International Journal of Women's Health

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Treatment Approaches, Risk Factors, and Perinatal Outcomes in Pregnancy Complicated by Nephrolithiasis: A Single-Center Retrospective Study

Xian Chen*, Rui-Lan Ni*, Bing-Qing Lv

Department of Gynecology and Obstetrics, Fujian Maternity and Child Health Hospital College of Clinical Medicine for Obstetrics & Gynecology and Pediatrics, Fujian Medical University, Fuzhou, Fujian, 350000, People's Republic of China

*These authors contributed equally to this work

Correspondence: Bing-Qing Lv, Department of Gynecology and Obstetrics, Fujian Maternity and Child Health Hospital College of Clinical Medicine for Obstetrics & Gynecology and Pediatrics, Fujian Medical University, No. 18 Daoshan Road, Gulou District, Fuzhou, Fujian, 350000, People's Republic of China, Tel +86 18950330039, Email Lvbingqing2024@163.com

Objective: Nephrolithiasis is a common non-obstetric cause of abdominal pain during pregnancy. This study aimed to investigate various treatment approaches for nephrolithiasis during pregnancy, identify the associated risk factors, and evaluate perinatal outcomes.

Methods: A retrospective analysis was conducted on the clinical treatment of 208 patients diagnosed with nephrolithiasis during pregnancy, admitted to Fujian Maternal and Child Health Hospital, China, between January 2020 and December 2023. Data on maternal demographic characteristics were extracted to analyze the risk factors associated with nephrolithiasis in pregnancy and to explore correlations with specific treatment modalities through Chi-squared test, Fisher's exact probability method, and univariate logistic regression analysis.

Results: The study included 208 patients, of whom 130 were managed with observation, 46 patients received symptomatic treatment with appropriate medications, and 32 patients underwent surgical intervention, specifically ureteral stent placement. Statistical analysis identified that the timing of symptom onset, presence of clinical symptoms, dilatation of ureter, location of dilation, stone size, and abnormalities in routine urine tests were significant risk factors influencing treatment modalities for nephrolithiasis in pregnancy. A statistically significant difference was observed in treatment modalities among patients with nephrolithiasis complicated by hypertensive disorders. In contrast, patients with combined hyperglycemic disorders exhibited no statistically significant difference among the different treatment modalities.

Conclusion: Effective and timely management of nephrolithiasis in pregnancy, guided by patient-specific clinical characteristics, is essential for optimizing maternal and perinatal outcomes.

Keywords: abnormal routine urine test, perinatal outcomes, pregnancy complicated by nephrolithiasis, risk factors, treatment modalities

Introduction

Nephrolithiasis is a common non-obstetric cause of abdominal pain during pregnancy. Clinical manifestations often include hematuria, bladder irritation, fever, and abdominal pain. Renal colic, in particular, is frequently misdiagnosed as obstetric-related abdominal pain due to overlapping symptoms.[1] The anatomical changes of the pyelocaliceal system are predominantly encountered in the right side, due to the anatomical relationship of the ureter with iliac and ovarian vessels Ureterohydronephrosis, along with hormonal and immune changes, predispose pregnant women to infectious complications that range between simple urinary tract infections to urosepsis. At the same time, the limitations of radiologic testing during

Received: 29 November 2024
Accepted: 21 February 2025
Published: 7 March 2025

pregnancy can lead to delays in clinical diagnosis and treatment. Such delays may increase the risk of complications, including miscarriage, premature labor, gestational hypertension, and premature rupture of membranes, potentially leading to adverse pregnancy outcomes. In addition to physiological and anatomical changes that occur during pregnancy, nephrolithiasis is closely associated with conditions such as urinary tract infection, renal hydrocele, nephritis, and hydroureter.[2] Some studies and clinical data indicated that cesarean delivery, urinary tract infection at delivery, gestational hypertension, gestational diabetes, preeclampsia, and sepsis were all significantly positively associated with urolithiasis.[3] Therefore, the diagnosis and treatment of nephrolithiasis during pregnancy often necessitate a multidisciplinary approach, involving collaboration among obstetricians, urologists, nephrologists, and anesthesiologists. Due to the absence of established guidelines and expert consensus regarding the diagnosis and treatment of pregnancy complicated by nephrolithiasis, clinicians must consider both maternal and fetal health. Significant uncertainties remain regarding the effects of disease progression on maternal pregnancy outcomes and neonatal prognosis.[4] It is estimated that 50–80% of stones will pass spontaneously during pregnancy. Therefore, conservative management is a reasonable option as long as symptoms are manageable. Selective Alpha-1 blockers are category B drugs in pregnancy and thought to be safe. Although, a small cohort, the safety of alpha1-blocker therapy with tamsulosin was demonstrated in a retrospective study, which showed no significant differences in maternal or fetal outcomes.[5,6] If conservative management fails, definitive stone treatment, such as ureteroscopy should be offered to prevent long term damage to the obstructed renal unit.[7] This uncertainty raises clinical concerns about the safety and efficacy of various treatment modalities.

This study retrospectively analyzed the clinical data of 208 pregnant individuals with nephrolithiasis admitted to Fujian Maternal and Child Health Hospital, China, between January 2020 and December 2023. The analysis focused on evaluating different treatment approaches, identifying associated risk factors, and assessing their influence on perinatal outcomes.

Data and Methods

General Data

Clinical data, including age, symptom onset, gestational week, presenting symptoms, pregnancy complications, mode of delivery, and imaging findings, were collected from 208 patients with nephrolithiasis during pregnancy and admitted to Fujian Maternal and Child Health Hospital, China, between January 2020 and December 2023. Patients were categorized into three groups based on the treatment modality: observation, drug treatment, and surgical intervention. This study was approved by the local ethics committee (approval number: 2024KY280) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

Grouping by Treatment Modality

Observation Group

This group included 130 patients who were managed conservatively with regular monitoring following a diagnosis of nephrolithiasis during pregnancy.

Drug Treatment Group

This group consisted of 46 patients who received appropriate symptomatic treatment during pregnancy. Analgesic and antispasmodic medications, such as intramuscular injections of progesterone, and anisodamine (654–2), were administered to alleviate contractions. Additionally, antibiotics were administered to prevent infections. For patients experiencing irregular contractions, symptomatic treatments with contraction inhibitors, such as magnesium sulfate and ritodrine hydrochloride, were used as needed, continuing until the contractions subsided.

Surgical Treatment Group

Thirty-two patients underwent ureteral stent placement at external hospitals during their pregnancies for the management of nephrolithiasis.

Statistical Analysis

Statistical analysis was performed using SPSS version 27.0. Quantitative data that followed a normal distribution were presented as mean ± standard deviation (x ± s), while quantitative data that did not follow a normal distribution were expressed as median and interquartile range [M (P25, P75)]. For normally distributed quantitative data, a homogeneity of variance test was conducted. The *t*-test was employed for intergroup comparisons of data with homogeneity, while the Kruskal–Wallis *H*-test was utilized for comparisons of data that exhibited heterogeneity or non-normal distribution. Categorical data were expressed as the number of cases (percentage), with intergroup comparisons conducted using the chi-squared test, Fisher's exact probability method, and univariate logistic regression analysis. All tests were considered statistically significant when $P < 0.05$.

Results

General Data

The ages of the 208 individuals with pregnancies complicated by nephrolithiasis ranged from 18 to 40 years old, with a mean age of 30.2 ± 4.0 years. Among these women, 26 (12.5%) were classified as advanced maternal age (≥35 years). Nephrolithiasis was diagnosed prior to pregnancy in 33 cases (15.87%), during pregnancy in 174 cases (83.65%), and postpartum in 1 case (0.48%). Among those diagnosed with nephrolithiasis during pregnancy, the mean gestational week at diagnosis was 27.07 weeks (interquartile range: 22.29–32.71 weeks). The gestational outcomes, defined by the gestational week at which pregnancy was terminated, ranged from 27 to 41 + 1 weeks, with a mean of 39.14 weeks (interquartile range: 38.00–39.86 weeks).

Table 1 Clinical Data of Patients With Pregnancy Complicated by Nephrolithiasis

Clinical Characteristics	Number of Cases	Clinical Characteristics	Number of Cases
Expected Age of Delivery (years)		**Pregnancy Complications**	
< 35 years old	182	Gestational Hypertension	38
≥ 35, < 40 years old	25	Gestational Hyperglycemia	40
≥ 40 years old	1	Premature Rupture of Membranes	23
Onset		Premature Delivery	35
Pre-pregnancy	33	**Treatment Modalities**	
During Pregnancy	174	Observation	130
Postpartum	1	Drug	46
Trimester of Pregnancy at Disease Onset		Surgical	32
First Trimester	4	**Location of Stone**	
Second Trimester	89	Left Kidney	98
Third Trimester	81	Right Kidney	69
Mode of Delivery		Bilateral	41
Spontaneous Vaginal Delivery	116	**Ureteral Dilatation**	
Cesarean Section	88	Yes	85
Forceps-Assisted Delivery	4	NA	123
Symptoms (not single)		**Location of Ureteral Dilatation**	
Low back pain	117	Left	36
Fever	6	Right	47
Hematuria	11	Bilateral	2
Vomiting	9	**Stone Size**	
		<0.5cm	93
		≥0.5cm	115

https://doi.org/10.2147/IJWH.S509407

There were 116 spontaneous vaginal deliveries (55.77%), 88 cesarean sections (42.31%), and 4 forceps-assisted deliveries (1.92%). Additionally, there were 173 full-term deliveries (83.17%) and 35 premature deliveries (16.83%). The clinical data of the patients is shown in Table 1.

Analysis of Different Treatment Modalities During Pregnancy

A total of 208 patients were included in this study. Of these, 130 were managed through observation alone, without active intervention, 46 received conservative treatment with appropriate medications for symptomatic management during pregnancy, and 32 patients underwent surgical intervention, specifically ureteral stent placement, performed at external hospitals. The relationships between treatment modalities and pregnancy outcomes are summarized in Table 2.

Table 2 Analysis of Treatment Modalities and Pregnancy Outcomes in Patients With Pregnancy Complicated by Nephrolithiasis

Item	Number of Cases	Observation Group	Drug Treatment Group	Surgical Treatment Group	χ^2	*P* value
Onset					–	0.025
Non-pregnant	34*	28	1	5		
First Trimester	4	3	1	0		
Second Trimester	89	54	24	11		
Third Trimester	81	45	20	16		
Symptom					54.521	0.000
NA	83	77	2	4		
Yes	125	53	44	28		
Location of stone					0.944	0.918
Left	98	61	22	15		
Right	69	41	16	12		
Bilateral	41	28	8	5		
Ureteral Dilatation					81.602	0.000
NA	123	107	14	2		
Yes	85	23	32	30		
Location of Ureteral Dilatation					90.196	0.000
NA	123	107	14	2		
Left	36	4	18	14		
Right	47	18	14	15		
Bilateral	2	1	0	1		
Stone size					45.252	0.000
< 5mm	93	81	10	2		
≥ 5mm	115	49	36	30		
Routine Urine Test					15.838	0.000
Not Abnormal	43	38	4	1		
Abnormal	165	92	42	31		
Dietary Habits					11.594	0.003
Not Adjusted	91	68	16	7		
Adjusted	117	62	30	25		
Hypertensive disease					6.594	0.037
NA	170	104	43	23		
Yes	38	26	3	9		
Hyperglycemia Disease					1.869	0.393
NA	168	104	40	24		
Yes	40	26	6	8		

(*Continued*)

Table 2 (Continued).

Item	Number of Cases	Observation Group	Drug Treatment Group	Surgical Treatment Group	χ^2	*P* value
Premature Rupture of Membranes					2.835	0.242
NA	185	119	38	28		
Yes	23	11	8	4		
Premature Delivery					1.019	0.601
NA	173	110	36	27		
Yes	35	20	10	5		
Mode of Delivery					2.158	0.340
Vaginal Delivery	120	70	30	20		
Cesarean Section	88	60	16	12		

Note: P < 0.05 indicates statistical significance. "NA" denotes data not available, and where applicable, Fisher's exact probability method was employed for statistical analysis. *These 34 pregnant patients were diagnosed with kidney stones before pregnancy.

Statistical analyses identified several risk factors influencing the selection of treatment modalities for pregnancies complicated by nephrolithiasis. The risk factors included the time about symptom onset, presence of clinical symptoms, dilatation of ureter, the location of ureteral dilation, stone size, and the presence of abnormal routine urine test findings.

Univariate analysis revealed a statistically significant difference between ureteral dilatation and treatment modalities (χ^2 = 81.602, P = 0.000). The relative risk (RR) of requiring active treatment (either conservative or surgical) for patients with ureteral dilatation was 18.027 (95% CI: 8.858–36.690) compared to those managed under observation. Additionally, the RR for patients who received surgical treatment during pregnancy compared to those who received conservative management (observation or drug therapy) was 33.000 (95% CI: 7.615–143.011). Additionally, there was a statistically significant difference in the location of ureteral dilation and the treatment modalities (P = 0.000). This difference was observed between the observation group and the treatment groups for patients with left-sided ureteral dilation (χ^2 = 49.334, P = 0.000), as well as for patients with right-sided ureteral dilation (χ^2 = 18.091, P = 0.000). For patients with left-sided ureteral dilatation, the RR for requiring treatment (drugs or surgical) was 55.500 (95% CI: 16.694–171.456) compared to patients without ureteral dilatation. In contrast, the RR value for patients with right-sided ureteral dilatation was 10.774 (95% CI: 4.897–23.707). Additionally, for patients with bilateral ureteral dilatation, the RR value was 6.688 (95% CI: 0.398–112.325).

A statistically significant difference was found in stone size (classified by 0.5 cm) across treatment modalities (χ^2 = 45.252, P = 0.000). Additionally, a significant difference was observed between the observation group and the treatment groups (drug and surgical) (χ^2 = 43.420, P = 0.000) and between the conservative treatment group and the surgical treatment group (χ^2 = 22.631, P = 0.000). Compared to stones measuring less than 5mm, the RR value for stones equal to or greater than 5 mm that required treatments (drugs or surgery) was 9.092 (95% CI: 4.470–18.493). For stones requiring surgical intervention, the RR value was 16.059 (95% CI: 3.724–69.257). There was a statistically significant difference in the presence of abnormal urine routine tests (specifically, abnormal erythrocytes, leukocytes, and urinary proteins) between the different treatment modalities (χ^2 = 15.838, P = 0.000). Dietary modifications, such as increased water intake, reduced oil consumption, and decreased salt intake, were recommended during outpatient maternity checkups for patients with pregnancy complicated by nephrolithiasis. These modifications were found to be statistically significant when compared to other treatment modalities (χ^2 = 11.594, P = 0.003).

A statistically significant difference was observed in treatment modalities among patients with nephrolithiasis complicated by hypertensive disorders (P = 0.037). The RR value for those requiring surgical treatment was 1.984. In contrast, patients with combined hyperglycemic disorders exhibited no statistically significant difference among the different treatment modalities (P = 0.393).

Discussion

Nephrolithiasis represents a frequent non-obstetric cause of abdominal pain during pregnancy, often complicating differential diagnosis due to similarities with obstetric pain, particularly renal colic. In the present study, the most common presenting symptom was low back pain, observed in 56.3% of individuals, followed by gross hematuria (5.3%), fever (2.9%), and vomiting (4.3%). Urinalysis revealed abnormalities in 79.3% (165/208) of cases, including microscopic hematuria and varying levels of leukocytes, ranging from + to +++.

Previous studies have indicated that 50% to 80% of urinary stones during pregnancy may be naturally expelled through increased intake of water, diuretic infusions, and appropriate physical activity. The conservative management of nephrolithiasis offers the advantage of reduced risks to both the pregnant individual and the fetus, making it a preferred method when symptoms are manageable.[4,5] However, the findings of this study suggest that conservative treatment was ineffective in patients with stones measuring 5 mm or larger. The RR value for stones measuring 5 mm or larger that require treatments (drugs or surgery) was 9.092, while the RR for stones necessitating surgery was 16.059, compared to stones smaller than 5 mm in size. In this study, several risk factors influencing the selection of treatment modalities for pregnancies complicated by nephrolithiasis included the time about symptom onset, presence of clinical symptoms, dilatation of ureter, the location of ureteral dilation, stone size, and the presence of abnormal routine urine test findings. For patients with ureteral dilatation were more in need of treatment (drugs or surgery) compared to patients without ureteral dilatation.

A retrospective study demonstrated the safety of selective α1-blockers in managing nephrolithiasis during pregnancy. Despite the small cohort size, the study found no significant differences in maternal or fetal prognosis.[6] Patients receiving conservative treatment require regular follow-up in urology clinics to monitor stone expulsion and symptom resolution. Routine evaluations, including any necessary diagnostic tests, are essential to ensure the effective resolution of the condition and to mitigate risks to both maternal and fetal health.

If conservative treatment fails to alleviate symptoms or resolve nephrolithiasis, timely surgical intervention, such as ureteroscopy or ureteral stent placement, is recommended to prevent irreversible renal dysfunction due to nephrolithiasis and renal hydrocele. In a retrospective study involving 3904 patients with pregnancy complicated by nephrolithiasis, the rate of premature labor was found to be 19.6% among those who underwent percutaneous nephrostomy placement, compared to only 9.1% in women who received conservative treatment. Those who underwent ureteroscopy or ureteral stenting had a preterm delivery rate of 11.2%. Therefore, there may be a higher preterm delivery rate associated with percutaneous nephrostomy tube placement.[1,7] If there is concern for a septic obstructing stone, urgent collecting system decompression is required with ureteral stent placement. When placed, regardless of the tube type, due to gestational hyperfiltration and resulting hyperuricosuria and hypercalciuria, there is a higher rate of tube encrustation during pregnancy and expedited follow-up must be scheduled to ensure timely removal/exchange. Thus, ureteral stents should be exchanged every 4 weeks until definitive management.[1]

Several studies have demonstrated the safety of ureteroscopy during pregnancy, with no significant differences observed in rates of urinary tract infections or ureteral injuries and complication rates comparable to those in non-obstetric patients.[8–11] The American College of Obstetricians and Gynecologists (ACOG) Expert Consensus on Non-obstetric Surgery in Pregnancy advises that conservative treatment of urologic stones during the third trimester of pregnancy may increase the risk of preterm labor. Therefore, surgical intervention is recommended during the second trimester when feasible.[5] However, in the current study, a statistically significant difference was observed between symptom onset across different trimesters and treatment modality ($P = 0.025$). In contrast, there was no statistically significant difference between treatment modality and the occurrence of premature labor ($P = 0.601$).

Several studies have indicated that pregnant women with a history of nephrolithiasis are at an increased risk for premature labor, as well as the development of gestational diabetes and gestational hypertension, particularly when they have a high body mass index (BMI) in the early stages of pregnancy.[12] In the general population, the relationship between a history of nephrolithiasis and diabetes mellitus is bidirectional. Diabetes mellitus serves as an independent risk factor for the formation of nephrolithiasis, while the presence of nephrolithiasis is also a risk factor for the development of diabetes mellitus.[13,14] A meta-analysis of 10 prospective cohort studies found that individuals with diabetes mellitus

had a 16% increased relative risk of developing kidney stones compared to those without diabetes mellitus.[15] In this study, a statistically significant difference was observed in treatment modalities among patients with nephrolithiasis complicated by hypertensive disorders. In contrast, patients with combined hyperglycemic disorders exhibited no statistically significant difference among the different treatment modalities.

There was no statistically significant difference between the different treatment modalities and the methods of termination of pregnancy in cases of pregnancy complicated by nephrolithiasis (P = 0.340). First-line treatment for both ureteric calculi and symptomatic hydronephrosis of pregnancy in the majority of patients is conservative management. The majority of patients who received treatment (both conservative and drug) experienced symptomatic relief and were able to continue their pregnancies. Failing this, both ureteric stents under sedation, local or general anesthetic and percutaneous nephrostomy insertion can be utilized depending on availability and access for each interventional modality.[10] Numerous studies and clinical data indicated that non-obstetric surgery during pregnancy posed minimal risk to both maternal and fetal health. However, the potential long-term safety risks associated with such procedures still warrant further investigation. Thus, dietary modifications, such as increased water intake, reduced oil consumption, and decreased salt intake, were recommended during outpatient maternity checkups for patients with pregnancy complicated by nephrolithiasis. In patients who experience symptomatic onset of nephrolithiasis during the third trimester of pregnancy, these stones can be managed in the urology department after the termination of pregnancy, provided that there is an obstetric indication for a cesarean section.

This study has several limitations. Firstly, being a single-center retrospective study conducted at a gynecology and obstetrics hospital, patients requiring surgical intervention were referred to external urology departments, which may have resulted in missing data and potential biases. Additionally, the loss of follow-up visits for postoperative test results could impact the overall findings of the study.

Conclusion

The majority of patients who received treatment (both conservative and drug) experienced symptomatic relief and were able to continue their pregnancies. Failing this, ureteric stents under sedation, or local anesthetic can be utilized depending on availability and access for each interventional modality. Asymptomatic patients complicated by nephrolithiasis were recommended during outpatient maternity checkups have been found to get a good prognosis by dietary modifications. However, the potential long-term safety risks associated with such procedures still warrant further investigation. Further research is needed to identify associated risk factors and develop novel therapeutic and preventive strategies to improve maternal and fetal outcomes in this population.

Data Sharing Statement

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

Ethics Approval and Consent to Participate

This study was conducted with approval from the Ethics Committee of Fujian maternal and child health hospital. This study was conducted in accordance with the declaration of Helsinki. Written informed consent was obtained from all participants.

Acknowledgments

We would like to acknowledge the hard and dedicated work of all the staff that implemented the intervention and evaluation components of the study.

Funding

No external funding received to conduct this study.

Disclosure

The authors declare that they have no competing interests in this work.

References

1. Lee MS, Fenstermaker MA, Naoum EE, et al. Management of nephrolithiasis in pregnancy: multi-disciplinary guidelines from an academic medical center. *Front Surg*. 2021;8:796876. doi:10.3389/fsurg.2021.796876
2. Sebastian N, Czuzoj-Shulman N, Spence AR, et al. Clinical presentation and management of urolithiasis in the obstetric patient: a matched cohort study. *J Matern-Fetal Neo M*. 2021;35(25):6449–6454. doi:10.1080/14767058.2021.1915274
3. Clennon EK, Garg B, Duty BD, et al. Obstetric outcomes of pregnancy complicated by urolithiasis: a retrospective cohort study. *J Perinat Med*. 2020;49(1):54–59. doi:10.1515/jpm-2020-0199
4. Sebastian N, Czuzoj-Shulman N, Spence AR, et al. Maternal and fetal outcomes of urolithiasis: a retrospective cohort study. *J Gynecol Obstet Hum Reprod*. 2021;50(9):102161. doi:10.1016/j.jogoh.2021.102161
5. ACOG Committee Opinion No. 775 summary: nonobstetric surgery during pregnancy, *Obstet Gynecol*. 2019;133(4):844–845. PMID: 30913194. doi:10.1097/AOG.0000000000003175
6. Bailey G, Vaughan L, Rose C, Krambeck A. Perinatal outcomes with tamsulosin therapy for symptomatic urolithiasis. *J Urol*. 2016;195(1):99–103. PMID: 26144335. doi:10.1016/j.juro.2015.06.097
7. Radu VD, Vasilache IA, Costache RC, et al. Pregnancy outcomes in a cohort of patients who underwent double-j ureteric stenting-a single center experience. *Medicina-Lithuania*. 2022;58(5). doi:10.3390/medicina58050619
8. Keenan RA, Hegarty NJ, Davis NF. Symptomatic hydronephrosis and ureteral calculi in pregnancy: a narrative review with a proposed management protocol. *J Endourol*. 2022;36(8):1099–1112. doi:10.1089/end.2021.0876
9. Juliebø-Jones P, Beisland C, Gjengstø P, et al. Ureteroscopy during pregnancy: outcomes and lessons learned over 4 decades at a tertiary center in Norway. *Curr Urol*. 2022;17(1):7–12. doi:10.1097/CU9.0000000000000157
10. Laranjo Tinoco C, Oliveira MJ, Araújo AS, et al. Surgical management of obstructing ureteral stones during pregnancy: a systematic review of different techniques. *Arch Ital Urol Andro*. 2024;96(3):12153. doi:10.4081/aiua.2024.12153
11. Burgess KL, Gettman MT, Rangel LJ, Krambeck AE. Diagnosis of urolithiasis and rate of spontaneous passage during pregnancy. *J Urol*. 2011;186(6):2280–2284. PMID: 22014825. doi:10.1016/j.juro.2011.07.103
12. Tangren JS, Powe CE, Ecker J, et al. Metabolic and hypertensive complications of pregnancy in women with nephrolithiasis. *Clin J Am Soc Nephrol*. 2018;13(4):612–619. PMID: 29472305; PMCID: PMC5969466. doi:10.2215/CJN.12171017
13. Hameed HM, Belal S, Elatrebi M. Hypertensive and metabolic issues in nephrolithiasis with pregnancy. *J Gynecol Reprod Med*. 2019;3(1). doi:10.33140/jgrm/03/01/05
14. Mao Y, Hu W, Liu L, Liu Q. Association between gestational diabetes mellitus and future risk of kidney stones. *Front Public Health*. 2022;10:843383. PMID: 35237556; PMCID: PMC8882577. doi:10.3389/fpubh.2022.843383
15. Trinchieri A. Body fatness, diabetes, physical activity and risk of kidney stones: a systematic review and meta-analysis of cohort studies. *Eur J Epidemiol*. 2019;34(12):1175–1176. PMID: 31506835. doi:10.1007/s10654-019-00557-8