Epidemiology of Upper Urinary Tract Stone Disease in a Taiwanese Population: A Nationwide, Population Based Study

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Abbreviations and Acronyms

LHID2005 = Longitudinal Health Insurance Database 2005

NHI = National Health Insurance

NHIRD = NHI Research Database

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Purpose: We investigated the epidemiology of upper urinary tract stone disease in Taiwan using a nationwide, population based database.

Materials and Methods: This study was based on the National Health Insurance Research Database of Taiwan, which contains data on all medical beneficiary claims from 22.72 million enrollees, accounting for almost 99% of the Taiwanese population. The Longitudinal Health Insurance Database 2005, a subset of the National Health Insurance Research Database, contains data on all medical benefit claims from 1997 through 2010 for a subset of 1 million beneficiaries randomly sampled from the 2005 enrollment file. For epidemiological analysis we selected subjects whose claims records included the diagnosis of upper urinary tract urolithiasis.

Results: The age adjusted rate of medical care visits for upper urinary tract urolithiasis decreased by 6.5% from 1,367/100,000 subjects in 1998 to 1,278/100,000 in 2010. There was a significantly decreasing trend during the 13-year period in visits from female and all subjects ($r^2 = 0.86$, $p = 0.001$ and $r^2 = 0.52$, $p = 0.005$, respectively). In contrast, an increasing trend was noted for male subjects ($r^2 = 0.45$, $p = 0.012$). The age adjusted prevalence in 2010 was 9.01%, 5.79% and 7.38% in male, female and all subjects, respectively. The overall recurrence rate at 1 and 5 years was 6.12% and 34.71%, respectively. Male subjects had a higher recurrence rate than female subjects.

Conclusions: Our study provides important information on the epidemiology of upper urinary tract stone disease in Taiwan, helping to quantify the burden of urolithiasis and establish strategies to decrease the risk of urolithiasis.

Key Words: urinary tract, urolithiasis, epidemiology, Taiwan, risk

Among urinary tract disorders, urolithiasis is an important, costly cause of morbidity.[1] It also puts a strain on health care systems with an estimated annual expenditure in 2001 in the United States of $2.1 billion.[2,3] Urolithiasis affects patients of all ages and with a prevalence rate of 5% to 12% in men and 4% to 7% in women.[3–5] Previous series indicated an increasing trend in stone frequency in the last quarter of the twentieth century in each gender.[3–6] Increased detection of asymptomatic stones by current radiological studies with improved sensitivity may partly explain this increase in prevalence.[7]

Epidemiological studies also show geographic and racial variations.[4,6,8–11] Most prior series were based on pa-

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tient reported outcomes, hospital records and health care organization databases.[1,12–14] Few population based studies of the epidemiology of urolithiasis have been done outside the United States.[8,9,11]

We investigated the epidemiology of upper tract urolithiasis in Taiwan using a single payer, nationwide, population based health insurance database.

MATERIALS AND METHODS

Data Sources

National Health Insurance Research Database. The Taiwan NHI Bureau has collected the records of all inpatient and outpatient medical benefit claims for almost the entire population of Taiwan since the inception of the single payer NHI program in 1995. As of 2005, the NHI covered 22,717,053 enrollees, representing almost 99% of the population of Taiwan. The entire data collection is known as the NHIRD.

Longitudinal Health Insurance Database 2005. This study was based on a subset of the NHIRD known as the LHID2005, which contains all inpatient and outpatient medical benefit claims from 1998 through 2010 for a sample of 1 million enrollees randomly drawn from the 22.72 million individuals in the NHI registry of beneficiaries in 2005. The 1 million de-identified individuals in the LHID2005 provide a good statistical representation of the entire population of Taiwan.[15]

Study Sample

To assess the annual rate of medical care visits for upper tract urolithiasis, we first identified all patients enrolled in NHIRD during the study period of 1998 to 2010 whose claims records included at least 1 diagnosis of upper tract urolithiasis. The diagnosis was identified by ICD-9-CM codes 592.X and 274.11. From the LHID2005 we selected subjects whose claims records included at least 1 diagnosis of upper tract urolithiasis. To minimize the effects of coding errors in diagnosis, we kept only those whose claims records included the additional diagnostic codes for radiological imaging, ultrasound and urinalysis. We excluded from analysis subjects whose claims data were missing from subsequent rate calculations.

Definitions

Annual rate of medical care visits for upper urinary tract stone disease. To calculate the annual rate of medical care visits for upper tract urolithiasis per 100,000 individuals, we determined the number of NHIRD enrollees whose claims record included at least 1 diagnosis of upper tract urolithiasis during each calendar year. This value was divided by the number of the Taiwanese population midway through the calendar year. An estimated average of 22,594,785 subjects were enrolled during the study period of 1998 to 2010.

Prevalence rate in 2010. The prevalence rate was defined as the proportion of subjects with 1 or more stone events in their claim records among our LHID2005 study sample. Prevalence rates were determined by the number of subjects with diagnosis codes for urolithiasis with additional diagnostic procedures from all claims records divided by the total population in the corresponding age and gender specific categories.

Recurrence rate. The recurrence rate was assessed by calculating the subject annual recurrence rate after the initial stone event. We defined recurrence by limiting the interval between 2 urolithiasis episodes to more than 180 days. If the interval between a subsequent stone event and the initial diagnosis was less than 180 days, the subsequent stone event was arbitrarily defined as residual urolithiasis rather than recurrence. The 180-day interval was chosen after comparing different cutoff values of 90, 120 and 180 days, and determining that 180 days best excluded complications or ongoing care from the initial diagnosis while still allowing the capture of additional stone recurrences beyond 180 days.

Statistical Analysis

Statistical analysis was performed using SAS®, version 9.1. The temporal trend was determined using linear regression analysis. The age adjusted rate of visiting medical care and the prevalence rate were based on the WHO standard population in 2000. Statistical significance was considered at 2-tailed $p \leq 0.05$.

RESULTS

The supplementary table (http://jurology.com/) and figure 1 show the annual rate of medical care visits for upper tract urolithiasis per 100,000 subjects during the study period of 1998 to 2010 based on the NHIRD database. In the population the age adjusted rate of medical care visits for upper tract urolithiasis decreased from 1,367/100,000 subjects in 1998 to 1,278/100,000 in 2010, resulting in a 6.5% reduction ($r^2 = 0.86$, $p = 0.001$). Similarly, the rate of female patients seeking medical care for upper tract urolithiasis decreased from 1,177/100,000 female population in 1998 to 868/100,000 in 2010, resulting in a 26.2% reduction ($r^2 = 0.52$, $p = 0.005$). In contrast, medical visits by male patients with upper tract urolithiasis increased by 8.9%, from 1,557/100,000 population in 1998 to 1,695/100,000 in 2010. A significantly increasing trend in the male population was observed during the 13-year period ($r^2 = 0.45$, $p = 0.012$). The peak age range of patients seeking medical care for upper tract urolithiasis was 60 to 69 years for each gender. The male-to-female ratio of patients seeking medical visits for upper tract urolithiasis increased from 1.32 in 1998 to 1.95 in 2010.

We then analyzed the LHID2005 to determine the prevalence rate of upper tract urolithiasis in Taiwan in 2010. A total of 109,446 subjects were diagnosed with upper tract urolithiasis during the 13-year period, of whom 98,806 (59,346 males and 39,460 females) had further diagnostic claims confirming the urolithiasis diagnosis. In this sample urolithiasis was diagnosed at outpatient clinics in 79,033 of subjects (80.0%), at an emergency department in 9,977 (10.1%) and during inpatient hospitalization in 9,796 (9.9%).

Figure 1. Annual rate of medical care visits for upper urinary tract urolithiasis in Taiwan from 1998 to 2010

Table 1 and figure 2 show the prevalence rates of upper tract urolithiasis in 2010 categorized by patient age and gender. The age adjusted prevalence in 2010 in male and female subjects, and overall was 9.01%, 5.79% and 7.38%, respectively. The prevalence rate increased as each gender aged with the peak prevalence in the 60 to 69-year age range (19.4%). This decreased after age 70 years.

The recurrence rate was defined as 2 episodes of urolithiasis occurring more than 180 days apart. Table 2 lists the 1 to 5-year recurrence rates in males, females and overall. The overall recurrence rate at 1 and 5 years was 6.12% and 34.71%, respectively. Males had a recurrence rate similar to that of females at 1 year but a higher rate at 5 years.

Table 1. *Prevalence rate of upper urinary tract stone disease in 2010 by patient gender and age*

Age	% Female	% Male	% Overall
Less than 10	0.15	0.27	0.22
10–19	0.32	0.47	0.40
20–29	2.54	3.73	3.07
30–39	5.96	10.76	8.30
40–49	9.22	17.12	13.17
50–59	13.52	20.35	16.94
60–69	16.83	22.16	19.44
70–79	16.56	21.46	18.92
80 or Greater	13.22	17.23	15.31
Crude	7.93	12.21	10.04
Age adjusted*	5.79	9.01	7.38

* Based on 2000 WHO world standard population.

DISCUSSION

Urolithiasis is a common, significant health problem that appears to be increasing in frequency in recent decades in each gender.[4,6,8,11–14] Previous studies showed that the prevalence of urolithiasis varies greatly by patient age, gender, race and geographic area.[4,6,8–13,16,17] A recent population based study in the NHANES (National Health and Nutrition Examination Survey) cohort indicated that the urolithiasis prevalence in the United States increased by 5.2% from 1988 to 1994 compared to 3.8% in 1976 to 1980.[4] A subsequent study using the same data set revealed that in 2007 to 2010 the prevalence increased to 8.8% (10.6% in males and 7.1% in females).[6]

Few national studies of the temporal trends of renal stone prevalence have ever been done outside the United States. Hesse et al reported that the prevalence of urolithiasis increased from 4% to 4.7% from 1979 to 2001 in Germany.[8] In Japan a nationwide survey demonstrated an increase in the annual incidence of upper tract urolithiasis from 1965 to 2005 of 54.2/100,000 to 114.3/100,000 individuals.[11] Interestingly, in Iceland the age adjusted prevalence was 4.3% in men and 3.0% in women 30 to 79 years old with no significant increase with time.[9]

In our population based study the age adjusted rate of patients seeking medical care for upper tract urolithiasis significantly decreased in the total and female populations but increased in males each year from 1998 to 2010. Moreover, the age adjusted prevalence of upper tract urolithiasis in 2010 was 7.35% overall,

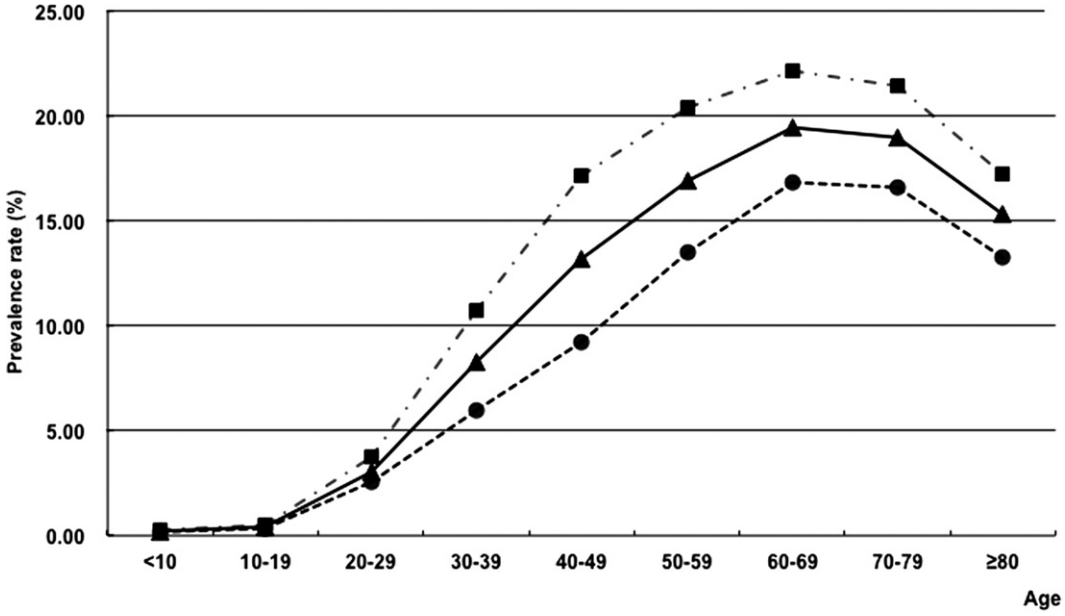

Figure 2. Upper urinary tract urolithiasis prevalence rate by gender and age in 2010. Squares indicate male. Circles indicate female. Triangles indicate overall.

5.77% in females and 8.97% in males. In our study the age adjusted prevalence of upper tract urolithiasis in 2010 was similar to that previously described in the United States and other countries.[6,8,9,11,17]

The increasing use and sensitivity of radiology studies may partly explain the increase in the urolithiasis prevalence.[6,7] To examine this possibility, we analyzed the use of radiology studies in our subjects before enrollment and in other subjects without urolithiasis. Radiology use was significantly higher in study subjects with urolithiasis than in those without urolithiasis. Further studies are warranted to clarify the impact of radiology use on the stone prevalence in claims based data analyses.

Table 2. *Upper urinary tract stone disease recurrence within 1 to 5 years*

	No. Pts/No. Recurrence (%)*
Overall (within yrs):	
1	98,806/6,045 (6.12)
2	93,373/14,772 (15.82)
3	87,371/19,927 (22.81)
4	81,203/23,615 (29.08)
5	75,361/26,157 (34.71)
Male (within yrs):	
1	59,346/3,252 (5.48)
2	56,094/9,585 (17.09)
3	52,423/13,031 (24.86)
4	48,766/15,512 (31.81)
5	45,161/17,240 (38.17)
Female (within yrs):	
1	39,460/2,128 (5.39)
2	37,279/5,187 (13.91)
3	34,948/6,896 (19.73)
4	32,437/8,103 (24.98)
5	30,200/8,917 (29.53)

* Recurrence defined as episodes occurring more than 180 days apart.

Previous studies demonstrated demographic and regional variation in the renal stone prevalence.[4,6,10,14] In a study in the United States Soucie et al noted that the stone prevalence increased with age until 70 years and then decreased.[10] The prevalence was higher in men vs women and in white vs black patients. The prevalence in Hispanic and Asian men was intermediate between that in white and black men. The marked variation in the frequency of urolithiasis by age, gender, race and geographic location may be attributable to factors of genetics, environment, lifestyle and medical access.[3–5,8,10,11,16,18]

A decrease in the male-to-female ratio was suggested in several recent series.[14,19,20] NIS (Nationwide Inpatient Sample) data on the prevalence of upper tract stone from 1997 to 2002 revealed that the male-to-female ratio of treated urolithiasis changed from 1.7:1 to 1.3:1.[14] This was much lower than the commonly reported 2:1 to 3:1 ratio.[5,10,11,20] In our series male subjects had a higher rate of medical care visits for urolithiasis and a higher prevalence rate for upper tract urolithiasis than females. The male-to-female ratio of the rate of medical care visits for upper tract urolithiasis increased from 1.32 in 1998 to 1.95 in 2010. The age adjusted prevalence rate in 2010 in male and female subjects was 9.01% and 5.79% with a male-to-female ratio of 1.56.

Although most patients had only 1 stone episode during our study period, 25% experienced recurrent

episodes.[8] The estimated recurrence rate is 10% within 1 year and 35% to 50% within 5 years.[3,13] While few studies provide reliable information on the recurrence rate, case series indicate that stones form in 30% to 40% of untreated patients within 5 years after the initial episode.[21] We noted that the overall recurrence rate at 1 and 5 years was 6.12% and 34.71%, respectively. Also, males had a higher recurrence rate than females.

The current series is based on records generated by the accessible, well used NHI system in Taiwan. There were several advantages of using the NHIRD. 1) The NHIRD is a nationwide, population based database that includes all medical claims for more than 22 million Taiwanese enrollees, representing more than 99% of the population of the island.[15] Of the enrollees 98.38% were retained in the data set during the study period. Therefore, results represent the general population as a whole. Also, our study population was homogeneous. More than 98% of the population of Taiwan are of Han Chinese ethnicity, minimizing effects originating from variations in race and medical access.[22] 2) The database contains original claim records for the studied population and was not designed for academic study. This attenuated patient selection bias. 3) The NHIRD includes all inpatient and outpatient data, while most diagnoses of urolithiasis are made on an outpatient basis. Therefore, we avoided the bias of underestimating the number of cases, as in previous studies including only inpatient data.

Since there is a high risk of recurrent urolithiasis, exact epidemiological data can only be obtained in a large cohort with long-term followup. To look beyond the hospital based databases and individual self-reported stone events from surveys or questionnaires used in previous studies, we assessed the annual rate of medical care visits for upper tract urolithiasis using the NHIRD database, representing 99% of the whole population of Taiwan, to clarify the temporal trend of urolithiasis.

We emphasize that the rate of patients seeking medical care for urolithiasis is not a complete representation of the frequency of urolithiasis. To calculate the prevalence rate in 2010, we used the LHID2005, which contains all medical claims from 1997 to 2010 for a sample of 1 million beneficiaries randomly drawn from the 22.72 million individuals enrolled in the NHI during any part of 2005. The LHID2005 does not contain medical claim records before 1997, which may have resulted in underestimating the prevalence due to ignoring stone events before 1997.

Our study is limited because it was retrospective. Also, the NHIRD lacks some important clinical data, such as body weight and height, laboratory data on metabolic evaluation, and stone composition, size and location. Above all, this data set does not reflect age at urolithiasis onset since prior urolithiasis episodes beyond the database are unknown.

Furthermore, all NHI system claims and billing records are subject to a strict quality control process, in which medical charts are spot checked by qualified record review teams. Therefore, we used principal ICD-9-CM codes for upper tract urolithiasis and further diagnostic claim data as study entry criteria. However, bias inevitably exists since simply checking for the performance of a diagnostic test without knowing what it revealed does not necessarily validate that subjects had urolithiasis. We believe that adopting relatively strict criteria would improve the quality of this study.

CONCLUSIONS

The current study provides important information on the epidemiology of upper urinary tract urolithiasis in a Taiwanese population. Epidemiological features derived from this study may help further investigations aimed at understanding the etiology of urolithiasis.

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