

Renal and Obstetric Outcomes in Pregnant Women with Urolithiasis: A Prospective Cohort Study

Einas Mustafa Mudawi Ahmed¹, Sunila Gul², Madiha Afzal³, Uzma Aziz⁴, Asifa Ghulam Rasool⁵, Nayma Gul⁶, Marwah Mohamad Amen Fallath⁷, Ahmed Sahoud R. Al-Sultany⁸, Hamdan Siddig Sirag Ahmad⁹

¹Assistant Professor, Department of Obstetrics and Gynecology, Faculty of Medicine, Najran University, Najran, Saudi Arabia.

²Trainee medical officer, Lady reading hospital, Peshawar, Pakistan.

³Professor, Department of Obstetrics and Gynecology, Unit II, Arif Memorial Teaching Hospital, Rashid Latif Medical College, Lahore, Pakistan.

⁴Professor, Department of Obstetrics and Gynecology, Rashid Latif Medical College, Lahore, Pakistan.

⁵Assistant Professor, Makran Medical College, Turbat, Pakistan.

⁶Consultant Gynaecologist, Department of Obstetrics and Gynecology, Sindh Rangers Hospital, Pakistan.

⁷Resident Doctor, Department of Obstetrics and Gynecology, Ibn Sina College.

⁸Northern Border Regional Laboratory, Northern Border University, Arar, Saudi Arabia.

⁹Assistant Professor, Department of Obstetrics and Gynecology, Faculty of Medicine, Najran University, Najran, Saudi Arabia.

ABSTRACT

Background: Urolithiasis during pregnancy may compromise renal function and adversely influence pregnancy outcomes, yet prospective comparative data remain limited. This study evaluated renal, obstetric, and neonatal outcomes in pregnant women with urolithiasis.

Methods: This prospective comparative cohort study included 100 pregnant women recruited from Fatima Memorial Hospital and Rashid Latif Medical College, Lahore, Pakistan, between March 2025 and February 2026. Fifty women with symptomatic, ultrasonography-confirmed urolithiasis were compared with 50 pregnant controls without active stone disease. Participants were followed until delivery and six weeks postpartum. Primary outcomes were acute kidney injury and/or pyelonephritis and preterm birth before 37 weeks. Multivariable modified Poisson regression estimated adjusted relative risks.

Results: Renal complications occurred in 22.0% of women with urolithiasis versus 6.0% of controls, with urolithiasis independently associated with the composite renal outcome (adjusted relative risk 3.12, 95% CI 1.05–9.29; $p=0.041$). Acute kidney injury occurred in 12.0% versus 2.0%, and pyelonephritis in 16.0% versus 4.0%, respectively. Preterm birth occurred in 22.0% versus 10.0%. Women with urolithiasis delivered earlier and had lower mean neonatal birth weight. Moderate-to-severe hydronephrosis and urinary infection at presentation independently predicted renal complications. Hospital readmission and neonatal intensive-care admission were also more frequent among affected women, although several comparisons lacked statistical significance because of limited event numbers.

Conclusions: Urolithiasis in pregnancy was associated with increased maternal renal morbidity and less favorable obstetric outcomes. Early identification of obstruction and urinary infection may help define women requiring multidisciplinary surveillance and timely intervention.

Keywords: pregnancy; urolithiasis; nephrolithiasis; acute kidney injury; pyelonephritis; hydronephrosis; preterm birth

How to cite this article: Einas Mustafa Mudawi Ahmed. Renal and Obstetric Outcomes in Pregnant Women with Urolithiasis: A Prospective Cohort Study. *Int J Drug Deliv Technol.* 2026;16(83s):432-438. DOI: 10.25258/ijddt.16.83s.49.

INTRODUCTION

Urolithiasis during pregnancy is an important non-obstetric cause of acute flank and abdominal pain and may complicate maternal management because of physiological alterations in the urinary tract and limitations in diagnostic imaging and treatment. During pregnancy there is ureteral dilatation, decrease in ureteral peristalsis, increase in glomerular filtration, urinary stasis and physiological hydronephrosis all of which alter the clinical presentation of urinary calculi and can make it difficult to distinguish between the physiological and pathological causes [1,2]. The

overall incidence of symptomatic urolithiasis in pregnancy is relatively low, but women with urolithiasis may need repeated emergency visits, hospitalisation, antibiotics or urological intervention [3].

The clinical importance of urolithiasis in pregnancy is not limited to pain and urinary obstruction. When the obstruction persists, hydronephrosis, acute renal injury, frequent UTIs, and pyelonephritis may ensue, especially if there is an infecting calculus in addition to the obstruction [4,5]. Meanwhile, inflammatory

responses, infection, frequent renal colic and physiological stress in the mother could have a negative impact on pregnancy and have been linked to pre-labor rupture of membranes, preterm birth and operative delivery [6,7]. Given these complications, it is especially crucial that they are promptly recognized and appropriately risk-stratified [8].

This is also difficult to diagnose and manage as both the mother and the baby need to be taken care of. In general, ultrasonography is the imaging technique of choice, although magnetic resonance imaging might be helpful if ultrasonography is not diagnostic. Ureteric stenting, percutaneous nephrostomy or ureteroscopy may be indicated in cases of persistent pain or progressive obstruction, renal impairment or infection [8,9] while most uncomplicated cases can be managed conservatively with hydration, pregnancy appropriate analgesia, antiemetic treatment and surveillance. The identification of patients at high risk of adverse renal or obstetric outcomes may therefore help to inform the intensity of surveillance and timing of intervention [10].

Although there has been a great deal of interest in this condition, most of the available data on urolith disease in pregnancy is from retrospective databases and administrative records and from diverse case series. These studies often do not provide clear details with regard to stone characteristics, hydronephrosis, renal function, infection status, and subsequent obstetric outcomes. Future trials in the same population to assess renal and pregnancy outcomes are still relatively small [11,12].

Thus the objective of this prospective cohort study was to assess the renal and obstetric outcome in pregnant women with urolithiasis and to compare these outcomes with the outcomes of pregnant women without stone disease. One of the secondary aims was to determine the clinical and radiological features of urolithiasis in women that predispose them to renal complications and obstetric complications [13].

Materials and Methods

Study Design and Setting

The study was a prospective comparative cohort study conducted at the Department of Medicine and Endocrinology at Fatima Memorial Hospital, Lahore, Pakistan, and the Department of Obstetrics and Gynecology at Rashid Latif Medical College, Lahore, Pakistan, from March 2025 to February 2026. Antenatal clinic, emergency department, and inpatient pregnant women were recruited sequentially and were followed up till six weeks after delivery.

Study Population

Total 100 pregnant women were included in the study, 50 of them were cases of pregnant women with urolithiasis with symptoms and imaging diagnosis and 50 pregnant women without urolithiasis without

symptoms were considered as control. The inclusion criteria were women with a viable singleton pregnancy 18–45 years. Urolithiasis was diagnosed based on the presence of compatible symptoms (renal colic, flank pain, hematuria or urinary obstruction) and ultrasonographic detection of renal or ureteral calculi. Excluded were women with multiple pregnancy, chronic kidney disease stage 3 or higher, renal transplantation, major congenital urinary tract abnormalities, pre-existing obstructive uropathy, major fetal abnormalities and incomplete follow-up.

Clinical and Laboratory Assessment

The following baseline data were obtained: maternal age, body mass index, gravidity, parity, gestational age, previous urolithiasis, diabetes mellitus, hypertension, urinary tract infection, and previous preterm birth. If the patient was female, symptoms and the clinical findings pertinent to urolithiasis were recorded.

Laboratory testing was performed, which consisted of complete blood count, serum creatinine, blood urea nitrogen, electrolytes, and urinalysis. Urine culture was performed in women with urinary symptoms, fever, pyuria, or suspected pyelonephritis.

Imaging and Stone Characteristics

The initial imaging test was renal and urinary tract ultrasonography. The location, laterality, largest diameter of the stones and the degree of hydronephrosis was documented. Stone size was divided into three groups, which were <5 mm, 5–7 mm and ≥8 mm, and hydronephrosis was divided into three categories: mild, moderate and severe. Further imaging was only carried out in clinically selected cases where ultrasound findings were equivocal.

Management

Initial management of uncomplicated urolithiasis was conservative using hydration, pregnancy appropriate analgesics, antiemetics and clinical observation. Antibiotics were given if urinary infection was suspected or confirmed.

Urological intervention was judged to be indicated for ongoing pain, worsening hydronephrosis, acute kidney injury, pyelonephritis and sepsis, or failure of conservative treatment. The procedures performed were ureteric stenting, ureteroscopy and percutaneous nephrostomy as clinically indicated and in a multidisciplinary assessment.

Outcome Measures

The main kidney outcome was an acute kidney injury and/or acute pyelonephritis. Acute kidney injury was diagnosed based on standard criteria based on serum-creatinine, and pyelonephritis was diagnosed as compatible clinical picture supported by urinalysis and/or urine culture.

Secondary renal outcomes were recurrent renal colic, urinary tract infection, hospital readmission,

progression of hydronephrosis and the need for urological intervention.

The main obstetric outcome was preterm birth defined as < 37 weeks completed gestation. Secondary outcomes were preterm prelabor rupture of membranes, cesarean delivery, gestational age at delivery, maternal hospitalization, and gestational hypertension or preeclampsia.

Neonatal outcomes were birth weight, low birth weight (LBW) (<2500 g), and 5 minute Apgar score <7 and admission to the neonatal intensive-care unit (NICU).

Follow-up

All participants were followed up prospectively during pregnancy and for 6 weeks after childbirth. Renal complications, admission, urological interventions, obstetric events, mode of delivery and neonatal outcomes were documented from the clinical and hospital records.

Statistical Analysis

IBM SPSS Statistics (version 29.0) software was used for data analysis. Data for continuous variables were reported as mean $\pm$ standard deviation or median (interquartile range), and for categorical variables as frequencies and percentages. Student's t-test or Mann–Whitney U test was used for continuous variables, and the chi-square or Fisher's exact test for categorical variables.

Major outcomes were analysed by relative risks with 95% CI. To adjust for potential confounders, a multivariable modified Poisson regression model with robust standard errors was used, which included maternal age, body mass index, parity, gestational age, diabetes mellitus, hypertension and history of preterm birth. In the urolithiasis group, stone size, stone location, hydronephrosis and urinary infection were assessed as risk factors for renal complications. Statistically significant results were taken as $p < 0.05$ (two-sided).

Ethical Considerations

Approval by the appropriate institutional review committee was secured for any ethical issues. Written informed consent was obtained from all participants. Data were anonymised and kept confidential and the study was carried out according to the Declaration of Helsinki.

Results

Participant Characteristics

A total of 100 pregnant women completed follow-up, including 50 women with urolithiasis and 50 controls without active stone disease. In urolithiasis group and control group mean maternal age was 28.9 ± 4.5 y and 28.2 ± 4.3 y, respectively. Groups were similar with respect to baseline BMI, parity, gestational age at enrollment, diabetes mellitus, chronic hypertension, and history of pre-term birth (Table 1).

Table 1. Baseline Characteristics of the Study Population

Characteristic	Urolithiasis (n=50)	Controls (n=50)	p-value
Maternal age, years	28.9 ± 4.5	28.2 ± 4.3	0.43
BMI, kg/m ²	26.5 ± 3.8	25.9 ± 3.7	0.42
Gestational age at enrollment, weeks	22.4 ± 5.9	22.8 ± 5.7	0.73
Primigravida	18 (36.0%)	20 (40.0%)	0.68
Previous preterm birth	5 (10.0%)	4 (8.0%)	0.73
Diabetes mellitus	4 (8.0%)	3 (6.0%)	0.69
Chronic hypertension	3 (6.0%)	2 (4.0%)	0.65
Previous urinary tract infection	11 (22.0%)	7 (14.0%)	0.30

Data are presented as mean $\pm$ SD or n (%). BMI: body mass index.

Characteristics of Urolithiasis

Among women with urolithiasis, ureteric calculi were most common, occurring in 31 patients (62.0%), while 15 (30.0%) had renal calculi and four (8.0%) had stones involving both renal and ureteric sites. The median maximum stone diameter was 6 mm (IQR 4–8 mm). Moderate-to-severe hydronephrosis was identified in 18 women (36.0%), and urinary infection at presentation was present in 12 (24.0%).

Conservative management was successful in 36 women (72.0%). Fourteen women (28.0%) required urological intervention, including ureteric stenting in six (12.0%), ureteroscopy in six (12.0%), and percutaneous nephrostomy in two (4.0%) (Table 2).

Table 2. Clinical and Radiological Characteristics of Women With Urolithiasis

Variable	Urolithiasis cohort (n=50)
Renal stone	15 (30.0%)
Ureteric stone	31 (62.0%)
Renal and ureteric stones	4 (8.0%)
Maximum stone diameter, mm	6 (4–8)
Stone size <5 mm	15 (30.0%)
Stone size 5–7 mm	21 (42.0%)
Stone size $\geq$ 8 mm	14 (28.0%)
Mild hydronephrosis	20 (40.0%)
Moderate-to-severe hydronephrosis	18 (36.0%)
Urinary infection at presentation	12 (24.0%)
Conservative management	36 (72.0%)

Ureteric stent	6 (12.0%)
Uteroscopy	6 (12.0%)
Percutaneous nephrostomy	2 (4.0%)

Data are n (%) or median (IQR).

Renal Outcomes

Women with urolithiasis experienced significantly more renal complications than controls. The composite renal outcome of acute kidney injury and/or acute pyelonephritis occurred in 11 women with urolithiasis (22.0%) compared with three controls (6.0%; $p=0.021$). Acute kidney injury occurred in 6 (12.0%) versus 1 (2.0%), while pyelonephritis developed in 8 (16.0%) versus 2 (4.0%), respectively. Hospital readmission was also more frequent among women with urolithiasis (20.0% vs 6.0%; $p=0.037$). After multivariable adjustment, urolithiasis remained independently associated with the primary renal composite outcome (adjusted relative risk [aRR] 3.12, 95% CI 1.05–9.29; $p=0.041$) (Table 3).

Table 3. Renal Outcomes According to Urolithiasis Status

Outcome	Urolithiasis (n=50)	Controls (n=50)	Adjusted RR (95% CI)	p-value
Renal complication composite	11 (22.0%)	3 (6.0%)	3.12 (1.05–9.29)	0.041
Acute kidney injury	6 (12.0%)	1 (2.0%)	4.76 (0.61–37.3)	0.14
Acute pyelonephritis	8 (16.0%)	2 (4.0%)	3.51 (0.82–15.0)	0.09
Urinary tract infection	14 (28.0%)	5 (10.0%)	2.38 (0.95–5.95)	0.064
Hospital readmission	10 (20.0%)	3 (6.0%)	2.87 (0.86–9.57)	0.085
Urological intervention	14 (28.0%)	—	—	—

Adjusted for maternal age, BMI, parity, gestational age at enrollment, diabetes mellitus, and chronic hypertension.

Obstetric and Neonatal Outcomes

Preterm birth before 37 weeks occurred in 11 women with urolithiasis (22.0%) compared with five controls (10.0%; $p=0.10$). Although the unadjusted comparison did not reach conventional statistical significance, multivariable analysis suggested an increased risk of preterm birth among women with stone disease (aRR 2.08, 95% CI 0.80–5.39; $p=0.13$).

Preterm prelabor rupture of membranes occurred in 6 (12.0%) women with urolithiasis compared with 2 (4.0%) controls. Cesarean delivery was performed in 22 (44.0%) and 18 (36.0%) women, respectively.

Mean gestational age at delivery was lower in the urolithiasis group (37.6 ± 2.1 vs 38.4 ± 1.7 weeks; $p=0.039$), and mean neonatal birth weight was also lower (2965 ± 510 vs 3160 ± 455 g; $p=0.046$). NICU admission occurred in 10 neonates (20.0%) born to women with urolithiasis compared with four (8.0%) in the control group (Table 4).

Table 4. Obstetric and Neonatal Outcomes

Outcome	Urolithiasis (n=50)	Controls (n=50)	p-value
Preterm birth <37 weeks	11 (22.0%)	5 (10.0%)	0.10
PPROM	6 (12.0%)	2 (4.0%)	0.14
Preeclampsia	5 (10.0%)	3 (6.0%)	0.46
Cesarean delivery	22 (44.0%)	18 (36.0%)	0.42
Gestational age at delivery, weeks	37.6 ± 2.1	38.4 ± 1.7	0.039
Birth weight, g	2965 ± 510	3160 ± 455	0.046
Low birth weight <2500 g	8 (16.0%)	3 (6.0%)	0.11
5-minute Apgar score <7	3 (6.0%)	1 (2.0%)	0.31
NICU admission	10 (20.0%)	4 (8.0%)	0.084

PPROM: preterm prelabor rupture of membranes; NICU: neonatal intensive-care unit.

Predictors of Renal Complications

Within the urolithiasis cohort, moderate-to-severe hydronephrosis and urinary infection at presentation were the strongest predictors of renal complications. Moderate-to-severe hydronephrosis was associated with an adjusted relative risk of 2.74 (95% CI 1.17–6.41; $p=0.020$), while urinary infection at presentation was associated with an aRR of 3.11 (95% CI 1.39–6.95; $p=0.006$).

Stone diameter ≥ 8 mm showed a weaker association with renal complications and did not remain statistically significant after adjustment. Ureteric location was not independently associated with the primary renal outcome (Table 5).

Table 5. Multivariable Predictors of Renal Complications Among Women With Urolithiasis

Predictor	Adjusted RR	95% CI	p-value
Moderate-to-severe hydronephrosis	2.74	1.17–6.41	0.020

Urinary infection at presentation	3.11	1.39–6.95	0.006
Stone diameter ≥ 8 mm	1.68	0.77–3.67	0.19
Ureteric stone location	1.24	0.56–2.75	0.60
Diagnosis after 20 weeks	1.31	0.61–2.81	0.49

Overall, women with urolithiasis demonstrated a greater burden of renal morbidity and trends toward less favorable obstetric and neonatal outcomes. The highest negative correlation was found between women with severe hydronephrosis and urine infection at presentation.

DISCUSSION

This prospective cohort study found that women with urolithiasis had significantly more kidney complications during pregnancy than women without active stone disease. The compound event of acute kidney injury and pyelonephritis was more common in the urolithiasis group, and this was still significant after adjusting for important maternal and obstetric characteristics. Additionally, female patients with urolithiasis had more UTI and hospital readmission and moderate to severe hydronephrosis and UTI at presentation were the most significant risk factors of renal complication. These results are consistent with the idea that urolithiasis in pregnancy is not just a case of renal colic and may have important renal morbidity in the mother [1,2].

The greater incidence of acute kidney injury among women with urolithiasis is biologically plausible. The effects of mechanical obstruction are exacerbated by physiological dilatation of the ureters and urinary stasis during pregnancy. On top of these changes, when an obstructing calculus exists, intrarenal pressure may rise, and renal function may decrease, especially in women with bilateral obstruction, severe hydronephrosis, dehydration, and concurrent infection [2,3]. The individual estimates for acute kidney injury were not precise owing to the small number of events, but the direction of association was similar to that for the overall renal composite outcome [4].

Pyelonephritis was also more common among women with urolithiasis. Pregnancy is a risk factor for ascending urinary infection and urinary obstruction predisposes to urinary stasis and perhaps bacterial proliferation [5]. There have also been previous reports of a higher incidence of urinary tract infection and pyelonephritis among pregnancies that were complicated by nephrolithiasis [4,5]. Of particular interest in the present study is the close relationship between the presence of urinary infection at presentation and the occurrence of renal complication later on, which indicates that early urinalysis, culture if indicated and prompt treatment of infection,

especially in the presence of obstruction is important [6].

Renal complications were associated with moderate-to-severe hydronephrosis, and this association was independent. Hydronephrosis in pregnant women can be challenging to interpret as it is a physiological dilatation of the collecting system, especially in the second and third trimesters [7]. However, when there is hydronephrosis with a proven calculus, persistent symptoms, infection or a decline in renal function, there is reason for concern that the obstruction may be clinically significant [1,6]. From our findings, we believe that the degree of hydronephrosis, in combination with symptoms, renal function and infection can be used to provide additional risk stratification [8].

The majority of women who had urolithiasis were treated conservatively and only about 25% underwent urological procedures [9]. This follows the current management practice that relies on hydration, pregnancy compatible analgesia, anti-emetic therapy, and observation in uncomplicated cases whilst escalating to ureteric stenting, ureteroscopy or percutaneous nephrostomy in cases of obstruction, infection, refractory pain, or renal deterioration [3,7]. The necessity of intervention should not be mistaken for the cause of adverse outcomes as those that required an intervention tend to have a more severe clinical phenotype [10].

Women with urolithiasis had infants with mean birth weight lower and slightly earlier gestational age. Preterm birth was more common in the urolithiasis group but was not statistically significant in this relatively small cohort of women. Enhanced risks for preterm delivery have been reported in larger population based studies of pregnant women with urinary stone disease [5,8]. This can occur through several mechanisms such as recurrent severe pain, systemic inflammatory responses, urinary infection, maternal dehydration, hospitalization and physiological stress related to obstruction [6].

There were also more cases of preterm prelabor rupture of membranes and admission to the neonatal intensive-care unit (nonsignificant differences) among pregnancies complicated by urolithiasis [11]. The absence of statistical significance should be interpreted in the context of small sample size, rather than that there is no association. The study was largely designed to detect clinically important differences for common maternal outcomes, and consequently lacked precision for less common obstetric and neonatal outcomes [12].

The lower mean neonatal birth weight among women with urolithiasis might partly be due to the earlier mean gestational age at delivery. It is unclear if the stone disease directly impacts fetal growth or if

maternal infection, multiple hospitalizations, nutrition issues during episodes of symptoms, and other unmeasured factors play a role. A lack of any distinct difference in low birth weight or low 5-minute Apgar scores suggests that the primary effect may be more related to the timing of delivery than neonatal compromise per se [13,14].

These results have implications. Management of pregnant women with urolithiasis must be comprehensive, and include systematic assessment of urinary infection, urinary tract obstruction and renal dysfunction, and not be limited to symptom control. Women with hydronephrosis and/or urinary infection may be a vulnerable subgroup and should be monitored more closely by obstetricians, doctors and urologists as a team. If deterioration is identified early, decompression or antimicrobial therapy might be delivered before the onset of significant maternal complications [15-17].

The study has many strengths such as its prospective nature, contemporaneous control group, predetermined renal and obstetric outcomes, and follow-up to delivery and early postpartum period. Detailed clinical and radiological data also allowed evaluation of stone-related factors that may not be recorded in retrospective administrative data [18].

There are a number of caveats that need to be taken into account. First, the sample size was relatively small, and the single-city location may have resulted in diminished statistical power for relatively rare obstetric and neonatal outcomes and reduced precision of some effect estimates [19]. Secondly, as the management was based on clinical assessment and not protocol, there was potential for confounding by disease severity. Thirdly, ultrasonography is not sensitive for the detection of ureteric calculi, and it may be hard to differentiate between pathological obstruction and physiological hydronephrosis of pregnancy. Finally, unmeasured maternal, socioeconomic, nutritional or obstetric factors may have acted as residual confounds. Prospective, multicenter cohorts with more subjects are required for validation of these results and for the development of clinically applicable risk-prediction strategies [20].

CONCLUSION

Renal morbidity, especially acute kidney injury, pyelonephritis and hospital readmission, was greater among pregnant women with urolithiasis. The strongest predictors of renal complications were moderate to severe hydronephrosis and urinary infection at presentation. Women with urolithiasis also had worse obstetric and neonatal outcomes: delivery age and birth weight were lower; although several outcomes were not significant. The careful assessment of obstruction, infection and renal function, combined with coordinated obstetric and urological

management, may facilitate the identification of high-risk patients and timely intervention.

REFERENCES:

1. Machura P, Gašior JS, Ciebia M, et al. Maternal-fetal complications in renal colic during pregnancy: a scoping review. *J Clin Med*. 2024;13(18):5515. doi:10.3390/jcm13185515.
2. Graf S, Somani BK. Ureterorenoscopy for stone disease in pregnancy: a literature review and update. *Curr Opin Urol*. 2024;34(2):128-134. doi:10.1097/MOU.0000000000001133.
3. Salehi-Pourmehr H, Tayebi S, DalirAkbari N, et al. Management of urolithiasis in pregnancy: a systematic review and meta-analysis. *Scand J Surg*. 2023;112(2):105-116. doi:10.1177/14574969221145774.
4. Chan K, Shakir T, El-Taji O, et al. Management of urolithiasis in pregnancy. *Curr Urol*. 2023;17(1):1-6. doi:10.1097/CU9.0000000000000181.
5. Juliebø-Jones P, Somani BK, Baug S, et al. Management of kidney stone disease in pregnancy: a practical and evidence-based approach. *Curr Urol Rep*. 2022;23(11):263-270. doi:10.1007/s11934-022-01112-x.
6. Morgan K, Rees CD, Shahait M, et al. Urolithiasis in pregnancy: advances in imaging modalities and evaluation of current trends in endourological approaches. *Actas Urol Esp (Engl Ed)*. 2022;46(5):259-267. doi:10.1016/j.acuroe.2022.03.005.
7. 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.
8. 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.
9. Dai JC, Nicholson TM, Chang HC, et al. Nephrolithiasis in pregnancy: treating for two. *Urology*. 2021;151:44-53. doi:10.1016/j.urology.2020.06.097.
10. Clennon EK, Garg B, Duty BD, et al. Obstetric outcomes of pregnancy complicated by urolithiasis: a retrospective cohort study. *J Perinat Med*. 2021;49(1):54-59. doi:10.1515/jpm-2020-0199.
11. Sohlberg EM, Brubaker WD, Zhang CA, et al. Urinary stone disease in pregnancy: a claims based analysis of 1.4 million patients. *J Urol*. 2020;203(5):957-961. doi:10.1097/JU.0000000000000657.

12. Ordon M, Dirk J, Slater J, et al. Incidence, treatment, and implications of kidney stones during pregnancy: a matched population-based cohort study. *J Endourol.* 2020;34(2):215-221. doi:10.1089/end.2019.0557.
13. Masselli G, Weston M, Spencer J. The role of imaging in the diagnosis and management of renal stone disease in pregnancy. *Clin Radiol.* 2015;70(12):1462-1471. doi:10.1016/j.crad.2015.09.002.
14. Semins MJ, Matlaga BR. Kidney stones during pregnancy. *Nat Rev Urol.* 2014;11(3):163-168. doi:10.1038/nrurol.2014.17.
15. Meher S, Gibbons N, DasGupta R. Renal stones in pregnancy. *Obstet Med.* 2014;7(3):103-110. doi:10.1177/1753495X14538422.
16. Laing KA, Lam TBL, McClinton S, et al. Outcomes of ureteroscopy for stone disease in pregnancy: results from a systematic review of the literature. *Urol Int.* 2012;89(4):380-386. doi:10.1159/000343732.
17. Johnson EB, Krambeck AE, White WM, et al. Obstetric complications of ureteroscopy during pregnancy. *J Urol.* 2012;188(1):151-154. doi:10.1016/j.juro.2012.02.2566.
18. Burgess KL, Gettman MT, Rangel LJ, et al. Diagnosis of urolithiasis and rate of spontaneous passage during pregnancy. *J Urol.* 2011;186(6):2280-2284. doi:10.1016/j.juro.2011.07.103.
19. Andreoiu M, MacMahon R. Renal colic in pregnancy: lithiasis or physiological hydronephrosis? *Urology.* 2009;74(4):757-761. doi:10.1016/j.urology.2009.03.054.
20. Swartz MA, Lydon-Rochelle MT, Simon D, et al. Admission for nephrolithiasis in pregnancy and risk of adverse birth outcomes. *Obstet Gynecol.* 2007;109(5):1099-1104. doi:10.1097/01.AOG.0000259941.90919.c0.