Prevalence of Hyperuricemia and the Relationship between Serum Uric Acid and Metabolic Syndrome in the Asian Mongolian Area

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Aim: To investigate the prevalence of hyperuricemia and the association between the serum uric acid (SUA) levels and incidence of metabolic syndrome (MetS) in the Mongolian area of China.

Methods: This cross-sectional survey was based on a population of 1,426 subjects (809 men and 617 women) 20-80 years of age who were recruited from Inner Mongolia, China. Metabolic and anthropometric indicators were measured according to standard methods. Hyperuricemia was defined as an SUA level of ≥7.0 mg/dL for men and ≥6.0 mg/dL for women. MetS was diagnosed based on the consensus criteria released in 2009 from a joint collaboration organization.

Results: The prevalence of hyperuricemia was 17.7% in men and 5.2% in women. The prevalence of MetS in men was higher than that observed in women (36.7% vs 17.8%). Waist circumference, BMI and the level of triglycerides were most strongly correlated with the SUA level in both sexes. Men with hyperuricemia had an increased risk of MetS [OR (95%CI) 2.95 (2.00-4.35)], while men with a “normal” SUA level (>5.0 mg/dL and <6.3 mg/dL) had a higher risk of MetS, central obesity and hypertriglyceridemia than men in the lower level group (≤5 mg/dL). Women with a higher SUA level (≥4.3 mg/dL) had an increased risk of MetS, central obesity, hypertriglyceridemia and hypertension compared with women in the lowest tertile SUA group (≤3.5 mg/dL).

Conclusions: The SUA level is significantly associated with various metabolic indicators. In this study, waist circumference and the level of triglycerides were most strongly correlated with the SUA level in both sexes. Individuals with a normal level of SUA had an increased risk of MetS and other metabolic disorders. Further research on appropriate cut-off values for pre-hyperuricemia is expected, and the early detection of hyperuricemia is essential for the prevention of MetS.


Key words: Metabolic syndrome, Serum uric acid, Hyperuricemia
Therefore, the people living in the Mongolian region maintain some traditional habits, such as consuming a large amount of red meat with an insufficient amount of fruits and vegetables and excessive drinking, while those living in modern society are physically inactive with a poor lifestyle. The result is the clustering of various cardiovascular risk factors in this mixed ethnicity population. As Yu et al.\(^1\) reported, the prevalence of obesity, elevated blood pressure, increased triglycerides, reduced HDL-cholesterol and elevated fasting glucose among the Mongolian population is much higher than that observed in other ethnic populations. A cluster of risk factors for cardiovascular disease and type 2 diabetes mellitus that occur together more often than by chance alone is known as MetS\(^2\). Hyperuricemia has also been reported to be another neglected independent risk factor for cardiovascular disease (CVD). Studies have demonstrated that a high serum uric acid level is closely associated with arterial stiffness, arteriolosclerosis\(^3\) and the severity of coronary disease\(^4\). Individuals with MetS often exhibit an elevated serum uric acid (SUA) level\(^5-9\). Therefore, the relationship between the SUA level and the incidence of MetS has recently received greater attention.

Although previous studies have investigated the prevalence of hyperuricemia and found positive associations between the SUA level and MetS in Asian populations\(^10\), most studies of the uric acid levels were performed in populations selected from coastal regions\(^11-18\). The prevalence of hyperuricemia and whether an association between the SUA level and MetS exists in the Mongolian population, which exhibits a high risk of CVD, remain unclear.

**Aim**

The present study investigated the prevalence of hyperuricemia and the association between the SUA level and the incidence of MetS in a representative sample of adults living in the Mongolian area.

**Methods**

**Study Design and Subjects**

A cross-sectional study was conducted among 1,426 participants (809 men and 617 women) 20-80 years of age. In this survey, two populations were covered. Urban subjects (\(n=1,060\)) were recruited through a health checkup program during the period of September 2006 and August 2009 in Xilinguole Meng, Inner Mongolia, China. The survey was conducted at one health examination center located in the central region of the city as a unique third-grade general hospital. Rural subjects (\(n=366\)) were recruited from Taibus Banner country, Inner Mongolia, China. One community in this village was selected as the survey spot. All inhabitants 20-80 years of age were recruited, excluding those with hypertension, diabetes or hyperlipidemia receiving drug treatment. Face-to-face interviews were conducted at the participants’ homes, and examinations were performed by nurses in the village clinics. This study was reviewed and approved by the Institutional Review Board of Xilinguole Meng Hospital.

**Data Collection and Measurements**

A self-designed questionnaire was used to collect the demographic characteristics and lifestyle information of the participants. The investigators included well-trained medical school students and nurses working at the hospital. Fasting blood was drawn from each subject, and the SUA level and other parameters of biochemistry and hematology were measured according to standard methods. In addition, some physiological parameters were measured. All of the above measurements were obtained by professional nurses. Anthropometric measurements of body weight, height and waist circumference were obtained twice, and the average of the two measurements was used in the present study. Height was measured to the nearest 0.1 cm, and weight was measured to the nearest 0.1 kg with light clothing. The body mass index (BMI) was calculated as the weight (in kg) divided by the height (in m\(^2\)). Waist circumference was measured midway between the lowest border of the ribs and the iliac crest in the horizontal plane to the nearest 0.5 cm with anthropometric tape. Well-trained nurses measured the systolic blood pressure (SBP) and diastolic blood pressure (DBP) two times in the left arm of the seated participants according to a standardized protocol. The average of the two readings was calculated to determine the reported blood pressure for each participant. Overnight fasting blood specimens were collected for measurement of the SUA, lipid and plasma glucose levels. A blood sample was collected into an EDTA anticoagulant tube for each participant. The SUA level was assayed using the colorimetric uricase-peroxidase system.

**Diagnostic Criteria**

In the present study, hyperuricemia was defined according to sex-specific SUA levels: SUA \(\geq 420\) mmol/L (7.0 mg/dL) for men and \(\geq 360\) mmol/L (6.0 mg/dL) for women\(^19, 20\).

MetS was defined according to the joint interim statement criteria established by the International Dia-
betes Federation Task Force on Epidemiology and Prevention, National Heart, Lung and Blood Institute, American Heart Association, World Heart Federation, International Atherosclerosis Society and International Association for the Study of Obesity, and the cut-off point for waist circumference was determined based on the WHO recommendations for the Asian population. Accordingly, the presence of three of the following five criteria was grounds for diagnosis: (1) elevated blood pressure: a blood pressure of at least 130/85 mmHg or the use of antihypertensive medications; (2) elevated triglycerides: a serum triglyceride level of at least 150 mg/dL or the use of medications for elevated triglycerides; (3) reduced HDL-C: an HDL-C level of < 40 mg/dL in men and < 50 mg/dL in women or the use of medications for reduced HDL-C; (4) elevated fasting plasma glucose (FPG): an FPG level of 100 mg/dL or more or the use of medications for elevated glucose; and (5) elevated waist circumference: a waist circumference of 90 cm in men and 80 cm in women.

The smoking and alcohol consumption status was also surveyed. Never-smokers were defined as participants who had never smoked, whereas ex-smokers were defined as participants who had smoked at least one cigarette per day for more than six months but were currently not smoking. Current smokers were defined as people who had smoked at least one cigarette per day in the past six months. Alcohol consumption was assessed in two stages. In the first stage, the subjects were categorized according to the frequency of alcohol drinking: never, occasionally but less than once a week, once or twice a week, every other day or almost every day. Those who reported consuming at least one drink per week were further questioned about their weekly average consumption of different alcoholic beverages in the second stage.

**Statistical Analysis**

A Pearson correlation analysis was used to evaluate independent associations between the factors under study and the relative importance of these factors as covariates of the SUA levels. We classified the participants according to sex-specific tertiles of the SUA level. For descriptive analyses across the tertile groups of SUA, we used chi-square analyses for categorical variables and ANOVA for continuous traits. A multivariable logistic regression analysis was used to quantify the strength of the association between the SUA level and the prevalence of MetS after controlling for potential confounding factors. All analyses were performed using the SPSS version 13.0 software program for Windows (SPSS Inc., Chicago, IL, USA), and all statistical tests were two-tailed with a level of 0.05.

**Results**

**Characteristics of the Participants**

Table 1 shows the mean ± S.D. values of the SUA level and other variables according to sex. The results are given for the urban and rural populations separately, as the mean SUA concentration was significantly lower in the rural population for both men and women. No age-related changes in the SUA level were observed in men; however, the mean value increased with age in women. Compared with that observed in the rural men, most of the indicators were signifi-
A notable upward trend was observed in the prevalence of MetS with age in women: women younger than 35 years of age rarely suffered from MetS, whereas, among women over sixty years of age, the prevalence of MetS was higher than that observed in men. Meanwhile, the prevalence of hyperuricemia decreased with age in men: men younger than 35 years of age exhibited the highest probability of having hyperuricemia. This trend was opposite in women. The overall prevalence of hyperuricemia was 19.0% in urban men, which was higher than that observed in rural men (12.8%, \( p = 0.055 \)), while the prevalence of hyperuricemia was not significantly different between urban and rural women.

### Prevalence of Metabolic Syndrome and Hyperuricemia

Table 2 presents the prevalence of MetS and hyperuricemia according to sex. The prevalence of MetS was significantly higher among men than women in both the urban and rural populations. Over 40% of urban men suffered from MetS; this prevalence was higher than that observed in rural men. There were no significant differences between the urban and rural women. Additionally, as shown in Fig. 1, the prevalence of MetS gradually increased with age, such that a notable upward trend was observed in the prevalence of MetS with age in women: women younger than 35 years of age rarely suffered from MetS, whereas, among women over sixty years of age, the prevalence of MetS was higher than that observed in men. Meanwhile, the prevalence of hyperuricemia decreased with age in men: men younger than 35 years of age exhibited the highest probability of having hyperuricemia. This trend was opposite in women. The overall prevalence of hyperuricemia was 19.0% in urban men, which was higher than that observed in rural men (12.8%, \( p = 0.055 \)), while the prevalence of hyperuricemia was not significantly different between urban and rural women.

### Association between Hyperuricemia and MetS

As shown in Table 3, the prevalence of MetS was approximately 60% in hyperuricemic men, who also exhibited a nearly three-fold increased risk of MetS compared with men without hyperuricemia. A difference in MetS prevalence associated with the hyperuricemia status was also observed in women; however, it

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**Table 2.** Serum uric acid levels and the prevalence of hyperuricemia and metabolic syndrome according to area and gender

<table>
<thead>
<tr>
<th>Hyperuricemia [n (%)]</th>
<th>Metabolic syndrome [n (%)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Men (n=630)</td>
<td>Urban Women (n=430)</td>
</tr>
<tr>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>120 (19.0)</td>
<td>23 (5.3)</td>
</tr>
<tr>
<td>272 (43.2)*</td>
<td>79 (18.4)</td>
</tr>
<tr>
<td>Rural Men (n=179)</td>
<td>Rural Women (n=187)</td>
</tr>
<tr>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>23 (12.8)</td>
<td>9 (4.8)</td>
</tr>
<tr>
<td>25 (14.1)</td>
<td>31 (16.6)</td>
</tr>
</tbody>
</table>

* \( p < 0.05 \), compared with the same gender in the rural group.

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**Fig. 1.** Prevalence of hyperuricemia and metabolic syndrome by age and sex.
Serum Uric Acid and Metabolic Syndrome

Table 3. Relationships between hyperuricemia and metabolic syndrome by sex

<table>
<thead>
<tr>
<th>Hyperuricemia</th>
<th>Participants of metabolic syndrome (+/−)</th>
<th>Prevalence of metabolic syndrome</th>
<th>Adjusted-OR (95%CI)§</th>
<th>ρ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men (−)</td>
<td>222/444</td>
<td>33.3</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>(+)</td>
<td>84/59</td>
<td>58.7</td>
<td>2.95 (2.00-4.35)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Women (−)</td>
<td>96/489</td>
<td>16.4</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>(+)</td>
<td>13/19</td>
<td>40.6</td>
<td>1.67 (0.72-3.87)</td>
<td>0.229</td>
</tr>
</tbody>
</table>

§Odds ratios and 95% CIs adjusted for age, area, smoking status and alcohol consumption

Table 4. Correlation coefficients (Pearson’s) between the uric acid levels and other metabolic variables after adjustments for age and sex

<table>
<thead>
<tr>
<th>variables</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson’s correlation (r)</td>
<td>p-value</td>
</tr>
<tr>
<td>Waist circumference</td>
<td>0.33</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BMI</td>
<td>0.32</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>0.29</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SBP</td>
<td>0.21</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HDL-C</td>
<td>0.16</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fasting plasma glucose</td>
<td>−0.04</td>
<td>0.251</td>
</tr>
</tbody>
</table>

was not significant after adjusting for confounding variables.

Correlations between the SUA Level and Other Metabolic Disorders

Table 4 shows the Pearson’s correlation coefficients between the uric acid level and other metabolic variables according to sex, after adjusting for age. In men, the SUA levels were positively correlated with the following factors: waist circumference, BMI, triglycerides, DBP, SBP and HDL-C; no associations were observed for fasting plasma glucose. In women, the SUA levels were positively correlated with all of the variables listed above, except for SBP. Waist circumference, BMI and triglycerides were most strongly correlated with the SUA level in both sexes.

Association between the SUA Level and the Incidence of MetS and its Components

Fig. 2 and 3 indicate that more metabolic abnormalities were clustered in the upper third group than in the lower third group in both sexes (p trend <0.001). Only 6% of men and 20% of women in the upper third group exhibited no metabolic risk factors. In the upper third group, 15% of men and 12% of women had 4-5 metabolic abnormalities.

We further separated the participants according to tertiles of the SUA level for each gender. The range and mean values of each tertile group are presented in Table 5, which also shows the associations between different tertiles of SUA and the incidence of MetS and its components. Subjects with a higher SUA level tended to exhibit a higher likelihood of having Mets. This positive gradient for the prevalence of MetS across the tertiles of the SUA level was more robust in men than in women. Men in the highest tertile uric acid group had a 2.8-times higher risk of having MetS compared with men in the lowest tertile group (p<0.001). In women, the adjusted risk for MetS was 1.8 among the subjects in the highest tertile group compared with that observed in those in the lowest tertile group (p<0.001).

Next, we analyzed the prevalence of each MetS-associated abnormality in the SUA tertile groups according to sex; the results are presented in Table 5. The prevalence of abdominal obesity, hypertriglyceridemia, high blood pressure and high fasting glucose increased in association with an increased level of SUA (trend p<0.001) in both men and women. Among the five components evaluated, the largest increases in the upper SUA tertile group compared with the lowest tertile group were seen in central obesity in both men and women (increased by 37% and 30%, respectively) hypertriglyceridemia in men (increased by 32.5%) and...
hypertension in women (increased by 32.6%). After adjusting for the other confounding variables listed in Table 3, men in the upper SUA tertile group had a 3.7-fold increased risk of central obesity and a 3.2-fold increased risk of hypertriglyceridemia, while women in the upper tertile group had a 2.8-fold increased risk of central obesity and a 2.5-fold increased risk of hypertriglyceridemia and hypertension.

**Discussion**

Previous studies of hyperuricemia and its association with MetS have been conducted among Asian populations22-30, mostly Taiwanese, Japanese, Korean and Han ethnic Chinese populations. In addition, previous studies have been primarily conducted in coastal areas30-32, where the intake of purine-rich marine products is dominant, contributing to hyperuricemia and possibly MetS. In contrast, many studies32-37 have found that an elevated SUA level is associated not only with purine intake from seafood, meat and beer, but also the presence of endogenous metabolic disorders. However, hyperuricemia is not as great of a concern as other metabolic disorders among people living in Mongolian regions, where the lifestyle is much different from that of other populations living in Asian regions. This study was conducted in the Mongolian region and found that, among the study population, the SUA levels differed according to gender and age. For example, possibly the SUA levels were lower in women than in men, as estrogen promotes the excretion of uric acid38, 39. Furthermore, the SUA levels
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Many studies have shown that a higher SUA level is often accompanied by obesity, hypertension, dyslipidemia and glucose intolerance, all of which play a causal role in the pathogenesis of cardiovascular disease. The clustering of the above metabolic disorders, when found together in the same individual, characterizes so-called MetS. We used the latest definitions to evaluate the prevalence of MetS in this population. Our results ultimately showed that the prevalence of MetS was nearly 40% in men, which is much higher than that observed in the male populations of Japan, Korea, Israel and some other areas of China. In the present study, women also had a higher prevalence of MetS than other similar populations. The prevalence of MetS has been shown to be higher in men than women under 60 years of age and higher in women than men over 60 years of age. Sex hormones, especially estrogen and/or the androgen/estrogen ratio, play crucial roles in this phenomenon. In addition, the particular dietary pattern of consuming foods high in energy and rich in fat along with a lack of vegetables inherited from a nomadic history likely contrib-

significantly increased with age in women, but not in men, and urban people had higher levels of SUA than rural people. The prevalence of hyperuricemia in men (17.7%) in this study is lower than that reported in 2008 in Taiwan (22.0%), urban Qingdao, China (25.3%) and Japan (24.4%). In addition, the prevalence of hyperuricemia in women was 5.2%, which is lower than that observed in other developing countries (8.7%) and other eastern coastal regions of China, such as Qingdao and Hangzhou. The relatively lower prevalence of hyperuricemia observed in this study is possibly due to the low consumption of seafood among the study population. Additionally, ethnic diversity may be responsible for this discrepancy. Differences in lifestyle between urban residents, who display higher energy intake and a lower level of physical activity, and rural residents may account for the different results. Younger men had a higher possibility of having hyperuricemia than older men in this population, possibly due to their higher level of alcohol consumption and lack of physical activity. Women over 50 years of age exhibited an increased risk of hyperuricemia, which is possibly related to meno-

Table 5. Multivariate analysis of the adjusted ORs and 95% CIs between the uric acid levels and the incidence of metabolic syndrome and its components

<table>
<thead>
<tr>
<th></th>
<th>Men (n=809)</th>
<th></th>
<th>Women (n=617)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower third</td>
<td>Middle third</td>
<td>Upper third</td>
<td>Lower third</td>
</tr>
<tr>
<td>Count</td>
<td>281</td>
<td>283</td>
<td>245</td>
<td>242</td>
</tr>
<tr>
<td>SUA range (mg/dL)</td>
<td>(2.3, 5.0)</td>
<td>(5.1, 6.2)</td>
<td>(6.3, 13.3)</td>
<td>(1.7, 3.5)</td>
</tr>
<tr>
<td>Metabolic syndrome†</td>
<td>67 (23.8)</td>
<td>100 (35.5)</td>
<td>130 (53.1)</td>
<td>27 (11.2)</td>
</tr>
<tr>
<td>Abdominal obesity†</td>
<td>1.0 (reference)</td>
<td>1.35 (0.92-2.00)</td>
<td>2.80 (1.89-4.15)</td>
<td>1.0 (reference)</td>
</tr>
<tr>
<td>Elevated triglycerides†</td>
<td>1.0</td>
<td>2.16 (1.51-3.10)</td>
<td>3.26 (2.23-4.76)</td>
<td>41 (16.9)</td>
</tr>
<tr>
<td>Elevated blood pressure†</td>
<td>1.0</td>
<td>0.95 (0.62-1.46)</td>
<td>1.52 (0.95-2.41)</td>
<td>76 (31.4)</td>
</tr>
<tr>
<td>Elevated fasting glucose†</td>
<td>1.0</td>
<td>0.94 (0.64-1.40)</td>
<td>1.18 (0.79-1.75)</td>
<td>1.0</td>
</tr>
<tr>
<td>Reduced HDL-C†</td>
<td>1.0</td>
<td>0.51 (0.10-2.46)</td>
<td>0.74 (0.15-3.59)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

§ Odds ratios and 95% CIs for men and women adjusted for age, area, smoking status and alcohol consumption
† Elevated waist circumference: a waist circumference of 90 cm in men and 80 cm in women.
‡ Elevated blood pressure: a blood pressure of at least 130/85 mmHg or the use of antihypertensive medications
§ Elevated fasting plasma glucose (FPG): an FPG level of 100 mg/dL or more or the use of medications for elevated glucose
† Elevated triglycerides: a serum triglyceride level of at least 150 mg/dL or the use of medications for elevated triglycerides
‖ Reduced HDL-C: an HDL-C level of <40 mg/dL in men and <50 mg/dL in women or the use of medications for reduced HDL-C
†† over three of the following "†"
uted to the high risk of metabolic disease associated with urbanization in populations consisting of herdsmen, farmers and citizens. Moreover, the rate of detection of MetS diagnosed based on the consensus criteria released in 2009 from a joint collaboration between the American Heart Association and other organizations is likely higher than that diagnosed based on other criteria, as abdominal obesity should not be a prerequisite for diagnosis. Moreover, abdominal obesity was one of the five criteria used in this study in association with the Asian cut-off point proposed by the WHO, which is higher than Chinese medical association recommendations.

Similar to other studies, we found that the subjects with hyperuricemia had an increased risk of MetS compared with those without hyperuricemia and that this association was especially significant in men. The results of the correlations between the SUA level and other metabolic indicators showed that waist circumference and triglycerides were the strongest factors correlated with the SUA level in both sexes. The contribution of a high uric acid level to the development of abdominal obesity, elevated triglycerides and hypertension in both men and women was noted as well. Abdominal obesity exhibited a stronger association with an increased SUA level than the other components of MetS, which is in line with the findings of other studies. The mechanisms underlying the obesity-linked increase in the SUA level involve two factors: excessive uric acid production and poor uric acid excretion. Matsuura found that, among individuals with visceral fat obesity, the overproduction of uric acid with a reduction in urinary urate excretion and clearance is the crucial mechanism contributing to an increased SUA level, which may occur because visceral fat accumulation induces excessive uric acid production, which in turns leads to an elevated influx of plasma free fatty acids into the portal vein and liver, stimulation of neutral fat synthesis and a consequent attendant surge in uric acid production in the activated uric acid synthesis pathway. In addition, Bedir A. suggested that leptin is a possible candidate for the missing link between obesity and hyperuricemia. In addition to abdominal obesity, the levels of hypertriglycerides were closely associated with the SUA levels in both men and women in this study, which is in accordance with the findings of various other studies demonstrating the serum triglyceride level to be independently and strongly related to the uric acid level. Hyperuricemia and elevated triglycerides are associated with insulin resistance syndrome, and the relationships between these parameters are complicated. In the present study, hyperuricemia was significantly related to hypertension in women, but insignificantly in men. Kuwahata reported that a high concentration of SUA is correlated with coronary endothelial microvascular dysfunction in Japanese women. Therefore, endothelial dysfunction possibly resulting from an increased SUA level directly contributes to the pathogenesis of hypertension.

The positive gradient in the prevalence of MetS across tertiles of the SUA level observed in this study was more robust in men than in women; there was a strong association between hyperuricemia and MetS in men only. This gender difference should receive more attention, as various other studies have concluded that the SUA level is more closely associated with the incidence of MetS in women than in men. An American study and Turkish study both showed that hyperuricemia is associated with MetS much more tightly in women than in men, while a Korean study demonstrated that the SUA level is closely linked and even independently associated with MetS in women only. The inconsistencies between genders in these studies are likely due to genetic differences between races.

Recently, a relationship between the SUA level and the incidence of MetS has been observed not only in patients with hyperuricemia, but also in those with an SUA level considered to be in the normal range. A high normal level of SUA may also reflect the presence of MetS and its component disorders. Therefore, we further divided the participants into three groups according to the SUA level in order to estimate the effect of a “normal” SUA level on the risk of metabolic disorders. The results of the present study demonstrated that men, but not women, in the middle SUA tertile group (>5.0 and <6.3) exhibited an increased risk of metabolic syndrome, particularly hypertriglyceridemia. The subjects in the middle SUA tertile group exhibited a significant number of risk factors in both men and women; this relationship remained significant even after controlling for other confounding factors, which indicates that the hyperuricemia cut-off points currently widely used for Chinese patients, at least men, are insufficient to identify populations with a high risk of metabolic disorders and that the identification of more cut-off points for pre-hyperuricemia is strongly suggested. Zhang suggested the appropriate cut-off points for Chinese individuals to be 4.9 mg/dL for women and 6.3 mg/dL for men, which are similar to the cut-off levels used in the middle and upper tertiles among men in the present study. Further research on the development of more appropriate cut-off values for pre-hyperuricemia or even revision of the criteria for hyperuricemia diagnosis is
expected.

The strengths and limitations of our study deserve comment. This study provided important epidemiological evidence for the association between hyperuricemia and MetS in the Mongolian population. It also applied the latest criteria for MetS diagnosis, which have not been used widely in research conducted in China or other countries. However, the cross-sectional design of this study cannot be used to address the potential temporal relationships between hyperuricemia and MetS, which require further investigation in longitudinal studies.

Conclusions

Our data indicate that an independent relationship exists between hyperuricemia and MetS in men living in the Mongolian region. Moreover, the SUA level was found to be significantly correlated with visceral obesity, hypertriglyceridemia and hypertension in women. The early detection of hyperuricemia is essential for the prevention of MetS.

Acknowledgements

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Conflicts of Interest

No authors have any financial relationships (within the past 12 months) with biotechnology manufacturers, pharmaceutical companies or other commercial entities with an interest in the subject matter or materials discussed in the manuscript.

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