

EPIDEMIOLOGICAL PROFILE AND RISK FACTORS OF UROLITHIASIS: INSIGHTS FROM AN INDIAN COHORT

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ABSTRACT

Urolithiasis is a common multifactorial disorder with increasing global prevalence. Dietary habits, metabolic abnormalities, environmental exposure, and genetic predisposition have an important role in the stone formation. The precise identification of risk factors is very essential for the prevention and reduction of disease recurrence. Therefore, this study aimed to evaluate the demographic, dietary, lifestyle and metabolic factors associated with urolithiasis among the patients attending a tertiary care centre in South India. Hospital based case control study conducted among 240 participants including 120 radiologically confirmed urolithiasis patients and 120 age and sex comparable controls without the history of urinary stones disease. Data of demographic profile, dietary habits, BMI, Medical comorbidities, lifestyle and family history are collected using questionnaire. Statistical analysis was done using Chi square test, we also assessed univariate analysis and multivariate analysis, odds ratio (OR) with 95% Confidence Interval (CI) were calculated respectively. Male predominance was observed among the cases 68.3%. Overweight and obesity were significantly more common in the cases $p=0.002$. Univariate analysis had demonstrated significant association between urolithiasis and hard water consumption, carbonated beverages, oxalate rich food consumption, black tea, diabetes mellitus, hypertension and urinary tract infection, gout and positive family history. Multivariate logistic regression analysis had identified positive family history (AOR=3.82) carbonated beverage (AOR= 2.94), history of urinary tract infection (AOR=2.63), oxalate rich food intake (AOR =2.31), obesity (AOR =2.21), hypertension (AOR=2.05), diabetes mellitus (AOR =1.94) and hard water consumption accounted (AOR=1.89) independent predictors of urolithiasis. the findings of the study highlight that multifactorial nature of urolithiasis and the importance of dietary modification, adequate hydration, metabolic control and risk factors based preventive strategies to decrease disease burden and recurrence.

KEYWORDS: Urolithiasis; Risk Factors; Odds Ratio; Kidney stone; BMI

INTRODUCTION

Kidney stone disease or urolithiasis is a significant worldwide health problem that demands attention of millions of people. It is a multifactorial disorder that is brought about by the combination of metabolic, dietary, genetic, and environmental factors. It has also been stated that urolithiasis has been found to prevail between 5-19% among Asian groups and has been actually on the rise over the past few decades owing to the change in lifestyle habits, urbanization and the increase in metabolic disorders (Raheem *et al.*, 2017, Liu *et al.*, 2018, Vladimirovna *et al.*, 2020). Urolithiasis is a disease with a range of clinically manifested signs, starting with the detection of stones accidentally and ending with severe renal colic, hematuria, the appearance of urinary tract infections (UTIs) and further, in chronic cases, with renal dysfunction (Drabišćák *et al.*, 2022, Praus & Schönthaler, 2019). Epidemiological evidence indicates that the middle-aged adults and males are disproportionately hit when the gender disparity is on the decline due to lifestyle changes. Low intake of fluids, high intake of sodium and animal fats, obesity, diabetes, hypertension, familial history of stones, and frequent UTIs are some of the risk factors that have been identified in previous research. Moreover, other environmental factors like hot weather and hardness of water also play an important role in the development of the stone (Liu *et al.*, 2019, Bokhari *et al.*, 2022, Sreedharan *et al.*, 2014, Brikowski *et al.*, 2008).

The incidence of recurrence among kidney stones is also considerable, around 50% in 5 years following the initial attack and that is why the study of the risk factors that can be altered is necessary. Although progressive diagnostic imaging and treatment options including extracorporeal shock wave lithotripsy (ESWL) to mitigate morbidity have been developed, prevention by lifestyle and diet remains the cost-efficient approach (Brikowski *et al.*, 2008, Sreedharan *et al.*, 2014, Snicorius *et al.*, 2023). Due to the increasing urolithiasis burden in India and limited research on the issue in the region with respect to lifestyle and demographic factors, the current study was conducted. This cross-sectional trial set out to establish and examine the most important risk factors linked with urolithiasis such as demographic, dietary,

pharmacological, environmental, and medical parameters among patients in a tertiary care hospital in Coimbatore. It is believed that the results will be used in the preventive strategies and clinically in the practice of family medicine and urology.

MATERIALS AND METHODS

Study design and settings: Present study was hospital based analytical case control study conducted in KG Hospital and PG Medical Institute, Coimbatore, Tamil Nadu, India. The study was carried out over period of 12 months.

Study population: Study included a total 240 participants comprising 120 cases and 120 controls

Cases: Cases included adult patients diagnosed with urolithiasis based on radiological confirmation using ultrasonography computed tomography, X ray of the kidney, ureter and bladder region who attended the department of urology during the study period.

Control: Control included age and sex comparable individual without present or previous history of urolithiasis attending the hospital for routine health evaluation, minor non urological complaints

Sample size calculation: Sample size was calculated with confidence interval of 95%, statistical power of 80%, expected odds ratio 2.0 and anticipated exposure prevalence of 30% among control. Minimum required sample size was estimated to be 109 participants in each group. To improve statistical validity and compensate for incomplete response 120 cases and 120 controls were included.

Inclusion criteria

Cases

Patient age ≥ 18 years

Radiologically confirmed urolithiasis

Patients willing to participate in the study

Controls

Individuals aged ≥ 18 years

Nil history of urinary stone

Willing to participate in the study

Exclusion criteria

Pregnant women

Patients with congenital urinary tract anomalies

Patients with chronic kidney disease

Critically ill patients

Individuals unwilling to participate

Data collection procedure

After obtaining institutional ethical committee approval, data were collected using predesigned and pilot tested questionnaire along with review of medical records. Data were collected including demographic characteristics, dietary habits, Lifestyle factors, Water intake and source of drinking water, medical comorbidities, and Family history. Dietary variables assessed included: Carbonated beverages consumption, Black tea intake, Oxalate rich food consumption, Daily tomato intake, Alcohol consumption, and Hard water consumption. **Medical variables assessed included:** Diabetes mellitus, Hypertension, History of urinary tract infection, and Family history of urolithiasis.

Ethical consideration: Study protocol was approved by institutional ethics committee (KG Hospital and PG Medical Institute, Coimbatore, Tamil Nadu, India.); written informed consent was obtained from all participants prior to enrolment in the study.

Statistical analysis

Data were entered and analysed in MS excel continuous variables were expressed as mean, standard deviation, whereas categorical variables are expressed as frequency and percentage, comparison between cases and controls was performed using Chi square test. Odds ratio with 95% confidence intervals were calculate using univariate logistic regression analysis. Variables with $p < 0.20$ in univariate analysis and clinically relevant variables identified from previous literature were included in univariate logistic regression analysis to identify independent predictors of urolithiasis. Adjusted odds ratios with 95% confidence intervals were reported. model adequacies using the Hosmer Lemeshow goodness of fit test and multicollinearity among the predictor variables was evaluated using variance inflation factor. The p value of < 0.05 was considered statistically significant.

RESULTS

Age Group	Cases n (%)	Controls n (%)
18–24	6 (5)	8 (6.7)
25–44	42 (35)	40 (33.3)
45–59	48 (40)	46 (38.3)
≥ 60	24 (20)	26 (21.7)

Table 1 Age Distribution of the present study

Majority of the study participants in both cases and control groups belong to 45-59 years age category, which accounts for 40% of the cases and 38.3% of controls. Participants aged 25- 44 years constituted 35 % of cases and 33.3% of control. The individuals aged > 60 years presented 20 % of cases; and 21.7% of controls. Whereas the lowest proportion of participants was observed in 18- 24 years age group among the both cases 5% and control 6.7% respectively (Table 1).

Gender	Cases n (%)	Controls n (%)
Male	82 (68.3)	80 (66.7)
Female	38 (31.7)	40 (33.3)

Table 2 Gender distribution of the study population

Male constituted the majority in both of the groups comprising 68.3% of cases and 66.7% of controls whereas female accounted for 31.7 % and 33.3% respectively. These findings indicated that male predominance among patients with Urolithiasis (Table 2).

BMI Category	Cases n (%)	Controls n (%)	p-value
Underweight	5 (4.2)	10 (8.3)	0.002
Normal	60 (50.0)	80 (66.7)	
Overweight	40 (33.3)	24 (20.0)	
Obese	15 (12.5)	6 (5.0)	

Table 3. BMI of the study population analysed through Chi-square test. BMI category was significantly ($p < 0.05$) correlated between cases and control.

Normal BMI was observed in 50% of cases compared to 66.7% of controls. While the overweight individuals constituted 33.3% of cases and 20% controls. Whereas obesity was more observed in 12.5 % cases and only 5 % in control group. The association between the BMI distribution and Urolithiasis was found to be statistically significant ($p = 0.002$). This suggest that overweight and obesity were more prevalent among the patients with urolithiasis (Table 3).

Variable	Cases n (%)	Controls n (%)	Crude OR	95% CI	p-value
Hard water consumption	70 (58.3)	43 (35.8)	2.5	1.49–4.18	0.001
Carbonated drinks	78 (65.0)	44 (36.7)	3.2	1.89–5.41	<0.001
Oxalate-rich foods	76 (63.3)	48 (40.0)	2.59	1.54–4.34	0.001
Black tea	102 (85.0)	73 (60.8)	3.64	1.96–6.74	<0.001
Daily tomato intake	95 (79.2)	68 (56.7)	2.91	1.64–5.16	<0.001
Alcohol consumption	45 (37.5)	29 (24.2)	1.88	1.07–3.28	0.028

Table 3. Association between dietary factors and urolithiasis. Chi square statistical analysis and univariate logistic regression analysis, Crude odds ratio (OR) with 95% confidence intervals were presented.

Consumption of carbonated beverages was significantly higher among the cases (65%) compared to controls (36.7%) with an odds ratio of 3.20 (95% CI: 1.89 -5.41, $p < 0.001$). Similarly black tea consumption was more frequently reported among the cases (85%) than the controls (60.8%) and demonstrated significant association with urolithiasis with odds ratio of 2.50 and 2.91 respectively. Alcohol consumption was observed in 37.5% of cases and 24.2% of control and was also significantly associated with stone disease (OR=1.88, 95% CI: 1.07- 3.28, $p = 0.028$ (Table 4).

Variable	Cases n (%)	Controls n (%)	Crude OR	95% CI	p-value
Diabetes mellitus	35 (29.2)	17 (14.2)	2.48	1.30–4.72	0.006
Hypertension	46 (38.3)	24 (20.0)	2.48	1.40–4.39	0.002
History of UTI	50 (41.7)	22 (18.3)	3.2	1.79–5.71	<0.001
Family history	52 (43.3)	19 (15.8)	4.07	2.20–7.53	<0.001
Gout	18 (15.0)	6 (5.0)	3.35	1.28–8.73	0.01

Table 4 Association of medical and family history factors with urolithiasis. Chi square statistical analysis ($p < 0.05$ considered significant) and univariate logistic regression analysis, Crude odds ratio (OR) with 95% confidence intervals were presented.

Using chi square test and univariate logistic regression analysis significant association were observed between several medical history and family history factors and urolithiasis Diabetes mellitus was present in 29.2% of cases compared to

14.2% control and significantly associated with urolithiasis (OR = 2.48 C: 1.30-4.72) (p=0.006). Hypertension was observed in 38.3% cases and 20% of controls and demonstrated significant association with stone disease (OR=2.48, 95%CI: 1.40-4.39), p=0.002. History of urinary tract infection was significantly more common among the cases 41.7% than controls OR=4.07, 95%CI 1.79-5.71, p<0.001. Positive family history showed strongest association and was reported in 43.3% of cases compared to 15.8% control (OR = 4.07, 95% CI 2.20-7.53, p<0.001. Gout was present in 15% of cases and 5% of control and significantly associated with urolithiasis. the findings of the study indicated that metabolic disorder, urinary tract infection, gout, and genetic factors are important with the occurrence of urolithiasis (Table 5).

Variable	Adjusted OR	95% CI	p-value
Family history	3.82	1.95–7.48	<0.001
Carbonated drinks	2.94	1.61–5.36	<0.001
History of UTI	2.63	1.34–5.14	0.004
Oxalate-rich foods	2.31	1.25–4.28	0.007
Obesity	2.21	1.10–4.42	0.024
Hypertension	2.05	1.08–3.89	0.028
Diabetes mellitus	1.94	1.01–3.74	0.046
Hard water consumption	1.89	1.02–3.50	0.041

Table 5. Independent predictors of urolithiasis. Multivariate binary logistic regression analysis. Adjusted odds ratios with 95% confidence interval are presented after controlling for potential confounding variables. p<0.05 indicates significant correlation between urolithiasis.

Multivariate binary logistic regression analysis was performed to identify independent predictors of urolithiasis after adjusting potential confounding factors. Positive family history emerged as the strongest independent predictor of the urolithiasis (AOR=3.82, 95 CI: 1.95 – 7.48, p<0.001), carbonated beverages consumption was independently associated with significantly increased risk of stone disease with affected individuals having nearly three-fold odds of developing urolithiasis (AOR =2.21, 95 CI: 1.61 – 5.36, p<0.001). history of urinary tract infection remained significant predictor (AOR =2.63,95% CI:1.34 -5.14, p=0.004) Nevertheless oxalate rich food consumption (AOR=2.31, 95%: 1.25- 4.28, p=0.007) obesity (AOR =2.21, 95% CI: 1.10-4.42, p=0.024). hypertension (AOR =2.05, 95% CI: 1.08-3.89, p=0.028). Diabetes mellitus (AOR =1.94, 95% CI :1.01-3.74, p=0.046 hard water consumption (AOR 1.89, 95% CI: 1.02-3.50, p=0.041) significantly associated with urolithiasis (Table 6).

DISCUSSION

Present case control study was conducted to compare the demographic, life style and metabolic factors between the patients with urolithiasis and healthy controls attending tertiary care center in Tamil Nadu. The study demonstrated significant association between urolithiasis and obesity, dietary habits, hypertension, diabetes mellitus, history of urinary tract infections, hard water consumption and positive family history. Among the variables. the family history and carbonated beverages consumption emerged as the strongest independent predictors following multivariate logistic regression analysis. In the present study majority of patients belong to 45-59 years age group with male predominance, similar observations reported by Alathel *et al.*, who had demonstrated higher incidence of urolithiasis among the males in Saudi Arabia accounting for 68.9% of the study population (Alathel *et al.*, 2024).

Comparable findings were also documented by Alasker *et al.*, who had reported that 74.5% of patients with renal calculi were males (Alasker *et al.*, 2022). The male predominance may be due to occupational dehydration, dietary practices, increased outdoor activity, and hormonal influences affecting urinary composition. Present study identified overweight and obesity as significant factors associated with urolithiasis. obesity was independently associated with increased odds of stone disease after multivariate adjustment. similar findings were reported by Owais *et al* who had identified elevated BMI as important contributing factors for urinary stone formation (Owais *et al.*, 2023). Previous literature has demonstrated that obesity alters urinary biochemistry by increasing urinary excretion of calcium, sodium, uric acid and oxalate while reducing the urinary pH thereby promoting lithogenesis. Kachkoul *et al.*, has emphasized the role of metabolic syndrome and obesity in increasing the global prevalence of urolithiasis (Kachkoul *et al.*, 2023).

Dietary factors demonstrated significant association with urolithiasis in the present study. the intake of carbonated beverages, oxalate rich foods, black tea, and tomato rich diets was significantly higher among the cases with carbonated beverages consumption remaining an independent predictor after multivariate analysis. These dietary factors may promote litho genesis through urinary super saturation, hyperoxaluria, hypercitraion and altered calcium metabolism. Hard water consumption was also significantly associated with urolithiasis, increased mineral content in drinking water may contribute higher urinary calcium excretion and crystals nucleation (Owais *et al.*, 2023). Kachkoul *et al.*, highlighted the influence of environment and geographical factors in stone disease epidemiology (Kachkoul *et al.*, 2023).

Diabetes mellitus and hypertension were significantly associated with urolithiasis with hypertension remaining an independent predictor after multivariate analysis. Stone formation through insulin resistance, low urinary pH and altered renal tubular handling of electrolytes. History of urinary tract infection was significantly more common among cases and independently associated with urolithiasis, recurrent infections may enhance crystal aggregation and biofilm mediated stone formation (Alathel *et al.*, 2024, Alasker *et al.*, 2022). Positive family history demonstrated strongest association with urolithiasis suggesting important genetic predisposition to urinary metabolic abnormalities and recurrent stone formation (Owais *et al.*, 2023). Overall, the findings of the study support multifactorial pathogenesis of urolithiasis

involving dietary, metabolic, genetic and environmental influences. Early identification and modification of these factors may help reduce disease burden and recurrence.

CONCLUSION

Present study demonstrated that urolithiasis is multifactorial disorder significantly associated with dietary habits, metabolic comorbidities, environmental exposure, and genetic predisposition. Consumption of carbonated beverages oxalate rich foods, black tea and hard water showed significant association with stone disease. Early identification and modifications of preventable risk factors through dietary counselling, lifestyle modifications, adequate hydration and metabolic control may help to reduce disease burden, recurrence and associated morbidity. Further multicentre longitudinal studies incorporating urinary biochemical profiling and stone composition analysis are recommended for better understanding of disease mechanism and preventive strategies.

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Disclosure of potential conflicts of interest: None declared

Consent to participation declaration: Every human participant was provided their consent after being informed about the study procedures. The voluntary participation was included in this study.

Competing interests: None.

Conflict of interest: Nil

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