Original Article

Prevalence and characterization of urolithiasis in the Western region of Saudi Arabia

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Abstract

Objectives: The main objective of this study is to determine the prevalence and risk factors of urolithiasis among the Saudi population in Makkah region.

Methods: A cross-sectional survey was conducted on February 2017 in Makkah region (Makkah, Jeddah, and Taif). Data were obtained through direct interviews with participants, using an 18-questions-self-questionnaire, inquiring about demographic data (age, gender, weight, height, location, and occupation), educational level, history of renal stone disease (symptoms, modality of diagnosis, hospital admission, and previous treatment), and risk factors of stone formation such as family history and daily fluid intake.

Results: A total of 1506 individuals were interviewed, including 82% from Makkah, 15.7% from Jeddah, and only 2.3% from Taif. The overall percentage of those diagnosed urolithiasis was 6.2%; including 6.6% males and 5.8% females ($P = 0.06$). Of those with stones, 5% were medically treated, 1.7% were hospitalized, and 1.2% were surgically managed for stones. There was a positive linear correlation between the prevalence of stones and participants' age group ($r = 0.87$, $P = 0.01$). More than 80% of participants were highly educated, which did not impact the prevalence of stones formation ($P = 0.14$). Urolithiasis was reported by 8.9% obese participants, 5.9% overweight, and 5.4% with normal body mass index ($r = 0.68$, $P = 0.03$). When stratified by jobs, stone prevalence significantly increased in retired participants (17.2%) than in workers (8.8%), followed by those without work (7.7%) and finally by students (3.3%) ($P < 0.001$). There was no significant difference between urolithiasis and type of drinking water ($P = 0.62$).

Conclusion: The prevalence of urolithiasis in the Western region of Saudi Arabia has not changed much since the previous report, which was 30 years ago. It seems that the middle-aged population in their third decade of life, those who are overweight and obese people are at a high risk of developing urolithiasis.

Keywords: Prevalence, risk factors, Saudi Arabia, stones

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INTRODUCTION

Urolithiasis is a multifactorial globally recurrent disease, representing a significant health problem with a significant impact on the patients' quality of life. Prevalence increased by almost 70% over the last 15 years in different parts of the world,[1] with an annual and lifetime prevalence of approximately 3%–5% and 15%–25%, respectively. Recurrence rates have progressively increased from 10% after a year from the first stone episode to 50% over 5–10 years and 75% over 20 years,[2] with an overall 25% recurrence of stone formation.[3] In addition,

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patients with urolithiasis are consequentially exposed to significant cumulative effects of ionizing radiation due to repeated imaging studies throughout management, which is unfortunately resulting in hazardous effects.

Stone formation is a multifactorial disease, involving environmental and metabolic factors, especially in males between 30 and 60 years old. For example, the Eastern Saudi region has an extremely hot climate during summer, resulting in a population prone to developing urolithiasis, the calculated annual incidence of urolithiasis was 111/100,000 individuals, where calcium oxalate stones accounted for about 70%–75% followed by uric acid (12.7%) and other stones (10%).[4] Thus, Saudis are 2.5 times more likely to develop urolithiasis, especially in hot regions.[5] Screening and evaluation of well-defined samples of an unselected population are of a major importance to appropriately detect regional variation regarding the incidence of urolithiasis, with its possible etiological implications.

Data from the National Health and Nutrition Examination Survey revealed a three-fold increase in the self-reported prevalence of kidney stones in the United States, from 3.2% to 8.8% in the period of 1976–1980 to 2007–2010.[6] A similar trend in the prevalence of kidney stones was reported in the United Kingdom, which increased by 7.14%–11.62% between 2000 and 2010.[7] Such increase in incidence of urolithiasis can be modified by addressing the epidemiology and risk factors responsible for its pathogenesis. Furthermore, cost-efficacy of renal stone prevention has been previously confirmed.[8] In the Western region of Saudi Arabia, the prevalence of urolithiasis has been previously reported as 8.1% in males and 4.0% in females, which progressively increased with age.[9] However, it was conducted about three decades ago, with no current updated data available. Therefore, the aim of the following study is to determine the prevalence and risk factors of urolithiasis among the Saudi population in Makkah region, including Makkah, Jeddah, and Taif.

METHODS

A cross-sectional survey was conducted on February 2017 among the Saudi general population in the Western Saudi region (Makkah, Jeddah, and Taif). Ages between 18 and 65 years were included, excluding non-Saudis and those living outside Makkah region.

Data were obtained through direct interviews with the participants, using a self-questionnaire which consisted of 18 questions (Appendix I), inquiring about demographic data (age, gender, weight, height, location, and occupation), educational level, history of renal stone disease (symptoms, modality of diagnosis, hospital admission, and previous treatment), and risk factors of stone formation such as family history and amount fluid intake per day.

The primary outcome was to determine the prevalence of urolithiasis among the Saudi population in the Makkah region. The secondary outcome was to assess the risk factors for stone formation in that population.

Statistical analysis

Data analyses were performed using the commercially available Statistical Package for the Social Science for Windows (SPSS, Chicago IL, USA) version 22. Depending on the normality of data distribution, descriptive data were presented in terms of numbers and percentages or means ± standard deviation or medians and ranges. Fisher's exact test was used to compare discrete variables, while continuous data were compared with the Student's *t*-test or Mann–Whitney test. A two-tailed $P < 0.05$ indicated significant differences between groups.

RESULTS

A total of 1506 surveys were collected by interviewing questionnaires, including 82% from Makkah, 15.7% from Jeddah, and only 2.3% from Taif. Fifty-five percent were females, while 51% were under the age of 25 years [Table 1]. Among those with history of stones 45% had abdominal or flank pain, 8.4% have painful urination, 3.3% reported gross hematuria, and 8.8% reported low urine output. Family history of urolithiasis was reported by 30.3% of participants.

The overall percentage of people who were diagnosed with urolithiasis was 6%, including 6.6% males and 5.8% females ($P = 0.06$). Compared to those with no history of stones, 43.1% of individuals with urolithiasis had abdominal pain ($P = 0.51$), 76.3% had flank pain ($P = 0.50$), 24.7% had hematuria ($P = 0.22$), 36.6% had painful urination ($P = 0.03$), and 33.3% had a small volume of urine ($P = 0.17$).

Table 1: Prevalence of urolithiasis stratified by age

Age group (years)	Total, *n* (%)	Diagnosed urolithiasis, *n* (%)	*P*
20-25	907 (60.0)	40 (4.4)	<0.001
26-30	195 (13.0)	9 (4.6)	
31-35	121 (8.0)	9 (7.4)	
36-40	102 (7.0)	10 (9.8)	
41-50	106 (7.0)	14 (13.2)	
51-65	75 (5.0)	11 (14.7)	
Total	1506 (100)	93 (6.2)	

In individuals who experienced urolithiasis, 1.3% had plain radiography, 1.4% had computed tomography imaging, and 3.3% underwent abdominal ultrasonography. Only 4.2% reported laboratory work-up and 1.7% were hospitalized for urolithiasis. Management of urolithiasis was either medical or surgical, 5% or 1.2%, respectively. There was an excellent positive linear correlation ($r = 0.87$, $P = 0.01$) between the prevalence of stones and participants' age group; as the age increased, the prevalence of urolithiasis increased [Figure 1].

More than 80% of participants were highly educated, either graduate (73.4%) or at higher education levels (7.2%), 15.8% had high school degree, while 3.7% had less than a high school education. Prevalence of stones were comparable among all groups (6% vs. 9.3% vs. 4.6% vs. 11%, $P = 0.14$), respectively.

Regarding body mass index (BMI), 44.6% of participants had normal BMI, while 48% were classified either overweight (27%) or obese (21%). Only 7.4% had below average BMI. Urolithiasis was reported by 8.9% obese participants, 5.9% overweight, 5.4% those with normal BMI, and by only 3.6% participants with low BMI ($r = 0.68$, $P = 0.03$) [Figure 2].

Most participants have jobs (48%), 26% were students, 21% do not have a fixed jobs, while 5% were retired or unemployed. When stratified by jobs, stone prevalence significantly increased with retirement or unemployment (17.2%) than workers (8.8%), those without fixed work (7.7%) and students (3.3%) ($P < 0.001$).

Most participants were drinking bottled water (71.4%), whereas 19.9% drink from water tanks and only 8.7% use other water sources. A total of 47% drink 3–8 cups/day, while 39% and 14% drink lower or higher amounts, respectively. There was no significant difference between urolithiasis and type of drinking water (6.1% vs. 7.0% vs. 4.6%, $P = 0.62$), respectively.

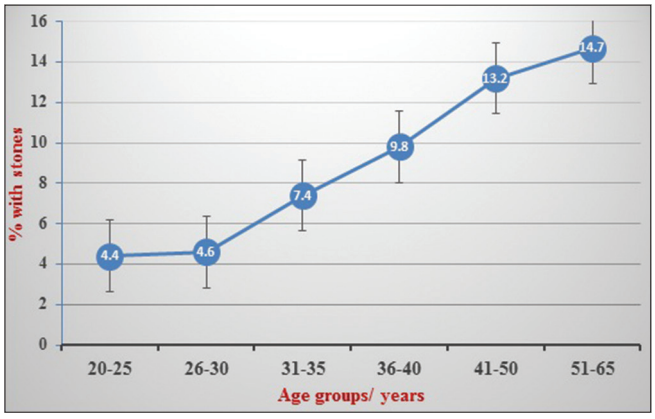

Figure 1: A positive linear correlation between increased prevalence of stones with increased age group

DISCUSSION

Urolithiasis is the most common worldwide urological problem, with an overall prevalence of 4%–20%.[10] The incidence of urinary stones varies widely among countries; therefore, screening specific populations is of utmost importance to determine the prevalence and regional variation of stones. Some authors identified "the stone-forming belt of the world" to include Egypt, Sudan, Saudi Arabia, Iran, United Arab Emirates, Philippines, India, Pakistan, Thailand, Myanmar, and Indonesia. In these regions, urolithiasis can be detected in all age groups, including child younger than 1-year and adults over 70-year-old.[11]

Compared to Western countries, the Gulf population consumes three-time higher oxalate and a 50% lower amount of calcium, consequently increasing the average intestinal oxalate/calcium ratio up to five to six times. The resulting enteric hyperoxaluria would thus increase the risk of calcium-oxalate stone formation.

Various aspects of urolithiasis and stone composition have been addressed previously in different regions of Saudi Arabia. Calcium oxalate stones were the most common stone composition, followed by uric acid and mixed and phosphate stones.[4,5] In addition, the risk of stone formation in the Gulf region is accentuated by the hot and dry climate, which decreases urine volume. Furthermore, there is a high intake of animal protein. These factors result in an increased urinary pH, with a consequent decrease in citrate excretion.[12] High purine intake, hyperuricosuria, and the acidic urine also increase the incidence of uric acid-forming stones in this region.

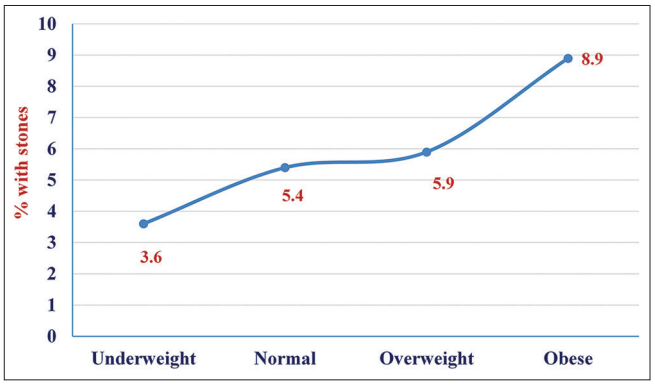

Figure 2: Prevalence of urolithiasis stratified by body mass index

The present study has been conducted in the Western region of Saudi Arabia and has included 1506 Saudi individuals. The prevalence of renal stones was 6%, including 6.6% males and 5.8% females, which was comparable to that previously reported in the same region about three decades ago; 8.1% in males and 4.0% in females.[9] It seems that the decreased percentage of men affected by stones may be due to increased awareness regarding stone disease prevention and changes in dietary and lifestyle habits. Most of our participants with urolithiasis were male and younger than 35 years, with a family history of renal stones, highlighting the risk factors in developing urinary stones, as previously reported.[4,5]

Obesity has been considered as a risk factor for calcium oxalate and uric acid urolithiasis.[13] About 14.8% of obese individuals reported urolithiasis versus only 5.4% of those with normal BMI, with a good correlation between BMI and stone formation. Some authors found that 36.9% of the Saudi population are overweight, and males were more significantly affected than females (42.4% vs. 31.8%).[14] Nearly half of our participants were obese or overweight and living in a hot and dry climate, and this consequently resulted in lower urine volumes and change in urinary pH. With the following factors considered, a dual prominent impact on stone formation is expected. In a recent systematic review of literature, researchers confirmed a worldwide trend of increased incidence of renal colic in warmer months and higher ambient temperature.[15] Similarly, increased renal colic presentations during the hot summer was reported in the Western region of Saudi Arabia.[16] Furthermore, most stoneformers in a study conducted on 347 Saudi individuals were obese or overweight.[4]

Despite being statistically insignificant, the highest level of stone formation was detected in those with the lowest level of education. This may be due to increased awareness of highly educated personnel regarding stone disease prevention and changes in dietary and lifestyle practices. In the present study, stone prevalence significantly increased in retired, unemployed participants than workers and those without fixed job. Unemployment may contribute to a stressed living condition, and a correlation between stress and kidney stones has been established.[17] In the latter study, the authors found that elevated stress in patients with urolithiasis may enhance the presence of symptoms and lead to passage of two or more stones per year.

Adequate amount of water intake seems to be crucial and has a great effect to decrease the risk of urinary saturation, and subsequently, stone formation and stone recurrence can be prevented by urinary volumes exceeding 2–2.5 L daily.[18] Of interest, despite being used by >70% of our participants, bottled water with its higher amounts of minerals did not influence stone formation in the current cohort. The impact of water quality on the risk for stone formation is controversial, and there are a sparse number of studies which addressed the relationship between water quality and urinary stone formation. While water hardness did not significantly influence the regional incidence of urolithiasis in several studies,[19-21] the intake of hard water increased the chance of stone formation in another study, by increasing urinary calcium concentration of about 50%.[22] Mitra *et al.* in a recent study found that it the quantity of water consumed rather than the quality of water that matters most in urinary stone formation.[23] Nevertheless, drinking hard water should be avoided in all individuals and is preferable to be replaced by tap water or low calcium content water.

Several limitations to the current study should be addressed, including recall bias in recounting episodes of symptomatic urolithiasis. Data were collected through self-reporting, with no available imaging studies or stone analyses for corroboration. Moreover, the large number of young participants may possibly underestimate the prevalence of symptomatic urolithiasis in the evaluated region, as the age showed positive correlation with the prevalence of urolithiasis. In addition, generalizability of the current results is reduced, and other risk factors of symptomatic urolithiasis were not evaluated in the present survey. Furthermore, uneven distribution of the study population over the three main cities of the Western region may impact the true prevalence of stones in this area. Nevertheless, the present study updated the current prevalence of urolithiasis in the region of study and included a large population, who were directly interviewed. Larger study, including different regions in Saudi Arabia, is strongly recommended to confirm the finding, identify other possible risk factors, and further work on management and preventive measures.

CONCLUSION

The prevalence of urolithiasis in the Western region of Saudi Arabia has not changed much over the last three decades. It seems that several factors can influence the development of urolithiasis, including the middle-aged population, overweight and obese people. It is crucial to support and facilitate awareness campaigns and programs that address the importance of drinking adequate amounts of healthy water daily.

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Conflicts of interest

There are no conflicts of interest.

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APPENDIX

Appendix I

1. **Gender:** [--] Male [---] Female
2. **Age: -**--------years **Weight:** ---------- kg **Height: -**---------- cm
3. **City: [--]** Makkah **[--]** Taif **[--]** Jeddah **[--]** Others:**----------**
4. **Education: -**----------
5. **Occupation:** ----------
6. **Have you ever suffered from any renal disease?** [--] Yes [--] No
   If yes, what is it? -----------

7. **Did you experience any of the symptoms below?** (you can choose more than one)**:**
   [--] Pain in the abdomen. [--] Pain in the flanks. [--] Frequent urination.
   [--] Painful urination. [--] Urination of small amount of urine.
   [--] Blood in urine. [--] Nausea and vomiting.

8. **Have you ever been diagnosed with renal stones?** [--] Yes [--] No
   If yes, you were diagnosed using what?
   [--] Urine/blood analysis
   [--] Plain X-ray
   [--] CT scan
   [--] Ultrasound
   [--] Other: ----------

9. **Have you ever been admitted to the hospital because of renal stones?**
   [--] Yes [--] No

10. **Have you gotten treated from renal stone before?** [--] Yes [--] No
    If yes, how was it treated? [--] Medications [--] Surgery

11. **Do you have any family history of renal stones?** [--] Yes [--] No
12. **What's the amount of water that you drink per day?**
    [--] Between 1-3 cups
    [--] Between 3-8 cups
    [--] More than 8 cups

13. **What's the type of water that you drink?**
    [--] Bottled water
    [--] Water tanks suitable for drinking.
    [--] Others: ----------

Thank you for your participation