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An assessment of kidney stone composition and risk factors: Matched case-control study at Orotta referral hospital in Asmara, Eritrea

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Abstract
Background: Nephrolithiasis, commonly called kidney stones, is a growing pandemic. In industrialised countries, it is estimated that prevalence ranges between 4% and 20%. The aetiology and pathogenesis of nephrolithiasis is complex and multifactorial. Despite of these facts, limited information is available on a range of factors concerning the condition in sub-Saharan Africa. On consideration of several factors including climatic conditions and the number of positive diagnosis of kidney stones at the main referral laboratory (an average of 15 cases per day); it can be asserted that nephrolithiasis is a significant problem in the country Eritrea.
Objective: The aim of this study was to evaluate kidney stone composition and potential risk factors in patients presenting with nephrolithiasis at Orotta Referral Hospital.
Methods and Materials: This was a cross-sectional matched case-control study. The study cohort consisted of 154 nephrolithiasis patients, meeting a pre-set criterion. Presence of kidney stones was confirmed using renal ultrasonography or plain abdominal radiography. The control group consisted of 154 respondents, with no kidney stone, matched for sex and region of residence. Urine samples were collected from individuals with kidney stone for microscopic analysis of stone composition. Dietary and other risk factors for kidney stone were evaluated using an interviewer administered questionnaire with a non-standardised component and a standardised Food Frequency Component.
Results: Microscopic analysis of urine samples indicated that Calcium oxalate (51.7%) was the most common stone type. Uric acid (21.7%), amorphous urate (13.3%) and amorphous phosphate (3.3%) were also indicated. In the multivariate logistic analysis, the data indicates that risk factors for nephrolithiasis included: family members with kidney stone (OR =0.414, 95% CI =0.046-434, p =0.001); previous residency in the hot regions of the country (OR =0.419, 95% CI =0.199-883, p =0.022); daily consumption of green vegetables (OR =0.054, 95% CI =0.016-0.183, p =0.000); Intake of less than 1 litres if water a day (OR =0.396, 95% CI =0164-0.958, p =0.04) and working as a labourer (OR =0.345, 95% CI =0.152-0.782, p =0.011).
Conclusions: Based on the study results, it can be concluded that calcium oxalate is the most common type of kidney stone. The risk factors include infrequent intake of water, daily consumption of green leafy vegetable, hard labor, living in hot environment and family members with kidney stone.

Keywords: Risk factors for Nephrolithiasis, Lithogenesis, Hypercalciuria, Stone Type, Orotta Referral Hospital, Eritrea

Introduction
Nephrolithiasis, commonly called kidney stones, is a growing pandemic. Worldwide, the life time prevalence of symptomatic nephrolithiasis is- 10% in men and 5% in women [1]. In industrialised countries, it is estimated that prevalence ranges between 4% and 20% [2]. Recently, studies relying on computer models predicted a significant, global warming-related, increase in prevalence and associated health-care expenditures in the next half a century [3].
The etiology and pathogenesis of nephrolithiasis is complex and multifactorial and include low urine volume, hypercalciuria, hyperoxaluria, hyperuricosuria, hypocitraturia and abnormalities in urinary p^H [4]. Physico-chemical elucidation of lithogenesis implicates urine super-saturation and mineral precipitation of stone-forming salts. Subsequent aggregation and agglomeration of precipitates may lead to the formation of large-sized structures/stones overtime.

Implied in the proposition highlighted above is the fact that stone composition: mostly calcium oxalate (CaOx), calcium phosphate, uric acid, struvite and cystine; and risk factors are linked [5]. Epidemiological studies have implicated several modifiable risk factors including increased higher dietary sodium intake [6], high calcium intake-especially in patients with absorptive hypercalciuria [7] obesity [8] Dyslipidemia [9] low dietary intake of fiber, fruit and vegetables [10] high oxalate/low calcium intake [1] dehydration and hot ambient temperatures/hot climates [11] genetic predisposition [12, 13] among others. The condition has also been linked to several comorbidities including chronic kidney disease (CKD), nephrolithiasis-induced bone pathology; coronary artery disease (CAD), hypertension, diabetes mellitus [14] and the metabolic syndrome [15].

In spite the fact that kidney stone is currently recognised as a growing pandemic, limited information is available on a range of factors concerning the condition in sub-Saharan Africa. However, a consideration of several factors including climatic conditions and the number of positive diagnosis of kidney stones at the main referral laboratory (an average of 15 cases per day); it can be asserted that nephrolithiasis is a significant problem in the country Eritrea. Moreover, little is known about the relationship between specific modifiable dietary risk factors to nephrolithiasis. Therefore, we sought to improve the current understanding of nephrolithiasis in Eritrea with this hospital-based study. The primary goal was to provide a preliminary report on stone composition and identify possible risk factors. These goals are informed by a duel consensus. That, nephrolithiasis, it must be emphasised, is a compound word describing a pathological condition involving multiple stone types with disparate etiology, pathogenesis and intersecting and, at times, non-intersecting risk profiles. As such, stone composition is diagnostic and can help in patient profiling, prediction of change in renal function and treatment [16]. Second, that medical therapy, prevention of recurrence and public health efforts can be informed by knowledge of stone composition and modifiable risk factors.

Materials and Methods

Study Design

This is was a cross sectional matched case-control study conducted from February 20-May 18, 2016 at Orotta Referral Hospital, Asmara, Eritrea.

Setting and Study Location

The study was carried out at Orotta Referral Hospital (ORH) Laboratory which serves the Urology department. The hospital draws its patients from the six administrative regions of the country. These regions represent the disparate climate zones, namely, the hot, dry desert strip along Red Sea coast (North Red Sea-and South Red Sea); relatively cool and wet central highlands (Maakel) and the semi-arid western hills (Gash-Barka and Anseba) and lowlands.

Study Population

After obtaining Institutional Review Board approval, patients with kidney stones meeting a pre-set criterion were enrolled throughout the duration of the study. Presence of kidney stones was confirmed using renal ultrasonography or plain abdominal radiography. All imaging studies were carried out by a single experienced radiologist to avoid inter-observer bias.

Children <8 years old; patients with catheters; pregnant women; patients with psychological abnormalities were excluded. A total of 154 cases were identified. The control group consisted of 154 respondents matched for sex and region of residence. The controls were recruited from patients who had no kidney stone or history of kidney stone. The absence of kidney stone was confirmed by ultrasonography as described above.

Data Collection

Clinical and Laboratory Data

First morning urine samples were taken from participants who had kidney stone after diagnosis by ultrasound in Orotta referral hospital. The size and location of the stone was recorded after the diagnosis by ultrasound. Microscopic evaluation was used to characterize stone composition. Additional data was extracted from the patient's records at the urinalysis department laboratory.

Dietary and Other Risk Factors

The survey included specific demographic, laboratory and health measures. Data was collected using an interviewer administered questionnaire with a non-standardised component and a standardised Food Frequency Component. The questionnaire was interpreted by a linguist to Tigrigna (the local language). The information on the questionnaire included: Sex, age, educational level, Occupation, region of residence, previous case of Kidney Stone; history of Kidney stone in the family and comorbidities.

Dietary items assessed included animal protein, citric fruits, non-citric fruit, green leafy vegetables, non-green leafy vegetables, alcoholic drinks. The response categories for these items ranged from daily, weekly to rarely (1time per day =Daily; 2 to 3 times =weekly; less than once a month =rarely. Similarly, source of drinking water and frequency of drinking water was evaluated. The scheme employed to categorise the frequency of drinking water was as follows: 1=<1 litre, 2=1-2 litres and 3>2 litres.

Laboratory Analysis of Samples

Urine Sampling

Urine specimen was collected for urinalysis. The participants were advised not to pee or drink water before sampling in the morning. Patients with negative results after microscopic evaluation of urine were advised to re-submit additional samples for analysis after one week.

Urinalysis

Bright-field-light microscopes was used to identify the type of crystals. The stones were classified into five groups, namely, calcium oxalate, Uric acid crystals, amorphous urate crystals, amorphous phosphate crystals and calcium oxalate mixed with uric acid stones. Multistix reagent strips were also used to determine the chemical nature of the urine like pH, nitrite, specific gravity, among others.

Statistical Analysis

All statistical analyses were carried out using SPSS Software version 20.0 (IBM, New York, NY, USA). Responses in the questionnaires were tabulated, coded and processed. Analysis of kidney stone composition was limited to 120 participants in whom stone composition could be verified microscopically. Intergroup comparisons

of relevant variables between cases and controls were analyzed using cross tabulations. Chi squire (χ^2) tests were subsequently conducted to evaluate the statistical significance. To estimate the association of demographic, dietary factors and clinical variables with kidney stones in cases and controls, logistic regression was used to obtain odds ratios for various exposures. In all cases, results were considered as statistically significant if the p value is <0.05.

Results

A total of 154 patients with kidney stone provided urine for analysis but only 120 cases could be graded. Positive results for kidney stone composition were only possible after evaluation of multiple samples in some patients. However, the questionnaire was completed by 308 individuals, 154 patients and 154 individuals in the control group.

Demographic characteristics of nephrolithiasis patients and controls

The mean age of patients with nephrolithiasis and those in the control group was 35.21±13.7 and 31.07±15.6 respectively. The patients' age ranged from 8 to 75. Disaggregation of the data into specific age ranges indicates that 14 of the cases were below 18 years of age; 64 were 19-35 years; 69 were 36-60 years and 5 were above 60 years of age. Analysis of educational levels shows that 48 of the individuals with nephrolithiasis had elementary & junior educational level, 62 had secondary level of education, 34 had post-secondary and 8 were had no formal education. Similarly, 70 individuals with Renal calculi were either residents/or had resided in hot regions of the country for an extended duration (Table 1)

In this study, participants with nephrolithiasis were statistically different from controls in terms of nephrolithiasis in family members, occupation and previous or current residency in hot parts of the country (Table 4). Compared to controls, patients with nephrolithiasis were mostly laborers (65.4%). Similarly, a significant proportion (28%) of patients with nephrolithiasis noted that they had family member with nephrolithiasis (p=0.000). Similarly, the proportion of patient with nephrolithiasis who had lived previously in hot parts of the country was high, 73.7% cases compared to 26.3%.

Table 1: Demographic characteristics of nephrolithiasis patients and controls

Demographic data		Frequency		Percentage (%)	
		Case	Control	Case	Control
Age	<18	14	35	28.6	71.4
	19-35	64	75	46	54
	36-60	69	35	66.3	33.7
	>60	5	9	35.7	64.3
Educational level	Elementary & junior	48	39	55.2	44.8
	High School	62	35	63.9	36.1
	Post-secondary	34	43	44.2	55.8
	Uneducated	8	27	22.9	77.1
Occupation	Labourer	51	27	65.4	34.6
	Office worker	44	37	54.3	45.7
	Unemployed	57	90	38.8	61.2
Residence in hot weather Region Region of Residence	Yes	70	25	74	26
	No	82	129	39	61.1
	Central	113	114	74.30	74.4
	Southern	20	22	13.20	12.3
	Anseba	3	14	1.97	7.8
	Gash barka	7	6	4.61	3.3
	Northern Red Sea	9	4	5.92	2.2

Renal Stone Composition

Analysis of stone composition indicated that 62 (51.7%) of the patients had calcium oxalate crystals; 26 (21.7%) of the patients had uric acid crystals; 16 (13.3%) had amorphous urate crystals; 4 (3.3%) had amorphous phosphate crystals and 12 presented with mixed Calcium Oxalate & Uric acid crystals (Table 2).

Table 2: Renal Stone Composition

Types of Crystals	Frequency	Percent (%)	Cumulative %
Calcium Oxalate crystals	62	51.7	51.7
Uric acid crystals	26	21.7	73.4
Amorphous urate crystals	16	13.3	86.7
Amorphous Phosphate crystals	4	3.3	90.0
Calcium Oxalate & Uric acid	12	10.0	100.0
Total	120	100.0	

Ultra Sound Results

Most of the stones were found in the right kidney in males (52.5%) and females (46.7%). Bilateral kidney stone in both sexes was rare, males 9.8% and females 13.3%. (Table 3). Subjects with 1-2mm sized stones were most prevalent in the left kidney (40.2%). In contrary, we observed a higher percentage of stones with more than 4mm size in the right kidney (66.9%). (Table 3)

Table 3: Ultrasound results of kidney stone patients N=136

A. Site of stone	Male N=61		Female N=75	
Right	32	52.5%	35	46.7%
Left	23	37.7%	30	40%
bilateral	6	9.8%	10	13.3%
B. Size of kidney stone (mm)	**Left Kidney (%) n=112**		**Right Kidney (%) n=118**	
1-2	40.2		28	
2-4	9		5.1	
More than 4	50.8		66.9	

Assessment of risk factors for nephrolithiasis

Occupation of the participants was grouped into three classifications. Out of the cases 51(33.6%) were manual workers, 44(28.9%) were office workers and 57(37.5%) were unemployed. Similarly 15(16.7%) of the controls were manual workers, 23(25.6%) were office workers and 52(57.8%) were unemployed. Here the p value of 0.004 indicates a significant association. From the cases most of the subjects 124(81.6%) had no kidney stone in their family members. 28(18.4%) of them, however, had family members with kidney stone. From the controls there were 5(5.6%) subjects that had and 84(94.4%) that did not have kidney stone in their family. And this association was found to be significant (p=0.03).

Thyroid and parathyroid diseases were found in 12(7.9%) of the cases while the rest 140(92.1%) didn't have that condition. Similarly 7(7.8%) of the controls had the same disease were as 83(92.2%). Although a slight difference was observed on the prevalence of thyroid and parathyroid diseases in kidney stone patients and controls, significant association was not found between thyroid diseases and the development of kidney stone (p=0.974). Regarding to climatic influences, 70(46.1%) of the kidney stone patients lived in hot areas for more than one year; some reside in those areas permanently. However only 15(16.7%) of those without the disease have ever lived for more than one year in hot area in their lifetime. This shows that there is statistically significant (p=0.06) difference between the patients and the controls in their life history of living in hot weathered areas.

Table 4: Risk factors for nephrolithiasis in patients presenting with the disease at Orotta Referral Hospital

Variables	**Status**	**Case**	**Control**	***p*-value**
Occupation	Labourer	51(65.4)	27(34.6)	0.004
	Office Worker	44(54.3)	37(45.7)	
	Unemployed	57(38.8)	90(61.2)	
Kidney stone in family members	Yes	28(82.4)	6(17.6)	0.000
	No	124(45.9)	146(54.1)	
Thyroid and parathyroid disease	Yes	12(50)	12(50)	0.571
	No	140(49.2)	142(50.4)	
Lived in hot weather	Yes	70(73.7)	25(26.3)	0.000
	No	82(38.9)	129(61.1)	

Dietary Factors and Risk of Nephrolithiasis

In our analysis, there was a significant difference between patients with nephrolithiasis and controls in terms of consumption of animal protein, green leafy vegetables, non-leafy vegetable and frequency of drinking water. In this study out of the total cases, 64(67.4%) consume animal proteins daily, 35(40.7%) weekly and 53(42.4%) rarely. The difference in animal protein consumption between cases and controls was significant (p=0.000).

Similarly, 60(92.3%) and 46(39%) of the patients with renal calculi noted that they consume green vegetables daily and weekly respectively. The remaining 53(42.4%) of cases indicated that they rarely consume green leafy vegetables. Evaluation of the consumption of non-green vegetables between cases and control yielded the following results: 34(89.5%) and 46(39%) of the patient's with renal calculi rated their consumption of non-green leafy vegetables in the daily and weekly category, respectively. The remaining 82 (46%) indicated that their consumption of non-green leafy vegetables is rare. A p-value =0.000 was observed between cases and control in the frequency of consumption of Green leafy vegetables and non-green leafy vegetables.

Frequency of water intake between cases and controls was grouped into three categories. According to the results obtained, frequency of water intake was 78(60.5%), 42(37.5%) and 33(50.8%) for respectively less than 1 litre, between 1 and 2 litres and above two litres respectively among patients cases. The observed p-value between cases and controls was 0.015. In this study, the observed frequencies in source of water and consumption of alcohol as comparative variables between cases and controls was not significant.

Table 5: Dietary Factors and Risk of Nephrolithiasis in patients presenting with the condition at Orotta Referral Hospital

Variables	Frequency	Case	Control	*p*-value
Animal protein	Daily	64(67.4)	31(32.6)	0.000
	Weekly	35(40.7)	51(59.3)	
	Rarely	53(42.4)	72(57.6)	
Green leafy vegetables	Daily	60(92.3)	5(7.7)	0.000
	Weekly	46(39)	72(47.8)	
	Rarely	46(37.4)	77(62.6)	
Non green leafy vegetables	Daily	34(89.5)	4(10.5)	0.000
	Weekly	36(40)	54(60)	
	Rarely	82(46.1)	96(53.9)	
Alcoholic drinks	Daily	6(75)	2(25)	0.347
	Weekly	13(50)	13(50)	
	Rarely	133(48.9)	139(51.1)	
Source of drinking water	Tap water	81(45.5)	97(54.5)	0.063
	Tank water	33(50)	33(50)	
	Mineral water	17(51.5)	16(48.5)	
	Salty water	21(72.4)	8(27.6)	
Frequency of drinking water	<1 liter	78(60.5)	51(39.5)	0.015
	1-2 liters	42(37.5)	70(62.5)	
	>2 liters	32(49.2)	33(50.8)	

Multivariate logistic regression analysis

An unadjusted multivariate logistic analysis was performed to identify independent risk factors of nephrolithiasis in patients presenting with the condition at Orotta Referral Hospital. To accomplish this, variables identified with p-value, less than 0.05 in the case-control cross-tabulation and subsequent analysis using Chi-squire were used in the multivariate analysis. Accordingly, in the multivariate logistic analysis individuals with family members with kidney stone were more likely to present with nephrolithiasis than those without (OR =0.414, 95% CI =0.046-434, *p* =0.001). Additional predisposing factors included previous residency in the hot regions of the country (OR =0.419, 95% CI =0.199-883, *p* =0.022); daily consumption of green vegetables (OR =0.054, 95% CI =0.016-0.183, *p* =0.000); Intake of less than 1 litres if water a day (OR =0.396, 95% CI =0164-0.958, *p* =0.04) and working as a labourer (OR =0.345, 95% CI =0.152-0.782, *p* =0.011) (Table 6).

Table 6: Multivariate logistic regression analyses predicting possible risk factors for nephrolithiasis at Orotta Referral Hospital, Asmara.

Risk Factors		*p*-Value	COR (95% C. I.)	*p*-Value	AOR (95% C. I)
Previous Case of Kidneys Stone	Yes		1		1
	No	0.000	0.028(0.006-0.139)	0.000	0.048 (0.014-0.171)
Lived in Hot Weather	Yes		1		1
	No	0.109	0.321(0.080-1.29)	0.018	0.245 (0.076-0.789)
Animal Proteins	Rarely	0.089	1		
	Weekly	0.920	0.927(0.210-4.09)		
	Daily	0.045	4.81(1.04-22.3)		
Green Vegetables	Rarely	0.144	1	0.033	1
	Weekly	0.052	0.118(0.014-1.02)	0.050	0.158 (0.025-1.00)
	Daily	0.746	0.772(0.161-3.697)	0.310	1.8 (0.579-5.56)
Non Green Vegetables	Rarely	0.102	1		
	Daily	0.923	1.126(0.10-12.71)		
	Weekly	0.035	6.597(1.14-38.29)		
Frequency of Water intake	>2 Litres	0.006		0.004	
	(<1 Litres	0.010	0.097(0.017-0.567)	0.005	0.11(0.023-0.511)
	(1-2 Litres)	0.774	1.262(0.258-6.17)	0.762	0.803 (0.193-3.34)
Age		0.789	1.009(0.945-1.077)		
Occupation	Labourer	0.953	1		
	Office worker	0.819	0.808(0.129-5.044)		
	Unemployed	0.764	0.801(0.188-3.411)		
Body Mass Index (BMI)		0.051	0.771(0.594-1.001)	0.046	0.824 (0.681-0.996)
Kidney Stone in Family Members	Yes		1		
	No	0.893	0.873(0.121-6.284)		

COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; C. I: Confidence Interval.

Discussion

Nephrolithiasis is a non-communicable disease with increasing incidence and prevalence worldwide [17]. Our analysis of stone types in this study indicated that CaOx was the most predominant crystal found in the urine samples (51.7%) with uric acid the second most predominant type of crystals found (21.7%). The high frequency of CaOx stones cuts across the age and sex spectra, with elevated frequency in middle aged men (36-60 years old) and decrease in the elderly(>60) similar to a study done in USA [18]. The relative frequency of various stone types in stone formers is similar to findings in several studies [18, 19].

In this study, we also evaluated the frequency of kidney stone recurrence in individuals with a previous history of nephrolithiasis. In this regard, our data indicated that 52% of the patients had a history of nephrolithiasis. Multivariate modelling of the results demonstrated that the likelihood of recurrence of kidney stone in those with a history of the condition is 17.8 as compared to individuals without a similar background. This result compares favourably to a previous study which reported that the likelihood of kidney stone recurrence is approximately 50% [20].

The current study also evaluated the presence of kidney stone in family members. Our data suggests that there is a significant association between kidney stone formation and the presence of kidney stone in family members. The reported association is in line with the conclusion in a seminal study by Curhan and collegues which averred that approximately 60% of the enhanced risk of stone formation among relatives of patients with idiopathic nephrolithiasis might be related to genetic inheritance [21]. In particular, several twin studies, genome wide association studies (GWAS) and studies involving the use of microarray platforms have established a strong association between alleles in specific candidate genes and nephrolithiasis [11, 13, 22]. However, the results reported here should by no means be interpreted as necessarily implying inherited transmission. The association maybe due to the effect of environmental factors shared by family members, mainly those related to dietary habits or geography.

Living in relatively warmer parts of the country was also associated with kidney stone formation in this study. Multivariate modelling of the results indicated that living in hot weather increases the risk of developing kidney stone by a factor of two. The reported association is in accord with previous studies which have evaluated this problem from disparate perspectives. One study reported that stone recurrence is higher in summer/hot season than in winter and spring [23]. In a North American study, it was noted that the prevalence of stones tended to increase as the average annual temperature (5.2 °C in North Dakota to 22 °C in Florida) and sunlight index (14.6 in Washington State to 39.7 in Florida) increased [24]. Even the relationship between occupation and kidney stone, highlighted in this study; can be interpreted in line with ambient temperatures in work environment [25-11].

The connection between nephrolithiasis and high ambient temperature has been linked to the lower urine volume and higher supersaturation of stone-forming salts resulting from low water intake and water losses due to perspiration [11]. An alternative hypothesis proposes a positive link between high sunlight index in warmer climates, higher levels of vitamin D; hypercalciuria and predisposition to nephrolithiasis [3].

Another important finding in this study is the fact that frequency of water intake was a significant predisposing factor even in the multivariate model, Odds Ratio 2.7 (CI: 1.41-5.30). However, the source of water was not a significant differentiator between cases and controls. The data highlighting a connection between frequency of water intake and nephrolithiasis is consistent with established literature [26]. Existing guidelines recommend high fluid intake and excretion of at least 2.5 L of urine daily [27]. Present findings demonstrate the absence of a link between source of water and nephrolithiasis can only add to the existing mixed results. On the one hand, multiple studies have demonstrated that there no relationship between incidence of urinary calculi and mineral characteristics and source of water [28, 29]. This conclusion remains problematic given the controversy regarding the connection between consumption of calcium and lithogenesis. Some researchers have argued that reduced calcium absorption in the intestinal track due to the consumption of phytate rich diet is associated with reduced risk of stones [10]. In contrast, several lines of evidence indicate that low calcium intake, increases oxalate absorption and urinary oxalate excretion, hence, increased risk of nephrolithiasis [26]. In addition, reports indicate that calcium supplements, especially when consumed with oxalate free meal, predisposes to nephrolithiasis [6].

The hypothesised association between stone type and diet in lithogenesis is largely premised on the presumption that stone type depends on the composition of urine, which depends, in turn, on diet [30]. This study evaluated the relationship between the frequency of specific diets and nephrolithiasis. Frequent consumption of green and non-green leafy vegetables and animal proteins had a significant association with symptomatic kidney stone. These results are consistent with a study which demonstrated that frequent consumption of oxalate rich vegetables, green or otherwise, is significantly associated with kidney stone formation [31].

Similar to our study, Ince and his colleagues reported that animal protein intake has a great influence on the whole stone forming risk and the chemical composition of urinary calculi [32]. They contended that animal protein generates an acid load that increases urinary calcium excretion and reduces the excretion of citrate, an inhibitor of calcium stones.

Conclusions & Recommendations

The current study brought clear and unambiguous findings on the relationship between nephrolithiasis and a number of modifiable factors. The leading type of crystal in patients presenting with symptomatic Kidney stones at the hospital is CaOx (51.7%) followed by Uric Acid (21.7%). Inadequate intake of water, previous case of renal calculi, kidney stones in family members, frequent consumption of green or non-green leafy vegetables and animal proteins were the main risk factors.

The results highlight previous or current residency in high-temperature-zones in the country, as a risk factor for renal calculi is also instructive. It points at the possible existence of nephrolithiasis-belts which should be mapped, and appropriate intervention models are to be developed. A longitudinal epidemiological study, preferably with a larger sample size, expanded range of variables and long duration of follow up, should also be considered to confirm the findings of the present report.

Ethical Approval

Ethical approval for the study and experimental protocols used was obtained from Asmara College of Health Sciences (ACHS) research ethical committee. Informed consent was obtained from all participants. During the study, strict adherence to approved laboratory protocols was observed.

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Conflict Of Interest

The authors have no conflict of interest to declare on this study.

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