Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy Dovepress
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ORIGINAL RESEARCH

Metabolic Syndrome and 5-Year Incident Hyperuricemia Among Older Chinese Adults: A Community-Based Cohort Study

This article was published in the following Dove Press journal:
Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy

Jing-Hong Liu[1]
Qing-Hua Ma[2]
Yong Xu[1]
Xing Chen[3]
Chen-Wei Pan[1]

[1]School of Public Health, Medical College of Soochow University, Suzhou, People's Republic of China; [2]The 3rd People's Hospital of Xiangcheng District, Suzhou, People's Republic of China; [3]Department of Children Health Care, Affiliated Suzhou Hospital of Nanjing Medical University, Suzhou, People's Republic of China

Background: There was a lack of studies focusing on older adults about the longitudinal association between metabolic syndrome (MetS) and hyperuricemia (HUA). We aimed to assess the association of baseline MetS and incident HUA among older Chinese adults, with a special focus on the associations between different combinations of MetS components and HUA.

Methods: Data of 3247 Chinese adults aged 60 years or older included in a community-based longitudinal cohort study were analyzed. Anthropometric examinations and collection of blood sample were conducted both at baseline and follow-up. HUA was defined as 7 mg/dl or above for men and 6 mg/dl or greater for women. MetS was assessed based on the National Cholesterol Education Program-Adult Treatment Panel III, and older adults with the presence of at least three of MetS components were considered as having MetS.

Results: MetS and its components, including high blood pressure (BP), high body mass index, diabetes mellitus and high triglycerides, were significantly related to incident HUA. The association between high BP and incident HUA is strongest among the five MetS components. Among all combinations of MetS components, the group consisting of diabetes mellitus, high BP and high triglycerides had the highest odds for incident HUA (OR = 13.07, 95% CI = 4.95–34.54).

Conclusion: MetS and its components, except for low high-density lipoprotein cholesterol, could increase the risk of HUA among community-dwelling older adults, and high BP may be the most important determinant.

Keywords: hyperuricemia, metabolic syndrome, older adults, epidemiology

Background

Hyperuricemia (HUA), an important risk factor for gout,[1] is a worldwide public health problem with high prevalence across different ethnic groups.[2,3] The prevalence of HUA increased with age and was higher among older adults.[4,5] HUA could increase the risk of cardiovascular events and all-cause mortality,[6] and therefore understanding the risk factors for HUA is important for the prevention of gout and cardiovascular events. Specific metabolic abnormalities such as blood glucose, pressure and lipids have been suggested to be involved in the development of HUA.[7–9] Metabolic syndrome (MetS) is a constellation of major metabolic disorders and understanding its association with HUA could more comprehensively and accurately evaluate how metabolic abnormalities plays a role in the pathological mechanism of HUA.

Correspondence: Xing Chen
Department of Children Health Care, Affiliated Suzhou Hospital of Nanjing Medical University, No. 26 Dao Qian Road, Suzhou 215000, People's Republic of China
Tel +86 512 62362193
Email cx1708@126.com

Chen-Wei Pan
School of Public Health, Medical College of Soochow University, 199 Ren Ai Road, Suzhou 215123, People's Republic of China
Tel +86 512 65883907
Email pcwonly@gmail.com

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DovePress
http://doi.org/10.2147/DMSO.S278542

The prevalence of HUA was higher in MetS when compared to those without MetS,[10] and serum uric acid (SUA) was also reported to be increased in individuals with MetS.[11,12] Moreover, studies assessing the longitudinal associations between MetS and SUA/HUA indicated that MetS could predict elevated SUA or incident HUA.[13,14] However, some key questions remain unanswered. First, there was a lack of studies focusing on older adults, who have a high prevalence and incidence of both conditions compared with younger generations. Second, MetS includes 5 major components and which combination of these components best predicts the incidence of HUA has not been elucidated.

To address this gap, we performed a community-based longitudinal cohort study to assess the association of baseline MetS and incident HUA among Chinese adults aged 60 years or older, with a special focus on the associations between different combinations of MetS components and the occurrence of HUA. The findings would be conducive to tackling modifiable risk factors for the prevention of HUA and gout.

Methods

Study Design and Procedure

This was a community-based cohort study, which was conducted among older adults, aged 60 years or older, who lived in Weitang town of Suzhou located in the eastern part of China. Details of the baseline study have been described elsewhere.[15–17] In the baseline examinations, 6030 families who had an older adult aged 60 years or older based on local official records received an invitation letter, which explained the nature of the study and invited the older adults to participate. Exclusion criteria applied to those who had been living there shorter than six months, had migrated from the residing address, or had deceased. Of the 5613 eligible older adults, 4611 attended the baseline clinical examinations from August 2014 to February 2015. The final sample at baseline consisted of 4579 older adults who had a complete data of anthropometric examinations, questionnaires and blood sample analyses. Five years later, these participants were invited to attend the anthropometric examination and collection of blood sample. Home visits or revisits were conducted to encourage older adults who did not participate in the follow-up examinations to attend with the aim of improving the follow-up rate of study. Older adults at baseline were excluded when they declined to participate, moved away and could not be contacted or deceased before the follow-up examination. Older adults with HUA at baseline or without data about SUA at the follow-up examination were excluded. Official death registration forms were used to identify the death of individuals at baseline.

Both baseline and follow-up studies were conducted to abide by the tenets of the Helsinki Declaration and were approved by the Institutional Review Board of Soochow University.

Clinical and Biochemical Measurements

Blood samples of participants were collected and frozen at −80 °C before transferring to laboratory technicians to find related data including SUA, fasting plasma glucose (FPG), high-density lipoprotein cholesterol (HDL-C) and blood triglycerides.

Blood pressure (BP) was measured using an automatic blood pressure monitor (Dinamap model Pro Series DP110X-RW, 100V2; GE Medical Systems Information Technologies, Inc., Milwaukee, Wisconsin, United States) when older adults had a rest of 5 minutes or longer. The recorded BP was the average value of the last two readings. Body height and weight of older adults without shoes and with light clothing were measured using a wall-mounted measurement tape and digital scale, separately. Body mass index (BMI, kg/m^2) was calculated as the weight in kilograms divided by the square of the height in meters.

These clinical and biochemical indicators were examined with similar procedures for both baseline and follow-up study participants.

Definitions of HUA and MetS

HUA was defined as 7 mg/dl or above for men and 6 mg/dl or greater for women.[18]

The MetS of participants was assessed based on the National Cholesterol Education Program-Adult Treatment Panel III.[19] MetS was diagnosed when participants met three or more of the following components: (1) BMI of 25 kg/m^2 or above; (2) high BP (BP of 130/85 mmHg or greater or on antihypertensive drug treatment); (3) elevated blood triglycerides (1.7 mmol/L or higher); (4) diabetes mellitus defined as FPG of 7.0 mmol/L or above or with diabetes; (5) low HDL-C (lower than 1.0 mmol/L in men and 1.3 mmol/L in women).

Assessment of Main Covariates

Information on participants' socio-demographic characteristics including age, gender, marriage status (living with spouse/living without spouse), educational level (primary and below education/secondary education or above) and monthly income (≤1000/1001–3000/>3000 Chinese Yuan)

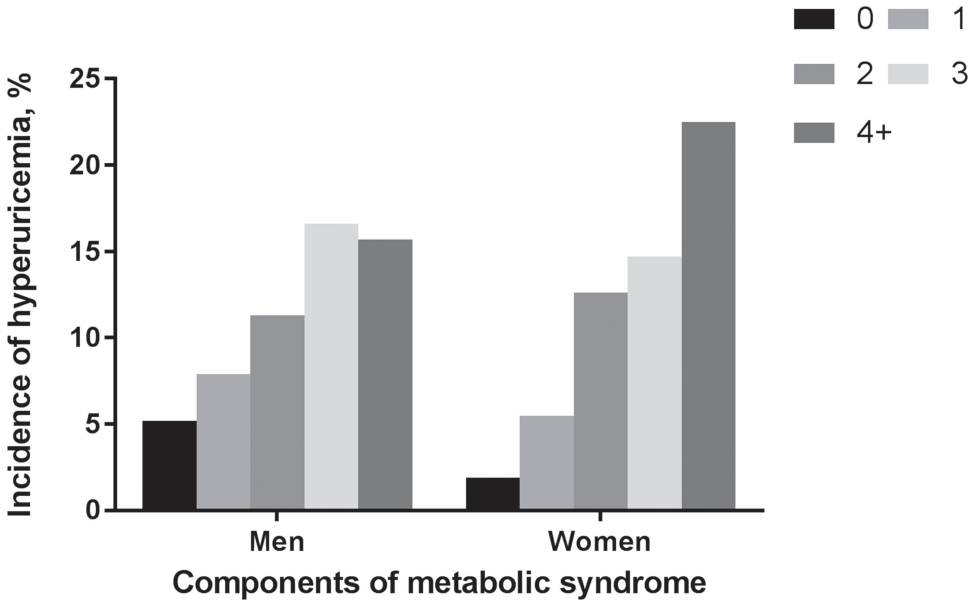

Figure 1 Incidence of hyperuricemia by increasing metabolic syndrome components in men and women.

as well as lifestyle habits was collected using a pre-designed questionnaire. Data regarding lifestyle habits such as smoking, alcohol intake, tea consumption and physical activity were also collected during the questionnaire interview. Smoking was queried through the question: "Have you ever smoked?".[20] Older adults who have drunk alcohol in the past three months were classified as alcohol intake.[21] Status of tea consumption was inquired with the question: "Do you usually drink tea?" and subjects who answered "yes" were coded as habitual tea drinkers.[22] Physical activity was queried with the question: "How long do you exercise every day?" and older adults with physical activity were participants who spent time on exercise.[23]

Statistics Analysis

Chi-square test and Student's *t*-test were separately used to compare categories and continuous variables of participants according to HUA status at follow-up, and percentage as well as mean ± standard deviation were calculated to express the comparison, as appropriate. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using two logistic regression models to estimate the effects of baseline MetS and its components on 5-year incident HUA. The first model adjusted for age and gender only, and the second one additionally adjusted for marriage status, educational level, monthly income, lifestyle habits including alcohol intake, smoking status, tea consumption, physical activity and baseline SUA. In addition, in logistic regressions of assessing linear trends, quartiles of MetS components at baseline were treated as continuous variables by assigning each quartile with a median. Logistic regression model was also used to investigate the influences of different combinations of baseline MetS components on incident HUA and those without any MetS components were treated as the "reference group". A stratified-analysis was performed to evaluate the associations of baseline MetS components with incident HUA in different statuses of diabetes mellitus component.

Data were analyzed using SPSS version 21.0 (SPSS Inc., Chicago, IL, USA) and statistical significance was considered if a p-value was less than 0.05.

Results

The prevalence of HUA at baseline was 15.8%. Among 4579 older adults at baseline, 183 (4.0%) deceased before the follow-up examination and 526 (11.5%) refused to participant or were out of touch. Of the 3870 participants enrolled in the follow-up examination, 608 older adults with HUA at baseline and 15 participants without data about SUA at follow-up examination were excluded. Eventually, 3247 older adults were included in this longitudinal analysis.

This study sample consisted of 1517 men and 1730 women with a respective average SUA of 5.4 mg/dl and 4.4 mg/dl at baseline. In Total, 308 (9.5%) developed HUA among 3247 participants free of HUA at baseline. As shown in Figure 1, incidence of HUA increased with elevated number of MetS components in both men and women (both p values for trend <0.001). In participants

with MetS, the incidence of HUA is similar in men and women (17.0% versus 16.3%). Participants' characteristics by HUA status at follow-up are displayed in Table 1. Compared to participants without HUA at follow-up, older adults with HUA were more likely to have higher level of SBP, DBP, BMI, FPG, TG and a lower level of HDL-C.

Table 2 displays linear trends between baseline MetS components and risk of HUA. Older adults in the 4th quartiles of systolic BP, BMI, FPG and triglycerides had a greater risk of developing HUA compared to those in first quartiles (P<0.05). Even after adjusting for socio-demographic characteristics, lifestyle habits and baseline SUA, elevated quartiles of MetS components except diastolic BP and HDL-C quartiles were associated with an increasing risk of HUA (all p values for trend <0.05). MetS (OR = 1.73, P < 0.001) and its components including high BP (OR = 2.16, P = 0.002), high BMI (OR = 1.87, P < 0.001), diabetes mellitus (OR = 1.76, P = 0.002) and high triglycerides (OR = 1.44, P = 0.01) were significantly related to incident HUA. The association between high BP and incident HUA is strongest among the five MetS components (Table 3). Moreover, increasing the number of MetS components at baseline was positively related to incident HUA though the presence of only one MetS component was not a significant predictor.

Table 4 presents the associations of specific combinations of MetS components at baseline with incident HUA. In this analysis, individuals free of MetS components were treated as the "reference group" and we found that the presence of a single MetS component had no influence on incident HUA. In combinations of two MetS components, groups of diabetes mellitus and high BP (2.1), high BP and high BMI (2.5), high BP and high triglycerides (2.6) as well as high BP and low HDL-C (2.7) were significantly related to incident HUA (all p values <0.05). Groups including both high BP and any other two MetS components were associated with higher risk of incident HUA (3.1, 3.2, 3.3, 3.7, 3.8, and 3.9). A combination of four MetS components without high triglycerides was not significantly linked to incidence of HUA while other four combinations showed significant associations. Participants with all five MetS components were associated with approximately five-fold odds of incident HUA (OR = 5.01, 95% CI = 1.31–19.26). Among all combinations of MetS components, the group consisting of diabetes mellitus, high BP and high triglycerides had the highest odds for incident HUA (OR = 13.07, 95% CI = 4.95–34.54). All combinations of MetS associated with incident HUA contained the component of high BP.

In stratified analysis by the presence of diabetes mellitus, high BP (OR = 3.17, 95% CI = 1.30–3.61), high BMI

Table 1 Baseline Characteristics of Study Participants According to Development of Hyperuricemia

Characteristic	No HUA (n = 2939)	HUA (n = 308)	P value
Age, mean (SD), years	66.9 (5.5)	67.5 (5.8)	0.09
Gender (women), n (%)	1565 (53.2)	165 (53.6)	0.91
Primary and below education, n (%)	2554 (86.9)	272 (88.3)	0.48
Living with spouse, n (%)	2470 (84.0)	256 (83.1)	0.67
Monthly income, n (%)			0.39
≤1000 CNY	1628 (55.4)	181 (58.8)	
1001–3000 CNY	1100 (37.4)	103 (33.4)	
>3000 CNY	211 (7.2)	24 (7.8)	
Current smoking, n (%)	763 (26.0)	80 (26.0)	0.77
Alcohol consumption, n (%)	629 (21.4)	76 (24.7)	0.19
Tea consumption, n (%)	964 (32.8)	108 (35.1)	0.42
Physical activity, n (%)	1231 (41.9)	127 (41.4)	0.86
SBP, mean (SD), mmHg	143.2 (19.3)	148.2 (19.4)	<0.001
DBP, mean (SD), mmHg	85.2 (11.2)	87.2 (11.5)	0.003
BMI, mean (SD), kg/m^2	23.2 (5.0)	24.3 (2.7)	<0.001
FPG, mean (SD), mmol/L	5.6 (1.1)	5.8 (1.3)	0.001
HDL-C, mean (SD), mmol/L	1.5 (0.4)	1.4 (0.4)	<0.001
TG, mean (SD), mmol/L	1.3 (0.7)	1.6 (0.9)	<0.001

Abbreviations: HUA, hyperuricemia; SD, standard deviation; CNY, Chinese Yuan; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; FPG, fasting plasma glucose; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides.

Table 2 Odds Ratios and 95% Confidence Intervals for the Risk of Hyperuricemia According to Quartiles of Metabolic Syndrome Components

Characteristics	Age, Sex-Adjusted Model		Multivariable-Adjusted Model*	
	OR (95% CI)	P value for Trend	OR (95% CI)	P value for Trend
SBP quartiles, mmHg		<0.001		0.01
1 (≤130)	1.00		1.00	
2 (131–143)	1.24 (0.86, 1.79)		1.08 (0.73, 1.59)	
3 (144–156)	1.59 (1.12, 2.27)		1.35 (0.92, 1.96)	
4 (>156)	1.85 (1.31, 2.62)		1.51 (1.04, 2.19)	
DBP quartiles, mmHg		0.003		0.18
1 (≤78)	1.00		1.00	
2 (79–85)	1.21 (0.86, 1.72)		0.99 (0.68, 1.44)	
3 (86–93)	1.35 (0.96, 1.90)		1.10 (0.76, 1.59)	
4 (>93)	1.63 (1.17, 2.28)		1.24 (0.87, 1.78)	
BMI quartiles, kg/m^2		<0.001		<0.001
1 (≤21.91)	1.00		1.00	
2 (21.92–23.42)	1.61 (1.09, 2.37)		1.36 (0.90, 2.04)	
3 (23.43–24.09)	1.83 (1.22, 2.73)		1.45 (0.94, 2.23)	
4 (>24.09)	3.20 (2.23, 4.61)		2.15 (1.45, 3.17)	
FPG, mmol/L		0.001		0.01
1 (≤4.98)	1.00		1.00	
2 (4.99–5.35)	1.20 (0.84, 1.71)		1.25 (0.86, 1.83)	
3 (5.36–5.83)	1.29 (0.90, 1.83)		1.28 (0.88, 1.87)	
4 (>5.83)	1.73 (1.24, 2.42)		1.61 (1.12, 2.31)	
HDL-C, mmol/L		<0.001		0.05
1 (≤1.20)	1.00		1.00	
2 (1.21–1.43)	0.66 (0.48, 0.90)		0.73 (0.52, 1.02)	
3 (1.44–1.71)	0.61 (0.44, 0.83)		0.81 (0.58, 1.15)	
4 (>1.71)	0.45 (0.31, 0.63)		0.66 (0.45, 0.96)	
TG, mmol/L		<0.001		<0.001
1 (≤0.83)	1.00		1.00	
2 (0.84–1.12)	1.15 (0.76, 1.71)		0.96 (0.63, 1.47)	
3 (1.13–1.55)	2.01 (1.39, 2.90)		1.45 (0.98, 2.14)	
4 (>1.55)	2.93 (2.06, 4.17)		1.79 (1.22, 2.61)	

Note: *Adjusted for age, sex, educational level, monthly income, marriage status, smoking status, alcohol intake, tea consumption, physical activity and baseline serum uric acid.

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; FPG, fasting plasma glucose; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides; OR, odds ratio; CI, confidence interval.

(OR = 2.06, 95% CI = 1.52–2.80) and low HDL-C (OR = 1.39, 95% CI = 1.00–1.92) increased risk of HUA only in participants without diabetes mellitus. (Table 5)

Discussion

This community-based cohort study among older Chinese adults aged 60 years or older indicated that MetS and its components of diabetes mellitus, high BP, high BMI and high triglycerides at baseline were associated with incident HUA. In addition, high BP may be the most important MetS component contributing to incidence of HUA. Older adults with simultaneous high BP, diabetes mellitus and high triglycerides may be most likely to develop HUA among all possible combinations of MetS components.

The result, that baseline MetS was a risk factor for incident HUA, was not unexpected and was consistent with some studies carried out in other countries.[13,14,24] A cohort study in middle-aged men in South Korea demonstrated that the incidence of HUA increased across MetS at baseline with the hazard ratio being 1.41.[13] In studies conducted in North American countries, MetS was reported to be associated with incident HUA both in men

Table 3 Risk of Developing Hyperuricemia According to Metabolic Syndrome and Its Components

Characteristics	Age, Sex-Adjusted Model		Multivariable-Adjusted Model*	
	OR (95% CI)	P value	OR (95% CI)	P value
MetS				
Absent	1.00		1.00	
Present	2.43 (1.87, 3.16)	<0.001	1.73 (1.30, 2.30)	<0.001
High BP component				
Absent	1.00		1.00	
Present	2.76 (1.73, 4.39)	<0.001	2.16 (1.33, 3.50)	0.002
High BMI component				
Absent	1.00		1.00	
Present	2.44 (1.88, 3.17)	<0.001	1.87 (1.41, 2.47)	<0.001
Diabetes mellitus component				
Absent	1.00		1.00	
Present	1.65 (1.19, 2.28)	0.003	1.76 (1.23, 2.52)	0.002
Low HDL-C component				
Absent	1.00		1.00	
Present	1.73 (1.31, 2.27)	<0.001	1.23 (0.92, 1.66)	0.17
High TG component				
Absent	1.00		1.00	
Present	1.98 (1.53, 2.57)	<0.001	1.44 (1.08, 1.90)	0.01
Number of MetS components				
0	1.00		1.00	
1	1.77 (1.00, 3.14)	0.05	1.41 (0.78, 2.55)	0.26
2	3.48 (1.96, 6.19)	<0.001	2.38 (1.31, 4.34)	0.005
3	4.73 (2.60, 8.60)	<0.001	2.70 (1.44, 5.07)	0.002
4+	6.80 (3.51, 13.17)	<0.001	3.57 (1.77, 7.18)	<0.001

Note: *Adjusted for age, sex, educational level, monthly income, marriage status, smoking status, alcohol intake, tea consumption, physical activity and baseline serum uric acid.

Abbreviations: MetS, metabolic syndrome; BP, blood pressure; BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides; OR, odds ratio; CI, confidence interval.

and women.[14,24] Moreover, a study with participants from three urban areas and one rural county of Beijing showed a 2.0-fold risk of HUA among community elderly with MetS,[25] which was similar to our results.

It was in line with some studies that MetS components of high BP, high BMI, diabetes mellitus and high triglycerides at baseline were related to an increased risk of HUA.[24,26] In this study, 96.6% of older adults were found to have abnormal BP, defined as 130/85 mmHg or greater, among individuals suffering from MetS. The high BP component may act as an important risk factor related to the incidence of HUA in this population. A longitudinal study has reported that those with hypertension were at a 1.65-fold risk of HUA.[26] Hypertension may result in the vascular disease related to decreased renal blood flow and finally stimulate urate reabsorption.[27] The other processes of hypertension causing HUA may be through blocking urate excretion and generating increased xanthine oxidase associated with production of uric acid.[8,28,29] In our study, high BMI also had a higher impact on incident HUA. According to a study conducted among large cohorts, the increment of risk of HUA was 7.5% per 4 kg/m^2 increased in BMI.[30] Insulin resistance may be a link between obesity and HUA. Obesity may, through chronic adipose tissue inflammation, cause the insulin resistance,[31] which may lead to the enhanced activity of hexose monophosphate shunt and eventually contribute to increased purine biosynthesis and turnover.[32] Moreover, higher serum leptin concentration in individuals with obesity could induce oxidative stress in endothelial cells.[33,34] The oxidative stress has been reported to be associated with increased SUA concentration.[34]

Table 4 Associations Between Individual and Specific Combinations of Metabolic Syndrome Components and Risk of Hyperuricemia

		Metabolic Syndrome Components				Hyperuricemia	
	Diabetes Mellitus	**High BP**	**High BMI**	**High TG**	**Low HDL-C**	**Age, Sex-Adjusted OR (95% CI)**	**P value**
Absence of any components of MetS							
1						1.00	
Individual component of MetS							
1	√					1.69 (0.21, 13.68)	0.62
2		√				1.77 (1.00, 3.14)	0.05
3			√			3.58 (0.95, 13.42)	0.06
4				√		1.44 (0.18, 11.54)	0.73
5					√	–	
Combination of two components of MetS							
1	√	√				3.20 (1.50, 6.83)	0.003
2	√		√			–	
3	√			√		–	
4	√				√	8.11 (0.79, 83.73)	0.08
5		√	√			4.55 (2.41, 8.61)	<0.001
6		√		√		2.77 (1.34,5.71)	0.01
7		√			√	3.50 (1.75, 7.00)	<0.001
8			√	√		–	
9			√		√	–	
10				√	√	–	
Combination of three components of MetS							
1	√	√	√			3.07 (1.05, 8.96)	0.04
2	√	√		√		13.07 (4.95, 34.54)	<0.001
3	√	√			√	3.29 (1.02, 10.66)	0.05
4	√		√	√		–	
5	√		√		√	–	
6	√			√	√	–	
7		√	√	√		6.77 (3.06, 15.02)	<0.001
8		√	√		√	5.40 (2.37, 12.28)	<0.001
9		√		√	√	3.58 (1.76, 7.29)	<0.001
10			√	√	√	–	
Combination of four components of MetS							
1	√	√	√	√		11.54 (3.52, 37.79)	<0.001
2	√	√	√		√	1.63 (0.20, 13.20)	0.65
3	√	√		√	√	4.29 (1.54, 11.94)	0.01
4	√		√	√	√	–	
5		√	√	√	√	9.48 (4.42, 20.34)	<0.001
Combination of all five components of MetS							
1	√	√	√	√	√	5.01 (1.31, 19.26)	0.02

Note: √Presence of the component of metabolic syndrome.
Abbreviations: BP, blood pressure; BMI, body mass index; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; MetS, metabolic syndrome.

Table 5 Associations Between Components of Metabolic Syndrome and Risk of Hyperuricemia by Status of Diabetes Mellitus Component

Components of MetS	With Diabetes Mellitus Component		Without Diabetes Mellitus Component	
	Multivariable-Adjusted* OR (95% CI)	P value	Multivariable-Adjusted* OR (95% CI)	P value
High BP	1.02 (0.20, 5.26)	0.98	2.17 (1.30, 3.61)	0.003
High BMI	1.03 (0.48, 2.20)	0.95	2.06 (1.52, 2.80)	<0.001
High TG	1.97 (0.99, 3.90)	0.05	1.30 (0.94, 1.78)	0.11
Low HDL-C	0.51 (0.24, 1.11)	0.09	1.39 (1.00, 1.92)	0.05

Note: *Adjusted for age, sex, educational level, monthly income, marriage status, smoking status, alcohol intake, tea consumption, physical activity and baseline serum uric acid.

Abbreviations: MetS, metabolic syndrome; BP, blood pressure; BMI, body mass index; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol.

In this study, socio-demographic characteristics, lifestyle habits were adjusted for predicting HUA. Among these covariates, alcohol intake was the primary variable influencing the associations of MetS and its components with incident HUA. It has been reported that alcohol intake is a modifiable risk factor for HUA.[35,36] Ethanol could inhibit the excretion of SUA by kidneys and accelerate the degradation of purine which eventually leads to the elevated SUA levels.[37] We also identified that some combinations of MetS components that made older adults at high risk of incident HUA. Various combinations of different components of MetS were associated with a 2.77–13.07-fold risk of HUA. However, there are several combinations of MetS having similar risk, and some groups including three or four components of MetS showed higher risk of incident HUA compared to the group with all five MetS components. The high prevalence of high BP in this study may partially explain the results. When participants of this study were divided into 32 groups according to specific combinations of MetS components, the number of subjects in each group was small, and therefore more researches are needed to be conducted to explore these relationships.

The findings of our study added to the evidence of the impact of MetS and its components at baseline on incident HUA. It has been reported that programmed HUA intervention could optimize their cardiovascular lesions.[38] A combination of high BP, diabetes mellitus and high triglycerides was associated with the highest risk of incident HUA among all possible combinations of MetS components. This result may help to identify community-dwelling older adults at high risk of developing HUA and thus take measures to prevent HUA through modifying these common diseases among older adults. In addition, realizing the importance of MetS on incident HUA may be beneficial to make interventions and the clinical management of MetS as well as HUA, which may eventually reduce the risk of HUA-related cardiovascular events.

The strengths of this study included community-based sample, longitudinal design, reasonable follow-up rate and sufficient numbers of individuals with incident HUA. However, there were also several limitations, which should be noted. First, although we have adjusted a wide range of confounders, residual confounding may still exist. For example, dietary habits might have an impact on SUA levels. Consumption of purine-rich foods like seafood may increase SUA levels but information on this issue was not collected in this study.[39] Second, the under ascertainment and misclassification of outcome measures are possible because the incident cases might have been underestimated. Information on anti-hyperuricemia medication intake had been collected but few were reported. Recall bias or social desirability bias may lead to the underestimation of the incidence of HUA and distort the association of MetS and its components at baseline with incident HUA.

Conclusions

In conclusion, MetS and its components such as high BP, high BMI, diabetes mellitus and high triglycerides could increase the risk of HUA among community-dwelling older adults and high BP may be the most important determinant. A combination of high BP, diabetes mellitus and high triglycerides best predicts incident HUA. Additional studies are needed to confirm the findings in other ethnic groups and to further investigate the underlying mechanisms for the association. Randomized controlled trials are also warranted to investigate whether lowering BP in hypertensive patients or losing weight in obese populations could reduce the risk of HUA among the elderly.

Compliance with Ethical Standards

The study adhered to the Declaration of Helsinki and ethics approval was obtained from the Institutional Review Board of the Soochow University. Written inform

consent was obtained from each participant at the recruitment stage of the study.

Funding

This study was supported by the Science and Technology Bureau of Xiangcheng District in Suzhou, China under grant no. XJ201706 and the Health Commission of Suzhou under grant no. GSWS2019090.

Disclosure

The authors report no conflicts of interest in this work.

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