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Risk Factors Associated with Kidney Stone Disease in Raya Block of Mathura District, Uttar Pradesh

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Abstract

Kidney stone disease, also referred to as nephrolithiasis or urolithiasis, is a prevalent urinary condition that affects people in both developed and developing countries [1,2]. The development of kidney stone is influenced by several factors such as age, gender, diet, water intake, job type, climate, family background, and metabolic issues. In India, the estimated prevalence of kidney stone disease is about 12%, which is similar to the rates found in other parts of the world. However, there is significant variation in the disease's impact across different regions, with higher rates reported in the northern regions of the country, where the prevalence is approximately 15%. This higher rate may be linked to factors like weather conditions, eating habits, lower fluid consumption, and other social and environmental influences that contribute to the formation of kidney stones [3]. The current study seeks to identify and assess the risk factors related to kidney stone disease among the residents of Raya Block in Mathura District, Uttar Pradesh.

Keywords: Kidney stone disease, Nephrolithiasis, Groundwater, Water intake, Risk factors, Raya, Mathura, Uttar Pradesh.

Introduction

Kidney stone disease is a complicated health issue that involves the buildup of hard, crystalline substances within the urinary system. These stones are commonly composed of materials such as uric acid, calcium oxalate, calcium phosphate, or other minerals. Stones form when urine becomes too concentrated with these substances [4]. Previous epidemiological studies indicate that kidney stone disease is influenced by multiple interacting factors including genetic predisposition, diet, climate, hydration status, and environmental exposure. India has been described as having regions with increased kidney stone occurrence, and northern parts of India are considered vulnerable due to climatic conditions and dehydration-related risk factors. Low fluid intake, hot climate exposure, dietary habits, and occupational dehydration have been reported as important contributors [5]. The overall probability of forming stones differs according to various parts of the world and is estimated at 5%–19.1% in West Asia, Southeast Asia, South Asia, as well as some developed countries (South Korea and Japan), whereas, it is only 1%–8% in most part of East Asia and North Asia [6].

The western Indian states of Gujarat, Maharashtra, and Rajasthan are characterized by extensive groundwater salinity, notably in arid, semi-arid, and coastal regions. These states also constitute part of India's "kidney stone belt," where the prevalence of urinary stone disease is relatively high [7]. Total harness of water mainly represents the concentration of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions usually expressed as calcium carbonate (CaCO_3). High calcium intake through drinking water may influence urinary calcium excretion, which may contribute to calcium-based stone formation in susceptible individuals. However, scientific evidence remains mixed. A recent prospective cohort study using UK Biobank data examined domestic water hardness, calcium, magnesium, and kidney stone occurrence. It reported no significant overall association between total harness and kidney stone disease, although subgroup differences were observed. Other regional studies have investigated correlations between water hardness and renal stone incidence using community-level water analysis [8]. KSD is a major health issue, the incidence of which is increasing day by day. A low intake of fluids, especially water, aggravates the chance of kidney stone formation [9]. An ecological study from Alwar, Rajasthan found that groundwater with high TDS, hardness, magnesium, and alkalinity was associated with a higher prevalence of kidney stone disease. The authors concluded that elevated groundwater TDS and hardness may increase long term vulnerability to KSD, although the study could not establish causation [10]. Therefore, the present study was designed to evaluate the epidemiological characteristics of kidney stone disease in wards number 3, 8 and 13 in Raya Block, Mathura District.

Study area

The current study was carried out in Ward No. 3, Ward No. 8, and Ward No. 13 of Raya Nagar Panchayat, located in Raya Block of Mathura District, Uttar Pradesh, India. Raya is one of the ten administrative development blocks of Mathura District and forms an important urban settlement within the district. These wards were selected for a specific purpose, as they represent densely populated residential areas where most households rely on groundwater for drinking and domestic purposes, have diverse socio-economic characteristics, and have a high prevalence of kidney stone disease among residents. According to the Census of India, Raya Nagar Panchayat is administratively divided into several municipal wards, including Ward Nos. 3, 8, and 13, which constituted the sampling frame for the present investigation. Approximately 88% of the rainfall in Mathura District occurs between June and September. During this monsoon period, there is ample surplus water that can percolate deeply into the groundwater. Major soil types are silty, sandy and loamy soils the geology of the district is covered with the homogenous formation and does not show any significant structural complications [11]. Mathura district of Uttar Pradesh experiences a warm climatic environment and has a large rural population dependent on agriculture and outdoor occupations [12].



Figure1: The location of the sampling sites in Raya block of Mathura district.

Table 1: Physiochemical characteristics of Groundwater in study area

S. No.	Sampling Sites	Latitudes and Longitudes	Parameter		
			TDS	EC	TH
p1.	Katra Bazar (Raya)	27.5556083682747, 77.7894027158618	2400	4100	1960
p2.	Near Momin Mosque (Sultan Ganj)	27.5550258503812, 77.78654515743256	1750	2650	1300
p3.	Dixit Nursing Home (Raya Railway Station Road)	27.554524019863166, 77.78956767171621	1710	2850	1310

Materials And Methods

Sample Collection and Analysis

The study based on primary data. Groundwater samples were collected from 3 government handpumps sites that were being used for drinking purpose for at least 10 years, in 500-mL high-density, clean and sterile

polyethylene bottles from 3 particular sites. The groundwater characterization has been carried out for the parameters like Electrical Conductivity (EC), total hardness (TH), total dissolved solids (TDS) by following the standard methods prescribed as per Bureau of Indian Standard 10500 (BIS 2012) and WHO (2017). Total hardness For TDS Each of the analysis in the study was repeated twice until concordant values were obtained, and all the tests were carried out according to the standard methods (APHA, 2005), and also case-control study was conducted among 100 patients with confirmed kidney stone disease and 100 without kidney stones in May, 2025 in Raya Block, Mathura District, U.P.

Data on demographic characteristics like education status, daily water intake, and gutkha/ tobacco were collected using a structured questionnaire. Data were analyzed using frequency distribution, with the Phi (ϕ) correlation coefficient used to assess the strength and direction of association between binary categorical variables. Statistical significance was evaluated using the corresponding p-values from the 2×2 association test (Pearson's chi-square test), with $p < 0.05$ considered statistically significant.

Result and discussions:

The distribution of Electrical Conductivity (EC), Total Dissolved Solids (TDS), and Total Hardness (TH) at sampling sites p1, p2, and p3 is presented in Table 1 and illustrated in Figure 1.

Electrical Conductivity:

Electrical conductivity (EC) reflects the concentration of dissolved ions in groundwater. Higher EC values indicate increased mineralization and salinity, often resulting from rock–water interaction, agricultural activities, or anthropogenic contamination. Elevated EC is commonly associated with higher total dissolved solids (TDS), influencing groundwater quality and its suitability for drinking purposes [14]. Electrical Conductivity (EC) is an important indicator of the ionic content and salinity of water. Although the Bureau of Indian Standards (BIS) IS 10500:2012 does not prescribe a specific acceptable or permissible limit for EC in drinking water, higher EC values generally indicate increased concentrations of dissolved ions and are often positively correlated with Total Dissolved Solids (TDS). Therefore, EC is widely used as a rapid indicator for assessing groundwater quality. Electrical conductivity (EC) and total dissolved solids (TDS) were determined using a Hanna digital EC/TDS meter.

Total Dissolved Solids (TDS) represent the combined concentration of dissolved inorganic salts (such as calcium, magnesium, sodium, potassium, chlorides, sulfates, and bicarbonates) and small amounts of organic matter present in water. According to BIS IS 10500:2012, the acceptable limit of TDS in drinking water is 500 mg/L, whereas the permissible limit is 2000 mg/L in the absence of an alternate source. TDS values exceeding these limits indicate poor water quality and may require appropriate treatment before the water is considered suitable for drinking. The groundwater samples from sites p1, p2, and p3 exhibited total hardness values of 2400, 1750, and 1710 mg/L, respectively.

Total hardness (TH) is a measure of the concentration of dissolved calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions in water, expressed as mg/L as CaCO_3 . It is an important indicator of groundwater quality, influencing domestic usability, scaling potential, and water suitability for drinking and industrial applications [16]. Total hardness is determined by the EDTA complexometric titration method. A measured water sample is buffered to pH 10, Eriochrome Black T indicator is added, and titrated with standard EDTA until the color changes from wine-red to blue. Hardness is expressed as mg/L CaCO_3 [17]. According to the Bureau of Indian Standards (BIS) IS 10500:2012, the acceptable limit for total hardness in drinking water is 200 mg/L, while a permissible limit of up to 600 mg/L is allowed in the absence of an alternate source [13]. The total hardness values recorded at sampling sites p1, p2, and p3 were 1960, 1300, and 1310 mg/L, respectively. These values exceeded the BIS permissible limit of 600 mg/L for drinking water, indicating that the groundwater samples were unsuitable for direct consumption without appropriate treatment.

To assess the factors associated with kidney stone formation, data were collected from 100 patients with kidney stone disease (cases) and 100 individuals without kidney stone disease (controls) in the study area. The distribution of the study participants and the investigated risk factors is presented in table 2.

Table 2: Distribution of Respondents by Age, Water Intake, Education, and Tobacco/Gutkha Consumption.

Variables	Categories	Cases (kidney stone disease) n=100	Controls (No Kidney Stone disease) n=100	Correlation (ϕ / Pearson r)	p-value	Interpretation
Education Status	Illiterate	58	62	-0.054	0.451	Very weak, not significant
	Literate	42	36			
Use of Tobacco/Gutkha	Yes	59	65	-0.062	0.385	Very weak, not significant
	No	41	35			
Average Daily Water Intake (L/day)	1–2.5	82	15	+0.670	<0.001	Strong positive association
	>2.5	18	85			

Note: “Phi correlation (equivalent to Pearson’s correlation for dichotomous variables) was used to assess the association between kidney-stone disease status and categorical risk factors.”

The findings of Table 2 demonstrate that average daily water intake was significantly associated with kidney stone disease. Most cases (82%) reported consuming 1–2.5 L of water per day, compared with only 15% of controls, while >2.5 L/day intake was reported by 18% of cases and 85% of controls. This association was strong and statistically significant ($\phi = 0.670$, $p < 0.001$). In contrast, education status ($\phi = -0.054$, $p = 0.446$) and tobacco/gutkha consumption ($\phi = -0.062$, $p = 0.382$) showed very weak and statistically non-significant associations with kidney stone disease. Overall, the results suggest that inadequate daily water intake was the most prominent factor associated with kidney stone disease in the present study population.

Conclusion:

The current study demonstrates that the kidney stone disease is a complex health issue subjected to numerous behavioral, environmental, socio-demographic, and lifestyle-related causes and contributing factors. Although the role of gutkha chewing in the development of the disease was not explicitly stated, it appears to be a risk factor due to certain harmful qualities that could increase the probability of stones formation. The correlation needs to be confirmed by additional research, and the possible causes explored are dehydration, oxidative stress, and reduced kidney function.

Hard water is another probable culprit and is suspected to be involved in the disease's origins. Research proves calcium and magnesium salts' direct effect on the urinary tract, but it has not yet been detected in hard water. Thus, water's high total dissolved solids and other chemicals like fluoride, combined with diet and lifestyle, may trigger kidney stones formation. Moreover, the evidence found shows a connection between low water intake and an increased risk of kidney stones, while a high fluid intake percentage decreases the chances of the disease. Conclusively, the study indicates that kidney stone disease should be tackled by encouraging people to take more fluids, increase health awareness, and embrace healthy lifestyles such as avoiding the use of tobacco and gutkha and ensuring drinking water is not contaminated. Nevertheless, the observed association does not necessarily a causal relationship.

Suggestions for Future Research

1. Longitudinal studies should be undertaken to establish temporal and causal relationships between gutkha consumption, water quality, hydration, and kidney stone formation.
2. Dose–response studies on gutkha/tobacco use should examine whether frequency, duration, and quantity of consumption are associated with increasing stone risk.
3. Future studies should assess the chemical composition of kidney stones to determine whether calcium, uric acid, struvite, or other stone types are associated with specific environmental and behavioral factors.
4. Detailed assessment of drinking-water quality should include hardness, TDS, calcium, magnesium, fluoride, nitrate, pH, and other relevant parameters.
5. Urinary biochemical investigations such as urinary calcium, oxalate, uric acid, citrate, phosphate, and urine volume should be incorporated to clarify the mechanisms underlying stone formation.
6. Larger case-control and cohort studies covering multiple blocks or districts should be conducted to improve the generalizability of findings.
7. Further research should investigate the combined effects of hard water, TDS, fluoride, dietary habits, and tobacco/gutkha consumption, rather than examining these factors independently.
8. Geospatial analysis using GIS and remote sensing may be used to identify spatial clusters of kidney stone prevalence and their relationship with groundwater quality, land use, and environmental conditions.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Hesse, A. (2005). Editorial. *World Journal of Urology*, 23(5), 302–303. <https://doi.org/10.1007/s00345-005-0033-3>.
2. Rizvi, S. A. H., Naqvi, S. A. A., Hussain, Z., Hashmi, A., Hussain, M., Zafar, M. N., Sultan, S., & Mehdi, H. (2002). Pediatric urolithiasis: Developing nation perspectives. *Journal of Urology*, 168(4 Part 1), 1522–1525. [https://doi.org/10.1016/s0022-5347\(05\)64509-0](https://doi.org/10.1016/s0022-5347(05)64509-0)
3. Hua, L., Cao, J., Zhao, X., Meng, X., & Qiu, J. (2025). Correlation between lifestyle choices, dietary factors, and the risk of adult urolithiasis: Insights from a systematic review and meta-analysis. *Translational Andrology and Urology*, 14(5), 1283–1294. <https://doi.org/10.21037/tau-2024-768>
4. Mitra, P., Pal, D. K., & Das, M. (2018). Does quality of drinking water matter in kidney stone disease: A study in West Bengal, India. *Investigative and Clinical Urology*, 59(3), 158. <https://doi.org/10.4111/icu.2018.59.3.158>

5. Chatterjee, D., Verma, V., Amiti, A., Rohil, S., Arunai Nambi Raj, N., & Vidya, R. (2012). Demographic Study of Water Hardness with Potential to Predict Formation of Renal Crystals. *Advanced Materials Research*, 584, 504–508. <https://doi.org/10.4028/www.scientific.net/amr.584.504>
6. Liu, Y., Chen, Y., Liao, B., Luo, D., Wang, K., Li, H., & Zeng, G. (2018). Epidemiology of urolithiasis in Asia. *Asian Journal of Urology*, 5(4), 205–214. <https://doi.org/10.1016/j.ajur.2018.08.007>
7. Guha, M., Banerjee, H., Mitra, P., & Das, M. (2019). The demographic diversity of food intake and prevalence of kidney stone diseases in the Indian continent. *Foods*, 8(1), 37. <https://doi.org/10.3390/foods8010037>
8. Zhang 1, J., Luo, H., Wu, H., Qian, Y., Tang, Z., Wang, J., & Li, Z. (2025). The association between domestic water hardness and kidney...: International journal of surgery. *LWW*, 2025 Feb 1;111(2): 1957-1967. (doi: 10.1097/JS9.0000000000002198. PMID: 39784501.). <https://doi.org/10.1097/JS9.0000000000002198>
9. Borghi, L., Meschi, T., Schianchi, T., Briganti, A., Guerra, A., Allegri, F., & Novarini, A. (1998). Urine volume: Stone risk factor and preventive measure. *Nephron*, 81(Suppl. 1), 31–37. <https://doi.org/10.1159/000046296>
10. Manna, S., Usharani Rathnam, Arun Udayaraj, Rajesh, & Tuhina Shree. (2024). Groundwater hardness and alkalinity as risk factors for kidney stone disease in Alwar, India: An ecological study. *Cureus*. <https://doi.org/10.7759/cureus.62272>
11. Qureshi, A., & Armo, Dr. C. (2022). Evaluation of groundwater quality in Raya Block, Mathura District (Uttar Pradesh) using water quality index. *International Journal of Geography, Geology and Environment*, 2022, Vol. 4(Issue 1, Part A), 49–53. [https://doi.org/Int J Geogr Geol Environ 2022;4\(1\)](https://doi.org/Int J Geogr Geol Environ 2022;4(1))
12. UPCCCE-Uttar Pradesh Climate Change and clean environment. (2024). Upccce.Org. <https://upccce.org/>
13. Indian Standard DRINKING WATER — SPECIFICATION (Second Revision). (2012, May). [PDF]. BIS. <chrome-extension://efaidnbmnnnibpcajpcgclclefindmkaj/https://law.resource.org/pub/in/bis/S06/is.10500.2012.pdf>
14. Guidelines for Drinking-water Quality (PDF FOURTH EDITION). (2017). WHO. <chrome-extension://efaidnbmnnnibpcajpcgclclefindmkaj/https://iris.who.int/server/api/core/bitstreams/1b7a285e-3635-45dd-a1a9-6068c8f8e173/content>
15. Adoni AD, Joshi G, Ghosh K, Chourasia SK, Vaishya AK, Yadav M et al. Workbook of Limnology. Department of Botany. Dr. Harisingh Gour Vishwavidyalaya, Sagar 1985, 1-212.
16. APHA.2005., Standard Methods for the Examination of Water and Wastewater. 21st ed. Washington DC, USA: American Public Health Association;