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National trend of the incidence of urolithiasis in Japan from 1965 to 1995

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National trend of the incidence of urolithiasis in Japan from 1965 to 1995.

Background. A nationwide survey of urolithiasis in Japan was made in order to evaluate the chronological trend of upper urinary tract stones in the Japanese. It succeeded previous studies done in 1955, 1966, 1979, and 1990.

Methods. All outpatient visits to urologists that resulted in a diagnosis of first-episode upper urinary tract stones in the years 1990 and 1995 were enumerated, irrespective of admission and treatment. The study enrolled all of the Japanese Board of Urology-approved hospitals, thereby covering nearly all urologists practicing in Japan. The annual incidence by sex and age was estimated and compared with the incidences in the previous nationwide surveys.

Results. The age-adjusted annual incidence of first-episode upper urinary tract stones in 1995 was estimated as 68.9 per 100,000 (100.1 in men and 55.4 in women), a steady increase from 54.2 in 1965. The annual incidence has increased in all age groups, except in those of the first three decades. The peak age for both sexes has shifted in toward the older population's direction. Estimations of longitudinal changes between 1965 and 1995 showed that the annual incidence has more than doubled for the cohort of the 1965 census population (from 43.7 in 1965 to 110.9 in 1995) and that younger generations have had progressively higher annual incidences.

Conclusions. The annual incidence of upper urinary tract stones in Japan has increased steadily over the past 30 years and will continue to do so in the near future, but it still is lower than in the United States.

The incidence of urolithiasis in Japan has steadily increased since the Second World War, which is a similar trend to other developed countries in Europe as well as the United States [1, 2]. During the full industrialization of Japan over the last decades, lifestyle and dietary habits have been dramatically Westernized. Idiopathic calcium urolithiasis in the upper urinary tract has become by far the most common type of urinary calculi. The changing pattern of urolithiasis in the Japanese population has been clearly demonstrated by the past four nationwide surveys on urolithiasis conducted in 1955 [3], 1966 [4], 1979 [5], and 1990 [6].

Extracorporeal shock wave lithotripsy (ESWL) and endourological treatments such as percutaneous nephrolithotripsy (PNL) and transurethral ureterolithotripsy (TUL), begun in Japan in 1984, fundamentally changed stone treatments in the subsequent years [6]. This development may have caused the change in the epidemiological trend of urolithiasis in Japan. Furthermore, Japan is the world's most rapidly aging society, and this aging is a comparatively recent phenomenon first observed in the 1970s. To evaluate the chronological trend of urolithiasis in Japan, we conducted the fifth nationwide survey on urolithiasis in cooperation with the Japanese Urological Association and Japanese Symposium on Urolithiasis Research.

METHODS

As of 1997, all 1193 Japanese Board of Urology-approved hospitals were enrolled in this retrospective study. Japanese Board of Urology-approved hospitals are general hospitals with ≥100 inpatient beds (including ≥15 beds in a urological department) or urological clinics with ≥50 inpatient beds. The enrolled hospitals were asked by a mailed questionnaire to investigate all outpatient visits in the years 1990 and 1995 that resulted in the diagnosis of urolithiasis. The diagnostic criterion of urolithiasis was defined as radiographic confirmation of stones. Patients with only a history of stone passage were excluded from the study. Urologists practicing in the enrolled hospitals reviewed the medical charts and abstracted the data. The survey questionnaire included items on the age and sex of the stone patients, locations of the stones (upper or lower urinary tract or both), and whether stones had developed for the first time in that patient's life. All of the stone patients were enumerated,

Key words: urinary tract stones, epidemiology, Japan, stones, calculi in upper urinary tract.

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Table 1. Enrolled and respondent hospitals in this study

	1990			1995		
	Hospitals	Beds	Patients with first-episode upper urinary tract stones	Hospitals	Beds	Patients with first-episode upper urinary tract stones
Enrolled hospitals	1,169	459,027		1,193	465,820	
Lithotripter (+)	227	106,931		475	218,977	
Lithotripter (−)	942	352,096		718	246,843	
Respondent hospitals	335	158,601	43,000	439	201,413	56,798
Lithotripter (+)	114	62,354	26,873	233	125,001	42,353
Lithotripter (−)	221	96,247	16,127	206	76,412	14,445

whether they were hospitalized or had treatment. Treatment modalities for urolithiasis in the years 1990 and 1995 were also investigated. The number of patients seen in each institution was entered in the survey questionnaire according to the items investigated. The same questionnaire has been used in the past and present nationwide surveys [5, 6].

Survey questionnaires were sent out in June 1997 to 534 of 1193 institutions that had replied that the investigation would be practicable. Final responses had been obtained from 439 (82.2%) of these hospitals by December 1997. The enrolled and respondent hospitals were located in both urban and rural areas throughout Japan.

To estimate the annual incidence, we enumerated only those patients with first-episode upper urinary tract stones. The total number of patients in Japan was estimated by the formula used in previous surveys [5, 6].

$$\text{Number of patients reported} \times \frac{\text{Total number of beds in the enrolled hospitals}}{\text{Total number of beds in the respondent hospitals}}$$

It should be noted that our estimation does not include stone patients seen only in private physicians' offices. The annual incidence was calculated as the estimated number of first-episode stone formers per 100,000 of the general population in the survey year (1990 or 1995). Data from the Population Census of Japan were used for that purpose. Life-long risk of urolithiasis was estimated by multiplying the annual incidence by the life expectancy at birth in a given year.

RESULTS

Estimated total number of urolithiasis patients

Table 1 shows the number of enrolled and respondent hospitals in this study. The total numbers of inpatient beds and of reported patients with first-episode upper urinary tract stones also are given based on whether the hospitals had lithotripters. The respondent hospitals covered 34.6% of the inpatient beds of the enrolled hospitals in 1990 and 43.2% of them in 1995. The number of patients was estimated separately for hospitals with and without lithotripters because the former accommodated 2.7 to 2.9 times more cases per institution and 1.9 to 2.3 times more patients per bed. The total number of patients in Japan was estimated by subtracting the proportion of patients who would have been double counted because of referral for ESWL (42%). The estimated number of patients with first-episode upper urinary tract stones in 1995 was as follows:

$$42{,}353 \times \frac{218{,}977}{125{,}001} + 14{,}445 \times \frac{246{,}843}{76{,}412} \times (1 - 0.42) = 101{,}300$$

Chronological changes in the annual incidence of upper urinary tract stones

Between 1965 and 1995, the entire Japanese population showed advanced aging, and the percentage of Japanese men and women ≥40-year-old, respectively, increased from 27.8% and 31.5% in 1965 to 48.0% and 51.9% in 1995 (Fig. 1). The age-adjusted annual incidence of upper urinary tract stones in Japan has also steadily increased from 54.2 in 1965 to 68.9 in 1995, accompanied by a decrease in the male to female ratio of 2.8 in 1965 to 1.8 in 1995 (Table 2). The risk of upper urinary tract stones occurring at some time in one's life was estimated to be 9.0% for men and 3.8% for women in 1995, a doubling of the value since 1965 (4.3% for men and 1.8% for women).

Table 3 shows chronological changes in the sex- and age-related annual incidence between 1965 and 1995. In men, the peak age of first-episode upper urinary tract stones has shifted from the 20s, 30s, and 40s (1965) to the 30s, 40s, and 50s (1995). In women, the peak age of the 20s in 1965 had shifted to the 50s and 60s by 1995. Whereas the annual incidence has remained relatively constant over the past 30 years for persons in their first decade, 10s, and 20s, there was a continuous increase after the age of 30.

Table 2. Annual incidence (per 100,000) of first-episode upper urinary tract stones

	1965	1971	1975	1980	1985	1990	1995
Annual incidence							
Men	63.8	73.0	75.7	78.9	91.6	93.8	117.5
Women	24.3	30.3	31.7	33.3	40.8	38.1	46.1
Total	43.7	51.2	53.4	55.7	65.7	65.5	80.9
Age-adjusted annual incidence[a]							
Men	81.3	84.8	80.5	78.9	86.0	83.3	100.1
Women	29.5	41.1	41.6	33.3	51.9	46.9	55.4
Total	54.2	58.6	56.4	55.7	62.0	58.4	68.9

[a] Ages were adjusted to those of the 1980 Japanese population

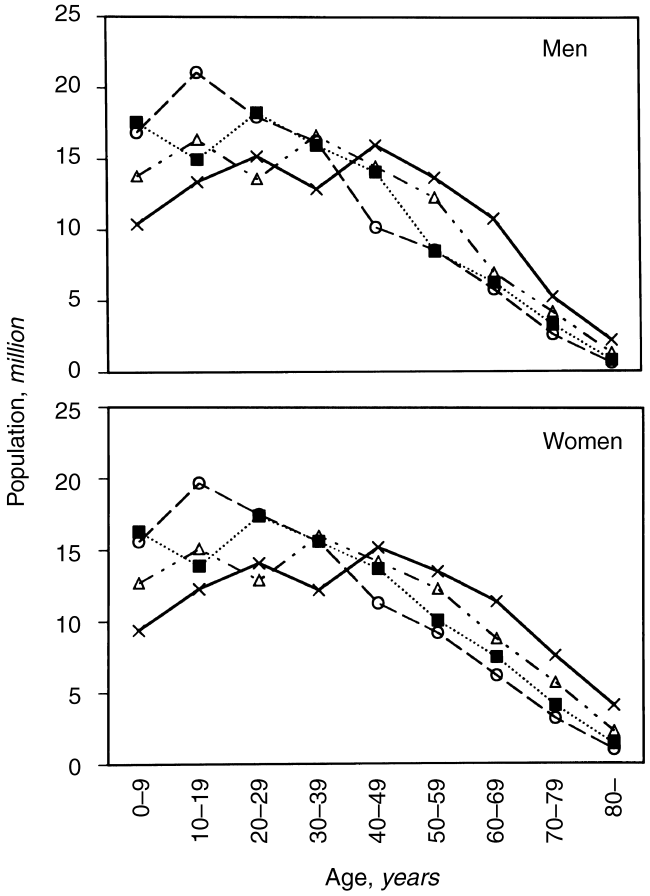

Fig. 1. Chronological change in age distribution of the entire Japanese population. Symbols indicate the census population; 1965 (○), 1975 (■), 1985 (△), and 1995 (×).

Because the past and present nationwide surveys of urolithiasis investigated the annual incidence for the entire Japanese population, we could calculate longitudinal changes in defined cohorts in that population (Fig. 2). For example, people born between 1926 and 1935, respectively, were in their 30s, 40s, 50s, and 60s in 1965, 1975, 1985, and 1995 (group 4). The younger the cohort, the higher the annual incidence became, especially in men. Furthermore, considering the entire Japanese population in 1965 (98.3 million) as a cohort, the annual incidence has steadily increased from 43.7 in 1965 to 64.0, 88.9, and 110.9, respectively, in 1975, 1985, and 1995.

Table 3. Time trends in sex- and age-related annual incidence (per 100,000) of first-episode upper urinary tract stones

Age	1965	1971	1975	1980	1985	1990	1995
Men							
0–9	1.6	2.4	1.9	1.0	1.0	0.9	1.0
10–19	11.0	17.7	14.8	16.4	17.1	11.7	12.7
20–29	105.1	95.3	90.2	85.1	100.4	83.3	95.1
30–39	114.4	122.9	120.3	116.1	132.3	135.8	176.0
40–49	116.1	136.4	141.4	143.3	149.2	146.5	171.0
50–59	84.4	100.3	121.1	133.7	152.1	155.4	182.5
60–69	59.0	71.5	80.4	96.3	118.9	132.5	158.9
70–79	37.8	43.9	54.6	65.1	82.1	86.3	116.8
≥80	21.0	17.0	27.7	32.6	40.7	46.0	53.0
Women							
0–9	0.3	0.4	0.7	0.5	0.7	0.5	0.7
10–19	7.3	14.6	12.1	10.5	13.6	9.3	9.1
20–29	47.4	47.8	44.9	42.6	47.0	39.2	43.0
30–39	36.2	44.0	45.4	41.8	49.2	42.9	51.4
40–49	38.9	41.8	45.4	52.5	55.7	49.0	60.9
50–59	30.1	41.2	49.7	56.8	72.7	70.1	78.7
60–69	21.3	31.9	39.3	45.6	62.0	57.8	72.5
70–79	10.2	13.9	17.3	23.3	36.5	40.7	53.6
≥80	3.6	2.1	5.6	12.5	12.6	13.1	26.1

Treatment modality for upper urinary tract stones

Table 4 shows chronological changes in the choice of interventional treatment for upper urinary tract stones (both first-episode and recurrent stones). Before the adoption of ESWL, open surgery was performed on 22.4% of stone patients. In 1990 and 1995, however, the percentage of patients receiving interventional treatment had increased to 42 to 43%. The majority of these patients were treated with ESWL (86 to 87% by ESWL monotherapy and 4% by ESWL combined with PNL and/or TUL), open surgery accounting for less than 3%.

DISCUSSION

Our nationwide surveys of urolithiasis have enrolled virtually all hospitals with practicing Japanese urologists. In 1996, 4440 (86%) of the 5174 urologists practicing in

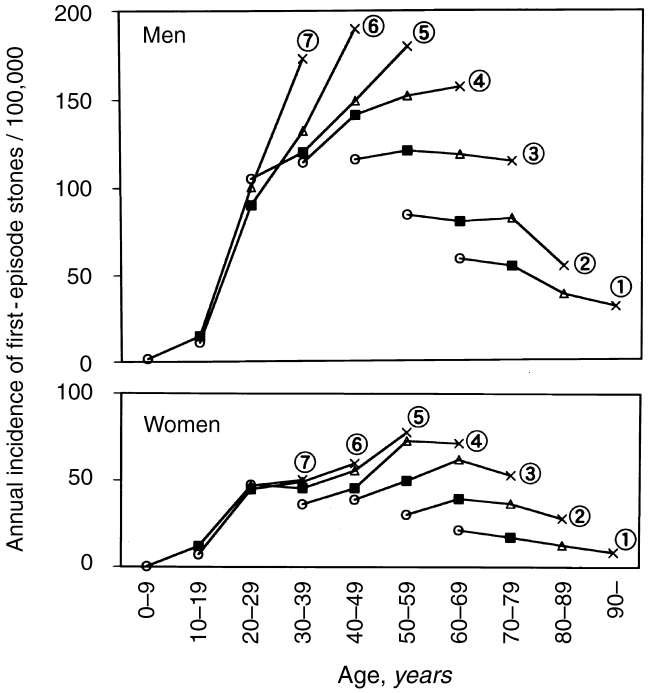

Fig. 2. Longitudinal changes in the annual incidence of upper urinary tract stones among different generations. Symbols indicate the annual incidences for 1965 (○), 1975 (■), 1985 (△), and 1995 (×), and the generations born in 1896–1905 (①), 1906–1915 (②), 1916–1925 (③), 1926–1935 (④), 1936–1945 (⑤), 1946–1955 (⑥), and 1956–1965 (⑦).

Japan were Japanese Board of Urology certified, and the majority of the others were urologists in training (data from the Japanese Urological Association and the Statistics and Information Department, Minister's Secretariat, Ministry of Health and Welfare of Japan). In Japan, a urologist must practice five years or more in a Japanese Board of Urology-approved hospital before qualification as a Japanese Board of Urology Certified Urologist.

The rationale for estimating the total number of urolithiasis patients from the actual number of reported patients and the ratio of inpatient beds in all hospitals to those in the respondent hospitals was based on the following data. Simple linear regression analysis showed that in 1980, the number of outpatient visits of first-episode stone patients (y) was linearly correlated with the number of inpatient beds (x), for example, $y = 0.159x$ ($P < 0.0001$, coefficient of determination, 0.761). Furthermore, the number of inpatient beds in the respondent hospitals was significantly higher than in nonrespondent hospitals (521 ± 241 vs. 336 ± 164 in 1980, $P < 0.0001$). Because stone patients in 1990 and 1995 were notably biased toward hospitals equipped with lithotripters, we estimated the total number of patients separately for institutions with and without lithotripters.

Clearly, our results underestimate the true incidence of urolithiasis because only stone patients diagnosed by urologists were included. In the survey of 1979 [5], however, 90.6% of the physicians practicing in private clinics replied that they would refer all or selected urolithiasis patients to urologists. We therefore presumed that the majority of stone patients visited urologists even though the actual percentage of those referred to urologists could not be determined.

Several epidemiological studies that were done in the United States and Japan are summarized in Table 5 (annual incidence) [7–15] and Table 6 (prevalence) [9, 14, 16]. Table 5 shows that the annual incidence in Japan has been lower than that in the United States. Although Iguchi et al in a population-based study (ages 20 to 59) in an urban satellite city in Japan reported an annual incidence of 971 per 100,000, their data may represent a geographic variation, because in our study, the incidence in the same age groups was 108 [14]. Table 6 shows that in the United States, the prevalence of stones in Asian Americans is lower than in whites. Johnson et al showed that cumulative incidence may be used to approximate the prevalence, on the assumption that the mortality for those with a history of urolithiasis does not differ from that for the general population [8]. Applying this procedure to our data, the estimate of prevalence shows a gradual increase from 3.6% and 1.4% in 1965 among men and women (age ≥ 30) to 5.2% and 2.1% in 1995, respectively, although these figures undoubtedly are underestimations. Furthermore, upper urinary tract calculi have become more common in the United States (Table 6) as well as in Japan.

Of particular interest is that 30-year longitudinal changes in the annual incidence for defined cohorts in the Japanese population can be estimated from our nationwide surveys (Fig. 2). This is the unique point of our study because the majority of published epidemiological surveys have been cross-sectional studies that did not account for chronological trends [17, 18]. As shown by the rapidly increasing annual incidence for the cohort of the entire Japanese population, as well as the progressively increasing annual incidence among the younger cohort groupings, there is sufficient evidence to predict that the occurrence of upper urinary tract stones will continue to increase in the near future. Furthermore, the peak age for first-episode upper urinary tract stones has moved in the elderly direction (Table 3). Older patients (≥60 years old) with first-episode upper urinary tract stones comprised 7.1% of all stone patients in 1965 but increased to 23.1% by 1995. This agrees with the findings of Gentle et al, which showed that geriatric stone formers (>65 years old) comprised 12% of all stone patients surveyed and that they commonly experienced the first symptomatic stone episode late in life (after age 50) [19]. Unfortunately, we failed to discriminate between symptomatic stone patients and incidental diagnoses.

Table 4. Frequency of interventional treatments for upper urinary tract stones

	1965–1980[a]	1985	1990	1995
No. patients reported[b]	74,444	44,038	59,600	82,022
No. patients receiving interventional treatment	16,672 (22.4%)	9,344 (23.6%)	25,313 (42.5%)	35,201 (42.9%)
ESWL (monotherapy or combined with PNL and/or TUL)[c]	0	1,765 (18.9%)	22,691 (89.6%)	32,091 (91.2%)
PNL and/or TUL[c]	0	2,619 (28.0%)	1,894 (7.5%)	2,538 (7.2%)
Conventional open surgery	16,672 (100%)	4,960 (53.1%)	725 (2.9%)	557 (1.6%)

Abbreviations are: ESWL, extracorporeal shock wave lithotripsy; PNL, percutaneous nephrolithotripsy; TUL, transurethral ureterolithotripsy.
[a] Sum of the years 1965, 1971, 1975, and 1980
[b] Both first and recurrent stone patients were included; patients referred to other hospitals were excluded
[c] ESWL, PNL, and TUL were begun in 1984

Table 5. Estimates of the annual incidence of urinary calculi in the United States and Japan

Authors [Reference]	Year(s) studied	Country	Area	Method	Sex[a]	Age	Stone location[b]	Annual incidence[c]
Boyce et al [7]	1952	USA	Nationwide	Hospital survey	B	All	B	94.7
Johnson et al [8]	1950–1974	USA	Rochester, Minnesota	Medical records	B	≥10	U	58.7–73.4
					M	≥10	U	78.5–123.6
					F	≥10	U	32.4–43.2
Hiatt et al [9]	1970–1972	USA	Northern California	Medical records	B	All	B	122
					M	All	B	181
					F	All	B	59
Sierakowski et al [10]	1974	USA	Nationwide	Hospital survey	B	All	B	164
Schey et al [11]	1977	USA	Forsyth County, North Carolina	Medical records	B	All	U	208
Thun et al [12]	1991	USA	Tennessee	Cohort study	M	30–69	U	421
Curhan et al [13]	1986–1992	USA	Nationwide	Cohort study	M	40–75	U	273–326
Iguchi et al [14]	1992	Japan	Kaizuka City (urban)	Population-based study	B	20–59	B	971
Takeuchi et al [15]	1991–1993	Japan	Tajima area (rural)	Medical records	B	All	U	93
This study	1995	Japan	Nationwide	Hospital survey	B	All	U	80.9[d]
					M	All	U	117.5[d]
					F	All	U	46.1[d]

[a] M, male; F, female; B, both sexes
[b] U, upper urinary tract stones; B, both upper and lower urinary tract calculi
[c] Annual incidence per 100,000
[d] Not age-adjusted

Table 6. Population-based prevalence of urinary calculi in the United States and Japan

Authors [Reference]	Year(s) studied	Country	Area	Race	Sex[a]	Age	Stone location[b]	Prevalence %
Hiatt et al [9]	1970–1972	USA	Northern California	White	M	30–69	B	2.8–6.0
					F			1.8–3.2
				Asian American	M			1.0–5.5
					F			1.3–1.0
Soucie et al [16]	1982	USA	Nationwide	White	M	≥30	U	8.9
					F			3.4
				Asian American	M			5.7
					F			1.7
Stamatelou et al[c]	1976–1980	USA	Nationwide	All	M	20–74	U	4.9
					F			2.8
	1988–1994	USA	Nationwide	All	M	20–74	U	6.32
					F			4.09
Iguchi et al [14]	1992	Japan	Kaizuka City (urban)	Japanese	M	20–59	B	9.64
					F			4.51

[a] M, male; F, female
[b] U, upper urinary tract stones; B, both upper and lower urinary tract calculi
[c] Abstract; *J Urol* 159:141A, 1998

Such data would be helpful for determining whether the time trend can be ascribed to the increased use of diagnostic imaging or to an increase in symptomatic stone disease.

The increased use of interventional treatments is clearly the result of the widespread use of ESWL. The number of lithotripters in Japan has increased explosively from 13 in 1986 to 258 in 1990 and 528 in 1995 (cumulative data from the monthly journal *Shin-iryo*). The total number of patients with upper urinary tract stones (both first-episode and recurrent stones) was estimated as 115,500 in 1990 and 147,700 in 1995. The total number of patients treated by ESWL was therefore estimated as 44,000 in 1990 and 57,800 in 1995. The decrease in the number of patients per institution (171 in 1990 and 109 in 1995) may reflect the saturation of lithotripters in Japan.

In summary, we conducted national-level hospital surveys of urolithiasis in order to investigate age and sex distributions of upper urinary tract stones between 1965 and 1995. The annual incidence in Japan has steadily increased over the past 30 years, but it still is lower than that in the United States. Longitudinal follow-ups of defined cohorts in the Japanese population revealed a rapid increase in the annual incidence for the entire Japanese population, as well as a progressive increase in annual incidence in the young generations.

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