delivery history, labour duration, instrumental delivery, perineal trauma and neonatal birth weight. Adjusted odds ratios with 95% confidence intervals were reported. All tests were two-sided, and a *P* value <0.05 was considered statistically significant.

Results

Table 1: Overall comparison of women following vaginal delivery and caesarean section (N=140)

Parameter	Total (N=140), n (%) or Mean (SD)	Vaginal delivery (n=70)	Caesarean section (n=70)	Effect estimate (95% CI)	Test of significance	P value
Age, years	29.6 (4.9)	28.9 (4.7)	30.2 (5.0)	MD=−1.30 (−2.92 to 0.32)	Welch's t=−1.58	0.115
BMI, kg/m²	25.2 (3.6)	24.8 (3.5)	25.6 (3.7)	MD=−0.80 (−2.00 to 0.40)	Welch's t=−1.31	0.191
Parity	2.0 (0.9)	2.1 (0.9)	1.8 (0.8)	MD=0.30 (0.02-0.58)	Welch's t=2.08	0.039*
Postpartum duration, months	6.3 (2.7)	6.4 (2.8)	6.1 (2.6)	MD=0.30 (−0.60 to 1.20)	Welch's t=0.66	0.512
Any LUTS present	50 (35.7)	32 (45.7)	18 (25.7)	OR=2.43 (1.19-4.96); RD=20.0% (4.5%-35.5%)	χ^2=6.10	0.014*
No LUTS	90 (64.3)	38 (54.3)	52 (74.3)	Reference		
Overall ICIQ-FLUTS score†	6.4 (5.0)	7.8 (5.2)	4.9 (4.4)	MD=2.90 (1.29-4.51)	Welch's t=3.56	<0.001*
Quality-of-life interference score	2.5 (2.3)	3.1 (2.4)	1.9 (2.0)	MD=1.20 (0.46-1.94)	Welch's t=3.21	0.002*

Statistically significant at P<0.05. †Higher ICIQ-FLUTS scores indicated greater symptom severity. BMI: body mass index; LUTS: lower urinary tract symptoms; ICIQ-FLUTS: International Consultation on Incontinence Questionnaire-Female Lower Urinary Tract Symptoms; MD: mean difference; OR: odds ratio; RD: risk difference; CI: confidence interval.

Table 1 presents the overall comparison of 140 women, equally divided between vaginal delivery and caesarean section groups. The mean age was 29.6 (4.9) years, with no significant difference between women following vaginal delivery and caesarean section [28.9 (4.7) versus 30.2 (5.0) years; MD=−1.30 years, 95% CI: −2.92 to 0.32; P=0.115]. Similarly, mean BMI and postpartum duration were comparable between the groups (P=0.191 and P=0.512, respectively). Mean parity was significantly higher in the vaginal-delivery group than in the caesarean-section group [2.1 (0.9) versus 1.8 (0.8); MD=0.30, 95% CI: 0.02-0.58; P=0.039]. Overall, 50 (35.7%) women had at least one lower urinary tract symptom. LUTS were significantly more frequent following vaginal delivery than caesarean section (45.7% versus 25.7%). Women following vaginal delivery had 2.43 times higher odds of LUTS (95% CI: 1.19-4.96), with an absolute risk difference of 20.0% (95% CI: 4.5%-35.5%; P=0.014). The mean overall ICIQ-FLUTS score was also significantly higher after vaginal delivery [7.8 (5.2) versus 4.9 (4.4); MD=2.90, 95% CI: 1.29-4.51; P<0.001], indicating greater symptom severity. Similarly, the quality-of-life interference score was significantly higher in the vaginal-delivery group [3.1 (2.4) versus 1.9 (2.0); MD=1.20, 95% CI: 0.46-1.94; P=0.002].

Table 2: Prevalence, pattern and severity of LUTS according to mode of delivery (N=140)

LUTS characteristic	Total (N=140), n (%) or Mean (SD)	Vaginal delivery (n=70)	Caesarean section (n=70)	Effect estimate (95% CI)	Test of significance	P value
Any LUTS	50 (35.7)	32 (45.7)	18 (25.7)	OR=2.43 (1.19-4.96)	χ^2=6.10	0.014*
Stress urinary incontinence	34 (24.3)	24 (34.3)	10 (14.3)	OR=3.13 (1.36-7.19)	χ^2=7.61	0.006*
Urgency	29 (20.7)	18 (25.7)	11 (15.7)	OR=1.86 (0.80-4.29)	χ^2=2.13	0.144
Urgency urinary incontinence	22 (15.7)	14 (20.0)	8 (11.4)	OR=1.94 (0.76-4.96)	χ^2=1.94	0.164

Increased daytime frequency	29 (20.7)	17 (24.3)	12 (17.1)	OR=1.55 (0.68-3.55)	χ^2=1.09	0.297
Nocturia	33 (23.6)	20 (28.6)	13 (18.6)	OR=1.75 (0.79-3.88)	χ^2=1.94	0.163
Voiding symptoms‡	16 (11.4)	9 (12.9)	7 (10.0)	OR=1.33 (0.47-3.79)	χ^2=0.28	0.595
Feeling of incomplete emptying	17 (12.1)	11 (15.7)	6 (8.6)	OR=1.99 (0.69-5.72)	χ^2=1.67	0.196
Symptom-severity score among women with LUTS§	8.3 (3.4)	8.9 (3.5)	7.1 (3.0)	MD=1.80 (−0.10 to 3.70)	Welch's t=1.92	0.063
Mild LUTS§	23 (46.0)	13 (40.6)	10 (55.6)			
Moderate LUTS§	18 (36.0)	12 (37.5)	6 (33.3)		χ^2=1.36†	0.508
Severe LUTS§	9 (18.0)	7 (21.9)	2 (11.1)			
Storage symptoms only§	16 (32.0)	9 (28.1)	7 (38.9)			
Incontinence symptoms only§	20 (40.0)	13 (40.6)	7 (38.9)		χ^2=0.76†	0.683
Mixed symptoms§	14 (28.0)	10 (31.3)	4 (22.2)			

Statistically significant at P<0.05. †Overall chi-square test for the distribution. ‡Included hesitancy, straining, intermittency or slow urinary stream. §Calculated among the 50 women with LUTS: 32 after vaginal delivery and 18 after caesarean section. Individual symptoms were not mutually exclusive. OR: odds ratio; MD: mean difference; CI: confidence interval.

Table 2 describes the prevalence, pattern and severity of LUTS according to mode of delivery. Overall, LUTS were identified in 50 (35.7%) women and were significantly more prevalent after vaginal delivery than caesarean section (45.7% versus 25.7%; OR=2.43, 95% CI: 1.19-4.96; P=0.014). Stress urinary incontinence was the most prominent symptom showing a significant difference between the groups. It occurred in 34 (24.3%) women overall and was more frequent following vaginal delivery (34.3%) than caesarean section (14.3%). Vaginal delivery was associated with more than threefold higher odds of stress urinary incontinence (OR=3.13, 95% CI: 1.36-7.19; P=0.006). Urgency, urgency urinary incontinence, increased daytime frequency and nocturia were also numerically more frequent after vaginal delivery; however, their group differences were not statistically significant (P>0.05). Likewise, voiding symptoms and a feeling of incomplete bladder emptying were somewhat more common after vaginal delivery, but these associations did not reach statistical significance. Among the 50 symptomatic women, the mean symptom-severity score was higher after vaginal delivery than caesarean section [8.9 (3.5) versus 7.1 (3.0)], although the difference was marginally non-significant (MD=1.80, 95% CI: −0.10 to 3.70; P=0.063). Mild LUTS were observed in 46.0%, moderate LUTS in 36.0% and severe LUTS in 18.0% of symptomatic women. Severe symptoms were numerically more common following vaginal delivery (21.9%) than caesarean section (11.1%), but the overall severity distribution did not differ significantly (P=0.508). Incontinence-only symptoms were the most frequent clinical pattern (40.0%), followed by storage-only symptoms (32.0%) and mixed symptoms (28.0%). The distribution of these symptom patterns was comparable between the two delivery groups (P=0.683).

Table 3: Association of delivery mode and maternal and obstetric factors with LUTS (N=140)

Maternal/obstetric factor	LUTS present (n=50), n (%)	LUTS absent (n=90), n (%)	Unadjusted OR (95% CI)	Test of significance	P value
Vaginal delivery	32 (64.0)	38 (42.2)	2.43 (1.19-4.96)	χ^2=6.10	0.014*
Caesarean section	18 (36.0)	52 (57.8)	Reference		
Age ≥30 years	31 (62.0)	39 (43.3)	2.13 (1.05-4.33)	χ^2=4.48	0.034*
Age <30 years	19 (38.0)	51 (56.7)	Reference		
BMI ≥25 kg/m²	33 (66.0)	42 (46.7)	2.22 (1.08-4.54)	χ^2=4.83	0.028*
BMI <25 kg/m²	17 (34.0)	48 (53.3)	Reference		
Parity ≥2	38 (76.0)	49 (54.4)	2.65 (1.23-5.72)	χ^2=6.35	0.012*
Parity <2	12 (24.0)	41 (45.6)	Reference		
Instrumental vaginal delivery	12 (24.0)	8 (8.9)	3.24 (1.22-8.57)	χ^2=5.99	0.014*
No instrumental delivery	38 (76.0)	82 (91.1)	Reference		
Prolonged labour >12 hours	17 (34.0)	13 (14.4)	3.05 (1.33-6.99)	χ^2=7.30	0.007*
Labour ≤12 hours/no labour	33 (66.0)	77 (85.6)	Reference		
Neonatal birth weight ≥3.5 kg	14 (28.0)	13 (14.4)	2.30 (0.98-5.40)	χ^2=3.79	0.051
Neonatal birth weight <3.5 kg	36 (72.0)	77 (85.6)	Reference		
Episiotomy or perineal tear	21 (42.0)	20 (22.2)	2.53 (1.20-5.37)	χ^2=6.07	0.014*
No perineal trauma	29 (58.0)	70 (77.8)	Reference		

Statistically significant at P<0.05. The reference category had OR=1.00. Percentages were calculated column-wise. BMI: body mass index; LUTS: lower urinary tract symptoms; OR: odds ratio; CI: confidence interval.

Table 3 demonstrates the univariate associations of delivery mode and selected maternal and obstetric factors with LUTS. Among women with LUTS, 64.0% had undergone vaginal delivery, compared with 42.2% of women without LUTS. Vaginal delivery was significantly associated with higher odds of LUTS compared with caesarean section (OR=2.43, 95% CI: 1.19-4.96; P=0.014). Women aged 30 years or older also had significantly greater odds of LUTS than younger women (OR=2.13, 95% CI: 1.05-4.33; P=0.034). Similarly, BMI ≥25 kg/m² was associated with approximately twice the odds of LUTS (OR=2.22, 95% CI: 1.08-4.54; P=0.028). Multiparity was another significant factor: 76.0% of symptomatic women had parity ≥2, compared with 54.4% of asymptomatic women, corresponding to an OR of 2.65 (95% CI: 1.23-5.72; P=0.012). Instrumental vaginal delivery was reported in 24.0% of women with LUTS and 8.9% of those without LUTS and was associated with more than threefold higher odds of symptoms (OR=3.24, 95% CI: 1.22-8.57; P=0.014). Prolonged labour lasting more than 12 hours was significantly associated with LUTS (OR=3.05, 95% CI: 1.33-6.99; P=0.007). A neonatal birth weight of ≥3.5 kg was associated with increased odds of LUTS, but its confidence interval included unity, and the finding narrowly failed to attain statistical significance (OR=2.30, 95% CI: 0.98-5.40; P=0.051). Episiotomy or perineal tear was significantly more frequent among women with LUTS than among those without LUTS (42.0% versus 22.2%) and was associated with 2.53 times higher odds of symptoms (95% CI: 1.20-5.37; P=0.014). Overall, vaginal delivery, age ≥30 years, overweight or obesity, multiparity, instrumental delivery, prolonged labour and perineal trauma were significantly associated with LUTS in the unadjusted analysis. However, multivariable regression would be required to determine whether these factors were independently associated with LUTS after adjustment for confounding.

Discussion

Overall comparison according to mode of delivery

In the present study, the mean age and BMI were comparable between women following vaginal delivery and caesarean section, indicating

reasonable baseline similarity between the groups. Parity, however, was significantly higher in the vaginal-delivery group [2.1 (0.9) versus 1.8 (0.8); P=0.039], and this difference should be considered because repeated childbirth may independently weaken pelvic-floor support. The overall prevalence of lower urinary tract symptoms was 35.7%, with symptoms occurring significantly more often after vaginal delivery than caesarean section (45.7% versus 25.7%; OR=2.43, 95% CI: 1.19-4.96; P=0.014). This prevalence was higher than the pooled postpartum urinary-incontinence prevalence of 26% reported by Dai et al. (2023)[1], but lower than the 70.6% prevalence of any LUTS reported at six weeks postpartum by Zhang et al. (2024).[2] The variation may be explained by differences in postpartum assessment time, definitions of LUTS, questionnaires, parity and population characteristics. Zhang et al. included the complete spectrum of storage and voiding symptoms and found storage symptoms in 65.4% and voiding symptoms in 23.0% of women, which increased their overall prevalence estimate.[2]

The significantly greater odds of LUTS following vaginal delivery agreed with the meta-analysis by Tähtinen et al. (2016)[3], which found that vaginal delivery was associated with an approximately twofold higher long-term risk of stress urinary incontinence compared with caesarean delivery. Similarly, Barca et al. (2021)[4] reported a higher overall prevalence of pelvic-floor morbidity following vaginal delivery, while Blomquist et al. (2018)[5] observed that caesarean delivery was associated with lower hazards of stress urinary incontinence and overactive bladder than spontaneous vaginal delivery. These associations may be related to stretching of the levator ani muscles, connective-tissue disruption, urethral-support impairment and pudendal nerve injury during fetal passage through the birth canal.

The present finding was also supported by Siahkal et al. (2020),[6] whose systematic review demonstrated a strong relationship between vaginal delivery and postpartum urinary incontinence. Nevertheless, caesarean section cannot be considered completely protective because pregnancy-related hormonal and mechanical changes, labour before surgery, maternal characteristics and pre-existing antenatal symptoms may also contribute to LUTS. This may explain why 25.7% of women in the caesarean group in the present study still reported symptoms. Pizzoferrato et al. (2023)[7] similarly concluded that the protective effect of caesarean delivery remained uncertain, especially among women who had already developed urinary incontinence during pregnancy.

In contrast to the present findings, Sharma et al. (2025)[8] observed no significant difference in urogynaecological symptoms between vaginal and caesarean delivery groups. Their study reported symptoms in 31.6% of women during the first postpartum week, decreasing to 7.3% at six weeks. Differences in timing, spontaneous symptom recovery and outcome definitions might account for the contrasting results. The present mean postpartum duration was 6.3 months, whereas Sharma et al. primarily evaluated early puerperal symptoms.[8]

The overall ICIQ-FLUTS score was significantly higher after vaginal delivery [7.8 (5.2) versus 4.9 (4.4); P<0.001], demonstrating that differences were not limited to symptom occurrence but extended to cumulative symptom burden. Li et al. (2019)[9] also found that LUTS were frequent during and after pregnancy and that urinary-incontinence symptoms were generally more bothersome than frequency or nocturia. The significantly higher quality-of-life interference score following vaginal delivery in the present study [3.1 (2.4) versus 1.9 (2.0); P=0.002] reinforced the clinical importance of these symptoms. Moossdorff-Steinhauser et al. (2021)[10] reported that postpartum urinary incontinence remained common between six weeks and one year after delivery and that a substantial proportion of affected women experienced frequent or bothersome leakage.

Prevalence, pattern and severity of LUTS

Stress urinary incontinence was the most important symptom differentiating the groups. It occurred in 24.3% of women overall and was significantly more common after vaginal delivery than caesarean section (34.3% versus 14.3%; OR=3.13, 95% CI: 1.36-7.19; P=0.006). This agreed with the systematic review by Wang et al. (2020),[11] which found that vaginal delivery increased the odds of postpartum stress urinary incontinence (pooled OR=2.08, 95% CI: 1.72-2.52). The present OR was somewhat higher but remained within the range suggested by previous studies. Gao et al. (2021)[12] also identified vaginal delivery and impaired pelvic-floor function as important risk factors for postpartum stress urinary incontinence among primiparous women.

Urgency, urgency urinary incontinence, frequency and nocturia were all numerically more frequent after vaginal delivery, although none reached statistical significance. Zhang et al. (2024)[2] found nocturia to be the most frequent LUTS at six weeks postpartum (35.4%), followed by frequency (25.6%), urgency (25.3%) and stress urinary incontinence (20.8%). In the present study, nocturia was reported by 23.6%, frequency and urgency by 20.7% each, and urgency urinary incontinence by 15.7%. The lower prevalence may reflect the later assessment, when transient pregnancy- and childbirth-related storage symptoms might have improved.

Voiding symptoms and incomplete bladder emptying were relatively uncommon and did not differ significantly between delivery groups. These symptoms may arise from transient detrusor underactivity, pelvic-floor discoordination, perineal pain, oedema or bladder overdistension, but they may be less dependent on delivery route than stress incontinence. The broad confidence intervals around their odds ratios also suggested limited precision because of the small number of events.

Among women with LUTS, the mean severity score was higher following vaginal delivery than caesarean section [8.9 (3.5) versus 7.1 (3.0)], but the difference narrowly missed statistical significance (P=0.063). Severe symptoms were approximately twice as common in the vaginal group (21.9% versus 11.1%), although the overall severity distribution did not differ significantly (P=0.508). Thus, the study demonstrated a clear difference in symptom prevalence but lacked adequate statistical evidence for a difference in severity categories. Åhlund et al. (2020)[13] likewise showed that urinary incontinence remained common during the first postpartum year even after uncomplicated spontaneous vaginal birth, supporting the need to assess symptom persistence and severity rather than only early postpartum occurrence.

Incontinence-only symptoms constituted the most frequent pattern (40.0%), followed by storage-only (32.0%) and mixed symptoms (28.0%). However, symptom-pattern distribution was similar between the delivery groups (P=0.683). Therefore, delivery mode appeared to influence whether LUTS occurred particularly stress urinary incontinence more clearly than it influenced the pattern among women who became symptomatic.

Association with maternal and obstetric factors

Women aged ≥30 years had significantly higher odds of LUTS (OR=2.13, 95% CI: 1.05-4.33; P=0.034). Advancing age may be associated with diminished collagen strength, reduced muscular recovery and accumulated obstetric exposure. This finding agreed with the reviews by Siahkal et al. (2020)[6] and Hage-Fransen et al. (2021),[14] which identified increasing maternal age as a predictor of later pelvic-floor dysfunction.

BMI ≥25 kg/m² was associated with more than twice the odds of LUTS (OR=2.22, 95% CI: 1.08-4.54; P=0.028). Increased body weight may chronically elevate intra-abdominal and intravesical pressure, increasing the demand placed on already weakened pelvic-floor and urethral-support structures. Wang et al. (2020)[11] and Dai et al. (2023)[1] similarly identified elevated maternal BMI as an important risk factor for postpartum urinary incontinence.

Parity ≥2 was significantly associated with LUTS (OR=2.65, 95% CI: 1.23-5.72; P=0.012). This supported the meta-analysis by Dai et al. (2023),[1] in which multiparity was a significant determinant of postpartum urinary incontinence, and the study by Leroy et al. (2016),[15] which identified multiparity as a postpartum risk factor. Repeated pregnancies and deliveries may produce cumulative neuromuscular and connective-tissue damage, explaining this relationship. Because parity was higher in the vaginal-delivery group, it may have partly confounded the unadjusted association between delivery mode and LUTS.

Instrumental vaginal delivery demonstrated one of the strongest associations with LUTS (OR=3.24, 95% CI: 1.22-8.57; P=0.014). Forceps or

vacuum delivery may increase pelvic-floor muscle stretching, levator ani injury and pudendal nerve compression. Zhang et al. (2024)[2] reported that vaginal delivery, particularly forceps delivery, predicted LUTS and was associated with lower pelvic-floor surface electromyographic activity. The systematic reviews by Siahkal et al. (2020),[6] Wang et al. (2020)[11] and Veliyeva et al. (2024)[16] also identified instrumental delivery as an important postpartum incontinence risk factor.

Prolonged labour exceeding 12 hours was significantly associated with LUTS (OR=3.05, 95% CI: 1.33-6.99; P=0.007). Prolonged fetal-head pressure may cause pelvic-floor ischaemia, muscular fatigue and nerve injury. Veliyeva et al. (2024)[16] identified prolonged second-stage labour as a significant risk factor for postpartum stress urinary incontinence. However, the present variable represented total labour duration rather than specifically the second stage; hence, direct comparison should be made cautiously.

A neonatal birth weight ≥3.5 kg was associated with increased odds of LUTS, although the finding was borderline and statistically non-significant (OR=2.30, 95% CI: 0.98-5.40; P=0.051). Wesnes and Seim (2020)[17] concluded that increasing birth weight, particularly above 3,500-4,000 g, increased postpartum urinary-incontinence risk. Wesnes et al. (2017)[18] similarly reported a significant increase in urinary incontinence at six months postpartum with higher neonatal birth weight. The borderline finding in the present study may therefore reflect inadequate power rather than a definite absence of association.

Episiotomy or perineal tear was significantly associated with LUTS (OR=2.53, 95% CI: 1.20-5.37; P=0.014). Perineal trauma may indicate difficult childbirth and can coexist with deeper pelvic-floor muscular or neural injury. Siahkal et al. (2020)[6] found significant associations of episiotomy and severe perineal tears with postpartum urinary incontinence, while Dai et al. (2023)[1] also identified perineal laceration as a relevant risk factor.

Conclusion

Lower urinary tract symptoms were common among postpartum women, affecting 35.7% of the study population. Women following vaginal delivery had a significantly higher prevalence of LUTS than those following caesarean section (45.7% versus 25.7%). Vaginal delivery was associated with 2.43 times higher odds of LUTS and significantly higher ICIQ-FLUTS and quality-of-life interference scores. Stress urinary incontinence was the symptom most strongly associated with vaginal delivery, occurring in 34.3% of the vaginal-delivery group compared with 14.3% of the caesarean-section group. Although urgency, urgency urinary incontinence, frequency, nocturia, voiding symptoms and incomplete bladder emptying were numerically more frequent following vaginal delivery, their differences were not statistically significant.

Age ≥30 years, BMI ≥25 kg/m², parity ≥2, instrumental vaginal delivery, prolonged labour and episiotomy or perineal tear were significantly associated with LUTS. Higher neonatal birth weight showed a borderline association. These findings suggest that postpartum LUTS have a multifactorial origin, with vaginal delivery and obstetric trauma contributing substantially to their occurrence. Routine screening for urinary symptoms should be incorporated into postnatal care, particularly for women with high-risk maternal and obstetric characteristics. Early counselling, pelvic-floor muscle training and appropriate urogynecological referral may reduce symptom persistence and improve quality of life. However, caesarean section should not be recommended solely to prevent LUTS, as it does not provide complete protection and carries its own maternal and neonatal risks.

LIMITATIONS

1. The hospital-based, single-centre design limited the generalisability of the findings to women in other healthcare settings and the general population.
2. The cross-sectional design established associations but could not confirm a causal relationship between delivery mode and LUTS.
3. LUTS were assessed at a single postpartum visit; therefore, their onset, progression, spontaneous recovery and long-term persistence could not be evaluated.
4. The postpartum assessment period varied among participants, and urinary symptoms may change considerably during the first postpartum year.
5. Urinary symptoms were primarily self-reported and were therefore susceptible to recall bias, reporting bias and differences in symptom perception.
6. Objective investigations such as uroflowmetry, post-void residual measurement, pelvic-floor ultrasonography and urodynamic studies were not routinely performed.
7. Pre-pregnancy and antenatal urinary symptoms may not have been completely documented, making it difficult to establish whether all identified symptoms developed after childbirth.
8. Parity was significantly higher in the vaginal-delivery group and may have confounded the association between delivery mode and LUTS.
9. The reported associations were based mainly on unadjusted analyses. Residual confounding by age, BMI, parity, antenatal incontinence, labour characteristics and previous delivery history could not be excluded.
10. Instrumental delivery and severe perineal trauma occurred in relatively small numbers, resulting in wide confidence intervals and reduced precision.
11. Caesarean sections were not analysed separately as elective, emergency, pre-labour or intrapartum procedures, although exposure to labour may influence pelvic-floor outcomes.
12. The study did not assess adherence to pelvic-floor exercises, constipation, chronic cough, physical activity, socioeconomic factors or other lifestyle characteristics that could affect LUTS.

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