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RELATIONSHIP BETWEEN DIETARY HABITS AND UROLITHIASIS OF A POPULATION IN SRI LANKA

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ABSTRACT
Introduction: Dietary factors are known to increase the risk of urolithiasis. This has led to numerous attempts at dietary modification to prevent urolithiasis. However, the high recurrence rate of urolithiasis suggests that there is still much to explore regarding prophylaxis against stone disease. Accordingly a detailed analysis of dietary factors influencing urolithiasis in Sri Lanka is long overdue. **Objectives:** Identify the dietary factors that contribute to urolithiasis in Sri Lanka. **Method:** A retrospective analysis of dietary data of patients who presented with symptomatic urolithiasis to the Teaching Hospital Peradeniya, Sri Lanka. **Results:** The mean age of patients with urolithiasis was 44.48 years which was significantly lower than that of patients without urolithiasis (p=0.003). Urolithiasis was significantly more common in men (p=0.000). 30.5% of patients with urolithiasis had a history of urolithiasis in the past, and 9.8% of patients had a family history of urolithiasis. A significantly reduced occurrence of urolithiasis was seen in patients consuming more than 3 liters of water a day (p=0.001), and in patients who frequently consumed small fish (p=0.000), or coffee (p=0.000). There was a significantly higher occurrence of urolithiasis in frequent consumers of tomato (p=0.027) and citrus fruits (p=0.021). **Conclusion:** Dietary factors play an important role in urolithiasis. Increased water intake, dietary oxalate restriction, normal calcium intake, and coffee consumption significantly reduce the risk of urolithiasis.

KEYWORDS: Urolithiasis, Renal stones, Nephrolithiasis, Diet, Food items.

INTRODUCTION
Urolithiasis is a common condition mostly affecting the young working population of society causing high morbidity and a significantly reduced quality of life due to its acute and painful presentation.[1] It is estimated that 8-12% of people will suffer from urolithiasis in their lifetime.[2,3] Symptomatic urolithiasis occurs due to supersaturation of stone forming constituents in urine, leading to aggregation of crystals, eventually forming into larger stones which may obstruct the path of urinary flow. The most common symptoms include severe abdominal pain which radiates from loin to groin or tip of the genitalia, haematuria, dysuria, urinary urgency & frequency.[2]

Urinary stones are classified according to their chemical composition as calcium-based stones, cystine stones, struvite stones, uric acid stones, and other stones (xanthine, indigo, triamterene, indinavir etc.).[3]

A multitude of genealogical and environmental factors are known to increase the risk of urolithiasis. Known risk factors include family history, medications, gout, renal infection, metabolic conditions (hypercalciuria, hyperoxaluria, hypocitraturia, chronic metabolic acidosis), and anatomic abnormalities of the urinary tract.[1,3,4]

Dietary factors are well known to increase the risk of urolithiasis.[3–5] The fact that dietary calcium restriction does not reduce the risk of kidney stones, but rather higher dietary calcium reduces the incidence of symptomatic kidney stones was brought to attention in 1993 by Curhan et al in a prospective study.[6] This challenged the then prevailing practice of dietary calcium restriction in stone formers and brought about the current clinical practice of advising normal calcium intake (≥30mmol/day).[3]

Some studies show a reduced consumption of green leaves and vegetables among patient cohorts with urolithiasis. Higher intake of finger millet and horse gram, which are rich sources of calcium, oxalate and dietary fiber, and a reduced fluid intake were also

reported by the subjects of this study.[7] Likewise, food items with high concentration of oxalates and relative vitamin A deficiency have been shown to increase the risk of urolithiasis.[8]

A prospective 5-year randomized study done by Borghi et al. in 1986 confirmed the importance of high fluid intake in prophylaxis of stone formation.[9] In another prospective cohort study of 45,619 US men, there was an inverse association between total fluid intake and the risk of stone formation.[10]

This association between diet and urolithiasis has led to numerous attempts at dietary modification to reduce the occurrence and recurrence of urolithiasis.[11–13] The DASH-style diet, which is high in fruits and vegetables, moderate in low-fat dairy products and low in animal proteins and salt has shown to decrease the deposition of calcium oxalate and thereby decrease the risk of stone formation.[12] Adequate water intake, right intake of calcium, low intake of sodium, and high levels of urinary citrate are important dietary measures which can be taken for the primary and secondary prophylaxis against urolithiasis.[5]

However, the high recurrence rate of urolithiasis suggests that there is still much to explore regarding prophylaxis against stone disease.[11]

There are wide variations in the epidemiology and risk factors of stone disease, even within the same country according to age, race, gender, and geographic location.[5] Accordingly a detailed analysis of dietary factors influencing urolithiasis in Sri Lanka is long overdue.

METHODOLOGY

The sample population consisted of 495 patients who presented to the surgical casualty or urology clinic of the Teaching Hospital Peradeniya (THP), Sri Lanka over a period of two years (October 2017 – October 2019). Of these patients, 417 had symptomatic urolithiasis, and 78 were a control group of patients who did not have urolithiasis. For the purpose of the study "symptomatic urolithiasis" was defined as any patient with typical signs and symptoms of urolithiasis (colicky abdominal pain, back pain, with or without urinary symptoms) with radiologically or ultrasonographically proven urinary calculi. The participants were administered an interview-based questionnaire consisting of basic demographic details (age, sex), medical history (past history of colic, family history, long-term illness), followed by a detailed account of common food and drink items consumed. Frequency of consuming a particular food item was graded using a scale of 0 to 8 (Table 1). Frequency of consumption was then classified as either "Frequent consumption" or "Infrequent Consumption". For the purpose of the study, "frequent consumption" was defined as intake of a particular food type 5 times a week or more, whereas consumption of a food item less than 5 times a week was defined as "infrequent consumption".

Table 1: Scale used in the study to grade the frequency of consumption of food items. Grade 6 and above were classified as "Frequent consumption", Grade 5 and below as "Infrequent consumption".

Frequency of consumption	Grade	Classification
Less than once a week	0	Infrequent consumption
Once a month	1	
2-3 times a month	2	
Once a week	3	
Twice a week	4	
3-4 times a week	5	
5-6 times a week	6	Frequent consumption
Once a day	7	
More than once a day	8	

Statistical Analysis

Data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. Chi-square analysis and independent samples T-test were used to identify correlations of statistical significance. A p value of <0.05 was accepted as statistically significant for all analyses.

RESULTS AND DISCUSSION

Age

The age of the total study population followed a normal distribution according to the Shapiro-Wilk test for normality (p = 0.001), with a skewness of +0.096.

The mean age was 45.36 (SD 15.057) with a median age of 45.0, and a modal age of 40. The age range was 73 years with minimum age of 14 and maximum age of 87. The majority of patients (n=97, 23.3%) were in the 41–50 year age group closely followed by the 31-40 year age group (n=94, 22.5%). This tendency for urolithiasis to affect the working age population is well documented.[8]

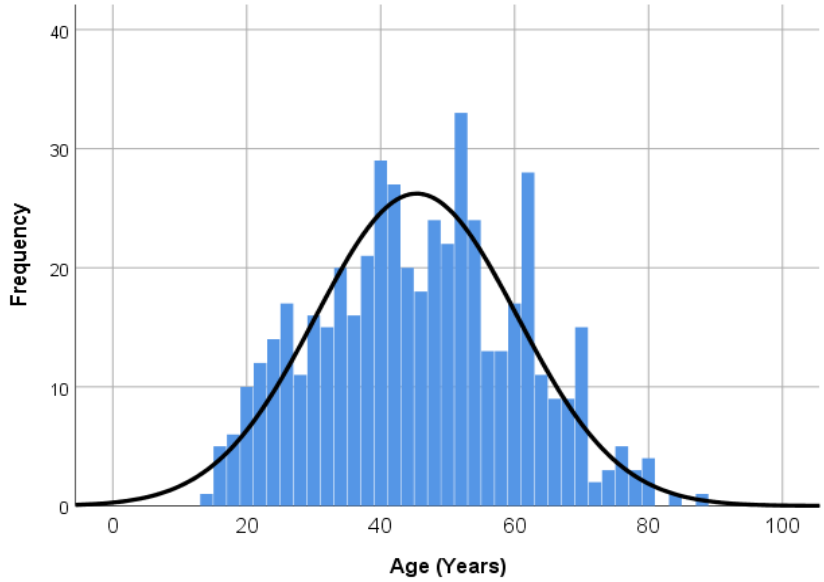

Figure 1: Histogram of the age distribution of the study population demonstrating a normal distribution.

The mean age of patients with symptomatic urolithiasis was 44.48 which was significantly younger than the mean age of the control group (50.04 years) according to independent sample T-Test (t = 3.015, p = 0.003).

The age distribution demonstrates occurrence of urolithiasis in a slightly older age group than previous published literature which shows highest incidence in men in their 30s and a bimodal age distribution in women, with peaks at 35 and 55 years.[3,5] The differences in Sri Lankan and Western dietary habits may well be responsible for this delay in stone occurrence.

Sex

From the total study population 74.34% (n=368) were males and 25.66% (n=127) were females. There was a significant correlation between male gender and presence of symptomatic urolithiasis (Chi-square value = 35.146, Phi = 0.266, p = 0.000) which is in keeping with the known predisposition of men for urolithiasis.[3,5,8]

Past History

From the patient group with symptomatic urolithiasis, 30.5% (n=127) had a past history of urolithiasis which is in keeping with the well-known tendency for recurrence of stone disease, with published series demonstrating recurrence rates as high as 30% - 50%.[3,8,10,14]

Family History

9.8% (n=41) of patients with urolithiasis had a positive family history. This comes as no surprise, given the known association of family history with stone disease.[3,4,8]

Dietary Survey

The different food items analyzed in the study, and the respective counts and percentages of participants with frequent and infrequent consumption is as shown below (Table 2).

Table 2: The food items analysed in the study, showing the counts and relative percentages of frequent and infrequent consumption.

		Infrequent Consumption		Frequent Consumption	
		Count	%	Count	%
Vegetables	Beet root	490	98.99	5	1.01
	Mushrooms	489	98.79	6	1.21
	Tomatoes	362	73.13	133	26.87
	Cucumber	485	97.98	10	2.02
	Okra	489	98.79	6	1.21
Green leaves	Spinach	492	99.39	3	0.61
	Kathurumurunga	489	98.79	6	1.21
Fruit	Citrus fruits	397	80.20	98	19.80
	Pine apple	495	100.00	0	0.00
	Strawberry	495	100.00	0	0.00
	Pears	495	100.00	0	0.00

	Grapes	493	99.60	2	0.40
Fish	Tuna	476	96.16	19	3.84
	Prawns	492	99.39	3	0.61
	Small fish	465	93.94	30	6.06
Meat	Red meat	488	98.59	7	1.41
	Chicken	473	95.56	22	4.44
	Meat products	489	98.79	6	1.21
Cereals	Cowpea	488	98.59	7	1.41
	Green gram	489	98.79	6	1.21
	Pea nuts	486	98.18	9	1.82
	Cashew	417	100.00	0	0.00
	Soy products	486	98.18	9	1.82
Dairy products & Egg	Milk	110	22.22	385	77.78
	Cheese	491	99.19	4	0.81
	Butter	486	98.18	9	1.82
	Curd	491	99.19	4	0.81
	Condensed milk	484	97.78	11	2.22
Drinks	Tea	56	11.31	439	88.69
	Coffee	462	93.33	33	6.67
	Fruit juice	483	97.58	12	2.42
	Carbonated drinks	490	98.99	5	1.01
	Alcohol	491	99.19	4	0.81
Sweets	Chocolate	486	98.18	9	1.82

There was a significant correlation between frequent consumption of tomato and occurrence of urolithiasis (Chi-Square value = 4.904, Phi = 0.100, p = 0.027). Whether this is due to high oxalate content is debatable since the oxalate content of tomato is highly variable, with mean values in published literature ranging from 5-35mg/100g fresh weight in some studies to as high as 50mg/100g fresh weight according to the USDA 1984 data.[15–17] Even though many do advocate restriction of tomato juice consumption as a measure to prevent recurrent urolithiasis, this is due to the high sodium content in commercial tomato juice preparations.[11]

A significant correlation between frequent consumption of citrus fruits and occurrence of urolithiasis was also observed **(**Chi-Square value = 5.309, Phi = 0.104, p = 0.021). This finding strongly contrasts with the prevailing dictum of increasing urinary citrate excretion as a preventive measure against stone formation.[5,13] The citrus fruits consumed in a tropical country like Sri Lanka (Nelli [Indian Gooseberry], Naran [Mandarin]) differ from those consumed in Western countries (Lemon, Orange). Whereas Lemon and Orange have a relatively lower oxalate content of 8-9mg/100g, Nelli and Naran are rich in oxalates with oxalate content ranging from 2640 – 7566mg/100g fresh weight.[17–19] This may well account for the differing findings related to citrus fruit and urolithiasis in our study compared with previous studies.

Frequent consumption of small fish was shown to significantly reduce the occurrence of urolithiasis (Chi-Square = 18.294, Phi = -0.192, p = 0.000). This is keeping with the widely accepted theory that reduced dietary calcium increases the formation of oxalate stones by increasing the share of oxalate absorbed in the intestine.[3,20]

Likewise, consumption of coffee was shown to significantly reduce the risk of urolithiasis (Chi-Square = 14.881, Phi = -0.173, p = 0.000). Published literature supports this finding, with speculations that caffeine reduces stone formation due to urinary dilution presumably through its interference with the action of antidiuretic hormone, reducing the concentrating ability of renal tubules.[8,10,11,21,22] It should be noted that previously published literature shows decreased risk of urolithiasis even with decaffeinated coffee although to a lesser degree. The reason for this is unclear; it is possible that for those beverages, it was simply the fluid intake that was protective.[10]

Other food items did not show a significant positive or negative correlation with urolithiasis.

Water intake

The distribution of water intake in the study population was as shown below (Table 3).

Table 3: Water intake (ml) among participants in the study grouped into categories of 1000ml.

Water intake (ml)	Count	Percentage (%)
0-1000	67	13.5%
1001-2000	270	54.5%
2001-3000	136	27.5%
3001-4000	15	3.0%
4001-5000	5	1.0%
5001-6000	2	0.4%

Only 22 participants (4.4% of the study population) consumed more than 3 liters of water per day. There was a significantly lower incidence of urolithiasis in participants with water intake more than 3 liters a day (Chi-square value = 10.972, Phi = -0.149, p=0.001). This is in keeping with the known reduction in risk of urolithiasis with increased fluid intake.[5,9,13]

CONCLUSION

Stone disease is significantly more common in men, with an age distribution closely following the working age of the population. A past history and / or family history of urolithiasis is seen in many patients who presented with stone disease. Dietary factors play an important role in the primary and secondary prophylaxis against urolithiasis. Increased water intake remains the single most effective measure to prevent recurrent stone formation. Other dietary measures which are of benefit include dietary oxalate restriction, normal calcium intake, and coffee. Dietary calcium restriction should not be advised as a measure to reduce recurrent stone formation. Citrus fruits were found to increase the risk of stone formation which contrasts with previously published studies. This could possibly be due to the difference in oxalate content of citrus fruits consumed in Sri Lanka, compared with the Western world.

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