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Clinical Profile and Metabolic Risk Factors in Patients with Urolithiasis: A Prospective Observational Study

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Abstract

Background: Urolithiasis is increasingly recognized as a systemic metabolic disorder rather than an isolated urinary condition. Emerging evidence suggests a strong association between metabolic syndrome and stone disease; however, prospective data correlating metabolic risk factors with stone burden remain limited. Aim of the study was to evaluate the clinical profile and metabolic risk factors in patients with urolithiasis and to determine their association with stone size. ***Material and Methods***: This prospective observational study was conducted in the Department of Urology and included 75 adult patients with radiologically confirmed urolithiasis. Demographic details, clinical presentation, recurrence history, and family history were recorded. Anthropometric measurements and blood pressure were obtained using standardized methods. Laboratory investigations included fasting blood glucose, serum creatinine, calcium, uric acid, and lipid profile. Metabolic syndrome was defined according to harmonized criteria. Stone characteristics were assessed by ultrasonography and/or non-contrast CT KUB. Statistical analysis was performed using chi-square test, independent t-test, and Pearson correlation. ***Results***: The mean age was 41.8 ± 12.6 years, with male predominance (69.3%). Metabolic syndrome was present in 42.7% of patients. Overweight/obesity was observed in 65.3%, hypertension in 34.7%, dyslipidemia in 41.3%, and hyperuricemia in 30.7%. Larger stones (>10 mm) were significantly associated with metabolic syndrome ($p = 0.008$). Serum uric acid showed the strongest correlation with stone size ($r = 0.49$, $p < 0.01$). ***Conclusion***: Metabolic abnormalities are highly prevalent among patients with urolithiasis and are significantly associated with increased stone burden. Routine metabolic evaluation should be integrated into urolithiasis management to improve preventive strategies.

Keywords: Urolithiasis; Metabolic syndrome; Obesity; Hyperuricemia; Stone size; Cardiometabolic risk.

INTRODUCTION

Urolithiasis (urinary stone disease) is a common and increasingly prevalent condition worldwide, contributing substantially to emergency visits, hospitalizations, work absenteeism, and recurrent urological interventions [1]. Rising global incidence has been attributed to dietary transitions (high salt and animal protein intake), reduced fluid consumption, climatic factors such as heat stress, and the growing burden of metabolic disorders [1]. While calcium oxalate remains the predominant stone type, uric acid stones—closely linked to obesity, insulin resistance, and acidic urine are increasingly reported [2]. These trends underscore the recognition of urolithiasis as a systemic metabolic condition rather than a localized urinary disorder, with important cardiometabolic and renal implications [3].

Metabolic syndrome (MetS), characterized by central obesity, hypertension, dyslipidaemia, and impaired glucose metabolism as defined by the 2009 Joint Interim Statement [4], has been strongly associated with stone formation. Insulin resistance reduces renal ammoniagenesis and urinary buffering capacity, resulting in lower urine pH and enhanced uric acid crystallization, while obesity increases urinary excretion of lithogenic solutes [5,6]. Population-based studies, including NHANES III, demonstrate a graded increase in stone prevalence with accumulation of MetS traits [7]. Systematic reviews and meta-analyses further confirm that hypertension, diabetes, obesity, and dyslipidaemia independently increase nephrolithiasis risk [8]. Contemporary guidelines now emphasize metabolic evaluation and recurrence prevention as central components of stone management [9,10].

Despite accumulating evidence, most studies are cross-sectional, with limited prospective data correlating metabolic clustering with stone burden and clinical outcomes, particularly in Indian settings [11]. Heterogeneity in metabolic

definitions, incomplete biochemical profiling, and limited real-world phenotyping remain key gaps. Therefore, the present prospective observational study aims to evaluate the clinical profile and metabolic risk factors in patients with urolithiasis and to assess their relationship with stone characteristics, thereby strengthening risk stratification and preventive strategies aligned with guideline-based care [10].

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Urology at a Mamata Medical College and General Hospital. The study included adult patients presenting with radiologically confirmed urolithiasis. Institutional Ethics Committee approval was obtained prior to study initiation, and written informed consent was secured from all participants.

Study Population and Sample Size

A total of 75 consecutive patients diagnosed with urolithiasis were enrolled during the study period. Consecutive sampling was adopted to reduce selection bias and ensure representativeness of the clinical population.

Eligibility Criteria

Inclusion Criteria:

- Age ≥18 years
- Radiological confirmation of urolithiasis (renal, ureteric, or vesical calculi) by ultrasonography (USG) and/or non-contrast computed tomography (NCCT KUB)
- Willingness to provide informed consent

Exclusion Criteria:

- Chronic kidney disease stage 4 or 5
- Structural urinary tract anomalies
- Urinary tract malignancy
- Pregnancy
- Patients on medications significantly affecting stone metabolism
- Critically ill patients unable to undergo metabolic evaluation

Clinical and Metabolic Assessment

Baseline evaluation included detailed history taking and physical examination. Demographic details (age, sex), clinical presentation (flank pain, hematuria, dysuria), recurrence history, and family history of stone disease were recorded. Comorbidities including diabetes mellitus, hypertension, and dyslipidemia were documented.

Anthropometric measurements were obtained using standardized instruments. Body mass index (BMI) was calculated as weight (kg)/height (m^2). Blood pressure was recorded as the average of two readings taken after adequate rest.

Metabolic syndrome was defined according to the Harmonized Criteria (Joint Interim Statement, 2009), requiring the presence of three or more of the following components: elevated fasting plasma glucose, hypertension, elevated triglycerides, reduced HDL cholesterol, and obesity (BMI criteria applicable to the study population).

Laboratory and Radiological Evaluation

All participants underwent standardized laboratory investigations after overnight fasting, including:

- Fasting blood glucose
- Serum creatinine
- Serum calcium
- Serum uric acid
- Lipid profile (total cholesterol, LDL, HDL, triglycerides)

Urine examination included routine microscopy and urine pH estimation. Imaging findings (stone size, number, and location) were recorded from USG and/or NCCT KUB reports.

Data Collection

Data were collected prospectively using a structured case record proforma. Clinical findings, biochemical parameters, and imaging results were documented at baseline. All entries were cross-verified and entered into a secured electronic database for analysis.

Outcome Measures

The primary outcome was the prevalence of metabolic risk factors among patients with urolithiasis. Secondary outcomes included the association between individual metabolic components and stone characteristics such as site and recurrence.

Statistical Analysis

Data analysis was performed using SPSS version 23.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequency and percentage. The Chi-square test was used to assess associations between categorical variables. Independent t-test or ANOVA was applied for comparison of continuous variables. Pearson correlation analysis was used to evaluate relationships between metabolic parameters and stone characteristics. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Demographic Characteristics of Patients with Urolithiasis (n = 75)

Variable	Value
Age (years)	41.8 ± 12.6
Male	52 (69.3%)
Female	23 (30.7%)
Male : Female Ratio	2.3 : 1

The study population comprised 75 patients with urolithiasis, with a mean age of 41.8 ± 12.6 years, indicating that stone disease predominantly affected individuals in the economically productive age group. A clear male predominance was observed, with males accounting for 69.3% of cases, resulting in a male-to-female ratio of 2.3:1.

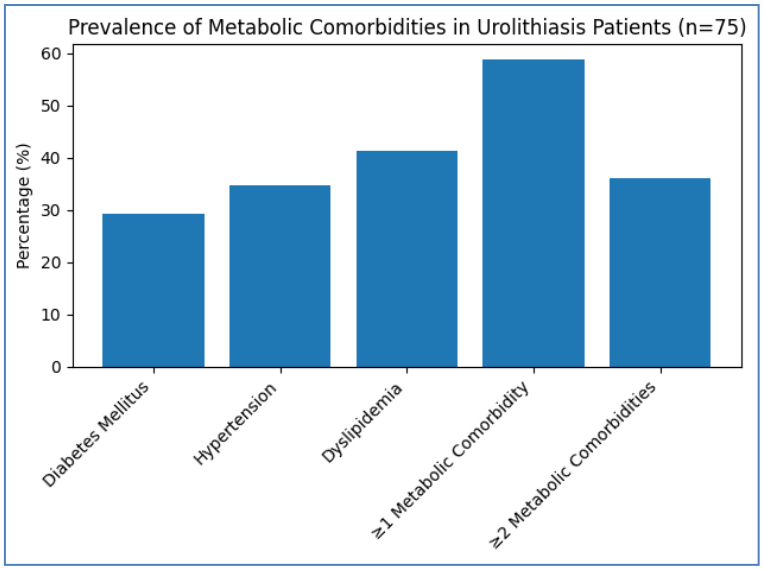
Table 2: Clinical Characteristics, Recurrence Pattern, and Family History among Patients with Urolithiasis (n = 75)

Category	Variable	Number (n=75)	Percentage (%)
Clinical Presentation	Flank Pain	63	84.0%
	Hematuria	29	38.7%
	Dysuria	21	28.0%
	Fever (associated UTI)	14	18.7%
Disease Pattern	First Episode	46	61.3%
	Recurrent Stone Disease	29	38.7%
Family History	Positive Family History	24	32.0%
	No Family History	51	68.0%

Flank pain was the predominant presenting symptom, reported in 84.0% of patients, reflecting the classical presentation of renal colic in urolithiasis. Hematuria (38.7%) and dysuria (28.0%) were other common symptoms, while 18.7% presented with fever suggestive of associated urinary tract infection.

Regarding disease pattern, 61.3% of patients were experiencing their first episode of stone disease, whereas 38.7% had recurrent urolithiasis, highlighting the chronic and relapsing nature of the condition. A positive family history was documented in 32.0% of patients, suggesting a potential genetic or shared environmental contribution to stone formation.

Figure 1: Prevalence of Metabolic Comorbidities among Patients with Urolithiasis (n = 75)



Metabolic abnormalities were highly prevalent in the study population. Dyslipidemia was the most common comorbidity, affecting 41.3% of patients, followed by hypertension (34.7%) and diabetes mellitus (29.3%). Notably, more than half of the patients (58.7%) had at least one metabolic comorbidity, while 36.0% had two or more metabolic risk factors. These findings support the strong association between urolithiasis and cardiometabolic disorders, reinforcing the need for routine metabolic evaluation in stone formers.

Table 3: Anthropometric Profile of Patients with Urolithiasis (n = 75)

Parameter	Mean ± SD	Range
Height (m)	1.64 ± 0.09	1.48 – 1.82
Weight (kg)	72.5 ± 13.8	48 – 104
Body Mass Index (kg/m²)	26.9 ± 4.3	19.2 – 36.8

The mean height of the study population was 1.64 ± 0.09 meters, and the mean body weight was 72.5 ± 13.8 kg. The calculated mean BMI was 26.9 ± 4.3 kg/m², placing the average participant in the overweight category. The BMI range (19.2–36.8 kg/m²) indicates a broad distribution from normal weight to class I obesity.

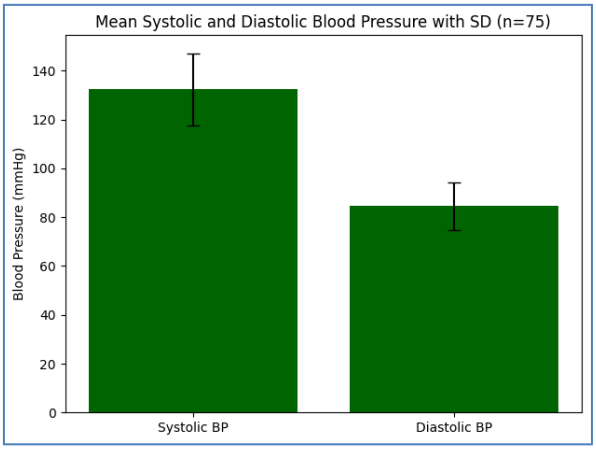
Table 4: Distribution of Patients According to Body Mass Index (BMI) Categories (n = 75)

BMI Category (kg/m²)	Number (n=75)	Percentage (%)
Normal (18.5–24.9)	26	34.7%
Overweight (25–29.9)	31	41.3%
Obese (≥30)	18	24.0%

Overweight + Obesity prevalence = 65.3%

Based on BMI classification, 41.3% of patients were overweight and 24.0% were obese, while only 34.7% had a normal BMI. Thus, nearly two-thirds of the study population (65.3%) were either overweight or obese. This high prevalence of excess body weight among patients with urolithiasis highlights the strong association between adiposity and stone disease. Obesity contributes to lithogenesis through mechanisms such as increased urinary excretion of calcium, oxalate, and uric acid, along with reduced urinary pH. These findings further support the metabolic basis of urolithiasis and the need for weight management strategies as part of preventive care.

Figure 2: Blood Pressure Profile of Patients with Urolithiasis (n = 75)



The mean systolic blood pressure was 132.4 ± 14.8 mmHg, while the mean diastolic blood pressure was 84.6 ± 9.7 mmHg. These values fall within the elevated to stage 1 hypertension range according to standard blood pressure classifications. The relatively wide range observed for systolic blood pressure (104–168 mmHg) indicates variability in cardiovascular risk status among participants.

Table 5: Distribution of Abnormal Laboratory Parameters among Patients with Urolithiasis (n = 75)

Parameter	Number (n=75)	Percentage (%)
Impaired Fasting Glucose / Diabetes (≥100 mg/dL)	34	45.3%
Elevated Serum Uric Acid (>7 mg/dL)	23	30.7%
Hypercalcemia (>10.5 mg/dL)	6	8.0%
Elevated Triglycerides (≥150 mg/dL)	39	52.0%
Low HDL (<40 M / <50 F)	31	41.3%
Elevated LDL (>130 mg/dL)	28	37.3%

Abnormal metabolic laboratory parameters were frequently observed in the study cohort. Elevated triglycerides were the most common abnormality (52.0%), followed by impaired fasting glucose or diabetes (45.3%) and low HDL levels (41.3%). Elevated LDL cholesterol was present in 37.3% of patients, while hyperuricemia was observed in 30.7%. Hypercalcemia was relatively uncommon (8.0%).

These findings indicate a substantial burden of dyslipidemia and impaired glucose metabolism among stone formers, supporting the concept that urolithiasis is closely linked to systemic metabolic dysfunction. The high prevalence of hypertriglyceridemia and hyperuricemia further strengthens the metabolic syndrome–urolithiasis association observed in the present study.

Table 6: Urine Examination Findings among Patients with Urolithiasis (n = 75)

Parameter	Mean ± SD / n (%)
Urine pH	5.68 ± 0.74
Acidic Urine (pH < 5.5)	29 (38.7%)

Calcium Oxalate Crystals	41 (54.7%)
Uric Acid Crystals	17 (22.7%)
Microscopic Hematuria	32 (42.7%)
Pyuria (>5 WBC/HPF)	18 (24.0%)

The mean urine pH was 5.68 ± 0.74, indicating a predominantly acidic urinary environment. Acidic urine (pH <5.5) was observed in 38.7% of patients, a finding commonly associated with insulin resistance and uric acid lithogenesis. Calcium oxalate crystals were the most frequently identified urinary crystals (54.7%), consistent with the predominance of calcium-based stones in clinical practice. Uric acid crystals were detected in 22.7% of patients, supporting the metabolic contribution to stone formation.

Microscopic hematuria was present in 42.7% of cases, reflecting mucosal irritation secondary to stone passage or obstruction, while pyuria was observed in 24.0%, suggesting associated urinary tract inflammation or infection. These urine findings reinforce the metabolic and inflammatory components underlying urolithiasis in the present cohort.

Table 7: Radiological Characteristics of Urolithiasis in the Study Population (n = 75)

Parameter	Value
Mean Stone Size (mm)	9.6 ± 4.8
Single Stone	48 (64.0%)
Multiple Stones	27 (36.0%)
Renal Calculi	44 (58.7%)
Ureteric Calculi	26 (34.7%)
Vesical Calculi	5 (6.6%)
Bilateral Stones	18 (24.0%)

Radiological evaluation revealed a mean stone size of 9.6 ± 4.8 mm, indicating a moderate stone burden in the study cohort. The majority of patients (64.0%) had a single stone, while 36.0% presented with multiple calculi, reflecting varying disease severity.

Renal calculi were the most common location (58.7%), followed by ureteric stones (34.7%), whereas vesical calculi were relatively uncommon (6.6%). Bilateral stone disease was identified in 24.0% of patients, suggesting a significant proportion with more extensive involvement.

Table 8: Distribution of Patients According to Stone Size Categories (n = 75)

Stone Size	Number (n=75)	Percentage (%)
≤5 mm	18	24.0%
6–10 mm	34	45.3%
>10 mm	23	30.7%

The majority of patients (45.3%) had stones measuring 6–10 mm, representing the most common size category in the study population. Smaller stones (≤5 mm) were observed in 24.0% of patients, while 30.7% had larger stones (>10 mm), indicating a considerable proportion with higher stone burden.

The presence of stones larger than 10 mm in nearly one-third of patients is clinically significant, as larger stones are more likely to require interventional management and may be associated with underlying metabolic abnormalities. This distribution supports the need for early metabolic evaluation and targeted preventive strategies to reduce progression to larger stone sizes.

Table 9: Association Between Metabolic Syndrome and Stone Size Categories (n = 75)

Stone Size Category	Metabolic Syndrome Present (n=32)	Metabolic Syndrome Absent (n=43)	Total (n=75)	p-value
≤5 mm	4 (12.5%)	14 (32.6%)	18	
6–10 mm	13 (40.6%)	21 (48.8%)	34	
>10 mm	15 (46.9%)	8 (18.6%)	23	**0.008***

Chi-square test = 9.71
p < 0.05 statistically significant

A statistically significant association was observed between metabolic syndrome and stone size (p = 0.008). Patients with metabolic syndrome were more likely to present with larger stones (>10 mm), with nearly half (46.9%) falling into this category compared to only 18.6% among those without metabolic syndrome. Conversely, smaller stones (≤5 mm) were more common in patients without metabolic syndrome.

Table 10: Pearson Correlation Matrix Between Metabolic Parameters and Stone Size (n = 75)

Variable	BMI	Triglycerides	Serum Uric Acid	Stone Size
BMI	1	0.41**	0.38**	0.46**
Triglycerides	0.41**	1	0.44**	0.42**
Serum Uric Acid	0.38**	0.44**	1	0.49**
Stone Size	0.46**	0.42**	0.49**	1

Pearson correlation analysis demonstrated statistically significant positive correlations between metabolic parameters and stone size. BMI showed a moderate positive correlation with stone size (r = 0.46), indicating that increasing adiposity is associated with greater stone burden. Triglycerides also exhibited a moderate correlation with stone size (r = 0.42), reflecting the influence of dyslipidemia on lithogenesis.

Serum uric acid demonstrated the strongest correlation with stone size (r = 0.49), suggesting that hyperuricemia may play a key role in stone growth and severity. Additionally, inter-correlations among BMI, triglycerides, and serum uric acid were observed, highlighting the clustering of metabolic abnormalities.

DISCUSSION

The present prospective observational study evaluated the clinical profile and metabolic risk factors among patients with urolithiasis and demonstrated a substantial burden of cardiometabolic abnormalities. The mean age of the study population was 41.8 ± 12.6 years, with a clear male predominance (69.3%). This demographic pattern is consistent with established epidemiological trends, which report higher stone prevalence in males and peak incidence in the fourth to fifth decades of life [12]. Scales et al. reported similar age distribution patterns and a male predominance in stone formers in the United States population-based study [12]. Likewise, the global epidemiologic analysis by Sorokin et al. highlighted that stone disease is increasingly common among middle-aged adults, particularly males [13].

Flank pain was the most common presenting complaint (84%), followed by hematuria (38.7%), findings that align with classic symptomatology described in clinical cohorts [14]. Recurrent stone disease was observed in 38.7% of patients, underscoring the chronic and relapsing nature of urolithiasis. Trinchieri reported recurrence rates ranging from 30–50% within five years, emphasizing the importance of metabolic evaluation in all stone formers [14]. Positive family history was present in 32%, supporting the contribution of genetic predisposition as previously documented in familial aggregation studies [15].

A major strength of the present study lies in its metabolic profiling. Metabolic syndrome was identified in 42.7% of participants, and ≥1 metabolic comorbidity was observed in 58.7%. This is comparable to the findings of Rendina et al., who reported significantly higher prevalence of metabolic syndrome among stone formers compared to controls [16]. The pathophysiological basis for this association is increasingly understood: insulin resistance reduces renal ammoniagenesis, resulting in persistently acidic urine and enhanced uric acid crystallization [17].

Anthropometric analysis revealed a mean BMI of 26.9 ± 4.3 kg/m², with 65.3% of patients classified as overweight or obese. Similar findings were reported in the Health Professionals Follow-up Study, where obesity was independently associated with increased stone risk [18]. Obesity contributes to lithogenesis through increased urinary excretion of calcium, oxalate, and uric acid, as well as reduced urinary pH [19].

The present study also demonstrated significant dyslipidemia, with elevated triglycerides in 52% and low HDL in 41.3% of patients. These findings mirror observations from cross-sectional analyses that showed a graded increase in stone prevalence with increasing metabolic syndrome traits [20]. Hypertriglyceridemia and low HDL are considered markers of insulin resistance and have been linked to uric acid stone formation through urinary acidification mechanisms [17,20].

Hyperuricemia was observed in 30.7% of participants, and serum uric acid showed the strongest correlation with stone size (r = 0.49). This is in agreement with Maalouf et al., who demonstrated that higher uric acid levels are associated not only with uric acid stones but also with mixed and calcium oxalate stones due to uric acid acting as a nidus for crystallization [21].

A key finding of the present study is the statistically significant association between metabolic syndrome and larger stone size (>10 mm) (p = 0.008). Patients with metabolic syndrome had a significantly higher mean stone size (11.2 ± 4.9 mm) compared to those without (8.3 ± 3.7 mm). Similar observations were reported by Jeong et al., who found that metabolic syndrome was independently associated with increased stone burden and bilateral disease [22]. This supports the concept that metabolic syndrome not only increases the risk of stone formation but may also influence disease severity.

Urine pH in the present cohort averaged 5.68 ± 0.74, with 38.7% demonstrating acidic urine (<5.5). Acidic urinary milieu is a well-established hallmark of insulin resistance and metabolic syndrome, as shown in studies by Sakhaee et al., where lower urine pH was strongly linked to obesity and diabetes [17]. The observed radiological distribution, with renal calculi being most common (58.7%), aligns with imaging patterns described in contemporary urology practice [13].

Research Gap

Most prior studies examining metabolic syndrome and urolithiasis have been cross-sectional or retrospective, limiting causal inference and comprehensive metabolic profiling [16,20]. Furthermore, many lacked detailed stone burden assessment in relation to metabolic clustering. The present prospective study bridges this gap by correlating metabolic parameters directly with stone size and burden in a real-world clinical setting. This strengthens the argument for routine metabolic evaluation in stone formers, particularly those with cardiometabolic risk factors.

CONCLUSION

The present study demonstrates a high prevalence of metabolic risk factors among patients with urolithiasis. Overweight/obesity, hypertension, dyslipidemia, hyperglycemia, and hyperuricemia were common findings. Metabolic syndrome was significantly associated with increased stone size, and serum uric acid showed the strongest correlation with stone burden. These findings reinforce the concept that urolithiasis is not merely a localized urinary disorder but a systemic metabolic disease. Early identification and management of metabolic abnormalities may reduce recurrence, decrease stone burden, and improve long-term outcomes. Routine metabolic screening should therefore be integrated into standard urolithiasis management protocols.

REFERENCES

1. Romero V, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. Rev Urol. 2010;12(2–3):e86–e96.
2. Stamatelou K, et al. Epidemiology of kidney stones (review; includes uric acid stone trends and association with obesity/metabolic syndrome). Healthcare (Basel). 2023.
3. Ramaswamy K, Shah O. Metabolic syndrome and nephrolithiasis. Transl Androl Urol. 2014;3(3):285–295.
4. Alberti KGMM, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation. 2009;120:1640–1645.
5. Besiroglu H, Otunctemur A, Ozbek E. The metabolic syndrome and urolithiasis: a systematic review and meta-analysis. Ren Fail. 2015;37(1):1–6.
6. Taylor EN, Stampfer MJ, Curhan GC. Obesity, weight gain, and the risk of kidney stones. JAMA. 2005;293(4):455–462.
7. West B, Luke A, Durazo-Arvizu RA, Cao G, Shoham D, Kramer H. Metabolic syndrome and self-reported history of kidney stones: the National Health and Nutrition Examination Survey (NHANES III) 1988–1994. Clin J Am Soc Nephrol. 2008.
8. Rahman IA, Nusaly IF, Syahrir S, et al. Association between metabolic syndrome components and the risk of developing nephrolithiasis: a systematic review and Bayesian meta-analysis. F1000Research. 2021;10:104.
9. European Association of Urology. EAU Guidelines on Urolithiasis (full guideline, 2024 edition). Arnhem: EAU Guidelines Office; 2024.
10. Skolarikos A, et al. Metabolic Evaluation and Recurrence Prevention for Urinary Stone Patients: An EAU Guidelines Update. Eur Urol. 2024.
11. Rams K, et al. Correlation of metabolic syndrome and urolithiasis (Indian cohort; highlights MetS components associated with urolithiasis). Urol Ann. 2020.
12. Scales CD Jr, Smith AC, Hanley JM, Saigal CS. Prevalence of kidney stones in the United States. Eur Urol. 2012;62:160–165.
13. Sorokin I, Mamoulakis C, Miyazawa K, Rodgers A, Talati J, Lotan Y. Epidemiology of stone disease worldwide. World J Urol. 2017;35:1301–1320.
14. Trinchieri A. Epidemiology of urolithiasis. Arch Ital Urol Androl. 2008;80:1–4.
15. Goldfarb DS. A genetic basis for kidney stone disease. Semin Nephrol. 2008;28:111–118.

16. Rendina D, De Filippo G, D'Elia L, et al. Metabolic syndrome and nephrolithiasis: a systematic review. Clin J Am Soc Nephrol. 2014;9:2059–2068.
17. Sakhaee K, Maalouf NM, Sinnott B. Kidney stones 2012: pathogenesis, diagnosis and management. J Clin Endocrinol Metab. 2012;97:1847–1860.
18. Taylor EN, Stampfer MJ, Curhan GC. Obesity, weight gain and the risk of kidney stones. JAMA. 2005;293:455–462.
19. Maalouf NM. Metabolic syndrome and the genesis of uric acid stones. J Ren Nutr. 2011;21:128–131.
20. West B, Luke A, Durazo-Arvizu R, Cao G, Shoham D, Kramer H. Metabolic syndrome and kidney stones. Clin J Am Soc Nephrol. 2008;3:1102–1108.
21. Maalouf NM, Cameron MA, Moe OW, Sakhaee K. Novel insights into the pathogenesis of uric acid nephrolithiasis. Curr Opin Nephrol Hypertens. 2004;13:181–189.
22. Jeong IG, Kang T, Bang JK, et al. Association between metabolic syndrome and the presence of kidney stones in a screened population. Am J Kidney Dis. 2011;58:383–388.