



## Risk factors and chemical composition of urolithiasis as seen at Saint Francis Referral Hospital and medical teaching Hospital Morogoro-Tanzania

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### Abstract

**Background:** Urinary Stone Disease also known as urolithiasis affects mankind worldwide which has been rarely reported in African population. However, seems to increase as the increase of population growth. Change of life style and dietary habits in African population, effects of climate change and advancement of diagnostic facilities in most countries may contributory factor for increased reported cases.

**Methods:** This was 1-year descriptive analytical cross-sectional hospital-based study, conducted from June 2023 to May 2024 by using structured data collection tool, laboratory results and X-Ray Inflorescence stone chemical analysis. Data analysis was done by using SPSS software 26 version.

**Results:** A total of 938 patients were admitted in urology department during 12months the study period of which 5.22% were diagnosed to have urinary tract stones. Majority of participants were male 81.63% and female accounted for 18.37% making M: F 5.4:1. The commonest urinary stone location was urinary bladder accounting for 46.94%. The majority of patients 97.94% had calcium as the main mineral component in the stones. The most common type of calcium stone was Calcium phosphate 29% of all cases in this study.

**Conclusion:** Compared to western countries, in our setup, urolithiasis affected persons of low socioeconomic status whereby urinary bladder stones were the most common.

**Keywords:** Urolithiasis; Bladder stone; Dehydration; Physical workers; Chemical composition; Calcium-based stone

### 1. Introduction

Urolithiasis may be defined as calculus material at any level in the urinary tract, [i.e. the kidney, ureter, urinary bladder and urethra] (1,2). It is a progressive process in the urinary tract causing often causing pain. However, in most cases it is asymptomatic for years(3) and hence diagnosed incidentally. The peak age for men is 40-60 years and for women is 35 and 55 years(4,5). Adult men are affected 2-3 times more than women(6,7). In USA white men are more affected, followed by Hispanics, Asians, and African-Americans(3,8). The risk of urolithiasis is 2.5 times greater in individuals with a family history urologic stone(2,5,9). The recent study report that urolithiasis prevalence in Sub Saharan region to range from 1.0% to 30.0%(10). Individuals working and living in a hot environment appear to be at higher risk for stone formation(1,5,7,11). The common complications of urolithiasis include recurrent urinary tract infection, urine retention and urologic malignancy due to chronic mucosal irritation which may result into mucosal metaplasia and hyperplasia, ultimately bladder cancer(12). There is limited data availability in low income resources including

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particularly in Tanzania. This study aimed to evaluate the risk factors and chemical composition urologic stone disease in Tanzania.

## 2. Methodology

### 2.1. Study design

The descriptive analytical cross-sectional study was conducted at Saint Francis referral Hospital at Ifakara, Morogoro Tanzania. The study was a hospital based that aimed to evaluated prevalence, risk factors and chemical composition of urinary stones of all patients who meet the criteria and were diagnosed to have urolithiasis attended from June 2023 to May 2024.

### 2.2. Inclusion and exclusion criteria

All patients diagnosed with urolithiasis signed for the consent willingly were included in the study.

### 2.3. Data collection

The study included 938 patients, aged with median age 53 years, who underwent biochemical urinary stone analysis in the urology department at Saint Francis Referral and medical school teaching hospital. The study was conducted between June 2023 to June 2024. Our hospital is the sole center in Morogoro for urological specialized care hence most of the patients were referred from district hospitals. In most cases the patient came due to nonspecific symptoms depending on the stone location. Treatment modalities was operative approach hence; all patients were admitted. Preoperative indications depended on the ultrasound, X-ray and Computed Tomography Scan (CT-scan) findings, Open or endoscopic surgery were performed depending on location of the stone.

### 2.4. Stone processing

Chemical composition analysis was done at Geological Survey of Tanzania (GST) chemical laboratory in Dodoma using X-Ray Inflorescence pressed powder without binder method.

### 2.5. Statistical Analyses

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software version 26.0.

### 2.6. Ethical issues

All ethical issues on human health research protocols were followed considerably. Hence, Ethical clearance was obtained from Saint Francis University internal reviewer board (IRB). All patients' particulars and information were confidentially protected.

## 3. Results

**Table 1** Social demographic characteristics of patients (n=49)

| Variable   |                               | Frequency+ percent (N+%) |
|------------|-------------------------------|--------------------------|
| Sex        | Male                          | 40 (81.63)               |
|            | Female                        | 9 (18.36)                |
| Race       | African                       | 48 (98.00)               |
|            | Asian                         | 1 (2.04)                 |
| occupation | sedentary                     | 7(14.29)                 |
|            | Peasants and Casual labourers | 31 (63.27)               |
|            | Long distance walk            | 10 (20.41)               |
|            | Professionals (employed)      | 1 (2.04)                 |

Out 938 patients who were admitted in the urology department with various diagnoses. Forty-nine patients were diagnosed with urinary stone disease accounting for 5.22%. Majority of patients with urolithiasis were male 81.63% (40) and females 18.37% (9) making 4:1 male to female ratio. Most of them were peasants and semiskilled laborers 63.27% (31), black Africans by race 98.0% (48) as it is summarized in table 1 below.

Life style particularly low water intake <1lt/day accounted for 63.27% together with addition of table salt during meal accounted for 83.67%.

**Table 2** Suspected predisposing factors for urinary stone disease

| Risk Factor                                   | Value         | Frequency(N) | Percent (%) |
|-----------------------------------------------|---------------|--------------|-------------|
| Water intake                                  | <1 litre      | 38           | 77.55       |
|                                               | 1-2 litres    | 7            | 14.29       |
|                                               | 2-3 litres    | 1            | 2.04        |
|                                               | >3 litres     | 3            | 6.12        |
| Family history of urinary stones              | Yes           | 2            | 4.08        |
|                                               | No            | 47           | 95.92       |
| Previous history of USD                       | Yes           | 7            | 14.29       |
|                                               | No            | 42           | 85.71       |
| History of antibiotic use during this illness | Yes           | 45           | 91.83       |
|                                               | No            | 4            | 8.16        |
| Body Mass Index                               | Obese         | 9            | 18.36       |
|                                               | Overweight    | 5            | 10.20       |
|                                               | Normal weight | 15           | 30.61       |
|                                               | Underweight   | 20           | 20.82       |
| Addition of salt table                        | Yes No        | 41           | 83.67       |
|                                               | No            | 8            | 16.32       |

**Table 3** Chemical composition of urinary stones

| Type of urinary stones    | Number (N+%) | Components of urinary stones | Frequencyand percent (N+%) |
|---------------------------|--------------|------------------------------|----------------------------|
| Calcium containing stones | 48(98%)      | Calcium phosphate            | 14(28.57)                  |
|                           |              | Calcium sodium Oxalate       | 11(22.45)                  |
|                           |              | Calcium phosphor-silicate    | 9(18.37)                   |
|                           |              | Calcium phosphor-sodium      | 4(8.16)                    |
|                           |              | Calcium phosphor-magnesium   | 4(8.16)                    |
|                           |              | Calcium silicate             | 2(4.10)                    |
|                           |              | Calcium magnesium crystals   | 2(4.10)                    |
|                           |              | Calcium potassium            | 1(2.04)                    |
|                           |              | Calcium Ferrous crystals     | 1(2.04)                    |
| Magnesium phosphate       | 1(2.04)      |                              |                            |

About a half of the patients 46.93% (23) had urinary bladder stones followed by renal pelvis 26.53% (13). Other areas included ureter 16.34% (8), renal stone 6.12% (3) and urethra 4.08% (2). The majority of patients 98.0% (48) had

calcium as the main mineral component in the stones. The most common type of calcium stone was Calcium phosphate 28.57% (14). Others are summarized in Table 3 below.

#### 4. Discussion

The prevalence of urolithiasis in this study was 5.22%. It has been reported in literature that prevalence of urolithiasis range between 1.0%-30% in sub Sharan African countries(10), but in some literature the prevalence has been reported to range between 2.2% to 68.7% (6). In Tanzania no recent data available on that aspect. This condition limit estimation of the effect within the country. The findings in this study are lower to what was reported by Scales *et al* (2023) whose finding revealed 8.8% of urinary stone(8). The median age 53 years of patients in this study was slightly higher in Nairobi Ngugi *et al*, who reported median age of participants to be 45 years(4). Ostudies reported high prevalence of urolithiasis in age between 40 to 60 include Muhamoud *et al* and others(13). However, the findings are contrary to what has been reported by Alkhunaizi Saud Arabia who reported the mean age of 48.5 years(7).

In elderly male urolithiasis can emerge after bladder outlet obstruction due to prostate enlargement, urethral strictures and other urinary tract co-morbidities(11,14). In this study, majority of patients were male accounting for 81.16% (40), hence giving 4:1 male to female ratio. It is lower to what was reported by Khan *et al* whose study found the M:f to be as high as 5:1 in Saud Arabia(1), while Lakshmi *et al* found male to female ratio of 8:1(1).

Most of the patients were peasants and semiskilled laborers 63.27% (31). The findings become similar to what was reported by Lakshmi *et al*, 85.7% patient with urolithiasis were casual labors and physical work group(1). People working outdoors and those who are exposed to high temperatures are at two times high of having urolithiasis(1), reason is that, they are likely to be on dehydration status with less water drinking habit(1,5,11). Furthermore, excessive exposure to sunlight results in more production of vitamin D and this after conversion to 1,25-dihydroxy-vitamin D in kidneys, can promote calcium absorption in the gut which signifies why high calcium component in this study was significantly high 98,0%(1,11). However, renal stone is mostly associated with executives people with sedentary life style(1,15).

Most of the patients 78% (38), had history of taking less than one liter of water per day of which 92% (35) of cases had urolithiasis. This align with what has been reported in various literature including another cross-sectional study done by Konjengbam and Meitei who found that high intake of water has preventive effect on urolithiasis(15). But also other literatures have been documented on the link between low water intake and urolithiasis(1,10,11,15,16). It has been reported that regions with hard water, hot to humidity climate are at high risk of having urolithiasis(1,2,5), dehydration and concentrating urine also promote stone formation, especially uric acid (UA) stones(5,9,17). Dietary habits and low water intake influencing stone composition by increasing urine concentration during hotter periods(1,11,15,18). These factors can be modified by life modification as a prevention of urolithiasis formation(3,15).

Forty-one patients 84% with urolithiasis in this study reported adding table salt to their food at table. The association of high dietary sodium intake with increased urinary calcium crystallization is based on tendency of sodium to increase urinary calcium and urinary pH while lowering urinary citrate(1,2,6,9,19). This signifies why there was high calcium-based stones of study findings. Nicolcar *et al*, in his control trial study reported that, excessive consumption of sodium was observed in both studies to be one on the significant risk factor for urolithiasis(20). But also Ghuran (2009) elaborated the association between nutrients and urolithiasis including animal protein which increase calcium and UA excretion, hence the increase of stone formation(1,9,15,19). A high sodium intake increases the risk of stone while potassium supplement decreases calcium secretion therefore decreasing stone formation(15). On the other hand, low sodium intake and hydration have been reported to be protective from urolithiasis(2,3,8,17,20). The current study could not measure the amount of sodium in patients as it was beyond the scope of the study; however, the study imply that restriction in excessive sodium intake and adequate daily water drinks are two simple preventive measures against urinary stones.

Most of the patients 95.91% in this study had bladder stones while patients with renal pelvis and ureter stones were 27% and 16% respectively. The study findings align with Zhang *et al* whose study reported high bladder stone incidence by 19.3% of all cases(6). Kassaw *et al* indicated bladder stone to be second to renal stone(10). This gives analysis on significant distribution of bladder stone in most population societies. In a study by Ngugi *et al*, renal pelvis was reported to be the commonest(4). Prostatic hyperplasia, which is considered a frequent cause of bladder outlet obstruction, is frequent in old men and could be a possible explanation for the high frequency of bladder stones in this study(11). Still changes in bladder function associated with relaxation of smooth muscle tonicity in the elderly, reducing the efficiency of bladder emptying and promoting urine stasis may explain the frequency of bladder stones(3,5,10). Taking into consideration that urolithiasis can complicate into malignant due to prolonged bladder mucosal irritation as stated by

Karuhanga *et al* which ultimately result into metaplasia and hyperplasia and finally into malignancy(12), hence early bladder stone diagnosis and management may reduce further complications which may be associated with poor prognosis. In other studies, urinary stones are mainly located in the upper urinary tract including kidney and ureter stones while the proportion of bladder calculi does not exceed 10.0%(4,10) therefore, findings in this study explain local characteristics of urolithiasis at SFRH. This finding represents significantly the general condition on urolithiasis in the other areas within the country. However, this gives an alert for regular screening for urolithiasis. There are several mechanism which can be used for problem estimation including, massive sonographic screening use of hair and urine composition method(17). In advancement of medical care and diagnostic modalities, urolithiasis screening is a point to be put into national practice to improve urinary tract system health among the population.

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## 5. Conclusion

Compared to western countries, in our setup urolithiasis affects persons of low socio-economic society. Reduced water intake, physical labor, addition of salt to food at table have been observed to contribute to urolithiasis incidence. Presence of calcium-based stone in majority of extracted urinary stones needs metabolic evaluation in all patients for preventive purposes hence another long-term cohort study is recommended study.

### *Study limitations*

The study period was short and hence small number of patients in the study group.

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## Compliance with ethical standards

### *Acknowledgments*

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### *Disclosure of conflict of interest*

No competing interests to the authors.

### *Statement of ethical approval*

Ethical clearance approval was obtained from SFUCHAS Internal reviewer board. However, all ethical guidelines were effectively followed. The individual names were replaced by numbers to keep individual confidentiality.

### *Statement of informed consent*

Informed consents were signed willingly by all individual participants included in the study.

### *Authors Contribution*

Idea generation; AM and MM. Data curation; AM and TK. Formal analysis; PM. Methodology; AM and MM. Software; PM. Writing original draft; TK. Writing review and editing; PM. All authors contributed to the article and approved the submitted version.

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