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Prevalence of hyperuricaemia in an Eastern Chinese population: a cross-sectional study

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ABSTRACT

Objectives In the past decade, China has been characterised by large-scale urbanisation as well as rapid economic growth. The aim of this study was to further investigate the prevalence of hyperuricaemia (HUA) in an Eastern Chinese population.

Design Cross-sectional study.

Setting Survey of Prevalence in East China of Metabolic Diseases and Risk Factors China study.

Participants In this study, 12 770 residents from 22 sites in Eastern China were recruited. Finally, 9225 subjects were included.

Main outcome measures The serum levels of uric acid (UA), fasting plasma glucose (FPG), glycated haemoglobin and other metabolic parameters were tested. Waist circumference, weight, height and blood pressure were also measured. Questionnaires regarding smoking, drinking, education were collected from the subjects. HUA was defined as serum UA >420 µmol/L for men and >360 µmol/L for women.

Results The prevalence of HUA in this Eastern Chinese population was 11.3% (9.9, 12.7) overall, 20.7% (17.7, 23.7) in men and 5.6% (4.3, 6.7) in women. The prevalence of HUA in urban subjects was higher than that in rural subjects (12.9 vs 10.8%, p<0.01). The prevalence of HUA was negatively and positively associated with age in men and women, respectively. Residents with high body mass index levels had a higher prevalence of HUA. In the logistic regression analysis, male sex, urban residency, total cholesterol, triglyceride, overweight, obesity, systolic blood pressure and low economic status were independently correlated with HUA.

Conclusions The estimated prevalence of HUA in this Eastern Chinese population was 11.3% (9.9, 12.7) overall and 20.7% (17.7, 23.7) and 5.6% (4.3, 6.7) in men and women, respectively. HUA has gradually become an important public health issue in China.

Trial registration number ChiCTR-ECS-14005052.

Strengths and limitations of this study

- ► This is the largest published hyperuricaemia study in an Eastern Chinese population.
- ► This study covers residents from 22 sites in five provinces.
- ► This is a regional survey instead of a national study.
- ► We do not consider the influence of diet.

INTRODUCTION

In humans, uric acid (UA) is the end product of purine metabolism and is mainly excreted via the kidneys. Xanthine oxidoreductase catalyses two enzymatic reactions, hypoxanthine to xanthine and xanthine to UA. Several conditions can influence the concentration of serum UA, including purine-rich food intake, neoplastic disease, cytotoxic drugs, obesity, hypertension.[1–3]

UA is reported to be associated with oxidative stress and inflammation.[1 4] In patients with hyperuricaemia (HUA), deposition of UA in joints and tissues promotes the occurrence of gout and chronic nephropathy. HUA has also been reported to be associated with insulin resistance, non-alcoholic fatty liver disease,[5 6] metabolic syndrome, type 2 diabetes, atherosclerosis and coronary heart disease.[7–11] The overall prevalence of HUA in adults in the USA was 21.4% in 2007–2008.[12] In 2009–2010, Liu *et al* showed the adjusted prevalence of HUA was 8.4% in Chinese adults.[13] Recently, Lu *et al* conducted a nationwide survey in 31 provinces in China. The prevalences of HUA were 13.7%–18.8% based on different urinary iodine concentrations (UICs).[14] These studies were national cross-sectional surveys using multistage, stratified sampling. There were also several local or regional investigations. In Henan Rural Cohort Study conducted from 2015 to 2017, the crude and age-standardised prevalences of HUA were 10.24% and 12.60%, respectively.[15] In 2017, Chen *et al* found that the prevalence of HUA was 13.4% in Jidong community of Tangshan City in northern China.[16] In an elderly Chinese population of 7 areas, the overall prevalence of HUA was 13.1% in 2018.[17] Liu *et al*[18] also conducted a meta-analysis including 38 regional studies between 2000 and 2014 to determine the prevalence of HUA in mainland China. The

pooled prevalence of HUA was 13.3% (male 19.4% and female 7.9%).

In the past decade, China has been characterised by large-scale urbanisation. The percentage of the urban population rose from 18% in 1978 to 56% in 2015.[19] As serum UA is closely related to economic development and urbanisation,[15] it is necessary to understand the latest prevalence of HUA in China.

China is characterised by regional and economic diversity. Eastern China has a relatively higher economic status than the rest of the country. In the present study, we performed a cross-sectional survey to investigate the prevalence of HUA and its risk factors in an eastern Chinese population.

METHODS

Study population

Data from the current study are from the Survey of Prevalence in East China of Metabolic Diseases and Risk Factors China, which is a population-based cross-sectional survey of the prevalence of metabolic diseases and risk factors in Eastern China.[20] A total of 12 770 residents from 22 sites in five provinces (Shanghai, Zhejiang, Jiangsu, Anhui and Jiangxi) were recruited from January 2014 to December 2015 (online supplementary figure 1). The inclusion and exclusion criteria were described previously.[20] Local residents more than 18 years old and lived in their current area for more than 6 months were included in this study. We excluded subjects with severe communication problems, acute illness or an unwillingness to participate. We also excluded residents who had no UA data (n=3535) and chronic kidney disease stage 5 (n=10). Finally, 9225 subjects were included. Informed consent was obtained from all the participants.

Table 1 Baseline characteristics between different groups

Variables	Men (n=3682)	Women (n=5543)	P value
Age year	55.57±13.23	54.30±12.82	<0.001
FPG mmol/L	5.72±1.63	5.50±1.36	<0.001
HbA1c, %	5.78±1.08	5.64±0.92	<0.001
TG mmol/L	1.88±1.79	1.55±1.20	<0.001
TC mmol/L	5.14±1.13	5.27±1.15	<0.001
LDL mmol/L	3.23±0.77	3.30±0.83	<0.001
HDL mmol/L	1.30±0.31	1.45±0.32	<0.001
UA umol/L	352.1±79.3	269.3±64.7	<0.001
BMI kg/m^2	25.11±3.45	24.40±3.67	<0.001
WC cm	85.85±9.42	78.72±9.90	<0.001
SBP mm Hg	134.3±20.7	131.1±22.2	<0.001
DBP mm Hg	82.1±12.9	77.8±12.9	<0.001
Diabetes, %	16.3	12.7	<0.001
Hypertension, %	53.4	44.1	<0.001

BMI, body mass index; DBP, diastolic blood pressure; FPG, fasting plasma glucose; HbA1c, glycated haemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein; SBP, systolic blood pressure; TC, total cholesterol; TG, triglycerides; UA, uric acid; WC, waist circumference.

Measurements and definition

HUA was defined as serum UA >420 µmol/L for men and >360 µmol/L for women.[21] Blood pressure and heart rate were measured with a sphygmomanometer (TERUMO-Elemano) three times. Mean value of the three records was used in the analysis. Hypertension was defined as a systolic blood pressure (SBP) ≥140 mm Hg or diastolic blood pressure (DBP) ≥90 mm Hg or any self-reported history of hypertension. Diabetes was defined as a self-reported history of diabetes or glycated haemoglobin (HbA1c) levels of 6.5% or more. Pre-diabetes was defined as HbA1c concentrations between 5.7% and 6.4%. Normal glucose tolerance was defined as an HbA1c less than 5.7%.[22] Weight, height and waist circumference (WC) were measured by standard procedure. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Overweight and obesity were defined as 24 kg/m^2 ≤BMI<28 kg/m^2 and BMI ≥28 kg/m^2, respectively. Demographic characteristics and lifestyle risk factors were collected by standard questionnaires. Current smoking, drinking and economic status were defined as previously described.[23 24]

Assessment of biochemical indexes

After fasting for 8 hours, venous blood samples were drawn from all participants and quickly centrifuged at room temperature. Within 2–4 hours of collection, blood samples were stored at −20°C and transported by air in dry ice to one central laboratory certified by the College of American Pathologists as previously described.[25] Serum UA was analysed with a Beckman Coulter AU 680 device with the original kit (Brea, California, USA). The validity and accuracy of UA were 6% and 4%, respectively. Other biochemical indexes were analysed as described previously.[26]

Statistical analysis

We performed statistical analysis by IBM SPSS V.22 (IBMk). Demographic and metabolic characteristics are expressed as the mean±SD for continuous variables and percentages (95% CI) for categorical variables in the overall population and in subgroups of location, age, economic status, BMI and glucose status. Logistic analysis was used to investigate the association of demographic, lifestyle and metabolic factors with the odds of HUA. According to the sixth national population census data, the proportions of the population in different age groups (<40, 40–60, ≥60) are 57.39%, 29.29% and 13.31% (total); 58.10%, 29.13% and 12.76% (male); and 56.61%, 29.46%, and 13.91% (female), respectively.[27] Thus, we adjusted the prevalence of HUA by these proportions. All analyses were two sided. P<0.05 was considered significant.

Table 2 Characteristics of eastern Chinese population

	Percentage % (95% CI)				Means±SD		
	Diabetes	**Hypertension**	**Smoking**	**Drinking**	**WC**	**SBP**	**BMI**
Overall	14.1 (13.4 to 14.8)	47.8 (46.8 to 48.9)	19.2 (18.3 to 20.0)	55.8 (54.8 to 56.9)	81.57±10.32	132.4±21.7	24.68±3.60
Location							
Rural	15.8 (14.4 to 17.2)	58.7 (56.8 to 60.6)	22.9 (21.3 to 24.5)	56.6 (54.7 to 58.5)	83.14±10.38	139.7±23.2	24.71±3.65
Urban	13.4 (12.6 to 14.2)	43.3 (42.1 to 44.5)	17.6 (16.7 to 18.6)	55.5 (54.3 to 56.7)	80.90±10.23	129.4±20.3	24.67±3.58
Age groups							
<40	1.6 (0.9 to 2.3)	11.1 (9.4 to 12.9)	12.9 (11.0 to 14.8)	42.0 (39.2 to 44.7)	75.22±10.55	116.8±15.0	23.38±3.61
40–60	11.3 (10.3 to 12.2)	41.8 (40.3 to 43.3)	20.8 (19.6 to 22.0)	54.9 (53.4 to 56.5)	80.78±9.87	129.5±20.1	24.82±3.35
≥60	21.5 (20.2 to 22.9)	67.1 (65.6 to 68.7)	19.4 (18.1 to 20.7)	61.5 (59.9 to 63.1)	84.60±9.59	141.0±21.5	24.96±3.79
Economic status							
Low	12.3 (11.3 to 13.3)	47.8 (46.3 to 49.4)	21.2 (19.9 to 22.5)	46.6 (45.1 to 48.2)	81.07±10.57	134.2±23.5	24.50±3.55
High	15.6 (14.6 to 16.6)	47.8 (46.4 to 49.2)	17.6 (16.5 to 18.6)	62.9 (61.6 to 64.3)	81.96±10.10	131.0±20.1	24.83±3.64
BMI							
<24	9.8 (8.9 to 10.7)	35.2 (33.7 to 36.7)	16.6 (15.4 to 17.7)	52.9 (51.3 to 54.5)	74.72±7.85	126.9±21.1	21.67±1.69
24–28	15.2 (14.0 to 16.4)	53.0 (51.4 to 54.7)	20.6 (19.2 to 21.9)	58.3 (56.7 to 59.9)	84.57±7.30	135.2±21.2	25.79±1.12
≥28	24.1 (21.8 to 26.3)	69.1 (66.7 to 71.5)	22.8 (20.6 to 25.0)	57.6 (55.0 to 60.2)	93.34±8.52	140.5±20.2	30.40±3.09
Glucose status							
Normal	–	37.0 (35.6 to 38.3)	16.2 (15.1 to 17.2)	50.6 (49.3 to 52.0)	78.95±9.88	128.0±20.6	24.08±3.44
Pre-diabetes	–	57.6 (55.7 to 59.5)	23.4 (21.7 to 25.0)	63.2 (61.3 to 65.1)	83.90±9.53	136.7±21.6	25.26±3.55
Diabetes	–	72.7 (70.3 to 75.2)	23.0 (20.6 to 25.3)	61.3 (58.7 to 64.0)	87.60±9.97	141.9±21.2	26.00±3.78

BMI, body mass index; SBP, systolic blood pressure; WC, waist circumference.

Patient and public involvement

Patients and the public were not involved in the development of research questions, design of the study, recruitment and conduct of the study or dissemination of the study results.

RESULTS

Characteristics of this eastern Chinese population

In our study, we analysed UA in 9225 Chinese adults, including 3682 males (age, 55.57±13.23y) and 5543 females (age 54.30±12.82y). The mean levels of serum UA were 352.12±79.30 nmol/L and 269.29±64.68 nmol/L in males and females, respectively. There were significant sex differences in blood glucose, blood lipids, UA, BMI, WC and blood pressure. The prevalence of diabetes and hypertension also showed a significant difference (table 1).

Metabolic risk factors of this Eastern Chinese population

The prevalence of diabetes and hypertension, WC, SBP and BMI increased with age. As BMI and glucose levels rose, the prevalence of hypertension, WC, SBP, BMI, triglyceride (TG), fasting plasma glucose (FPG), and HbA1c increased. Moreover, people living in rural areas had a higher prevalence of diabetes, WC, SBP, low-density lipoprotein (LDL), high-density lipoprotein (HDL), total cholesterol (TC) and HbA1c. People with a high economic status had a higher prevalence of diabetes, WC, UA, BMI, LDL, FPG, HbA1c and creatinine (tables 2 and 3).

Estimated prevalence of HUA in this Eastern Chinese population

The prevalence of HUA was 12.3% (11.6, 12.9), with 17.9% (16.7, 19.1) and 8.5% (7.8, 9.3) in males and females, respectively. The prevalence of HUA in urban areas was higher than that in rural areas (12.9% vs 10.8%). The prevalence of HUA in developed areas was slightly higher than that in underdeveloped areas (12.6% vs 11.8%). As BMI increased, the prevalence of HUA increased in both men and women. The prevalence of HUA in normal, prediabetic and diabetic women were 5.7% (4.9, 6.5), 11.6% (10.0, 13.2) and 15.2% (12.5, 17.9), respectively (table 4). So there was an increased trend of prevalence of HUA in women with different glucose status. However, this trend was not obvious in men. After adjusting for the proportions of the population in different age groups, the prevalence of HUA was 11.3% (9.9, 12.7), with 20.7% (17.7, 23.7) and 5.6% (4.3, 6.7) in males and females, respectively (table 4). When HUA was defined as serum UA of more than 420 µmol/L in both men and women, the prevalence of HUA was 8.4% (7.8, 9.0) in total and

Table 3 Biochemical index of Eastern Chinese population

		Means±SD						
	UA	LDL	TG	HDL	TC	FPG	HbA1c	Creatinine
Overall	302.0±81.5	3.28±0.81	1.68±1.48	1.39±0.32	5.22±1.14	5.58±1.48	5.70±0.99	77.31±14.96
Location								
Rural	294.8±83.0	3.38±0.83	1.69±1.56	1.44±0.31	5.37±1.07	5.63±1.60	5.80±1.03	73.76±14.20
Urban	305.6±80.9	3.23±0.80	1.67±1.43	1.37±0.33	5.16±1.17	5.57±1.42	5.65±0.96	78.87±15.13
Age groups								
<40	294.1±85.7	2.81±0.65	1.35±1.25	1.39±0.30	4.60±0.87	4.98±0.76	5.09±0.57	75.82±14.73
40–60	298.0±82.8	3.29±0.78	1.76±1.71	1.39±0.32	5.24±1.16	5.52±1.46	5.62±0.94	76.26±14.59
≥60	310.1±78.3	3.42±0.83	1.69±1.20	1.38±0.34	5.39±1.13	5.86±1.60	5.98±1.04	79.09±15.47
Economic status								
Low	299.8±85.1	3.23±0.82	1.70±1.65	1.45±0.32	5.20±1.05	5.54±1.48	5.62±0.99	76.29±15.23
High	304.4±78.7	3.31±0.80	1.66±1.31	1.34±0.32	5.23±1.21	5.62±1.47	5.75±0.98	78.20±14.83
BMI, kg/m^2								
<24	279.5±73.3	3.15±0.80	1.35±1.05	1.48±0.33	5.11±1.09	5.39±1.35	5.53±0.92	75.83±14.26
24–28	313.9±81.7	3.36±0.81	1.85±1.50	1.33±0.30	5.28±1.18	5.64±1.47	5.76±0.99	78.34±15.37
≥28	335.5±85.3	3.44±0.80	2.20±2.13	1.27±0.28	5.39±1.17	6.00±1.74	6.02±1.10	78.95±15.44
Glucose status								
Normal	294.9±81.3	3.12±0.76	1.54±1.38	1.41±0.32	5.05±1.10	5.09±0.54	5.16±0.36	76.81±14.77
Pre-diabetes	313.1±81.1	3.51±0.81	1.71±1.17	1.38±0.32	5.49±1.12	5.45±0.72	5.93±0.20	77.95±14.83
Diabetes	310.9±81.2	3.42±0.86	2.18±2.14	1.29±0.32	5.38±1.21	7.89±2.63	7.38±1.49	78.22±16.38

BMI, body mass index; FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TC, total cholesterol; TG, triglycerides; UA, uric acid.

Table 4 Estimated prevalence of HUA in Eastern Chinese population

	Percentage % (95% CI)		
	Overall	Men	Women
Overall	12.3 (11.6 to 12.9)	17.9 (16.7 to 19.1)	8.5 (7.8 to 9.3)
Overall*	11.3 (9.9 to 12.7)	20.7 (17.7 to 23.7)	5.6 (4.3 to 6.7)
Location			
Urban	12.9 (12.1 to 13.7)	19.1 (17.6 to 20.7)	8.9 (8.0 to 9.8)
Rural	10.8 (9.6 to 12.0)	15.2 (13.1 to 17.3)	7.7 (6.4 to 9.0)
Age groups			
<40	10.8 (9.0 to 12.5)	22.8 (19.0 to 26.6)	3.3 (2.0 to 4.5)
40–60	11.2 (10.3 to 12.2)	18.9 (17.0 to 20.8)	6.5 (5.5 to 7.4)
≥60	13.9 (12.8 to 15.0)	15.4 (13.6 to 17.2)	12.8 (11.4 to 14.2)
Economic status			
Low	11.8 (10.9 to 12.8)	18.3 (16.5 to 20.1)	7.2 (6.1 to 8.2)
High	12.6 (11.7 to 13.5)	17.5 (15.8 to 19.2)	9.5 (8.5 to 10.6)
BMI, kg/m2			
<24	6.7 (5.9 to 7.5)	10.5 (8.9 to 12.2)	4.8 (3.9 to 5.6)
24–28	14.1 (13.0 to 15.3)	19.9 (18.0 to 21.9)	9.4 (8.1 to 10.7)
≥28	22.5 (20.3 to 24.6)	27.3 (23.9 to 30.8)	18.5 (15.7 to 21.2)
Glucose status			
Normal	10.1 (9.3 to 10.9)	17.5 (15.8 to 19.2)	5.7 (4.9 to 6.5)
Pre-diabetes	15.2 (13.9 to 16.6)	20.3 (17.9 to 22.7)	11.6 (10.0 to 13.2)
Diabetes	15.1 (13.1 to 17.0)	15.0 (12.1 to 17.8)	15.2 (12.5 to 17.9)

*Standardised by proportions of population of sixth national population census data.
BMI, body mass index; HUA, hyperuricaemia.

2.1% (1.7, 2.5) in females. After adjusting for the proportions of the population in different age groups, the prevalence of HUA was 8.8% (7.5, 10.1) in total and 1.4% (0.7, 2.0) in females (online supplementary table 1).

Logistic regression analysis of HUA

Male sex, urban residency, increased TC or TG, overweight, obesity, elevated SBP and low economic status were all risk factors for HUA in this eastern Chinese population (table 5). However, increased age, higher educational status, increased LDL or HDL, current smoking or drinking and elevated DBP were not associated with the risk of HUA. When HUA was defined as serum UA of more than 420 µmol/L in both men and women, the association was similar to the above results (online supplementary table 2).

DISCUSSION

In this Eastern Chinese population, the prevalence of HUA was 11.3%, which was similar to the pooled prevalence reported in a systematic review performed in China (13.3%).[18] However, this prevalence was more than that in the national HUA survey, which reported that the prevalence of HUA was 8.4% in 2009–2010.[13] These two studies investigated different populations. Recently, a national study was performed on the relationship between HUA and iodine intake. The prevalence of HUA was 17.8%, 18.8%, 16.0% and 13.7% in the UICs <100, 100–199, 200–299 and ≥300 ug/L groups.[14] Our result was between these national surveys, which was performed in 2014–2015. As a regional study, the prevalence of our result was similar to other regional investigations in China.[15–18] However, our prevalence was relatively lower than that in Qingdao, Shandong Province, which is close to the sea and where residents consume high amounts of seafood and beer.[28] Moreover, the prevalence of HUA in our population was lower than those in the USA and Japan,[12 29] which might be attributed to economic status.

The prevalence of HUA in young men (<40 years) was seven times greater than that in young women. However, as age increased, the prevalence of HUA gradually decreased in men and increased in women, which was coincident with values previously reported.[30] In residents more than 60 years of age, men and women had a similar prevalence of HUA. We deduced that the diet of young men contains more purine than that of old men. The young men also had an active metabolism. The prevalence of HUA was dramatically increased in women older than 60 years, which might be caused by reduced oestrogen levels.

Table 5 Risk factors for HUA in Eastern Chinese population

Risk factors	OR	(95% CI)
Female sex	0.510	0.427 to 0.609
Age per 10 years	1.041	0.976 to 1.112
Urban residency	2.218	1.681 to 2.927
≥Junior middle school education	1.042	0.866 to 1.253
Lipids		
LDL per 1SD	1.018	0.888 to 1.168
HDL per 1SD	0.936	0.850 to 1.032
TC per 1SD	1.226	1.050 to 1.432
TG per 1SD	1.672	1.491 to 1.875
Current smoking	0.942	0.778 to 1.141
Current drinking	0.913	0.784 to 1.062
BMI, kg/m^2		
Overweight obesity	1.772 2.874	1.481 to 2.120 2.338 to 3.532
Blood pressure SBP per 10 mm Hg	1.055	1.009 to 1.103
DBP per 10 mm Hg	1.012	0.944 to 1.085
High economic status	0.688	0.538 to 0.879

Data are expressed as unstandardised B (95% CI). The enter procedure was used.
BMI, body mass index; DBP, diastolic blood pressure; HDL, high-density lipoprotein; HUA, hyperuricaemia; LDL, low-density lipoprotein; SBP, systolic blood pressure; TC, total cholesterol; TG, triglyceride.

Risk factors for HUA were also evaluated in our study. We found that male sex, urban residency, hypertriglyceridaemia, hypercholesterolaemia, overweight, obesity, high SBP and low economic status were risk factors for HUA. In previous studies, hypertriglyceridaemia was thought to be the strongest risk factor for HUA.[30 31] However, the OR for HUA was 1.7 times with 1 SD elevation of triglyceridaemia. In addition, obesity was the strongest risk factor (OR=2.874) in our study. China has the largest obese population in the world.[32] In this case, the prevalence of HUA will increase with the rising trend of obesity. Therefore, we should pay more attention to prevent its consequences.

HUA is closely related to lifestyle and dietary habits. In previous studies, the prevalence of HUA in urban areas was much greater than that in rural areas.[13 30] In our study, the prevalence of HUA in urban areas was mildly elevated (12.9% vs 10.8%), and urbanisation was a risk factor for HUA. Eastern China is considered the developed area in the whole country. Therefore, the difference between urban and rural areas was not obvious as in other places. Moreover, people with high economic status consumed more healthy food that contained low purine ingredients. This could partly explain why low economic status became a risk factor for HUA. In accordance with a previous study, smoking was not associated with HUA.[13] However, according to a previous study, alcohol intake influences serum UA, which is different from the results of our study. This difference might have been caused by our definition of current drinking (current drinking was defined as drinking in the past 1 month), which mixed nonhabitual drinkers and habitual drinkers together.

As age increased, UA together with components of metabolic syndrome (FPG, SBP, WC) also increased, which indicated that there might be a close relationship between metabolic syndrome and HUA. Other studies have also found that HUA is associated with metabolic syndrome.[33 34] An epidemiological study showed that HUA is positively correlated with fasting serum insulin.[35] Krishnan *et al* reported that people with HUA have 1.36 times the risk of developing insulin resistance in a 15-year follow-up study.[36] Thus, research has indicated that insulin resistance plays an important role in the relationship between metabolic syndrome and HUA.[37]

There were several limitations in our study. First, this was not a national study but a local survey. Second, we did not consider the influence of diet. Blood was drawn after fasting for 8 hours. However, the diet ingested near the blood drawing time was unknown. In addition, this was a cross-sectional study. Therefore, we could not identify a causal relationship between HUA and its risk factors.

In this study, we estimated the prevalence of HUA in an eastern Chinese population. To prevent the prevalence of HUA, more attention should be paid to life status (such as economic status and residence) and metabolic indexes (TC, TG, BMI and SBP).

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Contributors YL and BH designed and supervised this investigation. BH performed this investigation. YiC, CZ and YinC contributed to the data collection. NW and QL provided technical or material support. All authors read and approved the final manuscript.

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