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Biochemical Parameters and Their Risk Factors in Patients Presenting With Nephrolithiasis and Renal Dysfunction

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Abstract

Background: Nephrolithiasis is a significant contributor to chronic kidney disease (CKD) in India. The condition is closely associated with metabolic risk factors such as hypertension, diabetes and obesity. All these factors are prevalent in the Indian population. Regional studies consistently showed that calcium oxalate is the dominant stone type - yet the interaction between stone composition, comorbidities and biochemical parameters in patients with renal dysfunction needs continued attention as patterns of disease vary with changing lifestyles and demographics.

Objectives: To assess the biochemical parameters, systemic risk factors and stone’s chemical analysis among adults presenting with nephrolithiasis and impaired renal function at a tertiary care centre in North-East India; to evaluate the associations between these factors and the severity of renal dysfunction.

Methodology: A prospective, observational study was conducted involving 143 adults with radiologically confirmed renal calculi and raised serum creatinine. Demographic data, comorbidities (hypertension, diabetes, obesity), laboratory values and type of stone on basis of chemical analysis were systematically recorded. Stones were analysed using special chemical technique .Group differences were assessed using chi-squared and t-tests. Logistic regression models were constructed to identify predictors of stone type and advanced renal dysfunction.

Results: Calcium oxalate stones were identified in 88.8% of cases, struvite in 5.6%, uric acid in 3.5%, and other types in 2.1%. Hypertension and diabetes were present in 42% and 29% of patients, respectively. Multivariable analysis showed no independent association between these comorbidities and stone composition. Age was the only significant predictor of severe renal dysfunction (OR per year = 1.06, 95% CI: 1.00–1.11). Urine pH was higher in non-calcium oxalate stones ($p = 0.036$); other biochemical parameters did not differ significantly between groups.

Conclusion: Calcium oxalate predominates as the stone type in this region, with advanced renal impairment largely driven by age rather than metabolic risk factors or stone composition. Early detection and comprehensive risk management remain critical for improving renal outcomes in nephrolithiasis.

Keywords: Nephrolithiasis, Urolithiasis, Kidney Calculi, Calcium Oxalate, Chronic Kidney Disease, Risk Factors, Biochemical Analysis, India

Introduction

Nephrolithiasis[1] is a prevalent and increasingly recognised contributor to chronic kidney disease (CKD).[2–5] This is especially the case in low and middle-income countries where access to early urological care and routine screening may be limited. In India - the burden of kidney stone disease has grown substantially over recent decades.[6–8] It is driven by dietary shifts, ageing, climatic factors and rising rates of hypertension, diabetes and obesity.[1,9,10] The condition affects both renal function and quality of life and is associated with considerable morbidity due to recurrence, obstruction, infection and (in advanced cases) permanent nephron loss. Systematic evaluations of the biochemical and metabolic milieu[8,10] in which stones form are sparse in regional literature - particularly in North-East India - where climatic, dietary and socioeconomic factors may differ from those in other parts of the country and the world.

Calcium oxalate stones are acknowledged to be the most common stone type globally.[11,12] Their formation is influenced by urinary supersaturation of oxalate and calcium in the context of low citrate, low urine volume and acidic pH.[13,14] Other stone types i.e., struvite, uric acid and calcium phosphate indicate distinct pathophysiological processes (e.g., infection, hyperuricaemia or impaired tubular acidification). The composition of a stone impacts patient's biochemical profile and also the underlying systemic conditions and long-term risk of recurrence.[3,15]

The relationship between stone disease and renal impairment is equally important. Obstructive nephropathy, recurrent infections and stone-related inflammation may all contribute to declining kidney function.[11,15] Metabolic conditions such as diabetes and hypertension are independently associated with CKD and are also known risk factors for nephrolithiasis. This raises the possibility of a shared pathway of renal injury. Identifying the clinical and biochemical features associated with stone type and renal dysfunction may improve risk stratification; which in turn could help prioritise early intervention in high-risk individuals.

Our study aimed to characterise the biochemical profile, risk factors and renal function status of adults presenting with nephrolithiasis at a tertiary centre in North-East India. We focussed on stone composition and its association with systemic comorbidity and severity of renal impairment.

Methodology

This study was designed as a prospective, observational analysis conducted at the Department of Urology, Gauhati Medical College & Hospital, Assam, India. Data were collected over a 12-month period from adults presenting with radiologically confirmed nephrolithiasis and evidence of impaired renal function. The study received approval from the institutional ethics committee prior to initiation.

Eligible participants included men and women aged 18 years or older with newly diagnosed or previously untreated renal calculi (as confirmed by ultrasonography, computed tomography or plain radiography). Impaired renal function was defined as a serum creatinine above the upper limit of normal for age and sex. Exclusion criteria were prior surgical or medical treatment for nephrolithiasis, known congenital anomalies of the urinary tract and patients unwilling or unable to provide informed consent. All participants provided written informed consent prior to enrolment. Patient confidentiality was strictly maintained. The study was conducted in accordance with the Declaration of Helsinki and local regulatory requirements.

The final analysis included 143 consecutive patients who met the inclusion criteria during the study period. The sample size was determined using standard formulae for observational studies. We accounted for the expected prevalence of nephrolithiasis and anticipated rates of systemic comorbidity within the regional population.

Data Collection: Baseline demographic details—including age, sex, and body mass index (BMI)—were recorded at presentation. Clinical histories were obtained, with emphasis on the presence of hypertension, type 2 diabetes mellitus, cardiovascular disease, smoking status, alcohol use, and obesity. A thorough physical examination was performed, and anthropometric data were documented. Blood samples were collected in the fasting state for the measurement of serum creatinine, calcium, phosphate, uric acid, albumin, and random blood glucose. All biochemical assays were conducted in the hospital's central laboratory using standardised automated methods. Urine pH was measured from a fresh spot sample. After that - a 24-hour urine collection was analysed for further metabolic workup.

24 hour urine Analysis: is used for compositional analysis using standard chemical analysis techniques. Stones were categorised as calcium oxalate, struvite, uric acid, calcium phosphate or mixed composition based on the findings.

Definitions: Obesity was defined as BMI $\geq$ 30 kg/m². Hypertension and type 2 diabetes mellitus were diagnosed based on established clinical criteria and/or ongoing pharmacological treatment. Severe renal dysfunction was categorised as serum creatinine > 5 mg/dL at presentation.

Statistical Analysis: The collected data was entered into a secure database and analysed using SPSS version 29. Continuous variables were described as mean ± standard deviation or median with interquartile range, as appropriate. Categorical variables were summarised as frequencies and percentages. Comparisons between groups were performed using chi-squared tests or Fisher's exact test for categorical variables, and Student's t-test or Welch's t-test for continuous variables. p-values were reported with a significance threshold set at $\alpha = 0.05$. Multivariable logistic regression was used to assess the association of demographic and clinical risk factors with stone composition (calcium oxalate versus other types) and with advanced renal dysfunction. Results were expressed as odds ratios (OR) with 95% confidence intervals. All analyses were conducted by a single investigator and ambiguous cases were duly resolved by consensus.

Results

Demographic profile: The cohort was predominantly male with a mean age in the early fifties.

Table 1: Demographic characteristics (n = 143)

Variable	n	Percentage / Mean ± SD
Male	116	81.10%
Female	27	18.90%
Age (years)	143	51.7 ± 13.69

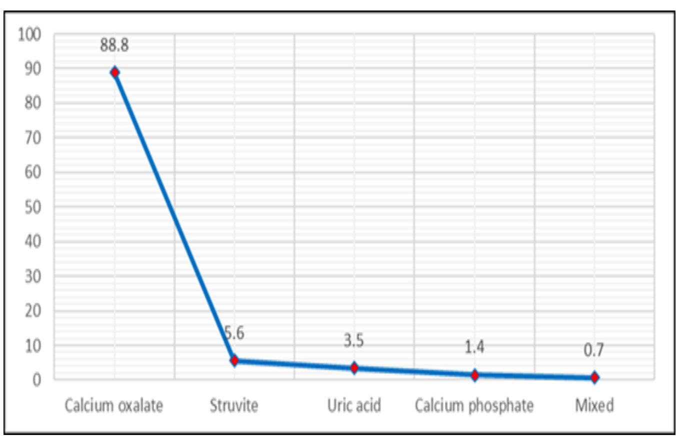
Of the 143 participants, 81 % were male (male-to-female ratio ≈ 4.3: 1). The mean age was 51.7 ± 13.7 years (range 19–80 years). This was consistent with the recognised peak incidence of stone disease in mid-adulthood.

Stone-composition distribution: Calcium oxalate stones overwhelmingly predominated in our study population. A χ^2 goodness-of-fit test (df = 4) was applied to determine whether the observed distribution differed from an equal (20 % each) theoretical distribution.

Table 2: Type of stones

Stone type	n	%	p-value
Calcium oxalate	127	88.8	< 0.001
Struvite	8	5.6	
Uric acid	5	3.5	
Calcium phosphate	2	1.4	
Mixed	1	0.7	

Graph 1:



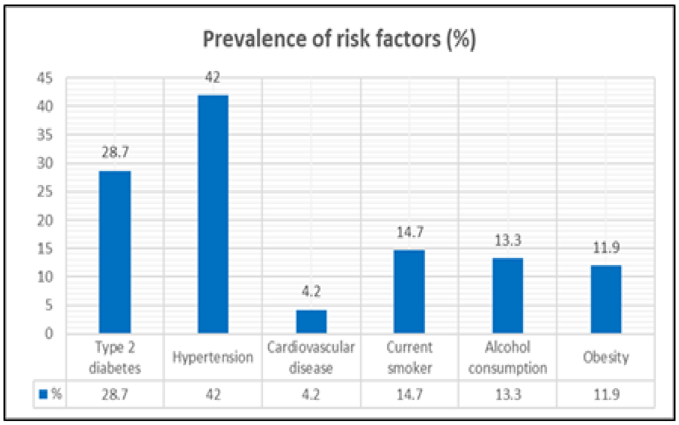
Calcium oxalate calculi accounted for nearly nine out of ten stones. Infection-related struvite stones comprised 5.6 % and uric-acid and calcium-phosphate stones were comparatively rare. A single specimen (0.7 %) had mixed composition (calcium oxalate + calcium phosphate). The composition pattern was highly non-uniform ($\chi^2 = 424.2$, $p < 0.001$), with calcium-oxalate calculi accounting for almost 89 % of cases; all other stone types were markedly under-represented relative to an equiprobable expectation.

Comorbid risk-factor burden: Hypertension and diabetes were the common systemic associations. For each binary risk factor a 2 × 2 χ^2 test compared its prevalence between calcium-oxalate stones and all other stones combined.

Table 3: Prevalence of predefined risk factors

Risk factor	n	%	p-value
Type 2 diabetes	41	28.7	0.792
Hypertension	60	42	1.000
Cardiovascular disease	6	4.2	0.297
Current smoker	21	14.7	0.873
Alcohol consumption	19	13.3	1.000
Obesity	17	11.9	1.000

Graph 2:



Forty-two per cent of patients were hypertensive and 29 % had type 2 diabetes mellitus. Lifestyle-related exposures were also evident, with 15 % current smokers and 13 % reporting regular alcohol intake. Obesity was documented in 12 % using BMI ≥ 30 kg m^{-2}. None of the predefined systemic or lifestyle risk factors exhibited a statistically significant association with stone composition (all $p > 0.29$). The numerically higher prevalence of hypertension (42 %) and diabetes (29 %) therefore appears to indicate the background metabolic profile of the cohort rather than a stone-specific effect.

Biochemical profile: Serum creatinine was markedly elevated and metabolic milieu favoured lithogenesis. Mean values were compared between calcium-oxalate and non-calcium-oxalate groups using Welch's unequal-variance t-test.

Table 4: Key biochemical parameters

Parameter	Mean ± SD	p-value
Serum creatinine (mg/dL)	4.57 ± 2.90	0.963
Serum calcium (mg/dL)	8.84 ± 0.70	0.166
Serum phosphate (mg/dL)	5.29 ± 1.21	0.072
Serum uric acid (mg/dL)	6.48 ± 1.59	0.326
Random blood glucose (mg/dL)	110.68 ± 32.08	0.478
24-hour urine pH	6.07 ± 0.53	0.036
Serum albumin (g/dL)	3.69 ± 0.46	0.986

Mean serum creatinine was 4.6 mg dL^{-1}, reflecting significant renal impairment at presentation. Calcium and phosphate were within the high-normal range, whereas mean serum uric acid was mildly raised. Average urine pH was slightly acidic (6.1), a milieu conducive to calcium-oxalate precipitation. Biochemical parameters were broadly comparable across stone types, with the exception of urinary pH: patients having non-calcium-oxalate stones had a marginally higher mean pH and this yielded a small but significant difference (p =

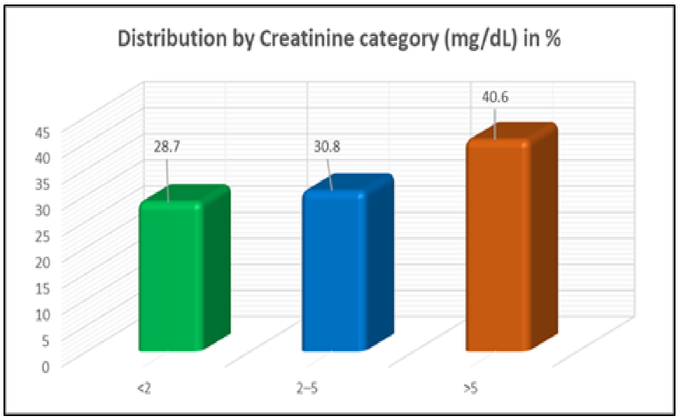
0.036). Creatinine, calcium, phosphate, uric acid and albumin did not differ significantly (all $p > 0.07$). This indicated that overall renal impairment and metabolic milieu were shared features irrespective of composition.

Renal-function stratification: Creatinine categories demonstrated a sizeable proportion with advanced dysfunction.

Table 5: Distribution of serum-creatinine strata

Creatinine category (mg/dL)	n	%
<2	41	28.7
2–5	44	30.8
>5	58	40.6

Graph 3:



Over 40 % of patients had serum creatinine > 5 mg dL^{-1} on admission. This indicated late presentation and emphasized the importance of early detection programmes in the region.

Predictors of calcium-oxalate stone formation: A multivariable logistic regression model (n = 143) was constructed with stone type as the dependent variable (1 = calcium-oxalate, 0 = all other compositions). Independent variables were pre-specified a priori: age, sex, type 2 diabetes, hypertension, smoking, alcohol use and obesity. Results have been expressed as odds ratios (OR) with 95 % confidence intervals (CI).

Table 6: Multivariable logistic regression—risk factors for calcium-oxalate stones

Variable	OR	95% CI Lower	95% CI Upper	p-value
Age (per year)	1.03	0.98	1.08	0.296
Male sex	3.33	0.76	14.59	0.11
Type 2 diabetes	1.36	0.34	5.48	0.669
Hypertension	0.51	0.12	2.13	0.355
Current smoker	1.03	0.16	6.65	0.972
Alcohol intake	0.78	0.12	5.21	0.799
Obesity	0.57	0.08	3.89	0.57

After simultaneous adjustment for all covariates – we observed that no single factor reached statistical significance (global likelihood-ratio $p = 0.81$). Male sex showed a non-significant trend towards higher odds of calcium-oxalate calculi (OR = 3.33, $p = 0.11$). Metabolic variables (diabetes, hypertension, obesity) were also not independently associated with stone composition in our study cohort.

Determinants of advanced renal dysfunction: A second logistic model explored predictors of severe chronic kidney disease (CKD). This was defined as serum creatinine > 5 mg dL^{-1}. Predictors included age, sex, calcium-oxalate stone status and the same cardiometabolic factors.

Table 7: Multivariable logistic regression: risk factors for severe CKD (Creatinine > 5 mg dL^{-1})

Variable	OR	95% CI Lower	95% CI Upper	p-value
Age (per year)	1.06	1	1.11	0.042
Male sex	3.43	0.67	17.46	0.138
Calcium-oxalate stone	0.64	0.17	2.43	0.509
Type 2 diabetes	2.33	0.68	7.91	0.177
Hypertension	0.69	0.2	2.39	0.559
Current smoker	0.47	0.09	2.48	0.374
Alcohol intake	3.28	0.59	18.19	0.175
Obesity	0.13	0.01	1.41	0.094

Increasing age was the sole independent predictor of severe CKD (OR per year = 1.06; 95 % CI 1.00–1.11; p = 0.042). Obesity tended towards significance (OR per year = 0.13; 95% CI 0.01-1.41; p = 0.094) but with a low odds-ratio. Stone composition itself was not related to renal impairment (p = 0.51). Although the point estimates for diabetes and alcohol use suggested elevated odds (OR ≈ 2–3) – the wide confidence intervals and p-values > 0.05 indicated inadequate power at this stage.

Discussion

This single-centre cohort of 143 adults with nephrolithiasis and impaired renal function provided a contemporary snapshot of stone epidemiology and its clinical correlates in North-East India. Five principal observations will be discussed.

Calcium-oxalate predominance: Almost nine in ten calculi were calcium oxalate, a proportion at the upper end of Indian series and appreciably higher than the 60–70 % typically reported from Western cohorts. The hot–humid local climate, a largely plant-based diet rich in oxalate (tea, leafy vegetables) and limited access to potassium-citrate-rich fruit may synergise to favour oxalate supersaturation. The very small fractions of uric-acid and calcium-phosphate stones suggest that purine-rich diets and distal renal tubular acidosis, respectively, are comparatively uncommon drivers of lithogenesis in this setting.

Cardiometabolic comorbidity without compositional specificity: Hypertension (42 %) and type 2 diabetes (29 %) were frequent, yet neither variable—nor obesity, smoking or alcohol intake—was independently associated with calcium-oxalate stone formation on multivariable analysis. This finding contrasted with several large registry studies where metabolic syndrome traits have predicted calcium-based stones. But effect estimates in those studies are modest. The absence of a signal here may stem from limited statistical power once non-calcium-oxalate cases (n = 16) are isolated - rather than true biological neutrality. The high absolute burden of cardiometabolic disease indicated a need for risk-factor management irrespective of stone type.

Biochemical homogeneity across stone groups: Serum creatinine was markedly elevated (mean 4.6 mg dL^{-1}), and calcium, phosphate and uric acid values lay within high-normal or mildly raised ranges, irrespective of composition. Urinary pH alone differed significantly. It was marginally higher in non-calcium-oxalate stones; this is pathophysiologically plausible due to the alkaline milieu impacting struvite and calcium-phosphate precipitation.

Age as the sole independent predictor of severe CKD: In the logistic model each additional year of age conferred a 6 % increase in the odds of creatinine > 5 mg dL^{-1}. Stone composition, diabetes and hypertension were neutral. These data corroborated the concept that older adults often presented late with obstructive-plus-degenerative renal decline. Calcium-oxalate stones themselves did not predict poorer renal function. Timely relief of obstruction and infection control may mitigate long-term damage irrespective of composition.

Work from Southern India by Vilapurathu and colleagues in 2025 shows that about 70% of stones analysed were calcium oxalate.[16] This matched the high proportion recorded in our series. The figure is close to that reported by Schott and co-authors in 2022.[17] A male excess is a recurring theme: Çil et al. in 2022 placed the male-to-female ratio near four to one and Dong's 2024 study in northern China reported a similar gradient.[18,19] These findings align with our own demographic profile.

The metabolic environment in which stones form has been subjected to much scrutiny. Shah et al. in 2020 examined hypertension in a nephrolithiasis clinic and found only a modest share of cases attributable to raised blood pressure. But they noted altered calcium handling in hypertensive patients.[20] In a Dutch cohort - Placzyńska et al. (2023) linked higher body mass index and diabetes with increased urinary oxalate.[21] This result was echoed by Waikar's Boston group in 2019 who measured greater oxalate excretion among diabetic participants.[22] Our multivariable model showed that once obesity, blood pressure and diabetes are considered together - none showed a strong independent association with calcium oxalate stones. This suggested that shared behavioural and dietary influences may overshadow individual risk factors when examined in isolation.

Type of stone and renal outcome have been paired in several recent analyses. In Northwestern Rajasthan - Singh et al. in 2018 recorded calcium oxalate as the most frequent stone and noted a trend towards poorer renal indices in those patients.[23] This raised the possibility that recurrent obstructive episodes compound chronic damage. Jung et al. in Korea in 2020 explored renal function after percutaneous nephrolithotomy and hinted that composition may affect postoperative creatinine.[24] Calcium oxalate was not singled out as an adverse factor. Xie's microbiome study from 2020 connected calcium-based stones with distinct urinary bacterial communities and suggested a pathway linking stone type to chronic kidney disease.[25] Our data provided limited support to composition as a driver of baseline dysfunction: age alone shows a clear association with creatinine above 5 mg dL^{-1}; calcium oxalate stones do not. This contrast implied that in settings where access to care is delayed - time-dependent damage may outweigh composition-specific effects.

These evidences indicated that preventive strategies in India should give priority to reducing urinary oxalate load through diet and hydration. Integrated management of diabetes and hypertension is also essential for wider renal and cardiovascular health. Community screening aimed at older adults could catch declining kidney function earlier and shorten the interval between the first symptomatic stone and definitive treatment. This is a step likely to limit long-term loss of renal tissue.

Strengths and limitations: Strengths of our study include prospective data capture, systematic stone analysis and adjustment for key confounders. Our single-centre design is a limitation. Also, small number of non-calcium-oxalate stones limited inferential power and reliance on a single baseline creatinine value rather than estimated glomerular filtration rate. Longitudinal follow-up will be necessary to explore recurrence and renal trajectory.

Clinical implications and future directions: Calcium-oxalate prevention strategies e.g., high fluid intake, dietary oxalate moderation and citrate supplementation are critical. We also highlight that the background cardiometabolic risk must be managed in parallel. Community-level screening for renal impairment in older adults could facilitate earlier referral and stone clearance before irreversible nephron loss. Future work should enlarge the non-calcium-oxalate subgroup and should incorporate 24-hour urinary chemistries to explore genetic or microbiome contributors.

Conclusion

Our prospective study highlights the overwhelming predominance of calcium oxalate stones among adults presenting with nephrolithiasis and impaired renal function in North-East India. The high burden of hypertension, diabetes and obesity in this cohort emphasizes the importance of addressing cardiometabolic risk factors as part of a comprehensive management strategy. Our analysis showed that these comorbidities do not independently predict stone composition or severity of renal dysfunction when considered alongside other variables. Advancing age was the main determinant of severe renal impairment at presentation. This suggested that delayed diagnosis and treatment was significant challenges in this setting. The biochemical profiles were broadly similar across stone types - with the exception of urine pH which was higher in non-calcium oxalate stones. Our findings support the need for early detection, preventive dietary and lifestyle intervention and integrated care pathways for patients with kidney stones. This is aimed both at reducing recurrence and at preserving renal function. Larger, multicentre studies with longitudinal follow-up are recommended to clarify the links between metabolic risk factors, stone composition and renal outcomes in diverse populations.

References

1. Keddis MT, Rule AD. Nephrolithiasis and loss of kidney function. Vol. 22, Current Opinion in Nephrology and Hypertension. 2013.
2. Chuang TF, Hung HC, Li SF, Lee MW, Pai JY, Hung CT. Risk of chronic kidney disease in patients with kidney stones - A nationwide cohort study. BMC Nephrol. 2020;21(1).
3. Stamatelou K, Goldfarb DS. Epidemiology of Kidney Stones. Vol. 11, Healthcare (Switzerland). 2023.
4. Shang W, Li L, Ren Y, Ge Q, Ku M, Ge S, et al. History of kidney stones and risk of chronic kidney disease: A meta-analysis. PeerJ. 2017;2017(1).
5. Rule AD, Bergstralh EJ, Melton LJ, Li X, Weaver AL, Lieske JC. Kidney stones and the risk for chronic kidney disease. Clinical Journal of the American Society of Nephrology. 2009;4(4).
6. Wilson E V., Bushiri MJ, Vaidyan VK. Characterization and FTIR spectral studies of human urinary stones from Southern India. Spectrochim Acta A Mol Biomol Spectrosc. 2010;77(2).
7. Girija EK, Kalkura SN, Sivaraman PB, Yokogawa Y. Mineralogical composition of urinary calculi from southern India. J Sci Ind Res (India). 2007;66(8).

8. Surinder K. Sharma Irs& Snp. Urinary Stones In Southern India: Biochemical Analysis And Its Clinical Implications. International Journal of General Medicine and Pharmacy (IJGMP). 2015;4(1).
9. Moudi E, Hosseini SR, Bijani A. Nephrolithiasis in elderly population; effect of demographic characteristics. J Nephropathol. 2017;6(2).
10. Obligado SH, Goldfarb DS. The association of nephrolithiasis with hypertension and obesity: A review. Vol. 21, American Journal of Hypertension. 2008.
11. Basavaraj DR, Biyani CS, Browning AJ, Cartledge JJ. The Role of Urinary Kidney Stone Inhibitors and Promoters in the Pathogenesis of Calcium Containing Renal Stones{A figure is presented}. Vol. 5, EAU-EBU Update Series. 2007.
12. Mehta M, Goldfarb DS, Nazzal L. The role of the microbiome in kidney stone formation. Vol. 36, International Journal of Surgery. 2016.
13. Chen T, Qian B, Zou J, Luo P, Zou J, Li W, et al. Oxalate as a potent promoter of kidney stone formation. Vol. 10, Frontiers in Medicine. 2023.
14. Alelign T, Petros B. Kidney Stone Disease: An Update on Current Concepts. Vol. 2018, Advances in Urology. 2018.
15. Skolarikos A, Straub M, Knoll T, Sarica K, Seitz C, Petřík A, et al. Metabolic evaluation and recurrence prevention for urinary stone patients: EAU guidelines. Eur Urol. 2015;67(4).
16. Vilapurathu JK, Carlmana CA, Francisa D, Varghesea S. A Comprehensive Investigation of the Prevalence and Risk Factors Associated With Renal Calculi in Southern India: A Prospective Study. Urol Sci. 2025;36(1):20–4.
17. Schott C, Pourtousi A, Connaughton DM. Monogenic Causation of Pediatric Nephrolithiasis. Frontiers in Urology. 2022;2.
18. Çil O, Chu T, Lee S, Haggie PM, Verkman AS. Small-Molecule Inhibitor of Intestinal Anion Exchanger SLC26A3 for Treatment of Hyperoxaluria and Nephrolithiasis. JCI Insight. 2022;7(13).
19. Dong C, Zhou J, Su X, He Z, Song Q, Song C, et al. Understanding Formation Processes of Calcareous Nephrolithiasis in Renal Interstitium and Tubule Lumen. J Cell Mol Med. 2024;28(7).
20. Shah P, Baral R, Agrawal CS, Lamsal M, Baral D, Khanal B. Urinary Calculi: A Microbiological and Biochemical Analysis at a Tertiary Care Hospital in Eastern Nepal. Int J Microbiol. 2020;2020:1–9.
21. Placzyńska M, Milart J, Lubas A, Samotyjek J, Jurkiewicz B, Kalicki B, et al. Association Between The metabolic Profile Of urolithiasis in Children With Idiopathic Hypercalciuria and The composition Of the stone Assessed by Infrared Spectroscopy. Pediatr Pol. 2023;98(4):271–7.
22. Waikar SS, Srivastava A, Pálsson R, Shafi T, Hsu C, Sharma K, et al. Association of Urinary Oxalate Excretion With the Risk of Chronic Kidney Disease Progression. JAMA Intern Med. 2019;179(4):542.
23. Singh V, Bhat M, Kumar V, Bhat A. Spectrum of Urinary Stone Composition in Northwestern Rajasthan Using Fourier Transform Infrared Spectroscopy. Indian Journal of Urology. 2018;34(2):144.
24. Jung JH, Yoo S, Park J, Cho MC, Son H, Jeong H, et al. Postoperative Renal Functional Changes Assessed By^{99m}Tc-Dtpa Scintigraphy and Predictive Factors After Miniaturized

Percutaneous Nephrolithotomy and Retrograde Intrarenal Surgery: An Observational 1-Year Follow-Up Study. Investig Clin Urol. 2020;61(1):59.

25. Xie J, Huang J, Huang X, Peng J, Zhou Y, Yuan Y, et al. Profiling the Urinary Microbiome in Men With Calcium-Based Kidney Stones. 2020;