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Cross-sectional and longitudinal associations between serum uric acid and metabolic syndrome: Results from Fangchenggang Area Male Health and Examination Survey in China

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ABSTRACT

Background: It is controversial whether serum uric acid (SUA) is a risk factor for the prevalence of metabolic syndrome (MetS). The current study was designed to highlight the association of SUA and MetS and its components.
Methods: Data on 3675 healthy male subjects, aged 17–88 years, were collected for the cross-sectional study. A representative sample of 2575 individuals who did not suffer from MetS at baseline was involved in the cohort study. A cox regression model was applied to evaluate causality for the 2- and 4-year large scale longitudinal study.
Results: In the cross-sectional analysis, SUA showed a statistically significant negative correlation with high-density lipoprotein cholesterol (HDL-c) and a positive correlation with blood pressure (BP), triglycerides (TG), waist circumference (WC), and body mass index (BMI) (all $P < 0.001$). In longitudinal analysis, examining the risk of developing MetS, SUA concentrations (hazard ratios comparing fourth quartile to the first quartile of 1.75; 95% CI, 1.26–2.41) were positively associated with incident MetS after adjusted for age, blood pressure, glucose, TG, HDL-c, smoking, alcohol drinking and education.
Conclusion: SUA is positively correlated with the prevalence of MetS. Increased SUA concentration may be an independent risk factor for MetS.

1. Introduction

Metabolic syndrome (MetS) is more prevalent than 20 years ago in China with the rapid economic development, transformed lifestyle and aging population. MetS means a cluster of metabolic abnormalities leading to increased risk of cardiovascular disease, diabetes mellitus and other chronic disease [1,2]. Serum uric acid (SUA) is the product of purine metabolism, and its concentrations are strictly controlled by the balance between production and exertion [3]. Several studies have reported that high SUA concentrations are associated with hypertension, hyperlipidemia, abdominal obesity and chronic renal disease as it is increasing [1,4–6]. In addition, SUA has proven to be the scavenger of free-radical and exerts a neuroprotective effect [7,8]. Some previous findings revealed that SUA may be a risk factor for erectile dysfunction and the development of cancer [9,10].

The relationship between SUA and MetS has been reported extensively. Previous studies have demonstrated that the prevalence of MetS was high among patients with gout [11]. Other authors have claimed that, even healthy individuals, hyperuricemia was associated with MetS [12]. However, a previous study in Iran suggested that SUA concentrations were not an appropriate risk factor of MetS [13]. The association was largely proven by cross-sectional study that could not illustrate the casual relationship [14,15]. The prospective data on SUA as a predictor of MetS incidence are limited in Chinese [16]. Therefore, we conducted the current study to shed light on the cross-sectional and longitudinal relationships between the increased SUA and MetS in Chinese male population.

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2. Subjects and methods

2.1. Study population

The Fangchenggang Area Male Health and Examination Survey (FAMHES) was described in detail in the previous study [17]. All participants provided written informed consent, and the local ethics committee approved the study.

The cross-sectional study was performed in 4303 consecutive subjects who completed a large scale of physical examination in Medical Center of Fangchenggang First People's Hospital from September 2009 to December 2009. The following participants were excluded from the present study for the diminution of confounding factors and bias: (a) currently diagnosed with diabetes mellitus, coronary heart disease, stroke, rheumatoid arthritis, and cancer; (b) taking any kind of medication; (c) with impaired hepatic function (alanine transaminase >2.0 times upper limit of normal); (d) with impaired renal function (serum creatinine >178 μmol/l); or (e) information loss to the extent of failing to judge MetS or SUA unavailable. Totally, 3675 unrelated participants were included in the baseline survey.

Based on the cross-sectional study, to promote the quality of follow-up and minimize bias, 1809 subjects being in a fixed workplace were enrolled to participate in the 4-year follow-up study. From July 2011 to October 2011, another 1713 subjects were recruited for the 2-year longitudinal study. The response rates of the 4-year and 2-year follow-up were 100% and 94% respectively. We excluded 103 participants who did not attend the follow-up from 2011 to 2013 and 754 subjects with MetS in the baseline for the longitudinal study. Eventually, 1378 and 1197 participants were included in the 4- and 2-year follow-up study, respectively (Fig. 1).

2.2. Data collection

A comprehensive physical examination and a face to face interview were conducted by trained physicians. Information on demographic characteristic (age, education, etc), lifestyle (smoking, alcohol consumption, and physical activity), health status, and history of taking medication were covered in a standard questionnaire. Alcohol status was defined as never, former (abstinence >6 months or frequency less than once a month), and current (daily drinking >6 months). Men were defined as non-smokers (never smoke), former smokers (had quit smoking >6 months), and smokers (daily smoking >6 months). According to the education concentration, education background of participants was divided into 3 groups (0–6, 7–9 and ≥10 years). Physical activity ≥300 min/week was considered as physical moderately. Anthropometric measurement including weight and height were measured without coat and shoes to the nearest 0.1 kg and 0.1 cm. Waist circumference (WC) then was measured at the meddle of costal margin and superior iliac to the nearest 0.1 cm. Blood pressure (BP) was measured twice by trained nurse with the mercury sphygmomanometer. The time interval was 15 min, and the average value was recorded.

2.3. Laboratory measurement

Blood specimens were taken by venipuncture after a 12-h overnight fast. Each sample marked a unique number for laboratory measurement was sent to the Department of Clinical Laboratory at the Fangchenggang First People's Hospital immediately for segregation. SUA, triglycerides (TG), high-density lipoprotein cholesterol (HDL-c), low-density lipoprotein cholesterol (LDL-c), alanine transaminase, serum creatinine and serum glucose were measured on a dimension-RxL chemistry Analyzer (Dade Behring, Newark, Delaware) with enzymatic detection.

3. Definition of MetS

The definition of MetS was based on the latest updated National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) for Asian American [18]. According to this criteria, having 3 or more of the following components was defined as MetS: (1) WC at least 90 cm; (2) TG at least 1.7 mmol/l; (3) HDL-c <1.03 mmol/l; (4) systolic blood pressure (SBP) at least 130 mm Hg and/or diastolic blood pressure (DBP) at least 85 mm Hg or with previously diagnosis of hypertension and current use of antihypertension medications; and (5) fasting glucose at least 5.6 mmol/l or previous diagnosis with type 2 diabetes.

3.1. Data analysis

For the cross-sectional analysis, the baseline data between MetS group and non-MetS group were compared using the paired *t* test or

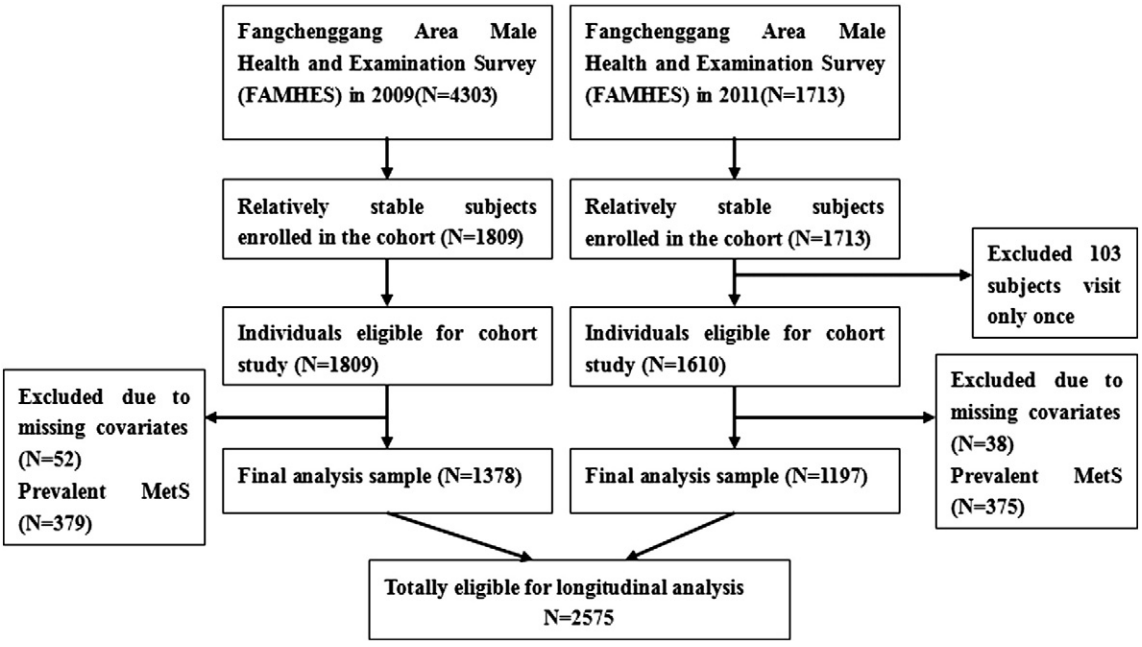

Fig. 1. Flowchart for sample construction of the longitudinal analysis.