IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 25, Issue 9 Ser. 4 (September. 2026), PP 15-21
www.iosrjournals.org

Urolithiasis among Adults in the Community: Role of Hydration, Diet, Occupation and Heat Expo-sure.

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Abstract-
Background *Urolithiasis is a common urological condition with multifactorial etiology. Hydration status, dietary habits, occupation, and environmental heat exposure may influence the risk of uri-nary stone formation. Understanding these factors can aid in prevention and early risk identifica-tion.*
Objectives
1. *To determine the prevalence of urolithiasis and assess hydration status among adults.*
2. *To assess the association of dietary patterns with urolithiasis.*
3. *To assess the association of occupation and heat exposure with urolithiasis and identify inde-pendent predictors.*

Methodology *A community-based cross-sectional study was conducted among 153 adults. Data regarding urolithiasis, hydration status, dietary patterns, occupation, and heat exposure were col-lected using a structured questionnaire. Associations were assessed using appropriate statistical tests, and multivariable binary logistic regression was performed to identify independent predic-tors.*
Results *The prevalence of self-reported/lifetime urolithiasis was 21.6% (95% CI: 15.8–28.7%). Daily water intake did not differ significantly between participants with and without urolithiasis ($p=0.071$). Frequent salty-food intake was statistically associated with urolithiasis, but the associa-tion was inverse ($OR = 0.20$, $p = 0.013$). Heat exposure ≥2 hours/day was significantly associated with urolithiasis ($\chi^2=9.11$, $p=0.003$). On multivariable analysis, heat exposure ≥2 hours/day (ad-justed OR=4.86, 95% CI: 1.54–15.38; $p=0.007$) and family history of urolithiasis (adjusted OR=8.59, 95% CI: 2.57–28.72; $p<0.001$) were independent predictors.*
Conclusion *Urolithiasis was prevalent in this community-based sample. Prolonged heat exposure and family history were independent predictors, highlighting the importance of adequate hydration during heat exposure and targeted preventive measures for individuals at increased risk.*
Keywords: *Hydration; Dietary patterns; Occupational factors; Heat exposure.*

Date of Submission: 12-09-2026 Date of Acceptance: 22-09-2026

I. INTRODUCTION

Urolithiasis, or urinary stone disease, is a common urological condition resulting from the for-mation of calculi within the urinary tract. Its development is multifactorial and is influenced by hy-dration status, dietary patterns, occupational characteristics, and environmental conditions. Inade-quate fluid intake and excessive fluid loss can reduce urine volume and increase urinary concentra-tion, while dietary and metabolic factors may further promote urinary supersaturation and stone formation. Occupational activities involving physical exertion and prolonged heat exposure may increase fluid loss and consequently contribute to stone risk.[1-3]

The prevalence of urolithiasis varies across geographical regions and populations. In India, published studies have reported prevalence estimates of approximately 12% in selected adult popu-lations, whereas studies conducted in specific populations in Maharashtra have reported estimates of around 6–7%. These estimates are population- and setting-specific and should not be interpreted as representative of the entire Indian or Maharashtra population. Maharashtra has been identified as part of India's "stone belt," with a relatively high occurrence of urinary stone disease reported in several regions. This geographical variation underscores the importance of generating population-specific evidence on the burden and factors associated with urolithiasis.[1,4]

Hydration is one of the most important potentially modifiable factors associated with urinary

stone formation. Inadequate fluid intake, excessive sweating, and insufficient replacement of fluid losses may result in low urine volume and increased urinary concentration, thereby favouring crys-tallization. Dietary patterns may also be associated with stone formation through their effects on urinary calcium, oxalate, uric acid, citrate, and sodium. Diets high in salt and animal protein and low in fruits and vegetables have been associated with an increased risk of stone formation, high-lighting the importance of evaluating overall dietary patterns rather than individual foods alone.[2,3,5,6]

Occupation and environmental heat exposure may further influence the risk of urolithiasis.

Outdoor and physically demanding workers, as well as individuals employed in hot environments, may experience repeated or prolonged dehydration due to excessive sweating and inadequate fluid replacement. However, the combined associations of hydration, dietary patterns, occupation, and heat exposure with urolithiasis remain insufficiently characterized in community-based adult popu-lations, particularly in Maharashtra. Evidence identifying factors independently associated with urolithiasis is also limited.[7–9]

Therefore, this study aimed to determine the prevalence of urolithiasis and assess hydration sta-tus among adults, examine the association between dietary patterns and urolithiasis, and evaluate the associations of occupation and heat exposure with urolithiasis while identifying factors inde-pendently associated with the condition. By examining these factors together, the study seeks to provide population-specific evidence that may inform targeted prevention and risk-reduction strat-egies for urolithiasis in the community.

II. Objectives

1. To determine the prevalence of urolithiasis and assess hydration status among adults.
2. To assess the association of dietary patterns with urolithiasis.
3. To assess the association of occupation and heat exposure with urolithiasis and identify inde-pendent predictors.

III. Methodology

1. **Study Design** A community-based cross-sectional study was conducted to determine the preva-lence of urolithiasis and assess its association with hydration status, dietary patterns, occupation, and heat exposure among adults in the community.
2. Study Period – 14 July 2026 to 14 September 2026.
3. Study Place – The study was conducted among adults from the Vidarbha and Khandesh regions of Maharashtra, India.
4. Study Population – The study population comprised adults aged 18 years and above.
5. Sample Size Calculation – For a cross-sectional study, the single-proportion formula was used:

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{E^2}$$

Where:

p = prevalence of urolithiasis = 7.9% = 0.079[1]

$q = 1 - p = 0.921$

Z = 1.96 for 95% confidence level

E = absolute allowable error = 5% = 0.05 Therefore,
$n = (1.96)^2 \times (0.079) \times (0.921) / (0.05)^2$ n = 111.84
Hence, the minimum required sample size was 112 participants.

Sampling Technique
A community-based non-random convenience sampling technique was used for participant re-cruitment.

Inclusion Criteria
1. Adults aged ≥18 years.
2. Both males and females.
3. Individuals engaged in all types of occupations.
4. Individuals willing to participate in the study and provide the required information.

Exclusion Criteria
1. Individuals with a known congenital urinary anomaly.
2. Seriously ill patients unable to answer the study questionnaire.
3. Pregnant women.

Data Collection
Data were collected using a pre-structured questionnaire. Information was obtained regarding socio-demographic characteristics, history of urolithiasis, hydration practices, dietary patterns, oc-cupation, occupational heat exposure, direct sunlight exposure, excessive sweating, and family his-tory of urolithiasis.

Urolithiasis was defined as a self-reported history of kidney or urinary stone disease, including previous doctor diagnosis, imaging confirmation, spontaneous stone passage, previous treatment or surgery, current stones, or recurrent stones.

Statistical Analysis
For assessment of the data, the Mann–Whitney U test, Fisher's exact test, Pearson's chi-square (χ^2) test, and multivariable binary logistic regression analysis were used.

Ethical Considerations
Institutional Ethics Committee approval was obtained prior to commencement of the study.

IV. RESULTS

A total of 153 adults were included in the analysis. Urolithiasis was defined as a self-reported history of kidney/urinary stone disease, including previous doctor diagnosis, imaging confirmation, spontaneous stone passage, previous treatment or surgery, current stones, or recurrent stones. On this definition, 33 participants (21.6%; 95% CI: 15.8–28.7%) had urolithiasis. Doctor-diagnosed and/or imaging-confirmed urolithiasis was reported by 20 participants (13.1%; 95% CI: 8.6–19.3%).

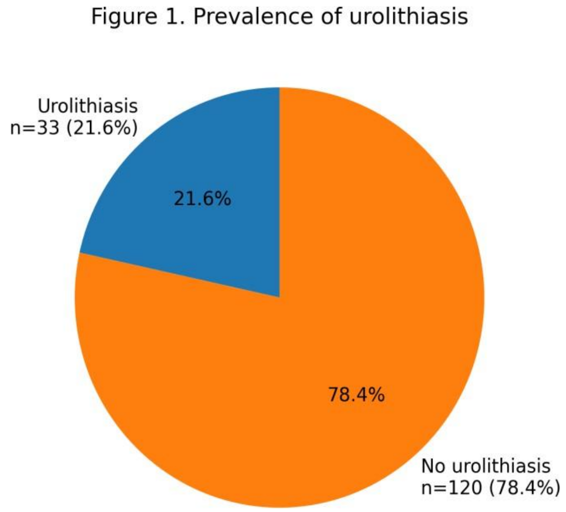

Figure 1. Prevalence of urolithiasis among study participants (N=153).

Hydration, dietary and occupational characteristics
Table 1 summarizes the principal exposure variables evaluated in relation to urolithiasis. Values are presented as n (%), unless otherwise stated.

Variable	Total, n (%)	Urolithiasis, n (%)
Water intake <2 L/day	17 (11.1%)	3 (9.1%)

Regular water intake through-out day: No	20 (13.1%)	3 (9.1%)
Reduce water intake when busy at work: Yes	107 (69.9%)	24 (72.7%)
Dark-yellow urine: Yes/Sometimes	98 (64.1%)	25 (75.8%)
Fewer than 4 daytime urina-tions: Yes	71 (46.4%)	20 (60.6%)
Frequent salty-food intake: Sometimes/Always	142 (92.8%)	27 (81.8%)
Packaged/processed foods: Sometimes/Always	120 (78.4%)	26 (78.8%)
Red meat: Sometimes/Always	86 (56.2%)	23 (69.7%)
Outdoor work: Yes	77 (50.3%)	20 (60.6%)
Hot environment: Yes	78 (51.0%)	22 (66.7%)
Heat exposure ≥2 h/day: Yes	78 (51.0%)	25 (75.8%)
Direct sunlight: Yes	55 (35.9%)	18 (54.5%)
Excessive sweating at work: Yes	68 (44.4%)	20 (60.6%)
Family history of stones: Yes	21 (13.7%)	9 (27.3%)

Table 1. Distribution of hydration, dietary, occupational/heat-exposure and family-history variables in the study population.

Association of hydration status with urolithiasis

Median daily plain-water intake was 3.0 L/day (IQR 2.5–4.0) among participants with urolithi-asis and 3.0 L/day (IQR 2.0–4.0) among those without. The Mann–Whitney U test showed no sta-tistically significant difference (U=2379.5, p=0.071).

Hydration variable	**Urolithiasis (n=33)**	**No urolithiasis (n=120)**	**p-value**
Water intake, L/day, median (IQR)	3.0 (2.5–4.0)	3.0 (2.0–4.0)	0.071
Water intake <2 L/day	3 (9.1%)	14 (11.7%)	—
Dark-yellow urine: Yes/Sometimes	25 (75.8%)	73 (60.8%)	—
<4 daytime urinations: Yes	20 (60.6%)	51 (42.5%)	—

Table 2. Comparison of selected hydration indicators according to urolithiasis status.

Association of dietary patterns with urolithiasis

Frequent salty-food intake (sometimes/always) was reported by 142 participants (92.8%). Fish-er's exact test showed a statistically significant association between frequent salty-food intake and urolithiasis (OR=0.20, p=0.013).

Dietary factor	**Urolithiasis n (%)**	**No urolithiasis n (%)**	**Test**
Frequent salty-food intake	27 (81.8%)	115 (95.8%)	Fisher's exact
Packaged/processed foods: Some-times/Always	26 (78.8%)	94 (78.3%)	Descriptive
Red meat: Some-times/Always	23 (69.7%)	63 (52.5%)	Descriptive
Sugar-sweetened/carbonated beverages	8 (24.2%)	42 (35.0%)	Descriptive
Citrus fruits: Always	6 (18.2%)	30 (25.0%)	Descriptive
Vegetables: Always	13 (39.4%)	65 (54.2%)	Descriptive

Table 3. Dietary-pattern distribution according to urolithiasis status.

Association of occupational and heat exposure with urolithiasis

Heat exposure for ≥2 hours per working day was reported by 78 participants (51.0%). Among participants with urolithiasis, 25 (75.8%) reported this exposure. Pearson's chi-square test demon-strated a statistically significant association ($\chi^2=9.11$, df=1, p=0.003).

Occupational/heat factor	Urolithiasis n (%)	No urolithiasis n (%)	p-value
Outdoor work	20 (60.6%)	57 (47.5%)	—
Hot work environment	22 (66.7%)	56 (46.7%)	—
Heat exposure ≥2 h/day	25 (75.8%)	53 (44.2%)	0.003
Direct sunlight	18 (54.5%)	37 (30.8%)	—
Excessive sweating	20 (60.6%)	48 (40.0%)	—

Table 4. Occupational and heat-exposure variables according to urolithiasis status.

Independent predictors of urolithiasis

A multivariable binary logistic regression model was constructed with urolithiasis as the de-pendent variable. Heat exposure ≥2 hours/day, direct sunlight exposure, family history, age and sex were entered as predictors.

Predictor	Adjusted OR	95% CI	p-value	Significance
Heat exposure ≥2 h/day	4.86	1.54–15.38	0.007	Significant
Direct sunlight exposure	1.17	0.42–3.25	0.764	Not significant
Family history of urolithiasis	8.59	2.57–28.72	<0.001	Significant
Age, per year	1.03	1.00–1.06	0.064	Not significant
Male sex	1.81	0.74–4.41	0.190	Not significant

Table 5. Multivariable logistic regression analysis of factors independently associated with uro-lithiasis.

Principal findings

In this community-based sample of 153 adults, the prevalence of self-reported/lifetime urolithi-asis was 21.6% (95% CI: 15.8–28.7%). Heat exposure ≥2 hours/day was significantly associated with urolithiasis ($\chi^2=9.11$, p=0.003). Daily water intake was not significantly different between the two groups (Mann–Whitney U, p=0.071). In multivariable analysis, heat exposure ≥2 hours/day and family history remained independent predictors.

A p-value <0.05 was considered statistically significant. Because this was a cross-sectional study, observed associations should not be interpreted as causal.

V. DISCUSSION

The present community-based study assessed the prevalence of urolithiasis and its association with hydration, dietary patterns, occupational factors and heat exposure among adults. The lifetime prevalence of urolithiasis was 21.6% (33/153), while the prevalence based on doctor-diagnosed and/or imaging-confirmed disease was 13.1%. The lifetime prevalence was higher than the 7.9% prevalence reported from the population-based Ballabgarh study in Haryana. This difference may be attributable to variations in geographical conditions, lifestyle, environmental exposure, study population and, importantly, differences in case definitions.[1]

Reported daily water intake was not significantly different between participants with and with-out urolithiasis (p=0.071). This contrasts with evidence supporting higher fluid intake and urine volume as protective against stone recurrence. The lack of association in the present study may be related to self-reported intake and behavioural modification among individuals with previous stone disease.[2,3]

Among dietary factors, frequent consumption of salty foods showed a statistically significant inverse association with urolithiasis (p=0.013). This contrasts with findings from a case-control study in Western Rajasthan, where high salt intake was associated with renal stones. Increased die-tary sodium may promote urinary calcium excretion and thereby contribute to calcium stone for-mation.[5]

A major finding was the significant association between occupational heat exposure for ≥2hours/day and urolithiasis ($\chi^2=9.11$, p=0.003). This association remained significant after adjust-ment, with an adjusted OR of 4.86 (95% CI 1.54–15.38). Heat exposure may increase sweating and reduce effective urine volume, resulting in greater urinary concentration. Studies among workers exposed to high occupational temperatures and heat stress have similarly demonstrated increased kidney-stone risk.[7–9]

The strong independent association observed with family history (adjusted OR 8.59, 95% CI 2.57–28.72) supports the importance of familial predisposition in urolithiasis. A prospective cohort study by Curhan et al. found that individuals with a positive family history had a substantially higher risk of kidney-stone formation even after adjustment for other risk factors.[10]

Findings from Maharashtra provide additional regional context. A study from Marathwada demonstrated significant urinary metabolic abnormalities among stone formers, including higher urinary calcium, oxalate and sodium and lower urinary citrate, supporting the importance of dietary and metabolic factors in this region.[4] A case-control study from Western Rajasthan also demon-strated associations between dietary factors and renal stones.[5]

The study's community-based design and assessment of multiple modifiable factors are im-portant strengths. However, the cross-sectional design, relatively small sample size, self-reported exposures and broad composite definition of urolithiasis limit causal inference and may affect di-rect comparison with imaging-confirmed hospital-based studies.

Overall, the findings suggest that occupational heat exposure, frequent salty-food consumption and family history are important factors associated with urolithiasis, while reported total daily wa-ter intake was not significantly associated in this population. Preventive strategies focusing on ade-quate hydration during heat exposure and reduction of excessive dietary salt may be particularly relevant.[2,6]

VI. CONCLUSION

In this community-based study, the composite lifetime prevalence of urolithiasis was 21.6%, while doctor-diagnosed and/or imaging-confirmed disease was 13.1%. Frequent salty-food con-sumption was inversely associated with urolithiasis, and reported daily water intake was not statis-tically significantly different between participants with and without urolithiasis.

Occupational heat exposure for ≥2 hours per day emerged as a significant independent predic-tor, with family history also showing a strong independent association. These findings highlight the importance of considering dietary behaviour, occupational heat exposure and familial susceptibility together when assessing the risk of urolithiasis. Community-based preventive strategies focusing on adequate hydration during heat exposure and targeted education of high-risk occupational groups may help reduce the burden of urinary stone disease.

Limitations

First, its cross-sectional design limits the ability to establish temporal or causal relationships.
Second, several variables, including water intake, dietary habits and occupational exposure, were self-reported and may be affected by recall or reporting bias.

Funding

This study was fully self-funded.

Conflict of Interest

There was no conflict of interest in relation to this study.

Acknowledgement

Sincere thanks are extended to Sarathi Bahuuddeshiya Sanstha, Ghatanji, Yavatmal, Maharash-tra, India, for their valuable assistance and cooperation in sample collection for this study.

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