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Prevalence and Risk Factors of Urinary Stones in Korean

To estimate the prevalence of urinary stone disease in Koreans, and to determine the inter-relationships between urinary stone disease and various epidemiological factors, 1,521 controls and 1,177 cases with urinary stones were evaluated. Of special interest in this study were: 1) proportion of past urinary stone history among controls; 1.9% 2) the point prevalence rate of urinary stones among controls; 0.2% 3) the recurrence rate of urinary stones (the proportion of past history of urinary stone) among cases; 56.8% 4) high incidences (76.3%) in the thirties to the fifties among cases 5) the risk factors for urolithogenesis; obesity [higher than 25 of BMI (body mass index, weight/height^2)], more than 10 year-experience as a production worker, past stone history, familial stone history, low physical activity (< 2,000 Kcal/day), and low intake of fruit. However, the well-known risk factors for urinary stones; over intake of meat or fish and milk or dairy products, perspiration, amount and kind of drinking water, and stress unexpectedly were not significantly different between the controls and the cases.

Key Words : *Urinary calculi; Prevalence; Risk factors*

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INTRODUCTION

Urinary stone is a metabolic disease which arises from disturbances of the physico-chemical balance and/or of the hydrodynamic system of the urine. The urinary stone clearly is a world-wide disease when it is recognized that the incidence of this disease has been estimated to be between 1 and 12 per cent (1). The incidence of urinary stones has been sharply increasing since the end of the 1970s in Korea when the GNP (gross national product) per capita was more than 1,000 dollars, and the life-style and dietary habits were westernized (2, 3). Currently, urinary stone disease is becoming one of the most common benign diseases, and it is a matter of course that urinary stone disease is an important and frequent occurrence in urological practice in Korea.

Because the genesis of urinary stones is complex and has not been fully explained, to have any chance of success, treatment and prevention must be based on knowledge of urinary stone epidemiology. In spite of the amount of research directed toward explaining the cause of urinary stones, few reliable data exist regarding the epidemiology of urinary stones in Korea, although several studies offer some information (2-4). Moreover, these studies may not reflect true data about stone disease because the information available on urinary stone epidemiology was based only on an analysis of patients requiring hospitalization in most studies and did not attempt to determine the incidence of outpatients with urinary stones.

The object of this study was to establish the prevalence of stone disease in the adult population in Korea, and to determine the risk factors of urinary stone disease. This report is the first description of the prevalence and recurrence rates for urinary stones in a well-defined population, and the first nationwide survey on risk factors of urinary stones in Korea.

MATERIALS AND METHODS

This study was carried out between June 1995 and May 1996 at the Department of Urology, College of Medicine, Chung-Ang University. With the cooperation of the Korean Urological Association, questionnaires were sent to 8 major hospitals which have each more than 300 inpatient beds, an extracorporeal shock wave lithotriptor, and a stone clinic.

The study population was divided into 7 regions based

Table 1. The study population of 7 regions

		Normal controls No. (%)	Patients No. (%)	Total No. (%)
Region 1 (Seoul)	Kyunggi	497	405	902
Region 2 (Pusan)	Kyungnam	180	212	392
Region 3 (Wonju)	Kangwon	207	201	408
Region 4 (Taegu)	Kyungbook	179	128	307
Region 5 (Taejeon)	Chungnam	200	7	208
Region 6 (Chonju)	Chonbuk	90	153	243
Region 7 (Kwangju)	Chonnam	166	71	238
Total		1,521 (56.4)	1,177 (43.6)	2,699 (100.0)

on geographic proximity and climatic similarity. The regions and corresponding states were region 1 (Seoul) - Kyunggi, region 2 (Pusan) - Kyungnam, region 3 (Wonju) - Kangwon, region 4 (Taegu) - Kyungbook, region 5 (Taejeon) - Chungnam, region 6 (Chonju) - Chonbuk, and region 7 (Kwangju) - Chonnam (Table 1).

We prepared questionnaires for the subjects with several items of quotations from 2 references; the questionnaires of the Hawaii cancer research survey which was made by the cancer research center of Hawaii, University of Hawaii, and the questionnaires of the Korean cohort study on disease prevention which was designed by the Department of Preventive Medicine, Seoul National University. The self-completed questionnaire was initially validated in our stone clinic. The subjects were questioned about the intrinsic, and extrinsic or environmental factors of their urinary stones. Intrinsic factors include heredity, age and sex, family history, past medical history, concomitant disease, and past history of urinary stones. Extrinsic or environmental factors include body weight and stature, residential area, occupation, working day, work history, medication history, physical activity, lifestyle (alcohol drinking, sleeping, stress), food intake habits, drinking water, and dietary patterns. Height and body weight were measured, and body mass index (BMI = weight/height^2) was computed.

These environmental and epidemiological factors were evaluated in 1,521 controls and in 1,177 patients with urinary stones. In this study, the 1,521 controls were selected by a random sampling among a great number of target populations who visited the 8 hospitals for a regular physical checkup. Simultaneously, ultrasonography was routinely applied to all of the 1,521 controls for the incidental detection of urinary stones. Especially, several supplemental questionnaires were referred to the 1,177 cases with urinary stones for further details, and the data were abstracted from the clinical records by the attending physician. The additional subjects for investigation were location, size, symptoms, treatment method, component of the urinary stones, and result of stone metabolic study. The survey to establish the point prevalence rates of urinary stone disease was carried out in 1,521 controls. And, the recurrence rate (proportion of past history of urinary stone) of urinary stones was obtained from 1,177 cases with urinary stones. The interrelationships between urinary stone disease and various environmental and epidemiological factors were evaluated in both 1,521 controls and 1,177 cases with urinary stones.

In this report, our definitions of the terms "incidence", "prevalence", and "recurrence" are presented below. In epidemiological terms the prevalence of a disease is the number of subjects who have the condition at a given time and the incidence is found by discovering the number of subjects who develop the condition in the population at a suitable interval after the prevalence figure is determined. Recurrence of the disease refers to episodes subsequent to the initial one (5).

A case-control design was adopted, and we tried to select two controls per case by individual matching using sex and age as far as was possible. The data analysis was performed by SAS PC program (release 6.12) (SAS, 1996) (6). The association between risk factors and urinary stones was determined with the conditional logistic model and the Mantel-Haenszel method (7-9). Adjustment for age was performed in the model. Odds ratios were computed for tertiles or quartiles and 2×2 table of adjusted risk factors. Statistical significance was tested with the likelihood ratio test based on the model.

RESULTS

The controls and the cases

Age and sex distribution. The ages of the controls and the cases ranged from 18 to 82 years (mean 34.6 years), and from 6 to 84 years (mean 44.8 years), respectively. A patient age of 40 years (27.7%) was the most common, followed by 30 (25.1%), 50 (23.5%), 60 (10.5%)

and 20 years (9.8%). The male-to-female ratio of control people was 1.3:1 and that of the patients with urinary stones was 2:1.

Body weight and Stature. We calculated the BMI (body mass index) for grading obesity in the control people and the patients. The BMI was estimated as follows: BMI=body weight (kg)/stature^2 (m). Normal range of the BMI is from 20 to 25, a BMI of less than 20 means a thin body habitus, and over 25 stands for obesity. The obese body habitus (BMI>25) of the patients (28.4%) was significantly ($p<0.001$) higher than that (15.9%) of the control people.

Occupation. A higher incidence of urinary stones occurred in the cases with certain occupations such as housewives (20.8%) and professionals (11.0%) than in officials (7.5%), clerical workers (7.3%), sales workers (7.4 %), service workers (8.3%), farmers, fishermen, forestry workers (10.9%), transport workers (5.9%), production workers (7.8%), unskilled workers (3.9%), and others (9.4%).

Working hours. Eleven per cent of the controls and 10% of the cases were working for more than 12 hours daily. There was no significant difference in working hours between the control people and the patients.

The period of physical labor. Urinary stones were more frequently developed in the male cases (18.7%) and female cases (18.6%) who had done over 10 years of physical labor ($p<0.001$).

The experience of residence in hot countries. Although 17 (1.1%) controls and 57 (4.8%) cases had lived in hot countries there was no significant difference in urinary stone occurrence.

Past medical history. The items of past medical history investigated were tuberculosis, hypertension, cerebrovascular accident, diabetes mellitus, thyroid disease, parathyroid disease, gall bladder stones, cholecystitis, gout, nephritis, bladder diseases, cancer, hereditary disease, enteritis, colitis, and intestinal surgery. No significant difference was noted between the controls and the cases.

Past stone history. Every new stone throughout a patient's life is counted as a recurrence, irrespective of the type and localization. Twenty-nine (1.9%; male 1. 4%, female 0.5%) controls and 668 (56.8%; male 38.0 %, female 18.8%) cases had had one or more recurrence. Therefore, in our study, the prevalence rate of urolithiasis in the controls was 1.9% and the recurrence rate in the cases was 56. 8%. Table 2 represents the number of cases with recurrent calculi and that of controls having history of urinary stone disease according to the number of recurrences. Recurrent calculi in the cases were located in the ureter (44.8%), kidney (41.0%), urethra (9.7%), and bladder (4.4%). The calculi of the cases were removed by extracorporeal shock wave lithotripsy (44.3%), spontaneous passage (28.4%), open surgery (13.4%), drug therapy (8.0%), endourologic management (4.2%), herb medicine (1.1%), and nephrectomy (0.7%).

Familial stone history. Of the 753 cases, 24 (3.2%) had a familial stone history, and this was higher than the 1.3% of the controls with significance ($p<0.01$).

Alcohol drinking. 48.5% of the controls and 49.4% of the cases had a history of alcohol drinking. There was no significant difference. However, 27.4% of the controls had a history of alcohol drinking over once a month against 13.1% of the cases. Similarly, the frequency of alcohol drinking (1.6 times per month) of the controls was higher than that (1.1 times per month) of the cases.

Physical activity. There was a remarkable difference ($p<0.001$) in energy consumption per day (Kcal/day) between the two groups. Energy consumption of over 2,000 Kcal/day was noted in 9.0% of the controls and in 3.3% of the cases. However, the frequency of violent physical exercise per week did not reveal a significant difference.

Diet. Likes and dislikes, the frequency of dietary intake per week was evaluated regarding meat, fish, vegetables, fruits, milk, and dairy products. The higher consumption of fruit (>10 times per week) was related to a lower incidence of stones ($p<0.001$). Unexpectedly, the consumption of meat, fish, milk, and dairy products were not significantly different between the two groups (Table 3).

Drinking water. The volume of water ingested, the water intake before night sleep, and the kind of drinking water were not distinctively different between the controls and the cases. However, the frequency of drinking water was significantly low in the cases (Table 4).

Perspiration (sweating). There was a significant difference in the female cases group ($p<0.001$) but not in the male (Table 4).

Stress. Data on stress factors and urolithogenesis revealed no serious variation between the two groups (Table 4).

Among all of the 1,521 controls who were routinely examined by ultrasonography for the incidental detection

Table 2. Stone recurrence in the normal controls and the patients

Number of recurrence	Normal controls No.	Patients No. (%)
1	25	476 (71.3)
2	4	110 (16.5)
3	-	45 (6.7)
4	-	18 (2.7)
5	-	13 (1.9)
≥6	-	6 (0.9)
Total	33	668 (100.0)

Table 3. Relationship between the monthly frequency intake of various foods and urinary stones

	Men			Women		
	No. of cases	No. of controls	Adjusted odds ratio* 95% confidence interval	No. of cases	No. of controls	Adjusted odds ratio* 95% confidence interval
Meat (beef, pork, and chicken)						
1(Low, <1)	17	19	1.0	19	40	1.0
2(1-2)	93	235	0.99 (0.55-1.79)	88	254	1.48 (0.83-2.64)
3(3-9)	110	295	1.02 (0.57-1.83)	44	197	0.96 (0.52-1.79)
4(High, ≤10)	107	290	1.12 (0.62-2.02)	20	145	0.72 (0.35-1.49)
		P value for trend = 0.9036			*P value for trend = 0.0211*	
Fish						
1(Low, <1)	20	46	1.0	10	37	1.0
2(1-2)	137	354	1.28 (0.76-2.15)	77	241	2.38 (1.16-4.85)
3(3-9)	94	252	1.20 (0.70-2.04)	49	164	1.97 (0.94-4.13)
4(High, ≤10)	75	188	1.32 (0.76-2.29)	36	203	1.20 (0.56-2.55)
		P value for trend = 0.8012			*P value for trend = 0.1355*	
Vegetables						
1(Low, <1)	21	35	1.0	6	35	1.0
2(1-2)	117	237	1.26 (0.74-2.13)	69	181	3.80 (1.65-8.74)
3(3-9)	102	283	0.86 (0.51-1.47)	54	211	2.33 (1.01-5.38)
4(High, ≤10)	86	285	0.71 (0.42-1.22)	44	214	1.98 (0.85-4.62)
		P value for trend = 0.0006			*P value for trend = 0.1527*	
Fruit						
1(Low, <1)	45	72	1.0	16	42	1.0
2(1-2)	111	249	1.05 (0.69-1.61)	80	153	2.17 (1.15-4.10)
3(3-9)	105	290	0.97 (0.63-1.49)	41	213	1.00 (0.57-2.05)
4(High, ≤10)	66	227	0.81 (0.51-1.28)	36	235	0.84 (0.43-1.66)
		P value for trend = 0.0844			*P value for trend = 0.0015*	
Milk and dairy products						
1(Low, <1)	30	51	1.0	18	34	1.0
2(1-2)	82	152	1.39 (0.83-2.30)	46	84	1.99 (1.01-3.94)
3(3-9)	111	287	1.08 (0.67-1.76)	59	196	1.08 (0.57-2.05)
4(High, ≤10)	104	350	1.03 (0.63-1.68)	50	330	0.86 (0.45-1.66)
		P value for trend = 0.1740			*P value for trend = 0.0127*	

* Adjusted in a conditional logistic regression model for age

of urinary stones, three normal controls had asymptomatic urinary stones [bladder stones in 2 (9×6 mm, 9×7 mm) and a lower ureteral stone in 1 (9×4 mm)]. Therefore, the point prevalence rate was 0.2% in this study.

The patients

Stone site. Location of the patient's stone was the ureter in 54.1% (upper 25. 8%, mid 7.1%, lower 21.2 %), kidney in 45.0% (upper calyx 8.0%, mid calyx 9.3%, lower calyx 17.0%, pelvis 8.0%, partial staghorn 1.6%, complete staghorn 1.4%), bladder in 0.8%, and urethra in 0.1%. Eighty per cent of the cases had a single stone.

Stone size. Most (85.5%) of the cases had a stone less than 5 mm in diameter, and 5.6% had a stone of larger than 1.0 cm in diameter.

Radio opacity. Sixty-six per cent of the cases had a radio opaque stone, and the remainder had a radio lucent or poorly radio opaque stone.

Number of recurrences. Of 668 cases who had had one or more recurrence 192 had suffered from urinary stones more than twice and as many as over 6 times in 6 (Table 2).

Clinical manifestations. The cases most commonly presented with flank pain (77.6%) and suffered from various symptoms (abdominal pain 4.9%, colic 4. 4%, nausea 1.0 %, vomiting 0.2%, gross hematuria 3.7%, fever 0.4%, frequency 0.4%, dysuria 1.4%, indigestion 1.1%, abdominal fullness 0.6%, no symptom 4.1%, etc. 0.3%). Diagnosis of the urinary stone was prompted by clinical manifestations in the majority (87.4%) of the cases. The stones in the remaining cases were incidentally discovered by microscopic hematuria or opaque stone on a plain

Table 4. Relationship between sweating, drinking water, and stress and urinary stones

	Men			Women		
	No. of cases	No. of controls	Adjusted odds ratio* 95% confidence interval	No. of cases	No. of controls	Adjusted odds ratio* 95% confidence interval
Frequency of drinking water						
1(Low)	49	84	1.0	62	153	1.0
2	169	401	0.86 (0.58-1.28)	80	339	0.65 (0.43-0.97)
3(High)	108	353	0.72 (0.48-1.08)	30	152	0.50 (0.29-0.84)
		P value for trend = 0.0342			*P value for trend = 0.0026*	
Amount of drinking water (glass of water)						
1(Low, <2)	13	44	1.0	19	74	1.0
2(2-5)	219	544	1.58 (0.90-2.76)	133	484	1.11 (0.65-1.89)
3(6-10)	67	171	1.84 (1.00-3.39)	13	66	0.87 (0.39-1.94)
4(High, 10<)	28	78	1.90 (0.94-3.83)	7	19	1.41 (0.49-4.04)
		P value for trend = 0.1622			*P value for trend = 0.9319*	
Frequency of drinking water before sleeping						
1(Low)	131	362	1.0	106	382	1.0
2	22	55	1.14 (0.66-1.99)	10	57	0.74 (0.35-1.57)
3	66	171	1.18 (0.82-1.69)	25	115	0.91 (0.54-1.52)
4(High)	103	244	1.26 (0.92-1.73)	30	87	1.24 (0.75-2.05)
		P value for trend = 0.1910			*P value for trend = 0.7247*	
Sweating						
1(Low)	74	171	1.0	62	244	1.0
2	132	371	0.82 (0.58-1.15)	59	285	0.82 (0.54-1.24)
3(High)	121	297	1.10 (0.78-1.57)	67	114	1.44 (0.90-2.30)
		P value for trend = 0.5801			*P value for trend = 0.2100*	
Stress						
1(Low)	49	69	1.0	22	53	1.0
2	158	411	0.97 (0.64-1.46)	78	377	0.82 (0.47-1.42)
3(High)	119	359	1.02 (0.66-1.58)	69	209	1.52 (0.85-2.71)
		P value for trend = 0.8071			*P value for trend = 0.0369*	

* Adjusted in a conditional logistic regression model for age

x-ray film during a physical checkup (11.6%) or spontaneous passage of urinary stone (1.0%). The interval between the symptom onset and the management was less than 7 days in 57.0% of the cases, and more than 1 month in 23.2%.

Anatomic anomalies and Coexisting disease. Among pre-existing renal or urinary tract diseases, calyceal diverticulum was present in 5 cases, medullary sponge kidney in 4, renal cyst in 3, ureteral duplication in 2, urethral stricture in 2, horseshoe kidney in 1, UPJ (ureteropelvic junction) stricture in 1, infundibular stenosis in 1, genitourinary tuberculosis in 1, and ureterocele in 1.

Methods of treatment. ESWL (extracorporeal shock wave lithotripsy) was performed in most (77.8%) of the cases, and 16.1% of the cases in this series passed their stones spontaneously. Endourological removal was successful in 3.3% of the cases (nephroscopic 1.1%, ureteroscopic 1.4%, cystoscopic 0.6%, stone basket 0.2%) and open surgery was required in 2.1%.

Stone component. Analysis of 328 stones with chem-

Table 5. Results of stone metabolic study in the patients

	No. (%)
Normal	472 (69.3)
Abnormal :	209 (30.7)
Idiopathic hypercalciuria	43
Absorptive hypercalciuria Type I	3
Absorptive hypercalciuria Type II	3
Renal hypercalciuria	9
Primary hyperparathyroidism	1
Renal phosphate leak	2
Enteric hyperoxaluria	14
Primary 1,25-(OH)2 vitamin K excess	1
Hyperuricosuria	16
Idiopathic hypocitraturia	96
Renal tubular acidosis	1
Gouty diathesis	4
Others	8
Total	681 (100.0)

ical analysis showed that 78.0% were calcium oxalate and/or calcium phosphate stones, 16.5% were struvite with or without carbonate stones, 4.3% were uric acid stones, and 0.3% were cystine stones.

Stone metabolic study. On stone metabolic study applied to 680 cases, no abnormality resulted in 472 (69.3%) cases. Abnormal metabolic disorders were found in 208 (30.7%) cases: 96 with hypocitraturia, 43 with idiopathic hypercalciuria, 16 with hyperuricosuria, 14 with enteric hyperoxaluria, and 9 with renal hypercalciuria (Table 5).

DISCUSSION

Urinary stones are a common, painful, and costly medical condition. Approximately 12 percent of the population will form a stone at some point in their lives (10) with a recurrence rate of 50% to 75% (11). Nevertheless, urinary stones are often under-recognized and under-evaluated.

Newer techniques for stone removal such as extracorporeal shock wave lithotripsy have facilitated treatment and reduced the morbidity associated with urinary stones. However, despite this success, efforts to find the causes of stone formation and prevent further episodes remain important, because about 50% of patients with a single episode of urinary stones will have a recurrence within 10 years (12-14). After basic evaluation, most patients with a first-time stone are routinely advised to increase their urine volume by increasing their fluid intake and to avoid calcium excess, which may prevent recurrence in up to 60% of patients (15, 16).

Even though the genesis of urinary stones is complex and has not been fully explained, urinary stones is one of the diseases known to be influenced by environmental factors. However, in Korea, there are no published national data on true stone incidence rates when incidence is defined as the rate of new stones formed in individuals with no previous stones during a specific period. Previous reports have assumed that discharge rates of hospitalized patients with urinary stones to total hospitalized patients reflect stone incidence rates but this may not be correct. Several factors may affect the regional hospitalization rates of the patients with urinary stones independent of the stone incidence rate. This survey was a large, national cross-sectional study of urinary stone disease in Koreans. We collected information on prevalent urinary stones in adults from 7 provinces.

In every case of urinary stones it is probable that both extrinsic (environmental and socio-economic) and intrinsic (congenital and acquired) factors are involved. Epidemiological studies from different parts of the world are therefore interesting and contributory. However, no epidemiological study has yielded valuable understanding of their relative importance in Korea. Although there are not many papers dealing with the incidence of stone formation in Korea, the extensive survey by Yoon et al. (4), in 1989, already showed that upper urinary stones were predominant in the country and endemic bladder stones were not found. This was a 20-year study of urinary stones in a geographically defined area in Pusan, in the south-east of Korea.

The prevalence of urinary stone disease varies widely throughout the world. It is reported to be as low as 0.5 to 1% in some Third World countries and as high as 10 to 15% in Scandinavia, Australasia and North America (17). Among all of the 1,521 controls who were routinely examined by ultrasonography for the detection of urinary stones in this study, 3 had asymptomatic urinary stones (bladder stones in 2 and lower ureteral stone in 1). Therefore, the point prevalence rate was 0.2 % in our study. Twenty-nine (1.9%) controls and 668 (56.8%) cases had had one or more recurrence. Therefore, in this study, the prevalence rate for urinary stones was 1.9% and the recurrence rate was 56.8%.

There is evidence of different patterns of stone incidence in industrialized and developing countries (10, 18-20). The incidence of urinary stones in Korea has been sharply increasing since the end of the 1970s when the GNP (gross national product) per head reached more than 1,000 dollars. Urinary stone is becoming one of the most common benign diseases. Korea has developed into an industrialized country and the life-style and dietary habits of the people have been dramatically westernized during the last decades. Accordingly, the incidence of urinary stones has increased to a great extent. In this racially homogenous country, the changing pattern in urinary stone prevalence may bear some important etiological implications.

Nationwide surveys have been previously performed in the United States (10, 18) and other countries (17, 20). However, the exact incidence of urinary stone disease among the general population still remains unknown. Sierakowski et al. (10) have calculated that approximately 12% of the US population will suffer from a urinary stone at least once in their life. The difference in frequency of urinary stones from country to country may have been caused by a variety of factors, such as life-style, nutrition, climate, or race, but exact answers still remain to be found.

Sexual difference existed in this survey, urinary stones were approximately twice as common in males as in females. This ratio does not differ from other reports from western countries (19, 20). The frequency of urinary stones by sex within a defined population as well as

nationwide shows a male : female ratio between 2:1 and 3:1 (12, 21).

Regarding age distribution, stone occurrence is high in the 4th to the 6th decade with the peak age in the 5th decade in our data. The age span of commonly affected generations is similar to that in western countries (19).

As the standard of living and the consumption of luxury goods have risen, so there has been a decrease in the general amount of exercise taken. A simultaneous increase in the incidence of urinary stones may be connected with these factors. The corresponding factors include a general gain in average body weight, and metabolic disorders such as gout and diabetes. Obesity is regarded as a risk factor for urinary stones. Horn et al. (22) reported that 83% of 149 stone patients were overweight. This is also true of the obese and the stone patients in our study in whom we calculated the BMI (body mass index) for grading obesity in the controls and the cases ($p<0.001$).

In the world literature there is some mention of the influence of occupation on stone formation. More recently, studies (23, 24) indicate that occupationally less active people seem to be more prone to develop stone disease. Sedentary occupations may be a contributory factor in the genesis of stones, since crystals may be trapped by gravity in upward-draining collecting tubules or in the inferior calices of the kidney. As Sutor and Wooley (25) reported, our data also showed that urinary stones are infrequent among unskilled workers. Lower prevalences are also noted among transport workers, clerical workers, and sales workers.

Every new stone throughout a patient's life is counted as a recurrence, irrespective of the type and location. Such a method results in a relatively high recurrence rate. In our own data the 56.8% recurrence rate is similar to the 41% - 77% of others' results (19, 26, 27).

Parents and siblings of stone formers have a greater possibility of developing stone disease, suggesting some environmental or inherited factors (28, 29). Ljunghall and Hedstrand (30) observed multiple recurrences of stones to be more common in patients with a family history of stones. In our survey, 24 (3.2%) of the 753 cases had a familial stone history, and this was higher than the 1.3% of the controls with significance ($p<0.01$).

Numerous dietary factors have been suggested to have an adverse effect on the incidence of urinary stone formation (31-33). These include a high intake of animal protein, refined carbohydrates or sugar, fat, ascorbic acid, oxalate, dairy products and a low intake of dietary fiber or vitamin B6. The increasing incidence of urinary stones can be attributed to the rapid change in the nutritional environment in Korea. Its incidence has consistently increased as intake of animal protein and milk have increased as Kwon (2, 3) reported. Unexpectedly, in our data, there are no such strong associations between stone formation and a high-protein diet or the intake of fat, refined carbohydrates or alcohol. Moreover, there is not an apparent relationship between stone formation and the intake of dairy products. However, there is a weak inverse relationship between the occurrence of stones and the consumption of fruit.

Finlayson (34) reported that the dilutional effects of water diuresis probably outweigh the changes in ion activity and therefore this helps to prevent stone formation. However, to be effective, a urine output of more than 3,600 ml/day would be theoretically necessary. Few patients ingest enough water to create such a high urinary output unless they are educated to do so. In our results, the volume of water ingested, the water intake before night sleep, and the kind of drinking water were not distinctively different between the controls and the cases. However, frequency of drinking water was significantly low in the cases.

Stress has been suggested to be a risk factor for urinary stone formation. A study on the effects of stress in stone formers and normal subjects showed that the patients produced marked increases in the urinary concentrations of calcium, oxalate and uric acid and small decreases in urinary magnesium (35). The reasons for the alterations in urinary biochemistry by stress are not yet clear. In our results, stress was not a risk factor for stone formation.

Anatomic anomalies and coexisting diseases were found in 24 cases and abnormal stone metabolism was found in 30.7% of the cases. Concerning the remainder we label as "idiopathic", our data are similar to the 70-80% incidence of idiopathic urolithiasis by Malek (36).

Changes in modes of treatment for urinary stones have occurred since endourological treatment and ESWL were introduced in 1987 in Korea. In our data, 81.6% of the cases were treated with endourological or ESWL treatments.

Uric acid stones comprise less than 5% of all urinary stones and 4.3% in our results. Cystine stones were found at an incidence of 0.3% in our study, which is less than the 1-2% of other countries (37, 38).

This survey showed that several environmental as well as intrinsic factors may have played an important role in the pathogenesis of urinary stones in Koreans. However, causative factors for each patient still remain to be identified. Urinary stones is a recurrent disease in many people and preventive measures must be based on such information. Important etiological factors of urinary stones may be illuminated by analyzing the accumulated data and comparing data from different countries. Future studies to identify the causes of increased risk will extend our understanding of the etiology of urinary stones and

may lead to new preventive therapies.

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