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ORIGINAL CONTRIBUTION

Epidemiology of Hyperuricemia in the Elderly

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Background: *Our study used data collected in Chung-Hsing Village to evaluate the relationship between hyperuricemia and the cardiovascular risk factors and the socio-demographic factors in the elderly in May 1998.*

Methods: *All individuals aged 65 and over were studied. A total of 1093 subjects, out of 1774 registered residents, were contacted by face-to-face interview. The response rate was 61.6 percent. However, only 586 respondents had blood tests and completed questionnaires. Analysis in this study was based on these 586 subjects. To study the significant correlates of hyperuricemia, t- test, two-way ANOVA, chi-square test and multivariate logistic regression were used.*

Results: *Our results showed that 66 percent were men and 34 percent were women. The mean age was 73.1 ± 5.3 years. The proportions of hyperuricemia were 57.3 percent in men and 40.9 percent in women ($p < .01$). In chi-square test, hypercholesterolemia, hypertriglyceridemia, renal function impairment, retirement status and marital status were related to hyperuricemia. After controlling the other covariates, the multivariate logistic regression analysis showed that the significant related factors of hyperuricemia were hypercholesterolemia, hypertriglyceridemia, and renal function impairment.*

Conclusions: *Hyperuricemia is often found in the elderly. Hyperuricemia is more common in elderly men than in elderly women. A large-scale investigation will be suggested in the future to address causal-effect issues between hyperuricemia and hypercholesterolemia, hypertriglyceridemia, or renal function impairment.*

INTRODUCTION

Gout usually affects the middle-aged men (aged 40 to 60) and postmenopausal women [1], and gout is much more common in men than in women [2]. Hyperuricemia is the hallmark of gout [3], but gout and hyperuricemia are not the same thing. Each can develop without the other [1]. The relationship between hyperuricemia and hypertension or other metabolic diseases, such as

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[e] *Abbreviations:* BMI, body mass index.

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Table 1. Serum uric acid levels and the proportions of hyperuricemia in the elderly by age and gender.

Age (years)	Uric acid (μmol/L)	Normal (%)	Hyperuricemia (%)	P value
Men:				
65-69	465.6 ± 105.4***	29 (30.2)	67 (69.8)	**0.031**
70-74	429.7 ± 112.8**	57 (44.5)	71 (55.5)	
75-79	430.2 ± 105.4*	55 (47.8)	60 (52.2)	
≥80	420.6 ± 95.8	24 (51.1)	23 (48.9)	
Subtotal	437.6 ± 107.7***	165 (42.7)	221 (57.3)	
Women:				
65-69	372.6 ± 86.7***	41 (58.6)	29 (41.4)	0.747
70-74	376.3 ± 93.1**	38 (61.3)	24 (38.7)	
75-79	383.9 ± 114.5*	22 (62.9)	13 (37.1)	
≥80	384.2 ± 106.7	13 (50.0)	13 (50.0)	
Subtotal	376.7 ± 95.5***	114 (59.1)	79 (40.9)	

* $p < .05$, ** $p < .05$, *** $p < .001$.

diabetes mellitus, obesity and hyperlipidemia, is well discerned in Caucasian populations [4-7]. The population aged 65 years or older has exceeded 7.0 percent in Taiwan since 1994, and a continued increase in numbers of elderly people is detected [8]. Up to now, there is scanty information on the association between hyperuricemia and the cardiovascular risk factors or the sociodemographic factors in the Taiwanese elderly. Thus, it is time to pay attention to the health status of elderly people in this country.

For early detection of hyperuricemia and early identification of its correlates and early intervention for hyperuricemia, during a series of comprehensive studies in the elderly living in Chung-Hsing Village in Taiwan, the prevalence of hyperuricemia was investigated. The association between hyperuricemia and its correlates was also examined.

MATERIALS AND METHODS

In May 1998, a cross-sectional study was conducted in Chung-Hsing Village in Taiwan. All individuals aged 65 and over were candidates for study, totally 1774 subjects according to the official household registration records. A total of 1093 subjects, out of 1774 subjects, participated in this study. The response rate was 61.6 percent. However, only 586 respondents had blood tests and completed questionnaires. Analysis in this study was based on these 586 subjects. Information about the subject socioeconomic status, family structure and educational level was collected by face-to-face interview by well-trained interviewers.

The subject educational level was classified into: junior high school or less, senior high school, professional training college, and undergraduate, or graduate. If the subject had retired from work, that status was identified. If the subject still lived with a spouse, the marital status was defined as living together. If not, the marital status was defined as living alone.

Blood pressure was measured by a mercury sphygmomanometer in the sitting position. Weight and height were measured. Blood samples were obtained in the morning after a 12-hour overnight fast. A number of biochemical markers, such as total cholesterol, triglyceride, fasting glucose, creatinine and uric acid were analyzed by a biochemical autoanalyser (Chem1$^+$, Technicon, USA) at the Depart-

Table 2. Correlates of hyperuricemia (men ≥ 416.5 μmol/l; women ≥ 386.8 μmol/l) in chi-square test in the elderly.

Variate	Total number	Hyperuricemia number (%)	P value
Body mass index (BMI ≥ 28 kg/m^2):			
No	498	249 (50.0)	0.059
Yes	70	44 (62.9)	
Systolic pressure ≥ 140 (mmHg):			
No	378	193 (51.1)	0.848
Yes	197	103 (52.3)	
Diastolic pressure ≥ 90 (mmHg):			
No	451	225 (49.9)	0.176
Yes	124	71 (57.3)	
Total cholesterol ≥ 5.18 (mmol/l):			
No	297	138 (46.5)	**0.018**
Yes	286	162 (56.6)	
Triglyceride ≥ 2.26 (mmol/l):			
No	455	224 (49.2)	**0.035**
Yes	126	76 (60.3)	
Fasting glucose ≥ 6.05 (mmol/l):			
No	465	241 (51.8)	0.867
Yes	117	59 (50.4)	
Creatinine ≥ 132.6 (μmol/l):			
No	405	172 (42.5)	**0.001**
Yes	176	127 (72.2)	
Educational level:			
Junior high school or less	164	70 (42.7)	0.065
Senior high school	152	84 (55.3)	
Professional training college	71	37 (52.1)	
Undergraduate or graduate	133	75 (56.4)	
Retirement status:			
Non-retired	150	62 (41.3)	**0.005**
Retired	433	238 (55.0)	
Marital status:			
Living together	425	231 (54.4)	**0.033**
Living alone	157	69 (44.0)	

ment of Clinical Laboratory of Chung-Hsing Hospital within 4 hours of collection.

Body mass index (BMI)[e] was measured as follows: weight (kg) divided by height (m)^2. BMI ≥ 28 was defined as obesity; 25 ≤ BMI < 28 as overweight; 20 ≤ BMI < 25 as normal; and BMI < 20 as underweight [9]. Hypercholesterolemia was defined as total cholesterol ≥ 5.18 mmol/l, and hypertriglyceridemia was defined as triglyceride ≥ 2.26 mmol/l [10]. Hyperglycemia was defined as fasting glucose ≥ 6.05 mmol/l [11]. Subjects were

considered to have high blood pressure if the average of three readings exceeded 140 mmHg systolically and/or 90 mmHg diastolically [12]. Hyperuricemia was defined as serum uric acid ≥ 416.5 μmol/l in men and ≥ 386.8 μmol/l in women [13]. Renal function impairment was defined as creatinine ≥ 132.6 μmol/l [14].

The statistical analyses were performed by the aid of a SAS package (Version 6.12, SAS Institute Inc., Cary, North Carolina). The methods of statistical analysis applied in this study were t test, two-way ANOVA, chi-square test and multivariate logistic regression. A p value less than .05 was considered statistically significant.

RESULTS

Among 1093 subjects, 65.7 percent were men and 34.3 percent were women. The mean age was 73.5 ± 5.6 years. Our study disclosed that 66 percent were men and 34 percent were women out of 586 subjects. The mean age was 73.1 ± 5.3 years. We performed chi-square test and t-test to examine the gender and age distributions between these two samples. No significant difference was observed. Therefore, the potential non-response bias could be minimized. So it is justified to look at the respondents as a representative subjects in Chung-Hsing Village.

Table 1 showed the mean value of serum uric acid and the proportions of hyperuricemia for both genders in different age groups. The mean value of serum uric acid was 437.6 ± 107.7 μmol/l in men and 376.7 ± 95.5 μmol/l in women ($p < .001$). The mean value of serum uric acid was statistically different between men and women for each age group ($p < .001$, $p < .01$, $p < .05$, respectively), except at aged 80 or over. Men at age 65 to 69 had the highest value of serum uric acid. The proportions of hyperuricemia were 57.3 percent in men and 40.9 percent in women ($p < .01$). Men at age 65 to 69 had the highest proportion of hyperuricemia. The proportion of hyperuricemia also decreased with age in men ($p < .05$). There was no relationship between age and the proportion of hyperuricemia in women.

The results of chi-square test for hyperuricemia among the cardiovascular

Table 3. Multivariate logistic regression of hyperuricemia (men ≥ 416.5 μmol/L; women ≥ 386.8 μmol/L) in the elderly.

Variable	EP (SE)	OR	95% CI
Intercept	-0.4 (0.3)		
Gender (men as reference):			
Women	-0.4 (0.3)	0.7	0.4-1.2
Total cholesterol (< 5.18 mmol/L as reference):			
≥ 5.18	0.5 (0.2)	1.7	**1.2-2.4****
Triglyceride (< 2.26 mmol/L as reference):			
≥ 2.26	0.4 (0.2)	1.6	**1.003-2.4***
Creatinine (< 132.6 μmol/L as reference):			
≥ 132.6	1.2 (0.2)	3.2	**2.1-4.8*****
Retired (non-retired as reference):			
Retired	0.1 (0.3)	1.1	0.6-2.0
Marital status (living together as reference):			
Living alone	-0.4 (0.2)	0.7	0.5-1.0

EP, estimated parameter; SE, standard error; OR, odds ratio; CI, confidence interval.
* $p < .05$, ** $p < .01$, *** $p < .001$

risk factors and the sociodemographic factors were shown in Table 2. The significant correlates of hyperuricemia were hypercholesterolemia, hypertriglyceridemia, renal function impairment, retirement status and marital status.

The results of multivariate logistic regression for hyperuricemia were shown in Table 3. After controlling the other covariates, the significant correlates of hyperuricemia were hypercholesterolemia (odds ratio = 1.7, 95 percent confidence interval = 1.2 to 2.4, $p < .01$), hypertriglyceridemia (odds ratio = 1.6, 95 percent confidence interval = 1.003 to 2.4, $p < .05$), renal function impairment (odds ratio = 3.2, 95 percent confidence interval = 2.1 to 4.8, $p < 0.001$). That is, people with hypercholesterolemia were more likely to have hyperuricemia than people with normal serum total cholesterol. People with hypertriglyceridemia were more likely to have hyperuricemia than people with normal triglyceride. People with renal function impairment were more likely to have hyperuricemia than people with normal renal function. No significant association was found between hyperuricemia and gender, retirement status or marital status.

DISCUSSION

Because the sample is small, we thought that the elderly in this community really cannot be representative of the Taiwanese elderly. However, this study could provide the background data for further studies on the epidemiology of hyperuricemia and its related factors in the Taiwanese elderly.

Hyperuricemia is a metabolic disorder frequently found in the general population [13, 15-16]. The overall prevalence of hyperuricemia in the Tecumseh and Framingham studies was 5 percent [15-16]. Uric acid concentration was usually 29.8 μmol/l lower in women than in men, maybe due to the different hormonal status of men and women, especially estrogen [7, 13, 15]. Renal excretion of uric acid was reduced by androgens and increased by estrogen [17].

In the Chen study, the hyperuricemic rates were 29.3 percent in adult men and 16.0 percent in adult women [18]. In our study, the proportions of hyperuricemia were 57.3 percent in men and 40.9 percent in women. Therefore, elderly men were more likely to have hyperuricemia than elderly women. However, age was a major determinant for hyperuricemia [19]. Serum uric acid also increased with age in males until about 19 years, when steady adult level was reached [7]. Because all of our subjects were elderly people, whose estrogen levels should be low, renal excretion of uric acid should be decreased in the elderly [17]. Thus, the hyperuricemic rates in our study were higher than in previous reports [15-16, 20]. In the other hand, estrogen level should be low in elderly women, but elderly men still had higher level of uric acid than elderly women (437.6 ± 107.7 μmol/l vs. 376.7 ± 95.5 μmol/l, $p < .001$). Therefore, androgen might play an important role in excretion of uric acid [17].

In Li's study, uric acid level was higher in hypertensive than non-hypertensive people [21]. Body mass index and serum triglyceride were strongly associated with serum uric acid [21]. In the other reports, hyperuricemia was often associated with obesity, diabetes, hyperlipidemia and hypertension [7, 13, 22-24]. Therefore, this association suggested the same pathogenesis for hyperuricemia, hyperglycemia and hyperlipidemia, and hypertension [7, 13, 22-24]. These findings further indicated that metabolic disorders would often cluster within the same individual [7, 13, 20, 22-24]. In our study, hyperuricemia was significantly associated with hypercholesterolemia and hypertriglyceridemia. However, no significant association was found between hyperuricemia and obesity,

hypertension, or hyperglycemia. This might be due to racial, dietary or environmental factors, but the real cause needs further investigation.

In our study, hyperuricemia was significantly associated with renal function impairment, which was similar to the previous reports [7, 14, 25]. The increase in serum uric acid might be due to age-related decline in renal function [7, 25]. Because creatinine was an index of renal function, this finding also indicated strong renal involvement in the balance of serum uric acid [25].

In conclusion, because of inherent limitation of our cross-sectional study, we cannot address any causal-effect hypothesis between hyperuricemia and hypercholesterolemia, hypertriglyceridemia or renal function impairment. In this study, many factors, such as dietary habits, cigarette smoking, alcohol consumption, and history of diuretic use, all of which might influence the serum uric acid, were not included in detail. Whether these factors affecting the study results still needs further large-scale investigation.

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