Original Article

Personal Characteristics and Urinary Stones

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Background: Urinary stone disease is a common, painful and costly condition that has affected humankind since antiquity, and there is evidence to show that its incidence has continually increased during past decades. Studies have shown that many extrinsic and intrinsic factors are related to this disease in different population groups. The aim of this study was to identify the personal characteristics that are associated with urinary stone formation.
Methods: All subjects were recruited in the same 7-month period: there were 161 patients with idiopathic renal stone disease and 254 age- and gender-matched healthy subjects. Each participant was individually interviewed with regard to their sociodemographic characteristics and family medical history.
Results: Of patients with renal stones, 66.5% were male; the male to female ratio was 1.98 to 1. The prevalence of renal stone was highest in men aged 30–50 years and in women aged 40–60 years. The main differences between stone formers and healthy subjects were that stone formers had higher body mass index ($p=0.007$), lower educational ($p=0.001$) and economic ($p=0.037$) levels, and more positive family history of urinary stones ($p<0.0001$), especially in their siblings. The percentage of unemployed subjects and housekeepers were higher in the case group. The type and duration of employment were significantly different in the two groups ($p=0.014$ for type and $p=0.003$ for duration). With regard to the job environment (i.e. workplace), most of the individuals in the case group worked outdoors ($p=0.025$) and in warm places ($p<0.0001$).
Conclusion: There are many personal characteristics that might be associated with an elevated risk of renal stone formation. People with high-risk characteristics could be more prone to stone formation and should be more carefully evaluated and followed-up. [*Hong Kong J Nephrol* 2009;11(1):14–9]

Key words: personal characteristics, urinary stones, urolithiasis

背景：尿路結石症自古已是人類的常見疾病，不僅爲患者帶來痛苦，更構成醫療資源的負擔。在過去數十年間，數據顯示尿路結石症的發生率持續在增加；研究亦發現，在不同群體中，此病與多種內、外在因素有關。本研究嘗試調查，尿路結石的形成是否與特定的個人因素有關。
方法：所有調查對象均在同一時期(7 個月) 內招募，包括 161 位原發性腎結石患者、及 254 位年齡性別與之匹配的健康人士。每位參加者均接受個別的訪談，內容包括其社會人口學特徵及家族史等。
結果：腎結石患者間有 66.5% 爲男性，男女比例爲 1.98 比 1；男性的腎結石比率以 30–50 歲爲最高，女性則爲 40–60 歲。與健康人士相比，結石症患者的主要差異在於：較高的體重指數 ($p = 0.007$)；較低的教育 ($p = 0.001$) 與經濟 ($p = 0.037$) 水平；及較多的尿路結石症家族史，特別是兄弟姊妹間 ($p < 0.0001$)。此外，腎結石患者間有較高比例的失業人士及主婦，其受僱種類及持續時間亦有別於健康人士 (受僱種類：$p = 0.014$；持續時間：$p = 0.003$)。至於工作環境方面，大部分腎結石患者均在室外 ($p = 0.025$) 及溫暖的地方 ($p < 0.0001$) 工作。
結論：本研究發現，有多種的個人因素可能與較高的腎結石風險有關；這些因素可能有助於高風險人士的辨別，以便臨床篩檢與追蹤的進行。

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Introduction

Urinary stone disease has affected humankind since ancient times; a renal stone was found in an Egyptian skeleton more than 7000 years old [1,2]. Urolithiasis is now the third most common urinary disease, and there is evidence to show that its incidence has increased continually in past decades [3].

The likelihood of urinary stone formation varies in different parts of the world. Its risk is 1–5% in Asia, 5–9% in Europe, 3% in North America and 20% in Saudi Arabia [4]. High incidence of urolithiasis has been reported in countries in the Afro-Asian stone belt (extending from Egypt and Sudan, throughout the Middle East, to India, Pakistan, Burma, Thailand, Indonesia and The Philippines). Also, countries in tropical and subtropical areas have reported a high incidence of urolithiasis [5]. The prevalence of renal stones in Iran was reported to be 5.7% [6].

Urinary stones are a major health problem, with a significant proportion of patients requiring extensive surgical procedures and a considerable minority losing their kidneys [7]. In addition to pain and nuisance for the individuals concerned, urinary stone increases the financial burden on society, with an estimated 9% of all patients requiring hospitalization for a mean of 3 days [8], at a total cost of US$1.83 billion in the United States [9].

A prophylactic approach to urolithiasis requires recognition of the factors that predispose patients to urinary stones in different populations [10]. The current understanding of the pathogenesis of idiopathic renal stone disease indicates that there is a multifactorial and complex interaction among environmental, metabolic and genetic factors [11]. A number of epidemiologic and demographic factors such as age, gender, ethnicity, previous medical condition, socioeconomic class, type of employment, family history and dietary factors are related to urinary stones [9–16]. But the extrinsic and intrinsic factors for renal stones are varied in different population groups [1]. Therefore, studies that undertake to identify the circumstances that put particular populations at risk for stone formation continue to be of special relevance.

Renal stones are more frequent in men than in women. Thus, some authors limit their research to the male population. Authors who study both sexes discuss the results for men and women separately or use a matched control group [14].

In order to define the factors that might be of particular importance to renal stone formation, this study was undertaken to investigate any significant differences in the expression of epidemiologic and demographic variables in stone formers as compared with unaffected subjects.

Methods

Sample/setting

A total of 161 patients with idiopathic renal stone disease attending Hasheminejad Hospital (which is a urology medical care center in Tehran, a central governmental hospital, that most patients with urologic disease are referred to for treatment and follow-up) constituted the stone formers group. Patients > 18 years of age were included regardless of the number of stone episodes, so cases consisted of patients with either first or recurrent stones.

The control group comprised 254 healthy subjects without personal history of stone disease. This group was recruited from persons (visitors of patients, other patients and hospital staff) who attended the same center and matched cases for age and sex. The healthy controls were selected during the same period as stone formers to avoid the influence of seasonal variations. A sequential sampling technique was used to recruit 161 consecutive cases and 254 consecutive matched controls.

All the individuals were informed of the research goals and if they were interested in participating, they signed written informed consent forms. Each participant was given a book about renal stones as a token of appreciation for participating in the study.

Procedure

This was a case-control study approved by the research ethics committee at the School of Nursing & Midwifery of Iran University of Medical Science and Health Services. A sociodemographic questionnaire was completed for all study participants through interviews. Data collection took place from November 2007 to May 2008.

Evaluation measures

All of the patients and healthy subjects were individually interviewed using a predesigned questionnaire about sociodemographic characteristics and family medical history. The questionnaire contained questions about age, gender, weight, height, educational level (illiterate, primary school, secondary school, high school graduate, university), economic status (excellent, good, moderate to good, moderate to poor, poor), employment status (employed, unemployed, housekeeper, retired), type of job (worker, farmer/animal husband, driver, tradesman, employee/teacher, medical team, others), duration of employment, workplace (indoors, outdoors), and climate of the work area (warm, just right, cold). As measuring the exact amount of earnings was not applicable, no questions were asked about subjects' precise income; rather, participants pronounced their economic status according to the groups mentioned above.

Body weight and height were measured, and body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters.

Family history of kidney stone was ascertained through two questions: (1) Is there any history of urinary stone in your family? (Yes, No); (2) If yes, in which of the following groups do you have a positive family history? First degree (father, mother, sister, brother), second degree (aunt, uncle, grandparents), both first and second degree (at least one of the first degree individuals and at least one of the second degree individuals).

This instrument was designed after a literature review of different epidemiologic studies. The appearance and content validity of the questionnaire was established by two urologists, one epidemiologist and 10 special nurses.

A pilot study was performed on the target population to identify and solve any potential problems. The reliability of the questionnaire was assessed through "test–retest", with $\alpha = 0.96$.

Data analysis

Data were analyzed using SPSS version 14 (SPSS Inc., Chicago, IL, USA) for Windows. Descriptive analysis was conducted to present demographic data. An independent sample *t* test and the χ^2 test were used to assess the differences between the two groups ($\alpha = 0.05$). Then, stepwise logistic regression analyses were computed using a probability value of 0.05.

Results

t test and χ^2 test findings

Findings show that 66.5% of patients were male, with a male to female ratio of 1.98 to 1. The prevalence of renal stone was highest in men aged 30–50 years and in women aged 40–60 years (Table 1). With regard to age and sex, there were no significant differences in these two variables between cases and controls.

Over 50% of stone formers stated that they had suffered from urolithiasis more than once (Table 2). While 23% reported that their stone was of the calcium type, over 73% did not know their stone type.

Table 1. Age distribution of stone formers according to sex*

Age (yr)	Male	Female
<20	0 (0)	3 (5.6)
20–29	22 (20.6)	9 (16.7)
30–39	34 (31.8)	6 (11.1)
40–49	24 (22.4)	17 (31.5)
50–59	17 (15.9)	13 (24.1)
60–69	7 (6.5)	6 (11.1)
70–79	3 (2.8)	0 (0)

*Data presented as *n* (%).

The *t* test results showed that there were no differences in the height and weight of the two groups ($p = 0.179$ and $p = 0.061$, respectively), but BMI was significantly different ($p = 0.007$; Figure). Table 3 shows that the percentage of obesity and overweight was much higher in the case group.

There was also a significant difference in the educational status of the two groups ($p < 0.001$). The percentage of subjects with an educational level less than diploma was 50.9% ($n = 82$) in the cases and 25.2% ($n = 64$) in the controls. Many more individuals in the case group expressed their economic status as poor and moderate to poor; the difference between cases and controls was statistically significant ($p = 0.037$).

Employment status was also significantly different ($p = 0.041$). In the case group, the percentage of unemployed people and housekeepers was higher while the percentage of employed and retired people was lower. In addition, the type of job and duration of employment

Table 2. Frequency and type of stone*

Frequency of urolithiasis	
1	69 (42.9)
2	43 (26.7)
3	16 (9.9)
4	7 (4.3)
5	10 (6.2)
≥6	16 (9.9)
Type of stone	
Calcium	37 (23)
Uric acid	5 (3.1)
Unknown	119 (73.9)

*Data presented as *n* (%).

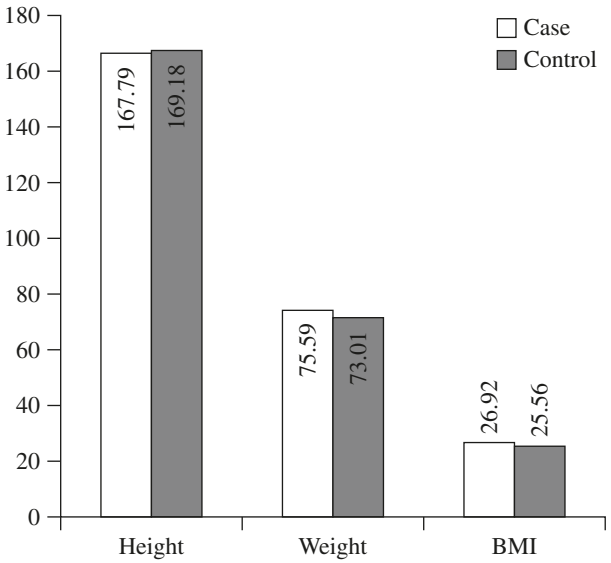

Figure. Anthropometric characteristics of renal stone formers and healthy subjects.

Table 3. Sociodemographic characteristics of renal stone formers and healthy subjects*

	Case	Control	*p*
BMI			0.007
<18.5	5 (3.1)	6 (2.4)	
18.5–24.9	60 (37.3)	115 (45.9)	
25–29.9	61 (37.9)	104 (40.9)	
≥30	35 (21.7)	29 (11.4)	
Educational level			<0.0001
Illiterate	16 (9.9)	5 (2)	
Primary school	35 (21.7)	27 (10.6)	
Secondary school	31 (19.3)	32 (12.6)	
High school graduate	45 (28)	73 (28.7)	
University	34 (21.1)	117 (46.1)	
Economic status			0.037
Excellent	0 (0)	3 (1.2)	
Good	25 (15.5)	46 (18.1)	
Moderate to good	71 (44.1)	134 (52.8)	
Moderate to poor	48 (29.8)	59 (23.2)	
Poor	17 (10.6)	12 (4.7)	
Employment status			0.041
Employed	98 (60.9)	170 (66.9)	
Unemployed	9 (5.6)	10 (3.9)	
Housekeeper	40 (24.8)	38 (15)	
Retired	14 (8.7)	36 (14.2)	
Type of job			0.014
Worker	18 (18.4)	25 (14.7)	
Farmer/animal husband	7 (7.1)	2 (1.2)	
Driver	7 (7.1)	6 (3.5)	
Tradesman	26 (26.5)	34 (20)	
Employee/teacher	26 (26.5)	62 (36.5)	
Medical team	5 (5.1)	22 (12.9)	
Others	9 (9.2)	19 (11.2)	
Workplace area			0.025
Outdoors	29 (25.9)	32 (15.5)	
Indoors	83 (74.1)	174 (84.5)	
Temperature in the workplace			<0.0001
Warm	26 (23.2)	21 (10.2)	
Just right	69 (61.6)	176 (85.4)	
Cold	17 (15.2)	9 (4.4)	

*Data presented as *n* (%).

were significantly different between the two groups ($p=0.014$ and $p=0.003$, respectively). The percentage of workers, farmers/animal husbands and drivers in the case group was higher, as was the duration of employment. With regard to job environment (workplace), most of the stone formers worked outdoors ($p=0.025$) and in warm places ($p<0.0001$) (Table 3).

Positive family history of stones was found more frequently in patients ($p<0.0001$). Table 3 shows that for first degree positive family history, stones were more frequent in brothers ($p=0.001$) and sisters ($p<0.0001$). Also, a significant difference was found in positive family history of second degree relatives ($p=0.043$) and both first and second degree relatives ($p<0.0001$) (Table 4).

Table 4. Familial medical history of renal stone formers and healthy subjects*

	Case ($n=254$)	Control ($n=161$)	*p*
Positive family history of urolithiasis	95 (59)	81 (31.9)	<0.0001
First degree			
Father	19 (11.8)	34 (13.4)	0.637
Mother	15 (9.3)	20 (7.9)	0.606
Sister	16 (9.9)	5 (2)	<0.0001
Brother	29 (18)	18 (7.1)	0.001
Second degree	14 (8.7)	10 (3.9)	0.043
Both first & second degree	15 (9.3)	3 (1.2)	<0.0001

*Data presented as *n* (%).

Table 5. Characteristics that were significant after regression

	Odds ratio	95% confidence interval	*p*
Educational level	0.334	0.154–0.725	0.006
Positive family history	1.896	1.093–3.290	0.023

Logistic regression findings

According to the regression results, of all of the above personal characteristics, only educational level and positive family history were associated with the risk of urinary tract calculi (Table 5). Positive family history was a risk factor for urolithiasis (odds ratio, 1.896; $p=0.023$), but postsecondary school education was associated with a reduced risk of urinary tract stone (odds ratio, 0.334; $p=0.006$).

Discussion

As the results show, different epidemiologic factors relate to urolithiasis. The prevalence of urinary stones is higher in men than in women. Epidemiologic studies have shown that the mean prevalence of renal stones in males is between 7% and 15%, while it is only between 3% and 6% in females [12]. All reports from white populations describe a male to female ratio > 1 [4], including Turkey with a ratio of 1.5:1 [13] and Saudi Arabia with a ratio of 5:1 [5]. The higher prevalence of nephrolithiasis in males can be attributed to the effect of sex hormones on some lithogenic risk factors: androgens appeared to increase, and estrogens decrease, urinary oxalate excretion and kidney calcium oxalate deposition [4].

We found that the prevalence of obesity and overweight was much higher in cases than in controls. A similar finding was noted by Leonetti et al [14]. Sarica et al showed that being overweight can increase the excretion of stone forming substances in the urine [11].

We also found that the educational level of the two groups was significantly different. The frequency of subjects with an educational level lower than high school was higher in cases than in controls. Tefekli et al showed that low socioeconomic and educational levels are commonly observed factors in people who present with urinary stone disease [13]. A case-control study by Krieger et al found that higher educational level was related to a decrease in the risk of stone formation [15]. Possible explanations for this may include differences in diet or other behaviors that affect the risk of stone formation.

Our other finding was that the economic status of the cases was lower than that of the controls. Some case-control studies reported that low annual income and socioeconomic status are associated with chronic kidney disease and renal stones [13,17]. But Robertson and Peacock's study showed that there was a direct relationship between socioeconomic status and renal stone formation, in that the frequency of urolithiasis was much higher in the high socioeconomic group [17].

In this study, there was a higher frequency of unemployed people and housekeepers and a lower frequency of employed and retired people in the case group. Compared with the controls, the percentage of workers, farmers/animal husbands and drivers in the case group was higher and the duration of employment was longer. The influence of occupational habits on stone formation has not been extensively investigated [18]. There is evidence to imply that people in particular occupations are at higher risk of urolithiasis. For example, sedentary occupations like being an aviation pilot or truck driver are associated with a higher incidence of stone formation. A possible explanation is that infrequent and insufficient fluid intake leads to increased urinary concentration of stone-forming salts [12]. However, it is difficult to confirm whether occupation is the primary reason for stone formation or is only related to other aspects such as diet, exposure to heat, and water drinking [18]. We found that most of the individuals in the case group worked outdoors and in warm places. In a previous study, chronic dehydration, related to a warm work environment, was found to be associated with a high rate of urolithiasis [15]. Atan et al indicated that workers exposed to high temperature presented more frequently with low urinary volumes and hypocitraturia, which are both risk factors for stone formation; these workers were also found to have frequent sweating [18].

In this study, family history of stones was found more frequently in patients. From the immediate family, it was mostly the sisters and brothers who were involved. Also, there was a significant difference in the positive family history of second degree and both first degree and second degree relatives. In many studies, a positive family history of nephrolithiasis has been found to be associated with a greater prevalence and recurrence of stone disease [9,19,20]. Family history of urinary stones is associated with a twofold increase in the risk of urolithiasis [15]. Anatol et al showed that more patients had a history of urinary tract stone disease in their immediate family than did controls [10]. Leonetti et al confirmed this finding and showed that in 25.7% of the patients, the father was involved; but the differences in the frequency of other relatives such as brothers, sisters and grandparents between cases and controls were not significant [14]. Also, Kodama and Ohno stated that the episodes of stone formation in family members, particularly father and brothers, are more frequent in stone formers than non-stone formers [21]. Some authors reported genetic transmission of hypercalciuria, one of the most prevalent urinary risk factors for stones [14]. An autosomal inheritance was defined for cystinuria and primary hyperoxaluria. However, familial recurrence does not necessarily imply an inherited transmission as stone formation may also be an effect of environmental factors such as having the same lifestyle and dietary habits [4,14].

This study suffered several limitations. Although some relationship between personal characteristics and renal stones was found, a definite cause and effect relationship could not be established by the methodology used. Cases and controls were closely matched for sex and age, which may have introduced selection bias. Some participants who were selected as controls might have had urinary stone disease without any signs and symptoms. Also, patients and unaffected subjects might have recall bias.

The findings of this survey show that different epidemiologic factors such as BMI, educational level, economic status, employment status, type of employment, workplace area (indoors or outdoors) and temperature, and positive family history are related to urinary stone formation and increased risk of having this disease. Therefore, by identifying the high-risk individuals who possess some risk factors and instructing them on preventative measures, it is possible to decrease the prevalence and recurrence rate of renal stones and reduce the health care burden of renal stones.

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