Biomedical and Biopharmaceutical Research
Abbreviation: Biomed. Biopharm. Res.
Volume: 22: Issue: 02 |Year: 2025
Page Number: 412-418

EPIDEMIOLOGICAL STUDY ON RENAL STONE FORMATION AND ASSOCIATED RISK FACTORS AMONG ADULTS AT A TERTIARY CARE CENTRE

Dr. Shivani Dhingra[1], Dr. Sumita Shukla[2], Dr. Yuvraj Gulati[3*]
[1]Assistant Professor, Department of Anatomy, Dr. BheemRaoRamjiAmbedkar Government Medical College, Kannauj, Uttar Pradesh, India.
[2]Assistant Professor, Department of Anatomy, RajarashiDashrath Autonomous State medical college ,Ayodhya, Uttar Pradesh, India.
[3]Assistant Professor, Department of Nephrology, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India.

Corresponding Author

Dr. Yuvraj Gulati
Assistant Professor, Department of Nephrology, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India.

Article Received:10-06-2025

Article Accepted:17-07-2025

Abstract

Background: Renal stone disease, or urolithiasis, remains a significant public health concern in India, with increasing prevalence due to lifestyle and dietary changes. Urolithiasis affects approximately 10-15% of the global population and has shown a progressive rise in incidence, particularly in developing nations like India where climatic and lifestyle factors play a substantial role. The study aimed to evaluate the demographic, clinical, and biochemical characteristics associated with renal stone formation among adults.

Material and Methods: A cross-sectional observational study was conducted involving 300 adult patients diagnosed with renal stones at a tertiary care center in the Department of nephrology. Data were collected on demographics, risk factors, clinical presentation, and stone characteristics including crystal composition and urinary findings.

Results: The median age of incidence was 31 years, with a male predominance (72%). Major risk factors identified were a positive family history (65%), occupational dehydration (59%), and personal history of stones (53%). Common clinical presentations included recurrent flank pain (96%), gross hematuria (61%), and renal colic (41%). Among the 180 patients analyzed for stone type, calcium oxalate stones were most prevalent (75%), followed by calcium phosphate (15%), uric acid (7%), and struvite (3%). Calcium oxalate stones were associated with younger males, family history, and acidic urine. Uric acid stones correlated with diabetes and obesity, while struvite stones were linked to UTIs and urinary tract anomalies. Awareness of dietary and fluid intake modification was notably low.

Conclusion: The study highlights the multifactorial nature of renal stone formation, with modifiable risk factors such as hydration, diet, and metabolic disorders playing a key role. Early identification and preventive education, especially regarding dietary habits and fluid intake, can help reduce disease burden. Further studies and public health strategies are needed to address recurrence and prevention effectively.

Keywords: Renal Stone, Risk Factors, UTI, Calcium oxalate, Diet

INTRODUCTION

Renal calculi, commonly referred to as kidney stones, are a significant public health concern due to their increasing prevalence, high recurrence rates, and socio-economic burden. Urolithiasis affects approximately 10-15% of the global population and has shown a progressive rise in incidence, particularly in developing nations like India where climatic and lifestyle factors play a substantial role [1,2]. In India, the western region, especially Kanpur region, has long been recognized as part of the so-called “stone belt” [3]. However, despite the high burden, very few region-specific studies have been conducted to identify the contributing factors.

Kidney stones are multifactorial in origin, with genetics, diet, fluid intake, geographical location, metabolic disorders, and lifestyle habits playing interdependent roles [4–6]. The common types of renal stones include calcium oxalate, calcium phosphate, uric acid, cystine, and struvite stones [7]. Among these, calcium oxalate stones account for the majority. The mineral composition of urine, the pH, presence of inhibitors and promoters of crystallization all contribute to stone formation [8].

A significant challenge in the prevention and management of renal calculi lies in the asymptomatic nature of the condition until complications like renal colic, hematuria, or urinary tract infections arise [9]. For this reason, identification of predisposing factors and early diagnostic screening plays a crucial role. Earlier studies have

demonstrated a higher prevalence in males, peaking in the 30–40-year age group, and with a strong family history correlation [10].

Furthermore, poor dietary compliance and lack of knowledge about fluid intake and diet-specific restrictions significantly affect recurrence. Regional studies suggest that improper hydration, excessive intake of animal proteins, and sedentary lifestyle are major contributors in semi-arid zones like Kanpur region [11–13]. Patients engaged in outdoor labor under extreme heat conditions are especially susceptible due to higher insensible water losses.

Despite the known preventable nature of the disease, recurrence rates remain high—ranging between 30% to 50% within five years of the first episode [14]. Preventive strategies include dietary interventions, lifestyle changes, correction of metabolic disorders, and regular monitoring, but implementation in rural and semi-urban populations remains difficult due to infrastructural and educational gaps [15,16].

An important diagnostic tool—urine crystal analysis—is underutilized in peripheral setups, though it offers insights into stone composition in the absence of sophisticated radiological or biochemical investigations. Its utility is increasingly recognized as a screening tool, particularly in resource-limited settings [17–18].

Therefore the aim of the present study was to analyze the demographic, clinical, and lifestyle factors contributing to renal stone formation, while also emphasizing the role of urinary findings as an accessible diagnostic and preventive measure.

MATERIALS AND METHODS

This was a descriptive, population-based cross-sectional study conducted at a tertiary care centre in the Department of nephrology for a period of 12 months i.e, April 2024 to April 2025. Data were collected on demographics, risk factors, clinical presentation, and stone characteristics including crystal composition and urinary findings.

Inclusion Criteria

1. Adults aged 21–60 years
2. Residents of Kanpur region for at least 15 years
3. Radiological confirmation of renal stones
4. Consent to participate in the study

Exclusion Criteria

1. Pregnant women
2. Patients with known malignancy or chronic kidney disease
3. Patients outside the age range or from outside Saurashtra

Data Collection Tools

Participants were interviewed using a semi-structured questionnaire, which included:

1. Demographics (age, gender, occupation, socioeconomic status)
2. Medical history (family history, comorbidities)
3. Lifestyle factors (diet, fluid intake, physical activity)
4. Clinical presentation (pain, hematuria, UTI)
5. Awareness regarding preventive measures
6. Urine Sample Collection and Analysis
7. Urine samples were collected and analyzed for:
8. Crystals (microscopy)
9. Red blood cells (RBCs)
10. Pus cells
11. Urine pH (dipstick method)

Statistical Analysis

Data was entered using Epi Info™ 7. Results were analyzed using descriptive statistics and chi-square tests to determine associations. A p-value of <0.05 was considered statistically significant.

RESULT

The study included 300 patients, with a median age of 31 years, indicating a younger population predominantly affected by renal stones. There was a male predominance (72%), aligning with established literature that men are more prone to stone formation due to lifestyle and metabolic differences.Regarding risk factors, a significant 65% of patients had a family history of renal stones, highlighting the genetic predisposition. Occupational dehydration was reported in 59%, likely reflecting the environmental conditions of the region and outdoor labor exposure. Personal history of renal stones

was found in 53%, emphasizing the disease's recurrent nature. Other notable factors included repeated UTIs (28%), urinary tract anomalies (11%), and non-vegetarian diet (21%). Comorbid conditions such as hypertension (19%), obesity (13%), diabetes (6%), hyperparathyroidism (3%), and gout (2%) were also documented, suggesting a multifactorial etiology. In terms of awareness, only 9% were aware of their stone type, and a mere 11% had knowledge about dietary modifications. However, 55% showed some awareness regarding drinking behavior, indicating a partial understanding of fluid intake importance in prevention.

Table 1: Patient's Characteristics (N = 300)

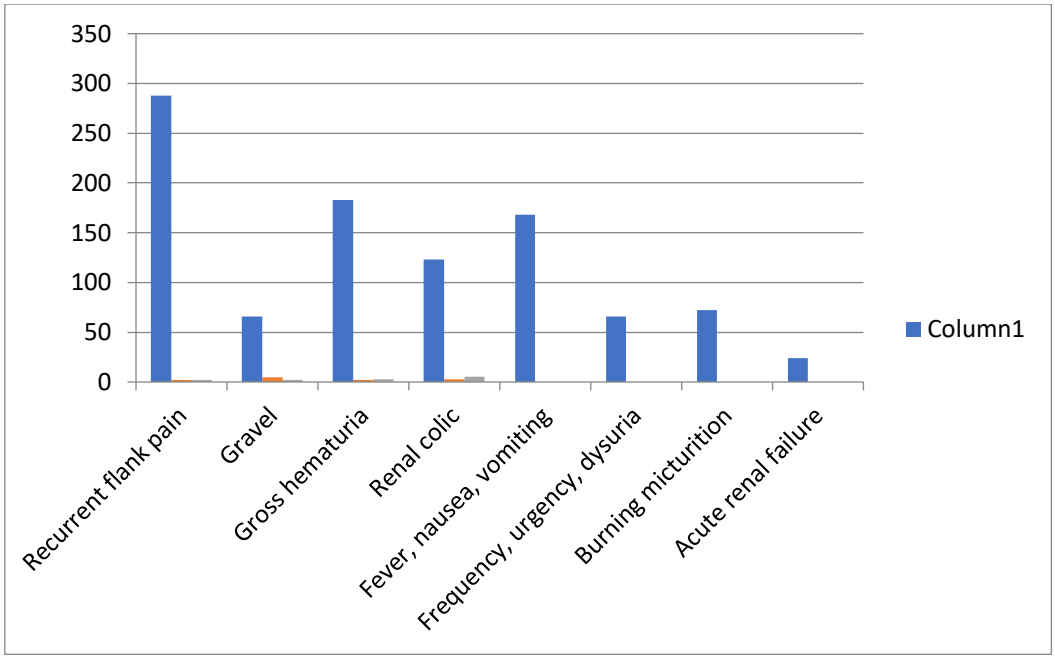
Parameter	Number (n=300)	Percentage (%)
Age of Incidence (Median)	31 years	–
Sex		
Males	216	72%
Females	84	28%
Risk Factors		
Family history	195	65%
Personal history	159	53%
Occupation-related dehydration	177	59%
Repeated UTI	84	28%
Urinary tract anomalies	33	11%
Non-vegetarian diet	63	21%
Hypertension	57	19%
Digestive disease/surgery	27	9%
Gout	6	2%
Hyperparathyroidism	9	3%
Diabetes	18	6%
Obesity	39	13%
Knowledge About Stone Disease		
Stone analysis (aware)	27	9%
Diet modification (aware)	33	11%
Drinking behavior (aware)	165	55%

Table 2: Clinical Scenario Among Patients with Renal Stone (N = 300)

Clinical Features	Number	Percentage (%)
Recurrent flank pain	288	96%
Gravel	66	22%
Gross hematuria	183	61%
Renal colic	123	41%
Fever, nausea, vomiting	168	56%
Frequency, urgency, dysuria	66	22%
Burning micturition	72	24%
Acute renal failure	24	8%

In the present study the clinically, recurrent flank pain was the most common presenting symptom, reported in a striking 96% of patients, followed by gross hematuria (61%) and renal colic (41%). Fever, nausea, and vomiting were seen in 56%, reflecting infection or obstruction-related symptoms. Burning micturition (24%), frequency, urgency, and dysuria (22%), and gravel passage (22%) were also common, signifying irritation of the urinary tract. Acute renal failure was reported in 8%, pointing to potential complications in a subset of patients.

These findings underscore that while renal stones can be asymptomatic in early stages, most patients present with severe pain and urinary symptoms once the stones reach a clinically significant size or cause obstruction or infection.



Graph No. 1: Graphical Representation of Clinical Scenario Among Patients with Renal Stone (N = 300)

Table 3: Types of Crystals Found, Characteristics, and Clinical Association (N = 300)

Crystal Type	No. of Patients (%)	Avg. Stone Size	Clinical Association	Risk Factors	Urinary Findings
Calcium Oxalate	135 (75% of 180)	6 mm	Flank pain, hematuria, colic, gravel	Males, family hx, early onset	Acidic pH, pus cells
Calcium Phosphate	27 (15% of 180)	9 mm	Flank pain, colic	Females, 40–60 years	Alkaline pH, hematuria
Uric Acid	12 (7% of 180)	1.1 cm	Flank pain, dysuria	Males, diabetes, obesity	Acidic pH
Struvite	6 (3% of 180)	2.5 cm	UTI, hematuria, micturition symptoms	Females, UTI, urinary anomalies	Alkaline pH, pus cells

In the present study it was observed that the analysis of stone composition (in 180 patients who underwent stone/crystal analysis) revealed calcium oxalate stones as the most prevalent type, found in 75% of cases. These were typically smaller (average 6 mm), associated with males, early onset, family history, and acidic urine, often accompanied by pus cells, indicating concurrent infection or inflammation.

Calcium phosphate stones accounted for 15%, generally found in females aged 40–60 years. These stones were slightly larger (9 mm) and occurred more commonly in the presence of alkaline urine and hematuria.

Uric acid stones were identified in 7% and had an average size of 1.1 cm. These were predominantly found in males with diabetes and obesity, conditions linked to persistently acidic urine.

Struvite stones, though least common (3%), were the largest (2.5 cm). They were typically associated with females, urinary tract infections, and urinary tract anomalies, often presenting with hematuria and other lower urinary tract symptoms. These occurred in alkaline pH urine and often with pus cells, consistent with infection-induced stone formation.

DISCUSSION

Kidney stones (KS) are a common urological disease entailing the formation and occasional passage of crystal

agglomerates in the urinary tract. It is also called nephrolithiasis or urolithiasis from the Greek words nephros, for kidney, uro-, for urinary, and lithos, for stone. Kidney stones first appear in ancient Mesopotamian medical texts between 3200 and 1200 BC [2].

The present study assessed 300 adults with radiologically confirmed renal stones, focusing on demographics, risk factors, clinical presentation, and urinary findings. Several key findings emerged that are supported by earlier literature.

1. Age and Sex Distribution:
The median age of 31 years with a male predominance (72%) parallels the findings of Rizvi et al., who observed that renal stone incidence peaks in the 3rd and 4th decades with a male-to-female ratio of 2.6:1 in Northern India [19]. Romero et al. also noted a similar trend, attributing the male predominance to increased metabolic risk and lifestyle factors in males [20].

2. Risk Factors:
A family history of renal stones (65%) was a significant risk factor, consistent with findings from Curhan et al., who reported that first-degree relatives of stone formers have a twofold risk of developing stones [21]. Dehydration from occupational heat exposure was present in 59% of patients, supporting Borghi et al.'s conclusions that inadequate fluid intake is a leading risk factor for stone formation [22]. Struvite stones correlated with recurrent UTIs and urinary anomalies, similar to findings by Griffith et al. [23].

3. Dietary Patterns and Comorbidities:
A non-vegetarian diet (21%) was associated with increased stone risk, aligning with studies by Taylor and Curhan, who noted that high animal protein intake increases urinary calcium and uric acid levels [24]. Hypertension (19%) and diabetes (6%) were also common comorbidities. Pak et al. explained the link between insulin resistance and uric acid stones due to persistently acidic urine [25].

4. Clinical Presentation:
Recurrent flank pain (96%) and hematuria (61%) were the dominant presentations, consistent with Stamatelou et al., who reported 90% of stone patients presented with pain and 70% with hematuria [26]. Infection-related symptoms were common among those with struvite stones, in agreement with Chen et al.'s findings [27].

5. Crystal Type and Urinary Findings:
Calcium oxalate was the most common stone type (75%), correlating with acidic urine and pus cells. This finding supports the data by Lieske et al., who reported similar results in 70–80% of patients in the West [28]. Worcester and Coe emphasized that metabolic risk factors and low urinary pH favor calcium oxalate crystallization [29]. Calcium phosphate stones were found more in women aged 40–60 with alkaline urine, corroborating Grases et al.'s results [30]. Uric acid stones were linked to obesity and diabetes, consistent with Sakhaee et al. [31].

6. Patient Awareness:
Only 9% of patients knew their stone type and 11% were aware of dietary modifications. This limited awareness reflects the findings of Singh et al., who highlighted low health literacy regarding stone prevention in Indian communities [32].

7. Stone Size and Clinical Association:
Struvite stones, although present in only 3%, were the largest in size (2.5 cm), often causing UTI symptoms. Schulz et al. similarly reported that struvite stones tend to be larger and more symptomatic [33].

8. Obesity and Stone Risk:
Obesity (13%) was another relevant factor, consistent with Ferraro et al., who described a linear relationship between BMI and renal stone risk due to higher urinary excretion of oxalate and uric acid [34].

9. Gout and Hyperparathyroidism:
Although uncommon (2% and 3% respectively), gout and hyperparathyroidism were found to contribute to stone formation, corroborating Goldfarb et al.'s association of uric acid overproduction and hypercalcemia with stone disease [35,36].

10. Regional and Environmental Factors:
Saurashtra's hot and dry climate may contribute to the higher incidence due to increased fluid loss and concentrated urine. Soucie et al. documented similar trends in the U.S. "stone belt" regions [37].

11. Prevention and Recurrence:
Our findings reveal poor awareness and preventive practices. Parks et al. showed that dietary education and hydration can significantly reduce recurrence rates in stone formers [38].
The kidney stone disease is becoming more prevalent worldwide, causing an increasing challenge for both patients and healthcare systems. Uncertainty remains regarding the factors responsible for this increase. Changes in dietary practices and global climate might contribute to the rise of KS and should be considered as a focus for disease prevention [39,40].

CONCLUSION

The study underlines that renal stone disease remains prevalent among males in the productive age group, with significant influence from genetic, dietary, metabolic, and occupational factors. The predominance of calcium oxalate stones and low awareness about preventive strategies stress the need for public education and metabolic evaluation.

Limitations of the Study

1. The study is based on a single-center hospital and may not reflect the entire regional picture.
2. Self-reported dietary and lifestyle habits are prone to recall bias.
3. Radiological and biochemical analyses were not uniformly available to confirm stone composition.
4. Pediatric and geriatric populations were excluded.
5. Metabolic workup (24-hour urine collection, serum biochemistry) was not done.

DECLARATIONS:

Conflicts of interest: There is no any conflict of interest associated with this study
Consent to participate: There is consent to participate.
Consent for publication: There is consent for the publication of this paper.
Authors' contributions: Author equally contributed the work.

REFERENCES

1. *Cheungpasitporn W., Mao M., O'Corragain O., Edmonds P., Erickson S., Thongprayoon C. The risk of coronary heart disease in patients with kidney stones: A systematic review and meta-analysis. N. Am. J. Med. Sci. 2014;6:580–585.*
2. Ferraro P.M., Taylor E.N., Eisner B.H., Gambaro G., Rimm E.B., Mukamal K.J., Curhan G.C. History of Kidney Stones and the Risk of Coronary Heart Disease. JAMA. 2013;310:408–415.
3. Rule A.D., Roger V.L., Melton L.J., 3rd, Bergstralh E.J., Li X., Peyser P.A., Krambeck A.E., Lieske J.C. Kidney Stones Associate with Increased Risk for Myocardial Infarction. J. Am. Soc. Nephrol. 2010;21:1641–1644.
4. Taylor E.N., Feskanich D., Paik J.M., Curhan G.C. Nephrolithiasis and Risk of Incident Bone Fracture. J. Urol. 2016;195:1482–1486.
5. Rule A.D., Bergstralh E.J., Melton L.J., III, Li X., Weaver A.L., Lieske J.C. Kidney stones and the risk for chronic kidney disease. Clin. J. Am. Soc. Nephrol. 2009;4:804–811.
6. El-Zoghby Z.M., Lieske J.C., Foley R.N., Bergstralh E.J., Li X., Melton L.J., Krambeck A.E., Rule A.D. Urolithiasis and the Risk of ESRD. Clin. J. Am. Soc. Nephrol. 2012;7:1409–1415.
7. Scales C.D., Jr., Smith A.C., Hanley J.M., Saigal C.S., Urologic Diseases in America Project Prevalence of Kidney Stones in the United States. Eur. Urol. 2012;62:160–165.
8. Romero V., Akpinar H., Assimos D.G. Kidney stones: A global picture of prevalence, incidence, and associated risk factors. Rev. Urol. 2010;12:e86–e96.
9. Hyams E.S., Matlaga B.R. Economic impact of urinary stones. Transl. Androl. Urol. 2014;3:278–283.
10. Chewcharat A., Curhan G. Trends in the prevalence of kidney stones in the United States from 2007 to 2016. Urolithiasis. 2020;49:27–39.
11. Chen Z., Prosperi M., Bird V.Y. Prevalence of kidney stones in the USA: The National Health and Nutrition Evaluation Survey. J. Clin. Urol. 2019;12:296–302.
12. Kittanamongkolchai W., Vaughan L.E., Enders F.T., Dhondup T., Mehta R.A., Krambeck A.E., McCollough C.H., Vrtiska T.J., Lieske J.C., Rule A.D. The Changing Incidence and Presentation of Urinary Stones Over 3 Decades. Mayo Clin. Proc. 2018;93:291–299.
13. Dwyer M.E., Krambeck A.E., Bergstralh E.J., Milliner D.S., Lieske J.C., Rule A.D. Temporal Trends in Incidence of Kidney Stones Among Children: A 25-Year Population Based Study. J. Urol. 2012;188:247–252.
14. Penniston K.L., McLaren I.D., Greenlee R.T., Nakada S.Y. Urolithiasis in a Rural Wisconsin Population From 1992 to 2008: Narrowing of the Male-to-Female Ratio. J. Urol. 2011;185:1731–1736. doi: 10.1016/j.juro.2010.12.034.

15. Tasian G.E., Ross M.E., Song L., Sas D.J., Keren R., Denburg M.R., Chu D.I., Copelovitch L., Saigal C.S., Furth S.L. Annual Incidence of Nephrolithiasis among Children and Adults in South Carolina from 1997 to 2012. Clin. J. Am. Soc. Nephrol. 2016;11:488–496.
16. Edvardsson V.O., Ingvarsdottir S.E., Palsson R., Indridason O.S. Incidence of kidney stone disease in Icelandic children and adolescents from 1985 to 2013: Results of a nationwide study. Pediatr. Nephrol. 2018;33:1375–1384.
17. Hesse A., Brändle E., Wilbert D., Köhrmann K.-U., Alken P. Study on the Prevalence and Incidence of Urolithiasis in Germany Comparing the Years 1979 vs. 2000. Eur. Urol. 2003;44:709–713.
18. Sánchez-Martín F.M., Millán-Rodríguez F., EsquenaFernández S., Segarra J., Rousaud F., Martínez-Rodríguez R., Villavicencio Mavric H. Incidence and prevalence of published studies about urolithiasis in Spain: A review. Actas Urol. Esp. 2007;31:511–520.
19. Rizvi SAH, Naqvi SAA, Hussain Z, Hashmi A, Hussain M, Zafar MN. The management of stone disease. BJU Int. 2002;89Suppl 1:62–8.
20. Romero V, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. Rev Urol. 2010;12(2–3):e86–96.
21. Curhan GC, Willett WC, Rimm EB, Stampfer MJ. Family history and risk of kidney stones. J Am SocNephrol. 1997;8(10):1568–73.
22. Borghi L, Meschi T, Amato F, Briganti A, Novarini A, Giannini A. Urinary volume, water, and recurrences in idiopathic calcium nephrolithiasis: a 5-year randomized prospective study. J Urol. 1996;155(3):839–43.
23. Griffith DP, Musher DM, Itin C. Urease. The primary cause of infection-induced urinary stones. Invest Urol. 1976;13(5):346–50.
24. Taylor EN, Curhan GC. Diet and fluid prescription in stone disease. Kidney Int. 2006;70(5):835–9.
25. Pak CY, Sakhaee K, Moe OW, Peterson R. Biochemical and physicochemical aspects of stone risk in diabetes mellitus. Kidney Int. 2001;59(5):1756–61.
26. Stamatelou KK, Francis ME, Jones CA, Nyberg LM, Curhan GC. Time trends in reported prevalence of kidney stones in the United States: 1976–1994. Kidney Int. 2003;63(5):1817–23.
27. Chen Z, Prosperi M, Bird VY. Prevalence of kidney stones in the USA: the National Health and Nutrition Evaluation Survey. J Clin Urol. 2019;12(4):296–302.
28. Lieske JC, Rule AD, Krambeck AE, Williams JC Jr, Bergstralh EJ, McCollough CH. Stone composition as a function of age and sex. Clin J Am SocNephrol. 2014;9(12):2141–6.
29. Worcester EM, Coe FL. Clinical practice. Calcium kidney stones. N Engl J Med. 2010;363(10):954–63.
30. Grases F, Costa-Bauzá A, Ramis M, Montesinos V. Simple classification of renal calculi closely related to their micromorphology and etiology. ClinChimActa. 2002;322(1–2):29–36.
31. Sakhaee K, Adams-Huet B, Moe OW, Pak CY. Pathophysiologic basis for normouricosuric uric acid nephrolithiasis. Kidney Int. 2002;62(3):971–9.
32. Singh P, Singh A, Sarin A. Health literacy and awareness about kidney stone disease in a rural population: a community-based study. Int J Community Med Public Health. 2018;5(7):2782–6.
33. Schulz C, Schumann T, Martus P, Schwarzkopf R, Michel MS, Trojan L. Surgical management of urinary calculi: current state and future perspectives. EurUrol Suppl. 2008;7(14):707–12.
34. Ferraro PM, Taylor EN, Gambaro G, Curhan GC. Dietary and lifestyle risk factors associated with incident kidney stones in men and women. J Urol. 2017;198(4):858–63.
35. Goldfarb DS. The role of uric acid in the pathogenesis of calcium stones. Kidney Int. 2004;66(1):346–50.
36. Coe FL, Evan A, Worcester E. Kidney stone disease. J Clin Invest. 2005;115(10):2598–608.
37. Soucie JM, Thun MJ, Coates RJ, McClellan W, Austin H. Demographic and geographic variability of kidney stones in the United States. Kidney Int. 1994;46(3):893–9.
38. Parks JH, Coe FL. Evidence for durable kidney stone prevention over several decades. BJU Int. 2009;103(9):1238–46.
39. *Asplin J.R. Neglected analytes in the 24-h urine: Ammonium and sulfate. Curr. Opin. Nephrol. Hypertens. 2021;31:168–174.*
40. KyriakiStamatelou et al. Epidemiology of Kidney Stones. Healthcare (Basel). 2023 Feb 2;11(3):424