International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/26-08-105*

Clinical Profile and Risk Factors Associated with Urolithiasis Among Patients Attending a Tertiary Care Hospital: A Cross-Sectional Study.

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Received: 12-06-2026
Revised: 27-06-2026
Accepted: 16-07-2026
Published: 17-08-2026

Abstract

Background: Urolithiasis is a common and recurrent urinary disorder influenced by genetic, demographic, dietary, metabolic, occupational, and environmental factors. Identifying its clinical spectrum and modifiable risk factors is important for early diagnosis and prevention of recurrence. ***Aim:*** To assess the clinical profile and risk factors associated with urolithiasis among patients attending a tertiary-care hospital. ***Materials and Methods:*** This hospital-based analytical cross-sectional study included 200 adult patients evaluated for symptoms suggestive of urinary stone disease. Sociodemographic characteristics, clinical presentation, dietary and lifestyle habits, occupational exposure, family history, comorbidities, laboratory findings, and radiological characteristics were recorded using a structured case-record form. Urolithiasis was confirmed by ultrasonography or non-contrast computed tomography. Participants with and without urolithiasis were compared using the independent-samples t-test, Mann-Whitney U test, chi-square test, or Fisher's exact test, as appropriate. Crude and adjusted odds ratios with 95% confidence intervals were calculated using univariable and multivariable binary logistic regression. A p value <0.05 was considered statistically significant. ***Results:*** Of the 200 participants, 116 (58.0%; 95% CI: 50.8%-64.9%) had imaging-confirmed urolithiasis. Among confirmed cases, the mean age was 44.68±13.24 years, 68.1% were aged ≥40 years, and 67.2% were male. Flank pain was the most common presentation (80.2%), followed by abdominal pain (52.6%), renal-angle tenderness (50.9%), haematuria (44.0%), and dysuria (40.5%). Renal stones were identified in 57.8%, ureteric stones in 32.8%, and vesical stones in 9.5%. Hydronephrosis was present in 39.7%, hydroureter in 29.3%, and multiple calculi in 26.7%. Univariable analysis showed significant associations with male sex, age ≥40 years, fluid intake <2 L/day, high salt intake, frequent animal-protein intake, occupational heat exposure, positive family history, BMI ≥25 kg/m^2, and recurrent urinary tract infection. Independent predictors were positive family history (aOR=2.76, 95% CI: 1.29-5.92; p=0.009), fluid intake <2 L/day (aOR=2.34, 95% CI: 1.23-4.47; p=0.010), occupational heat exposure (aOR=2.08, 95% CI: 1.05-4.13; p=0.037), age ≥40 years (aOR=1.94, 95% CI: 1.04-3.63; p=0.038), and high dietary salt intake (aOR=1.89, 95% CI: 1.03-3.47; p=0.040). ***Conclusion:*** Urolithiasis was frequently detected among symptomatic tertiary-care attendees and predominantly affected middle-aged men. Positive family history, inadequate fluid intake, occupational heat exposure, age ≥40 years, and high salt intake were independent predictors. Risk-based screening, adequate hydration, salt restriction, workplace heat protection, and individualized preventive counselling may help reduce the burden and recurrence of urinary stone disease.

Keywords: Urolithiasis; Risk factors; Fluid intake.

INTRODUCTION

Urolithiasis is a common disorder characterized by the formation of calculi within the kidneys, ureters, urinary bladder, or urethra. It represents an important public-health problem because of its increasing incidence, recurrent nature, substantial treatment costs, and potential complications, including urinary obstruction, recurrent urinary tract infection, hydronephrosis, renal impairment, and, in severe cases, loss of renal function. The global burden of urolithiasis has increased considerably over recent decades, although its prevalence varies according to geographical region, age, sex, ethnicity, climate, socioeconomic conditions, and diagnostic practices.[1]

Urolithiasis occurs most commonly among adults of productive age and has traditionally shown a male predominance; however, the difference between men and women appears to be narrowing because of changes in diet, occupation, obesity, and other lifestyle-related factors.[2] Stone formation is a complex and multifactorial process involving urinary supersaturation, crystal nucleation, aggregation, growth, and retention. Calcium oxalate is the most frequently encountered stone type, followed by calcium phosphate, uric acid, struvite, and cystine stones. The clinical presentation varies according to stone size, location, degree of obstruction, and associated infection. Patients may present with acute colicky flank pain, abdominal pain, haematuria, dysuria, nausea, vomiting, fever, urinary frequency, or incidental stones detected during imaging. Ultrasonography is commonly used as the initial imaging modality because it is inexpensive and avoids radiation, while non-contrast computed tomography of the kidneys, ureters, and bladder provides greater diagnostic accuracy for determining stone size, number, density, and anatomical location.[3]

Several non-modifiable factors, including increasing age, male sex, family history, anatomical abnormalities, genetic predisposition, and previous stone episodes, influence the risk of urolithiasis. Important modifiable factors include inadequate fluid intake, low urine volume, high dietary sodium, excessive animal-protein consumption, increased intake of oxalate- or purine-rich foods, obesity, physical inactivity, prolonged exposure to high environmental temperatures, and certain medications or supplements. Diabetes mellitus, hypertension, metabolic syndrome, hyperuricaemia, gout, chronic diarrhoeal disorders, hyperparathyroidism, and recurrent urinary tract infections may also contribute to stone development.[2,4]

India carries a considerable burden of stone disease, particularly in regions with hot climatic conditions, where dehydration, occupational heat exposure, dietary practices, and differences in mineral content of drinking water may influence stone formation.[5] Identifying the local clinical spectrum and potentially modifiable risk factors is necessary for early diagnosis, individualized treatment, counselling, and prevention of recurrence. The present study was therefore undertaken to evaluate the clinical profile and factors associated with urolithiasis among patients attending a tertiary-care hospital.

AIM

To assess the clinical profile and risk factors associated with urolithiasis among patients attending a tertiary-care hospital.

OBJECTIVES

1. To describe the sociodemographic characteristics, clinical presentation, laboratory findings, and radiological profile of patients evaluated for urolithiasis.
2. To determine the association of demographic, dietary, lifestyle, occupational, familial, and clinical factors with the presence of urolithiasis.
3. To identify the independent predictors of urolithiasis using multivariable logistic-regression analysis.

MATERIALS AND METHODS

Source of Data

The study data were obtained from patients attending the outpatient and inpatient services of the Departments of Urology, General Surgery, and General Medicine of the selected tertiary-care hospital. Patients who underwent clinical and radiological evaluation for symptoms suggestive of urinary stone disease during the study period constituted the study population. Information was obtained through patient interviews, clinical examination, hospital records, laboratory reports, and radiological investigations.

Study Design

A hospital-based analytical cross-sectional study was conducted. Participants were classified into a urolithiasis group and a non-urolithiasis group according to radiological findings. The clinical profile of participants with confirmed urolithiasis was described, and potential risk factors were compared between patients with and without urolithiasis.

Study Location

The study was conducted in the Departments of Urology, General Surgery, and General Medicine, in coordination with the Departments of Radiodiagnosis, Pathology, and Biochemistry, at a tertiary-care teaching hospital.

Study Duration

The study was conducted over a period of 18 months, including participant recruitment, clinical and laboratory assessment, data entry, statistical analysis, and preparation of the final report.

Sample Size

A total of 200 eligible participants were included in the study. Participants were enrolled consecutively until the required sample size was achieved. The sample included patients with radiologically confirmed urolithiasis and patients evaluated for similar urinary symptoms in whom imaging did not demonstrate a urinary calculus.

Sampling Technique

A non-probability consecutive sampling method was used. Every eligible patient presenting during the study period was approached for participation until the predetermined sample size of 200 was completed.

Inclusion Criteria

- Patients aged 18 years or older.
- Patients attending the selected departments with flank pain, abdominal pain, haematuria, dysuria, urinary frequency, nausea, vomiting, or other symptoms suggestive of urinary stone disease.
- Patients who underwent ultrasonography or non-contrast computed tomography of the urinary tract.
- Patients who provided written informed consent.
- Both newly diagnosed and previously diagnosed cases were included for assessment of the clinical spectrum; previous stone history was recorded separately.

Exclusion Criteria

- Patients younger than 18 years.
- Patients who did not provide informed consent.
- Pregnant women when the prescribed study imaging involved ionizing radiation; those evaluated safely using ultrasonography could be considered according to the approved protocol.
- Patients with incomplete clinical, laboratory, or radiological information.
- Patients who had undergone a urological procedure for the current stone episode before completion of the baseline assessment.
- Patients who were critically ill or unable to provide a reliable history and for whom no appropriate informant was available.
- Patients with known malignant disease of the urinary tract producing symptoms similar to urolithiasis.
- Patients in whom the presence or absence of urinary calculi could not be established through imaging.

Procedure and Methodology

Approval was obtained from the Institutional Ethics Committee before commencement of the study. Eligible patients were informed about the purpose, procedure, potential benefits, and confidentiality provisions of the study. Written informed consent was obtained before enrolment.

Each participant was interviewed using a predesigned and pretested case-record form. Sociodemographic data included age, sex, residence, education, occupation, socioeconomic status, and type of drinking-water source. Particular attention was given to occupations involving prolonged heat exposure, outdoor work, heavy physical activity, or restricted access to drinking water.

A detailed clinical history was recorded, including the onset, duration, site, nature, radiation, and severity of pain. Associated symptoms such as haematuria, dysuria, urinary frequency, fever, chills, nausea, vomiting, reduced urine output, and previous passage of stones were documented. Previous episodes of urolithiasis, previous surgical or endourological intervention, recurrence, family history of urinary stones, urinary tract infections, and use of stone-forming medications or supplements were recorded.

Lifestyle and dietary information included average daily fluid intake, frequency of water consumption, prolonged voluntary retention of urine, intake of added salt, processed foods, animal protein, red meat, organ meat, tea, coffee, sugar-sweetened beverages, carbonated drinks, dairy products, and oxalate- or purine-rich foods. Smoking, smokeless-tobacco use, alcohol consumption, physical activity, and usual exposure to hot environmental conditions were also assessed. Where exact dietary quantities were unavailable, intake was classified using predefined frequency categories.

The medical history included diabetes mellitus, hypertension, obesity, gout, hyperuricaemia, chronic kidney disease, inflammatory bowel disease, chronic diarrhoea, bariatric or intestinal surgery, hyperparathyroidism, recurrent urinary tract infection, and congenital urinary-tract abnormalities. Current and previous use of medications such as loop diuretics, topiramate, antacids, calcium supplements, vitamin C, vitamin D, and uricosuric drugs was recorded.

A general and systemic examination was performed. Height was measured to the nearest 0.1 cm and weight to the nearest 0.1 kg. Body mass index was calculated as:

Blood pressure, pulse rate, temperature, hydration status, abdominal tenderness, renal-angle tenderness, and palpable abdominal or urinary bladder masses were documented.

All participants underwent ultrasonography of the kidneys, ureters, and urinary bladder. Non-contrast computed tomography of the kidneys, ureters, and bladder was performed when clinically indicated. The presence, number, size, side, location, and density of stones were recorded. Associated hydroureter, hydronephrosis, urinary obstruction, anatomical abnormalities, perinephric changes, or evidence of infection was documented. Stone location was categorized as renal, ureteric, vesical, urethral, or involving multiple sites. Patients were classified as having urolithiasis when one or more urinary calculi were identified on imaging.

Sample Processing

A clean-catch midstream urine sample was collected in a sterile, labelled container after explaining the correct collection procedure. Urine was subjected to routine and microscopic examination for pH, specific gravity, red blood cells, pus cells, crystals, protein, glucose, and other abnormalities. Urine culture and antimicrobial-sensitivity testing were performed when urinary tract infection was clinically suspected.

A venous blood sample of approximately 5-10 mL was collected under aseptic precautions. The sample was divided into appropriate tubes according to the investigations required. Serum was separated by centrifugation and analysed for serum creatinine, blood urea, sodium, potassium, calcium, phosphorus, and uric acid. Complete blood count, blood glucose, and other clinically indicated investigations were performed according to the hospital protocol. Estimated glomerular filtration rate was calculated using an accepted equation.

Whenever a stone was passed spontaneously or retrieved during treatment, it was collected in a clean, dry container and sent for compositional analysis, subject to availability. Stones were classified as calcium oxalate, calcium phosphate, uric acid, struvite, cystine, or mixed stones according to the laboratory report. All specimens were labelled using unique study identification numbers and processed according to standard laboratory procedures.

Data Collection

Data were collected using a structured, predesigned, and pretested case-record form. The form included sections on:

- Sociodemographic and occupational characteristics.
- Presenting symptoms and clinical findings.
- Dietary habits and average fluid intake.
- Tobacco and alcohol use.
- Physical activity and environmental heat exposure.
- Medical, medication, family, and previous stone history.
- Anthropometric measurements and blood pressure.
- Urine and blood investigation findings.
- Imaging characteristics of urinary calculi.
- Stone composition, when available.
- Complications such as obstruction, hydronephrosis, infection, and impaired renal function.

The collected forms were reviewed daily for completeness and consistency. Each participant was assigned a unique identification number. Personal identifiers were kept separately from the analytical dataset, and confidentiality was maintained throughout the study.

Statistical Methods

The collected data were entered into Microsoft Excel and analysed using an appropriate statistical software package, such as IBM SPSS Statistics. Quantitative variables were assessed for normality. Normally distributed variables were expressed as mean and standard deviation, whereas non-normally distributed variables were expressed as median and interquartile range. Categorical variables were presented as frequencies and percentages. Prevalence estimates were reported with 95% confidence intervals.

The clinical profile of participants with confirmed urolithiasis was summarized descriptively. The independent-samples Student's t-test was used to compare normally distributed quantitative variables between patients with and without urolithiasis. The Mann-Whitney U test was used for non-normally distributed variables. The chi-square test was used to assess associations between categorical variables. Fisher's exact test was applied when expected cell frequencies were small.

Crude odds ratios with 95% confidence intervals were calculated for potential risk factors. Variables with a p value below 0.20 in univariable analysis, together with clinically important factors such as age and sex, were entered into a multivariable binary logistic-regression model. Adjusted odds ratios with 95% confidence intervals were reported to identify independent predictors of urolithiasis. Multicollinearity, model calibration, and overall model fit were assessed before interpretation. A two-sided p value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Overall clinical profile and distribution of potential risk factors among patients evaluated for urolithiasis (N=200)

Parameter	Mean (SD) or n (%)	95% CI	Test of significance	P value
Age, years	41.92 (14.18)	39.94-43.90	One-sample t=1.92†	0.057
Male sex	120 (60.0%)	52.9%-66.8%	Proportion z=2.83‡	0.005*
Rural residence	111 (55.5%)	48.3%-62.5%	Proportion z=1.56‡	0.119
BMI, kg/m²	24.83 (4.31)	24.23-25.43	One-sample t=-0.56§	0.577
Average fluid intake, L/day	1.91 (0.72)	1.81-2.01	One-sample t=-1.77¶	0.078
Daily fluid intake <2 L	120 (60.0%)	52.9%-66.8%	Proportion z=2.83‡	0.005*
High dietary salt intake	100 (50.0%)	42.9%-57.1%	Proportion z=0.00‡	1.000
Frequent animal-protein intake	86 (43.0%)	36.0%-50.2%	Proportion z=-1.98‡	0.048*
Occupational heat exposure	65 (32.5%)	26.0%-39.5%	Proportion z=-4.95‡	<0.001*
Positive family history of urolithiasis	50 (25.0%)	19.2%-31.6%	Proportion z=-7.07‡	<0.001*
BMI ≥25 kg/m²	61 (30.5%)	24.2%-37.4%	Proportion z=-5.52‡	<0.001*
Recurrent urinary tract infection	44 (22.0%)	16.5%-28.4%	Proportion z=-7.92‡	<0.001*
Diabetes mellitus	41 (20.5%)	15.1%-26.8%	Proportion z=-8.34‡	<0.001*
Current tobacco use	49 (24.5%)	18.7%-31.1%	Proportion z=-7.21‡	<0.001*
Imaging-confirmed urolithiasis	116 (58.0%)	50.8%-64.9%	Proportion z=2.26‡	0.024*

†Reference mean age=40 years. ‡Reference proportion=50%. §Reference BMI=25 kg/m².

Reference fluid intake=2 L/day.
*Statistically significant at p<0.05.

Among the 200 patients evaluated for urolithiasis, the mean age was 41.92±14.18 years (95% CI: 39.94-43.90), which did not differ significantly from the reference age of 40 years (p=0.057). Males constituted 60.0% of participants (95% CI: 52.9%-66.8%), representing a statistically significant predominance (p=0.005). Rural residents accounted for 55.5%, although their proportion was not significantly different from 50% (p=0.119). The mean BMI was 24.83±4.31 kg/m² (p=0.577), while 30.5% of participants had a BMI ≥25 kg/m². The mean daily fluid intake was 1.91±0.72 L (95% CI: 1.81-2.01; p=0.078), and 60.0% consumed less than 2 L/day, a significantly high proportion (p=0.005). High dietary salt intake was reported by 50.0%, whereas 43.0% frequently consumed animal protein (p=0.048). Occupational heat exposure was present in 32.5%, a positive family history in 25.0%, recurrent urinary tract infection in 22.0%, diabetes mellitus in 20.5%, and current tobacco use in 24.5%. Imaging confirmed urolithiasis in 116 patients, giving a prevalence of 58.0% (95% CI: 50.8%-64.9%), which was significantly higher than the reference proportion of 50% (z=2.26, p=0.024).

Table 2: Sociodemographic, clinical, laboratory, and radiological profile of patients with confirmed urolithiasis (n=116)

Parameter	Mean (SD) or n (%)	95% CI	Test of significance	P value
Sociodemographic characteristics				
Age, years	44.68 (13.24)	42.25-47.11	One-sample t=3.81†	<0.001*
Age ≥40 years	79 (68.1%)	58.8%-76.5%	Proportion z=3.90‡	<0.001*
Male sex	78 (67.2%)	57.9%-75.7%	Proportion z=3.72‡	<0.001*
Rural residence	68 (58.6%)	49.1%-67.7%	Proportion z=1.86‡	0.063
Outdoor/manual occupation	54 (46.6%)	37.3%-56.0%	Proportion z=-0.74‡	0.459
Clinical presentation				
Flank pain	93 (80.2%)	71.8%-87.0%	Proportion z=6.51‡	<0.001*
Abdominal pain	61 (52.6%)	43.1%-61.9%	Proportion z=0.56‡	0.577
Haematuria	51 (44.0%)	34.8%-53.5%	Proportion z=-1.30‡	0.194
Dysuria	47 (40.5%)	31.5%-50.0%	Proportion z=-2.04‡	0.041*
Nausea or vomiting	43 (37.1%)	28.3%-46.5%	Proportion z=-2.78‡	0.005*
Fever	27 (23.3%)	15.9%-32.0%	Proportion z=-5.75‡	<0.001*
Previous stone episode	37 (31.9%)	23.5%-41.2%	Proportion z=-3.90‡	<0.001*
Renal-angle tenderness	59 (50.9%)	41.4%-60.3%	Proportion z=0.19‡	0.852
Laboratory findings				
Haemoglobin, g/dL	13.18 (1.72)	12.86-13.50	One-sample t=1.13§	0.261
Serum creatinine, mg/dL	1.16 (0.48)	1.07-1.25	One-sample t=-0.90¶	0.372
Serum uric acid, mg/dL	6.84 (1.53)	6.56-7.12	One-sample t=-1.13‖	0.262

Microscopic haematuria	63 (54.3%)	44.8%-63.6%	Proportion z=0.93‡	0.353
Pyuria	34 (29.3%)	21.2%-38.5%	Proportion z=-4.46‡	<0.001*
Positive urine culture	21 (18.1%)	11.6%-26.3%	Proportion z=-6.87‡	<0.001*
Crystalluria	48 (41.4%)	32.3%-50.9%	Proportion z=-1.86‡	0.063
Radiological profile				
Mean largest stone size, mm	8.74 (4.62)	7.89-9.59	One-sample t=-2.94#	0.004*
Renal stone	67 (57.8%)	48.3%-66.9%	Proportion z=1.67‡	0.095
Ureteric stone	38 (32.8%)	24.3%-42.1%	Proportion z=-3.72‡	<0.001*
Vesical stone	11 (9.5%)	4.8%-16.3%	Proportion z=-8.73‡	<0.001*
Right-sided stone	49 (42.2%)	33.1%-51.7%	Proportion z=-1.67‡	0.095
Left-sided stone	43 (37.1%)	28.3%-46.5%	Proportion z=-2.78‡	0.005*
Bilateral stones	24 (20.7%)	13.7%-29.2%	Proportion z=-6.31‡	<0.001*
Multiple calculi	31 (26.7%)	18.9%-35.7%	Proportion z=-5.01‡	<0.001*
Hydronephrosis	46 (39.7%)	30.7%-49.2%	Proportion z=-2.23‡	0.026*
Hydroureter	34 (29.3%)	21.2%-38.5%	Proportion z=-4.46‡	<0.001*

†Reference mean age=40 years. ‡Reference proportion=50%. §Reference haemoglobin=13 g/dL.

Reference creatinine=1.20 mg/dL. ǁReference uric acid=7 mg/dL. #Reference stone size=10 mm.
*Statistically significant at p<0.05.

Among the 116 patients with imaging-confirmed urolithiasis, the mean age was 44.68±13.24 years (95% CI: 42.25-47.11), which was significantly higher than the reference age of 40 years (t=3.81, p<0.001). Most patients were aged ≥40 years (68.1%, p<0.001), and males constituted 67.2% (p<0.001), demonstrating an older-age and male predominance. Rural residents accounted for 58.6% and outdoor or manual workers for 46.6%, but neither proportion differed significantly from 50%. Flank pain was the most common clinical presentation, occurring in 80.2% of patients (95% CI: 71.8%-87.0; p<0.001), followed by abdominal pain in 52.6%, renal-angle tenderness in 50.9%, haematuria in 44.0%, dysuria in 40.5%, and nausea or vomiting in 37.1%. Fever was present in 23.3%, while 31.9% reported a previous stone episode. Mean haemoglobin, serum creatinine, and serum uric acid levels were 13.18±1.72 g/dL, 1.16±0.48 mg/dL, and 6.84±1.53 mg/dL, respectively; none differed significantly from their corresponding reference values. Microscopic haematuria was detected in 54.3%, crystalluria in 41.4%, pyuria in 29.3%, and a positive urine culture in 18.1%. The mean largest stone size was 8.74±4.62 mm (95% CI: 7.89-9.59), which was significantly below the 10-mm reference value (p=0.004). Renal stones were the most frequent type, affecting 57.8%, followed by ureteric stones in 32.8% and vesical stones in 9.5%. Stones were right-sided in 42.2%, left-sided in 37.1%, and bilateral in 20.7% of patients. Multiple calculi were detected in 26.7%, hydronephrosis in 39.7%, and hydroureter in 29.3%, indicating a considerable burden of obstructive complications.

Table 3: Association of demographic, dietary, lifestyle, occupational, familial, and clinical factors with urolithiasis (N=200)

Potential risk factor	Urolithiasis present (n=116), n (%)	Urolithiasis absent (n=84), n (%)	Crude OR (95% CI)	Test of significance	P value
Male sex	78 (67.2%)	42 (50.0%)	2.05 (1.15-3.66)	χ^2=6.03	0.014*
Age ≥40 years	79 (68.1%)	39 (46.4%)	2.46 (1.38-4.40)	χ^2=9.46	0.002*
Daily fluid intake <2 L	82 (70.7%)	38 (45.2%)	2.92 (1.62-5.25)	χ^2=13.15	<0.001*
High dietary salt intake	69 (59.5%)	31 (36.9%)	2.51 (1.41-4.47)	χ^2=9.93	0.002*
Frequent animal-protein intake	58 (50.0%)	28 (33.3%)	2.00 (1.12-3.58)	χ^2=5.52	0.019*
Occupational heat exposure	47 (40.5%)	18 (21.4%)	2.50 (1.32-4.73)	χ^2=8.09	0.004*
Positive family history	39 (33.6%)	11 (13.1%)	3.36 (1.60-7.06)	χ^2=10.95	0.001*
BMI ≥25 kg/m²	43 (37.1%)	18 (21.4%)	2.16 (1.14-4.11)	χ^2=5.62	0.018*
Recurrent urinary tract infection	32 (27.6%)	12 (14.3%)	2.29 (1.10-4.76)	χ^2=5.02	0.025*

Diabetes mellitus	29 (25.0%)	12 (14.3%)	2.00 (0.95-4.20)	χ^2=3.43	0.064
Current tobacco use	34 (29.3%)	15 (17.9%)	1.91 (0.96-3.79)	χ^2=3.46	0.063

OR=odds ratio; CI=confidence interval. Percentages were calculated using the corresponding group total.
*Statistically significant at p<0.05.

Univariable analysis demonstrated that several demographic, dietary, occupational, familial, and clinical factors were significantly associated with urolithiasis. Male patients had approximately twice the odds of urolithiasis compared with females (OR=2.05, 95% CI: 1.15-3.66; p=0.014). Age ≥40 years was also associated with increased odds of disease (OR=2.46, 95% CI: 1.38-4.40; p=0.002). Inadequate fluid intake was one of the strongest modifiable factors: 70.7% of patients with urolithiasis consumed less than 2 L/day compared with 45.2% of those without urolithiasis, corresponding to an OR of 2.92 (95% CI: 1.62-5.25; p<0.001). High dietary salt intake (OR=2.51, 95% CI: 1.41-4.47; p=0.002) and frequent animal-protein intake (OR=2.00, 95% CI: 1.12-3.58; p=0.019) were significantly associated with stone disease. Occupational heat exposure increased the odds by approximately 2.5 times (OR=2.50, 95% CI: 1.32-4.73; p=0.004). Positive family history produced the strongest crude association, with affected participants having 3.36 times higher odds of urolithiasis (95% CI: 1.60-7.06; p=0.001). BMI ≥25 kg/m² (OR=2.16, p=0.018) and recurrent urinary tract infection (OR=2.29, p=0.025) were also significant factors. Although diabetes mellitus and current tobacco use showed approximately twofold elevations in odds, their confidence intervals included unity, and the associations did not reach statistical significance (p=0.064 and p=0.063, respectively).

Table 4: Multivariable binary logistic-regression analysis of independent predictors of urolithiasis (N=200)

Predictor	**Regression coefficient (β)**	**SE**	**Adjusted OR (95% CI)**	**Wald χ^2**	**P value**
Daily fluid intake <2 L	0.850	0.329	2.34 (1.23-4.47)	6.67	0.010*
Positive family history	1.015	0.389	2.76 (1.29-5.92)	6.81	0.009*
Occupational heat exposure	0.732	0.350	2.08 (1.05-4.13)	4.37	0.037*
Age ≥40 years	0.663	0.320	1.94 (1.04-3.63)	4.29	0.038*
High dietary salt intake	0.637	0.310	1.89 (1.03-3.47)	4.22	0.040*
BMI ≥25 kg/m²	0.542	0.331	1.72 (0.90-3.29)	2.68	0.102
Recurrent urinary tract infection	0.610	0.381	1.84 (0.87-3.89)	2.56	0.109
Male sex	0.445	0.332	1.56 (0.81-2.99)	1.80	0.180
Frequent animal-protein intake	0.372	0.321	1.45 (0.77-2.72)	1.34	0.247
Diabetes mellitus	0.301	0.401	1.35 (0.62-2.97)	0.56	0.453
Constant	-2.247	0.568	—	15.65	<0.001*

Omnibus likelihood-ratio χ^2=53.84, df=10, p<0.001; Nagelkerke R²=0.322; Hosmer-Lemeshow χ^2=6.14, df=8, p=0.631; overall classification accuracy=74.0%.

*Statistically significant at p<0.05.

The multivariable binary logistic-regression analysis identified five independent predictors of urolithiasis after adjustment for the other variables included in the model. Positive family history was the strongest independent predictor; participants with a family history had 2.76 times higher adjusted odds of urolithiasis than those without such a history (95% CI: 1.29-5.92; p=0.009). Daily fluid intake below 2 L was associated with a 2.34-fold increase in adjusted odds (95% CI: 1.23-4.47; p=0.010). Occupational heat exposure independently doubled the odds of urolithiasis (aOR=2.08, 95% CI: 1.05-4.13; p=0.037). Age ≥40 years (aOR=1.94, 95% CI: 1.04-3.63; p=0.038) and high dietary salt intake (aOR=1.89, 95% CI: 1.03-3.47; p=0.040) also remained significant independent predictors. BMI ≥25 kg/m², recurrent urinary tract infection, male sex, frequent animal-protein intake, and diabetes mellitus did not retain statistical significance after adjustment, suggesting that their crude relationships might have been influenced by confounding or shared risk pathways. The regression model was statistically significant overall (likelihood-ratio χ^2=53.84, df=10, p<0.001), explained approximately 32.2% of the variation according to Nagelkerke R², and correctly classified 74.0% of participants. The non-significant Hosmer-Lemeshow test (χ^2=6.14, p=0.631) indicated satisfactory agreement between the observed and model-predicted outcomes.

DISCUSSION

The present hospital-based cross-sectional study evaluated 200 patients with symptoms suggestive of urinary stone disease, among whom 116 (58.0%; 95% CI: 50.8%-64.9%) had imaging-confirmed urolithiasis. This figure should be interpreted as the diagnostic yield among selected hospital attendees rather than the community prevalence of urolithiasis. Sorokin et al. (2017)[1] reported marked geographical variation in the population prevalence of stone disease, ranging from approximately 1%-5% in Asia to 5%-9% in Europe and 7%-13% in North America. Zhang et al. (2022)[2] similarly demonstrated a substantial global burden of urolithiasis and considerable variation according to age, sex, geographical region, environmental conditions, and level of socioeconomic development. Therefore, the comparatively high proportion in the present study was expected because the sample consisted of symptomatic patients referred for evaluation at a tertiary-care hospital.

The mean age of all participants was 41.92±14.18 years, while patients with confirmed urolithiasis had a higher mean age of 44.68±13.24 years. More than two-thirds of stone patients were aged ≥40 years. Age ≥40 years was associated with urolithiasis on univariable analysis (OR=2.46, 95% CI: 1.38-4.40; p=0.002) and remained an independent predictor after adjustment (aOR=1.94, 95% CI: 1.04-3.63; p=0.038). These findings were consistent with the epidemiological review by Stamatelou and Goldfarb (2023)[3], which showed that symptomatic stone disease commonly affects adults during middle age, although the age distribution may differ between incident and recurrent stone formers. The predominance in this economically productive age group is clinically important because recurrent pain, hospitalization, intervention, and work absenteeism can impose substantial individual and societal costs.

Males represented 60.0% of the total sample and 67.2% of patients with confirmed stones. Male sex was associated with twice the crude odds of urolithiasis (OR=2.05, 95% CI: 1.15-3.66; p=0.014). Sorokin et al. (2017)[1] and Zhang et al. (2022)[2] reported that urolithiasis has traditionally been more common among men, although the sex gap has narrowed in several populations because of changing dietary patterns, obesity, occupational exposures, and lifestyle behaviour. In the present multivariable analysis, however, male sex was no longer independently significant (aOR=1.56, 95% CI: 0.81-2.99; p=0.180). This attenuation suggested that some of the excess crude risk among men may have been explained by higher exposure to dehydration, outdoor work, heat, high-salt diets, or other correlated behaviours rather than sex alone.

The present study showed that 55.5% of all participants and 58.6% of stone patients belonged to rural areas. Rural residence was not significantly overrepresented among confirmed cases. Consequently, rural residence alone should not be interpreted as a causal factor. Nevertheless, residence may act as a proxy for differences in occupation, climate, drinking-water availability, healthcare access, dietary practices, and delays in diagnosis. The global evidence reviewed by Stamatelou and Goldfarb (2023)[3] indicates that environmental and socioeconomic conditions interact with individual susceptibility, making geographical residence an important contextual rather than necessarily independent determinant of stone formation.

Clinical, laboratory and radiological profile

Flank pain was the predominant clinical presentation, affecting 80.2% of patients with confirmed urolithiasis, followed by abdominal pain in 52.6%, renal-angle tenderness in 50.9%, haematuria in 44.0%, dysuria in 40.5%, and nausea or vomiting in 37.1%. This clinical pattern was compatible with the characteristic presentation of an obstructing renal or ureteric calculus. The EAU guideline reported by Skolarikos et al. (2025)[13] recognizes acute flank pain, haematuria, nausea, vomiting, and urinary symptoms as common features requiring appropriate imaging, urinalysis, renal-function assessment, and exclusion of urinary infection. The occurrence of fever in 23.3% of the present patients was particularly important because fever combined with an obstructed collecting system may indicate an infected obstructed kidney and require urgent decompression and antimicrobial treatment.[13]

A previous stone episode was documented in 31.9% of confirmed cases, indicating a considerable recurrent disease burden. Vaughan et al. (2019)[9] identified personal stone history, number and location of stones, stone diameter, male sex, higher BMI, and family history as relevant predictors of subsequent symptomatic recurrence. Wang et al. (2022)[10], in a meta-analysis involving 53 studies and 488,130 participants, likewise identified higher BMI, family history, personal history of stones, hypertension, certain stone compositions, and concurrent asymptomatic calculi as predictors of recurrence. Thus, patients with a previous episode in the present study constituted an important high-risk group who required metabolic evaluation and individualized recurrence-prevention counselling.

The mean haemoglobin, serum creatinine, and serum uric acid values were within or close to their respective reference ranges. The mean serum creatinine of 1.16±0.48 mg/dL suggested that renal function was generally preserved in most patients at presentation. Nevertheless, normal average creatinine should not obscure the possibility of renal impairment in individual patients with bilateral obstruction, infection, recurrent stones, or pre-existing renal disease. Skolarikos et al. (2025)[13] recommend serum creatinine, uric acid, calcium, electrolytes, urine pH, urine microscopy, and culture as components of the evaluation, with more detailed metabolic testing for recurrent and high-risk stone formers.

Microscopic haematuria was present in 54.3%, crystalluria in 41.4%, pyuria in 29.3%, and urine culture positivity in 18.1% of stone patients. These results demonstrated that urinary stones may be accompanied by mucosal injury, inflammation, crystallization, and infection. Recurrent urinary tract infection was significantly associated with urolithiasis in the unadjusted analysis (OR=2.29, 95% CI: 1.10-4.76; p=0.025), although the association became non-significant after adjustment (aOR=1.84, p=0.109). The direction of this relationship can be bidirectional: urinary stasis and obstruction caused by stones can facilitate infection, whereas urease-producing organisms can contribute to struvite-stone formation. Owing to the cross-sectional design, the temporal sequence between infection and stone formation could not be determined. The average largest stone diameter was 8.74±4.62 mm. Renal stones were the most common anatomical type (57.8%), followed by ureteric stones (32.8%) and vesical stones (9.5%). The anatomical pattern was consistent with the general observation that most urinary calculi originate within the kidney and may subsequently migrate into the ureter.[3,13] Bilateral stones were present in 20.7% and multiple calculi in 26.7%, both of which may indicate a higher stone burden and greater potential for recurrence. Hydronephrosis was observed in 39.7% and hydroureter in 29.3%, demonstrating that a substantial proportion of patients had radiological evidence of obstruction. These findings reinforce the importance of reporting stone size, number, site, laterality, degree of obstruction, and infection when planning treatment.[13]

Dietary, lifestyle and occupational factors

Low fluid intake emerged as one of the most important modifiable factors. Daily intake below 2 L was reported by 70.7% of stone patients compared with 45.2% of patients without stones. It was associated with almost threefold higher crude odds (OR=2.92, 95% CI: 1.62-5.25; p<0.001) and remained independently significant after adjustment (aOR=2.34, 95% CI: 1.23-4.47; p=0.010). Cheungpasitporn et al. (2016)[5] found in a systematic review and meta-analysis that high fluid consumption was associated with a substantial reduction in incident stone risk. Lin et al. (2020)[6] similarly reported that total fluid intake of up to 2 L/day was associated with an approximately 44% reduction in incident nephrolithiasis compared with intake below 1 L/day. Ferraro et al. (2017)[4] also identified low fluid intake as a major modifiable contributor to incident stones. The biological explanation is that inadequate intake reduces urine volume and increases urinary supersaturation of calcium, oxalate, uric acid, and other lithogenic substances.

High dietary salt intake was present in 59.5% of stone patients compared with 36.9% of non-stone participants. It increased the crude odds by 2.51 times and remained independently associated with urolithiasis (aOR=1.89, 95% CI: 1.03-3.47; p=0.040). High sodium consumption increases urinary calcium excretion and can therefore enhance calcium-stone formation. Ferraro et al. (2017)[4] demonstrated that adherence to healthier dietary patterns was associated with a lower risk of incident stones, while Wang et al. (2021)[12] concluded that a normal-calcium diet with reduced sodium and animal protein was beneficial in preventing recurrence. The present findings support dietary counselling focused on reduced added salt and limitation of highly processed foods rather than indiscriminate restriction of dietary calcium.

Frequent animal-protein consumption was associated with urolithiasis in the univariable analysis (OR=2.00, 95% CI: 1.12-3.58; p=0.019), although it did not remain significant after adjustment (aOR=1.45, p=0.247). Animal protein can increase dietary acid load, urinary calcium, and uric acid while reducing urinary citrate. Ferraro et al. (2016)[7] reported that the relationship between protein intake and stone risk depended on the type of protein and its contribution to dietary acid load. Chewcharat et al. (2022)[11] further showed that lower fluid, calcium, potassium, caffeine, and phytate intake was associated with incident symptomatic stones, while lower calcium and potassium intake predicted recurrence. Thus, the present non-significant adjusted association does not exclude a dietary role; it may reflect confounding by salt intake, fluid intake, BMI, or the limited sample size.

Occupational heat exposure affected 40.5% of stone patients compared with 21.4% of non-stone patients. It was associated with higher crude odds (OR=2.50, p=0.004) and remained an independent predictor (aOR=2.08, 95% CI: 1.05-4.13; p=0.037). Venugopal et al. (2020)[8], studying workers in a southern Indian steel industry, reported a higher risk of kidney stones among employees exposed to intense occupational heat, heavy workloads, and dehydration. Heat exposure increases insensible fluid loss, reduces urinary volume, and raises urinary concentration, especially when drinking breaks or toilet access are restricted. The current findings therefore have occupational-health implications, including provision of accessible drinking water, scheduled hydration breaks, heat-control measures, and worker education.

Familial, metabolic and clinical factors

A positive family history showed the strongest crude association with urolithiasis (OR=3.36, 95% CI: 1.60-7.06; p=0.001) and remained the strongest independent predictor in the adjusted model (aOR=2.76, 95% CI: 1.29-5.92; p=0.009). Vaughan et al. (2019)[9] identified family history as a predictor of symptomatic recurrence, and Wang et al. (2022)[10] confirmed its importance across multiple studies. Familial aggregation may reflect inherited abnormalities in calcium, oxalate, uric-acid or cystine metabolism, but it may also represent shared dietary patterns, environmental exposures, and hydration behaviours. A detailed family history should therefore form part of routine stone-risk assessment.

Overweight or obesity was more frequent among stone patients than non-stone participants (37.1% versus 21.4%), producing a significant crude association (OR=2.16, p=0.018). Aune et al. (2018)[7] demonstrated dose-response relationships between increasing adiposity and kidney-stone risk in a meta-analysis of cohort studies. Obesity may promote lithogenesis through insulin resistance, lower urinary pH, hyperuricosuria, hypercalciuria, and dietary factors. However, BMI ≥25 kg/m² did not remain independently significant in the present model (aOR=1.72, p=0.102), possibly because its effects overlapped with diabetes, dietary salt, animal-protein intake, and fluid consumption. The finding should therefore be interpreted as an absence of independent statistical significance in this sample, not proof of no biological relationship. Diabetes mellitus was more common among stone patients than controls (25.0% versus 14.3%), but the association did not achieve statistical significance either before (OR=2.00, p=0.064) or after adjustment (aOR=1.35, p=0.453). Aune et al. (2018)[7] found that diabetes was associated with increased stone risk in pooled cohort data. The lack of statistical significance in the present study may have resulted from limited power, differences in diabetes duration or glycaemic control, or adjustment for correlated metabolic variables. Tobacco use similarly showed a non-significant crude association (OR=1.91, p=0.063), and the available literature has been less consistent regarding smoking than regarding hydration, obesity, diet, and family history.

The final multivariable model was statistically significant (likelihood-ratio χ^2=53.84, p<0.001), showed acceptable calibration (Hosmer-Lemeshow p=0.631), explained 32.2% of outcome variation, and correctly classified 74.0% of participants. Low fluid intake, family history, occupational heat exposure, age ≥40 years, and high salt intake were independently associated with urolithiasis. These findings agreed broadly with contemporary evidence emphasizing the interaction of inherited susceptibility, urinary concentration, diet, metabolic health, and environmental heat.[3,4,6,8,10].

CONCLUSION

Urolithiasis was confirmed in 58.0% of the 200 patients evaluated, indicating a substantial burden among symptomatic tertiary-care attendees. The condition predominantly affected middle-aged men, and flank pain was the most frequent presentation. Renal stones were the commonest, followed by ureteric and vesical stones. Hydronephrosis, hydroureter, bilateral stones, and multiple calculi demonstrated a considerable burden of obstructive and recurrent disease. On univariable analysis, male sex, age ≥40 years, fluid intake below 2 L/day, high dietary salt and frequent animal-protein intake, occupational heat exposure, positive family history, BMI ≥25 kg/m², and recurrent urinary tract infection were significantly associated with urolithiasis. After adjustment, positive family history, inadequate fluid intake, occupational heat exposure, age ≥40 years, and high dietary salt intake remained independent predictors. These findings emphasize the combined contribution of familial susceptibility and modifiable environmental and dietary factors. Early identification, adequate hydration, reduced salt consumption, occupational heat-protection measures, prompt management of urinary infection, and targeted counselling of high-risk individuals may help reduce stone formation, complications, and recurrence.

LIMITATIONS

This study had several limitations. First, its cross-sectional design established statistical associations but could not determine temporal sequence or causality between the identified factors and urolithiasis. Second, the study was conducted at a single tertiary-care hospital; therefore, referral bias and the greater representation of symptomatic or complicated cases may limit the generalizability of the findings. The observed 58.0% represented the diagnostic yield among selected hospital attendees and should not be interpreted as community prevalence. Third, consecutive non-probability sampling may have introduced selection bias. Fourth, fluid intake, dietary habits, tobacco use, occupational heat exposure, family history, and previous stone episodes were self-reported and were therefore susceptible to recall and social-desirability bias. Dietary exposure was assessed using broad frequency categories rather than a validated food-frequency questionnaire or quantitative nutrient assessment. Fifth, a single assessment of fluid intake might not have reflected seasonal or long-term consumption. Occupational heat exposure was not quantified using objective environmental indices or individual temperature monitoring. Sixth, stone composition and 24-hour urinary metabolic evaluation were not available for every patient, limiting stone-specific risk assessment. Potential factors such as serum parathyroid hormone, urinary calcium, citrate, oxalate, uric acid, sodium, and urine volume could therefore not be evaluated comprehensively. Seventh, the relatively modest sample size may have reduced statistical power for diabetes, tobacco use, BMI, and urinary tract infection and limited detailed subgroup analyses. Finally, residual confounding from unmeasured genetic, metabolic, socioeconomic, medication-related, environmental, and drinking-water factors could not be excluded.

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