ORIGINAL ARTICLE

Assessment of knowledge and awareness level regarding urinary stone prevention among the Taif population, Saudi Arabia: a cross-sectional study

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ABSTRACT

Background: Kidney stones are a common urological condition influenced by environmental and lifestyle factors and are reported to be prevalent in hot climates, including Saudi Arabia. This study assessed knowledge and awareness of kidney stone prevention among the general population of Taif, Saudi Arabia.

Methods: This cross-sectional study included 363 adult residents of Taif City between 25 July 2025 and 15 November 2025; data were collected using an adapted questionnaire pilot-tested for clarity. Associations were assessed using chi-square tests; independent predictors were identified using multivariable logistic regression.

Results: A self-reported history of kidney stones was present in 28.7% (104/363) of participants. Awareness of common symptoms was high (95.6% recognized pain), while misconceptions about dietary risk factors persisted (58.6% incorrectly believed calcium-rich foods increase risk). Female sex (OR = 0.54, 95% CI 0.32–0.91) and a healthcare-related occupation or field of study (OR = 0.23, 95% CI 0.11–0.49) were independently associated with lower odds of reporting kidney stones, while family history was associated with higher odds (OR = 1.72, 95% CI 1.02–2.92). The median knowledge and awareness score was 13 (range: 2–19), corresponding to approximately 68.4% correct responses, with no significant subgroup differences.

Conclusion: Kidney stones were commonly reported in this Taif-based sample. Female sex and a healthcare-related background were independently associated with lower odds of reporting kidney stones, while family history was independently associated with higher odds; lower fluid intake was associated with kidney stone history only in unadjusted analysis. Notable gaps and misconceptions persist regarding dietary risk factors, and targeted education may help address them.

Keywords: Kidney stones, urolithiasis, risk factors, knowledge, awareness.

Introduction

Kidney stones are a common chronic condition that causes pain and can be a source of distress for those affected [1]. Approximately 8% of adult residents of the United States develop kidney stones [2]. Recent studies suggest that nephrolithiasis is not just an acute illness; patients with kidney stones have an increased risk of developing long-term complications [3], so it is important to take measures to prevent further kidney stone formation [4]. Nephrolithiasis also increases healthcare costs and affects daily functioning, supporting the importance of public awareness of preventive measures [5].

Kidney stones are a multifactorial disease in which genetic predisposition, environmental factors, dietary habits, and metabolic disorders interact in complex ways [6]. Several well-recognized risk factors have been

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Received: 26 August 2026 | **Accepted:** 02 September 2026

identified, such as low fluid intake, high dietary sodium and animal protein intake, obesity, type 2 diabetes, and metabolic syndrome [7]. The incidence of kidney stones has been increasing worldwide in the last few decades, probably due to the increasing prevalence of obesity and diabetes, as well as dietary habits and climate change [8]. Several studies in the last decade have shown that metabolic syndrome is an important risk factor for the development of kidney stone disease [7].

Several factors, including a lack of a healthy lifestyle, contribute to nephrolithiasis. Nephrolithiasis is associated with very low fluid intake and a high-fat diet, which contributes to the formation of kidney stones [9]. Recurrence of kidney stones occurs in some individuals; therefore, it is important for them to follow diets that restrict sodium and protein [10]. Other contributing nutritional factors associated with nephrolithiasis include energy drinks, black tea, chocolate, and a lower-than-recommended intake of vegetables [11]. High fructose consumption has been closely related to the prevalence of nephrolithiasis. Reducing calorie intake is a key factor in decreasing the likelihood of stone formation. Obesity and being overweight have been found to increase the chances of having stones, regardless of gender [12].

In Middle Eastern Gulf countries, including Saudi Arabia, a high risk of nephrolithiasis was strongly associated with the population's type of diet. This diet is low in calcium, high in animal protein, and high in oxalate, which results in increased calcium oxalate (hyperoxaluria) and thus increased risk of nephrolithiasis and stone formation [13]. Additionally, the hot and dry weather conditions that lead to decreased urine output could predispose to kidney stone formation [14]. In Saudi Arabia, in particular, the relatively high incidence of stone formation has been linked to the high ambient temperature and low water intake prevailing in the region [15]. Prevalence rates of 9.1% and 16% have been reported in studies conducted in Jeddah and Riyadh, respectively [16], while a recent study in Jazan revealed a prevalence of 14% [17].

Education programs should include the training of the general population to successfully develop a public education campaign on kidney stone risk factors [18]. However, there is very limited research on how much people in Saudi Arabia currently know about risk factors of nephrolithiasis [19]. Educating the public about the risks of developing kidney stones will enable them to make better-informed decisions about their health, thereby reducing stone formation and improving overall health. Currently, there is limited information about public awareness of the risk factors for the increased incidence of kidney stones.

Therefore, this study aimed to assess the level of knowledge and awareness regarding urinary stone prevention among the Taif population. Specifically, we sought to: (1) determine the prevalence of self-reported kidney stones in this population; (2) evaluate knowledge levels regarding symptoms, risk factors, prevention, diagnosis, and management of kidney stones; (3) identify sociodemographic and clinical factors associated with knowledge levels; and (4) examine the relationship between knowledge and self-reported history of kidney stones.

Subjects and Methods

Study design and participants

This cross-sectional observational study was conducted among the general population of Taif City, Saudi Arabia, using a self-administered questionnaire. The study population consisted of individuals aged 18 years and above living in Taif. Data were collected between **25 July 2025 and 15 November 2025**. The questionnaire was shared with the target population via social media platforms using a non-probability convenience sampling technique, and all eligible respondents who consented during the data collection period were included. The minimum required sample size was calculated using Raosoft's online sample size calculator, assuming a 5% margin of error, a 95% confidence level, and maximum variability (50% response distribution); a minimum of 363 participants was required and achieved.

Data collection

Data were collected using an electronic self-administered questionnaire distributed via a Google Forms link shared across social media platforms. The questionnaire was adapted, with minor contextual modifications, from a previously published questionnaire assessing public awareness of renal stone causes, symptoms, and management among Saudis [5], and was pilot tested among a small sample of the target population to assess clarity, comprehensibility, and face validity prior to full-scale data collection.

The questionnaire consisted of 22 items in total. The first section included demographic and exposure items (age, sex, healthcare-related field, personal and family history of kidney stones, fluid intake, and exposure to awareness campaigns). The second section contained 16 items assessing knowledge and awareness of renal stone symptoms, risk factors, prevention, diagnosis, and management (Table 2), one of which (symptom recognition) allowed multiple responses.

Study variables

The dependent variable was self-reported history of kidney stones (yes/no). Independent variables included age, sex, healthcare-related affiliation, and clinical and behavioral factors.

Scoring

For each of the 16 knowledge and awareness items shown in Table 2, a correct response received 1 point, while an incorrect response or "I don't know" received 0 points. The symptom-recognition item allowed multiple responses, and each correctly identified symptom contributed 1 point; therefore, this item could contribute more than 1 point to the total. Individual item scores were summed up to obtain each participant's total knowledge and awareness score. Observed total scores ranged from 2 to 19. The correct answer key for each item is available from the corresponding author on request.

Statistical analysis

Statistical analyses were performed using SPSS (version 26.0; IBM Corp., Armonk, NY, USA) [20]. Categorical variables were summarized as frequencies and valid percentages; normally distributed numerical variables were presented as mean ± standard deviation, and non-normally distributed variables as median with interquartile range (IQR), minimum, and maximum. Normality was assessed using the Kolmogorov–Smirnov test. Group comparisons were performed using the Mann–Whitney U test or Kruskal–Wallis test as appropriate, and associations between categorical variables were examined using the chi-square test. Independent predictors of self-reported kidney stone history were identified using multivariable binary logistic regression, with results reported as adjusted odds ratios (ORs) and 95% confidence intervals (CIs). Statistical significance was defined as $p < 0.05$.

Ethical considerations

Ethical approval was obtained from the Taif University Research Ethics Committee on 23 June 2025 (approval number HAPO-02-T-105) prior to initiating any study-related procedures. Electronic informed consent was obtained from all participants before completing the questionnaire.

Results

Age was reported by 362 participants, of whom 44.5% (n = 161) were aged 18–25 years. Of the 317 participants who reported their occupation/field of study, 73.5% (n = 233) had no current or past affiliation with the healthcare field. Of the 317 participants who reported their sex, 52.1% (n = 165) were female, and 47.9% (n = 152) were male.

A self-reported history of kidney stones (kidney, ureter, or bladder) was reported by 28.7% (n = 104) of participants, and 47.1% (n = 171) reported that at least one family member had experienced kidney stones. Regarding fluid intake, 35.8% (n = 130) drank less than four cups daily, 51.0% (n = 185) drank four to eight cups, and 13.2% (n = 48) drank more than eight cups per day. Only 33.8% (n = 121) reported having seen kidney stone awareness campaigns in public spaces or malls, while the majority (66.2%, n = 237) had not (Table 1).

Pain was the most recognized symptom (95.6%, n = 346), followed by a burning sensation during urination (77.2%, n = 281) and an inability to urinate completely (75.7%, n = 274). Blood in urine (46.7%, n = 169) and frequent urination (38.7%, n = 140) were less frequently recognized. Just over half of participants (60.3%, n = 219) correctly identified calcium oxalate as the most common stone type. Most participants (87.6%, n = 318) correctly

Table 1. *Sociodemographic characteristics of study participants (N = 363).*

Parameter	Category	Number	Percent
Age (years) (N = 362)	18–25 years	161	44.5
	26–45 years	113	31.2
	46 years and above	88	24.3
Sex (N = 317)	Male	152	47.9
	Female	165	52.1
Do you work/study in the health field? (N = 317)	No	233	73.5
	Yes	84	26.5
Have you ever had a kidney stone? (kidney, ureter, or bladder)	No	259	71.3
	Yes	104	28.7
Did any family member have a kidney stone?	No	192	52.9
	Yes	171	47.1
Cups of fluid consumed daily	Less than 4 cups	130	35.8
	4–8 cups	185	51.0
	More than 8 cups	48	13.2
Saw kidney stone awareness campaigns in public spaces/malls (N = 358)	No	237	66.2
	Yes	121	33.8

Table 2. *Distribution of participants' responses regarding kidney stone symptoms, causes, diagnosis, and treatment (N = 363).*

Item	Category	Number	Percent
1. Symptoms of kidney stones (N = 362)	Pain	346	95.6
	Inability to urinate completely	274	75.7
	Frequent urination	140	38.7
	Blood in urine	169	46.7
	Burning sensation when urinating	281	77.2
	Constipation	18	4.9

Item	Category	Number	Percent
	Diarrhea	10	2.7
2. Most common type of kidney stone	Calcium oxalate	219	60.3
	Uric acid	53	14.6
	Ammonium phosphate	10	2.8
	Don’t know	81	22.3
3. Drinking fluids prevents stone formation	No	19	5.2
	Yes	318	87.6
	Don’t know	26	7.2
4. Suitable daily water intake	Less than 1 l	18	4.5
	1–2 l	249	68.6
	2–3 l	94	25.9
	Don’t know	3	0.8
5. Urinary tract inflammation increases risk (N = 362)	No	73	20.2
	Yes	248	68.5
	Don’t know	41	11.3
6. Obesity/inactivity increases risk (N = 361)	No	64	17.7
	Yes	253	70.1
	Don’t know	44	12.2
7. Parsley water prevents/treats stones (N = 360)	No	57	15.8
	Yes	235	65.3
	Don’t know	68	18.9
8. High blood calcium/uric acid increases risk (N = 362)	No	38	10.5
	Yes	270	74.6
	Don’t know	54	14.9
9. Red meat consumption increases risk (N = 361)	No	68	18.8
	Yes	240	66.5
	Don’t know	53	14.7
10. Coffee/tea/chocolate increases risk (N = 362)	No	87	24.0
	Yes	210	58.0
	Don’t know	65	18.0
11. Calcium-rich foods increase risk (N = 360)	No	69	19.2
	Yes	211	58.6
	Don’t know	80	22.2
12. Parathyroid disease, gout, kidney disease related to stones (N = 361)	No	58	16.1
	Yes	220	60.9
	Don’t know	83	23.0
13. Family history increases risk (N = 362)	No	103	28.5
	Yes	186	51.4
	Don’t know	73	20.2
14. Complications of untreated stones (N = 362)	Urinary tract blockage and kidney failure	316	87.1
	No complications	35	9.6
	Diabetes	8	2.2
	Heart attack	3	0.8
15. Diagnosis method (N = 361)	Imaging	257	71.2
	Urine analysis	60	16.6
	Blood analysis	12	3.3
	Kidney biopsy	10	2.7
	Fecal analysis	3	0.8
	Don’t know	19	5.3
16. Treatment	Drinking parsley water	65	17.9
	Drinking milk daily	2	0.5
	Diuretic medications	212	58.4
	Endoscopy and surgical intervention	84	23.1

Table 3. Distribution of kidney stone history by sociodemographic characteristics.

Parameter	Category	No, *n* (%)	Yes, *n* (%)	*p*-value
Age (years)	18–25 years	126 (78.3)	35 (21.7)	0.024
	26–45 years	78 (69.0)	35 (31.0)	
	46 years and above	55 (62.5)	33 (37.5)	
Sex	Male	91 (59.9)	61 (40.1)	0.005
	Female	123 (74.5)	42 (25.5)	
Healthcare field	No	141 (60.5)	92 (39.5)	<0.001
	Yes	72 (85.7)	12 (14.3)	
Family history	No	151 (78.6)	41 (21.4)	0.001
	Yes	108 (63.2)	63 (36.8)	
Daily fluid intake	Less than 4 cups	78 (60.0)	52 (40.0)	<0.001
	4–8 cups	139 (75.1)	46 (24.9)	
	More than 8 cups	42 (87.5)	6 (12.5)	
Awareness campaign exposure	No	188 (79.3)	49 (20.7)	<0.001
	Yes	68 (56.2)	53 (43.8)	

Chi-square test.

Table 4. Multivariable logistic regression analysis of factors associated with kidney stone history.

Factor	OR (95% CI)	*p*-value
Age: 26–45 years (ref: 18–25 years)	0.69 (0.36–1.33)	0.265
Age: 46 years and above (ref: 18–25 years)	0.98 (0.48–2.01)	0.959
Sex: female (ref: male)	0.54 (0.32–0.91)	0.02
Healthcare field: yes (ref: no)	0.23 (0.11–0.49)	<0.001
Family history: yes (ref: no)	1.72 (1.02–2.92)	0.043
Awareness campaign exposure: yes (ref: no)	2.92 (1.69–5.03)	<0.001
Total knowledge score (continuous)	1.020 (0.933-1.115)	0.665

Table 5. Distribution of total knowledge and awareness score.

Parameter	Value
Median (IQR)	13 (4)
Mean (SD)	12.75 (2.98)
Min–Max	2–19

believed that adequate fluid intake helps prevent stone formation, and 68.6% (n = 249) correctly identified one to two liters as a suitable daily water intake.

Most participants correctly identified several risk factors: urinary tract inflammation (68.5%, n = 248), obesity/inactivity (70.1%, n = 253), elevated blood calcium/uric acid (74.6%, n = 270), and high red meat intake (66.5%, n = 240). However, a notable misconception persisted: 58.6% (n = 211) incorrectly believed that calcium-rich foods increase the risk of stone formation.

Just over half of participants (51.4%, n = 186) correctly identified family history as a risk factor, while 20.2% (n = 73) were unsure. Most participants (87.1%, n = 316) correctly identified urinary tract obstruction and kidney failure as complications of untreated stones. Regarding diagnosis, imaging was the most commonly selected correct method (71.2%, n = 257), followed by urine analysis (16.6%, n = 60); 5.3% (n = 19) did not know (Table 2).

Age was significantly associated with kidney stone history (p = 0.024): prevalence increased from 21.7% among participants aged 18–25 years to 37.5% among those aged 46 years and above. A history of kidney stones was significantly more common in males (40.1%) than in females (25.5%; p = 0.005). Participants with a healthcare-related occupation or field of study had a lower prevalence of stones (14.3%) than those without such affiliation (39.5%, $p < 0.001$). Family history was significantly associated with personal stone history (p = 0.001): 36.8% of participants with an affected family member reported stones, compared with 21.4% of those without.

Daily fluid intake was inversely associated with kidney stone history ($p < 0.001$), decreasing from 40.0% among those drinking less than four cups daily to 12.5% among those drinking more than eight cups daily. Participants who reported exposure to awareness campaigns had a higher rate of self-reported kidney stone history than those who did not (43.8% vs. 20.7%; $p < 0.001$) (Table 3); this counterintuitive association is addressed in the Discussion.

In the multivariable logistic regression model, female sex remained independently associated with lower odds of reporting kidney stones (OR = 0.54, 95% CI 0.32–0.91, p = 0.02), as did a healthcare-related occupation or field of study (OR = 0.23, 95% CI 0.11–0.49, $p < 0.001$). A positive family history was independently associated with higher odds (OR = 1.72, 95% CI 1.02–2.92, p = 0.043). Reported exposure to awareness campaigns was also independently associated with higher odds of reporting kidney stones (OR = 2.92, 95% CI 1.69–5.03, $p < 0.001$). In the multivariable logistic regression model (Table 4), the total knowledge and awareness score was not independently associated with self-reported kidney stone history (OR = 1.020, 95% CI 0.933–1.115, p = 0.665).

Table 6. *Association between participant characteristics and total knowledge and awareness score.*

Parameter	Category	Median (IQR) score	*p*-value
Age (years)	18–25 years	13 (4)	0.466[a]
	26–45 years	13 (4)	
	46 years and above	13 (4)	
Sex	Male	13 (4)	0.778[b]
	Female	13 (4)	
Healthcare field	No	13 (4)	0.214[b]
	Yes	13 (4)	
Family history	No	13 (4)	0.333[b]
	Yes	13 (4)	
Personal stone history	No	13 (4)	0.456[b]
	Yes	13 (3)	
Daily fluid intake	Less than 4 cups	13 (4)	0.736[a]
	4–8 cups	13 (4)	
	More than 8 cups	13 (6)	
Awareness campaign exposure	No	13 (5)	0.417[b]
	Yes	13 (4)	

[a]Kruskal–Wallis test; [b]Mann–Whitney U test.

The median (IQR) knowledge and awareness score was 13 (4), with a mean (SD) of 12.75 (2.98) and an observed range of 2–19 (Table 5). No significant differences in knowledge scores were observed across any sociodemographic characteristic, personal or family stone history, hydration habits, or campaign exposure (all $p > 0.05$) (Table 6).

Discussion

Urolithiasis affects both men and women [21]. Urolithiasis is a multifactorial condition associated with genetics, ethnicity, age, sex, diet, and environmental factors [15], and metabolic syndrome has also been associated with kidney stone disease [7]. Kidney stone disease can also affect daily functioning and impose financial costs on patients, supporting the importance of public awareness of preventive measures [5]. Diet and environmental exposure are generally considered the main drivers of stone formation in each population [22]; in Saudi Arabia specifically, the high ambient temperature and low water intake common in the region have been proposed as explanations for the relatively high incidence of stone formation [15].

At 28.7%, the self-reported prevalence of kidney stones in our sample was notably higher than figures previously reported from Jeddah (9.1%) and Riyadh (16%) [16], or from Jazan (14%) [17]. This difference may partly reflect climatic and geographic factors. Higher temperatures may increase fluid loss and urine concentration, conditions associated with stone formation [23]. It is worth noting that most affected participants were between the ages of 18 and 25, largely due to the size of that subgroup in our sample; prevalence increased with age, from 21.7% to 37.5% ($p = 0.024$), consistent with global patterns [2].

Male sex was significantly associated with a history of kidney stones in both the univariate ($p = 0.005$) and multivariable ($p = 0.02$) analyses. This finding is consistent with earlier epidemiological studies reporting a higher risk of kidney stones in men [24], although more recent evidence suggests that the sex difference may be narrowing [25]. Family history was one of the strongest correlates we found: 47% of participants reported an affected relative, and this group had significantly higher odds of a personal stone history (OR = 1.72), in line with earlier work identifying family history as a key risk factor [26].

Exposure to awareness efforts increased rather than decreased the risk of self-reported kidney stone history (OR = 2.92, $p < 0.001$). Given the cross-sectional methodology, the most likely explanation is reverse causality or selection bias: those with a personal or family history of stones are more likely to seek out, attend, or simply recall such programs, rather than the campaigns themselves posing a danger. The positive association between reported exposure to awareness campaigns and kidney stone history (OR = 2.92) is unlikely to reflect a causal effect of the campaigns themselves. Rather, it most likely reflects reverse causation or selection bias: individuals with a history of kidney stones may be more likely to notice, attend, or recall such campaigns, and campaigns may be targeted toward communities with higher baseline risk. This is not an argument against public health education; rather, it highlights the necessity for prospective or interventional research to properly evaluate whether these efforts are effective. A healthcare-related occupation or field of study, on the other hand, was associated with lower odds of reporting kidney stones (OR = 0.23, $p < 0.001$). While health literacy was not directly tested in this study, the association is credible and supports the need for formal public health education programs in Saudi Arabia [17].

Interestingly, higher knowledge scores were not independently associated with lower odds of a history of kidney stones in multivariable analysis. This may suggest that knowledge alone, without corresponding behavioral change, is insufficient to reduce stone risk, or that individuals who have already experienced stones may have acquired knowledge after their diagnosis (reverse causality), a limitation inherent to cross-sectional designs. These findings underscore the need for prospective studies to assess whether knowledge acquisition leads to meaningful changes in hydration and dietary behaviors [27].

Most participants correctly named calcium oxalate as the most common stone type. However, a major misconception persisted about dietary calcium: 58.6% believed high-calcium foods increase stone risk, when clinical guidelines recommend adequate dietary calcium to help prevent calcium oxalate stones by binding intestinal oxalate [28]. A similar misperception emerged around parsley water: 65.3% felt it helped prevent or treat stones, a claim with little scientific evidence [27]. Other regional studies of public awareness have reported a similar pattern [23].

Another notable finding was the absence of significant differences in knowledge scores across any participant characteristic (Table 6), including age, sex, healthcare-related background, family or personal stone history, fluid intake, and exposure to awareness campaigns. This uniformity suggests that knowledge about kidney stone prevention is not concentrated in specific demographic subgroups, but rather is broadly distributed or, conversely, broadly lacking, across the population. The lack of association with a healthcare background is particularly surprising, as one might expect individuals working in or studying healthcare to have superior knowledge. This may reflect the fact that kidney stones are a specialized topic not covered in depth in general healthcare curricula, or that knowledge acquisition in this domain is driven more by personal experience than by formal education. The absence of an association between campaign exposure and knowledge scores further calls into question the effectiveness of current awareness campaigns in improving knowledge and suggests that these campaigns may need to be redesigned or evaluated more rigorously. This negative finding reinforces the need for targeted, evidence-based educational interventions that reach all segments of the population, rather than relying on passive dissemination of information through public campaigns [17].

Two fallacies stand out as directly actionable: that eating calcium increases stone risk, and that parsley water is a good therapy. Taif›s primary care clinics should treat both briefly during routine appointments, especially for male patients and those with a family history of stones.

Limitations

Several limitations should be considered. First, a cross-sectional design can only establish associations, not causal relationships. Second, reliance on self-reported questionnaire data may introduce recall or misclassification bias, as participants' recollections of symptoms, diagnoses, and fluid intake may be imprecise.

Third, and importantly, the use of convenience sampling via social media introduces the possibility of selection bias. Individuals with a personal or family history of kidney stones or those with a particular interest in the topic may have been more likely to participate in the survey, potentially inflating the reported prevalence of 28.7%. This same selection bias may also explain the counterintuitive association between exposure to awareness campaigns and higher odds of a history of kidney stones: rather than campaigns increasing stone risk, it is more plausible that individuals with a history of stones were more likely to recall or seek out such campaigns. Selection bias could also have affected knowledge scores, as participants with greater health awareness may have been overrepresented, potentially leading to an overestimation of knowledge levels in the general population. Furthermore, the association between campaign exposure and stone history may be explained by reverse causation or by campaigns often targeting populations already at higher risk, rather than by the campaigns themselves having any harmful effect.

Fourth, the online nature of data collection may have excluded older adults, those with limited digital literacy, or those without internet access, potentially limiting the generalizability of our findings. Finally, since data were collected only in Taif, the findings may not generalize to other regions of Saudi Arabia or to populations with different demographic or environmental characteristics.

Conclusion

Kidney stones were commonly reported in this sample from Taif, Saudi Arabia (28.7%). In multivariable analysis, female sex and a healthcare-related background were independently associated with lower odds of reporting kidney stones, whereas family history and reported exposure to awareness campaigns were associated with higher odds; lower fluid intake was associated with kidney stone history only in the unadjusted analysis. The total knowledge score was not independently associated with a history of kidney stones. Awareness of basic symptoms was high, but important gaps and misconceptions persist regarding dietary risk factors and prevention. Longitudinal studies are needed to clarify causal pathways, alongside intervention studies evaluating structured education and hydration programs to reduce kidney stone burden in this population.

Conflict of interest

The authors declare that they have no conflict of interest regarding the publication of this article.

Funding

This research received no specific funding from any funding agency in the public, commercial, or not-for-profit sectors.

Consent for publication

Not applicable (no identifying individual data are presented).

Ethics approval and consent to participate

Ethical approval was obtained from the Taif University Research Ethics Committee (approval number HAPO-02-T-105, dated 23 June 2025). Electronic informed consent was obtained from all participants.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Supplementary content (If any) is available online.

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