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Original Article

A Body Shape Index and Body Roundness Index: Two new body indices for detecting association between obesity and hyperuricemia in rural area of China

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ABSTRACT

Objective: The first objective was to examine whether A Body Shape Index (ABSI) and Body Roundness Index (BRI) can identify hyperuricemia in rural China. The second aim was to compare the relative strength of association between anthropometric indices and hyperuricemia.

Methods: A total of 11,345 participants were involved in this cross-sectional study. Obesity measurements included BMI, WC, WHtR, ABSI and BRI. According to the statistical distribution of serum uric acid (SUA), we split our study population in sex-specific tertiles of SUA.

Results: After adjusting for confounding variables, BRI (linear regression: 0.170; AUC: 0.641; OR: 1.459) showed more powerful predictive ability for hyperuricemia than BMI (linear regression: 0.151; AUC: 0.630; OR: 1.108), while having a similar predictive power for hyperuricemia as WHtR (linear regression: 0.191; AUC: 0.656; OR: 1.067) and WC (linear regression: 0.209; AUC: 0.658; OR: 1.047) in the female group, but not in the male group. However, ABSI (A) (linear regression: 0.089 for women, 0.121 for men; AUC: 0.589 for women, 0.578 for men; OR: 1.027 for women, 1.034 for men) and ABSI (B) (linear regression: 0.118 for women, 0.121 for men; AUC: 0.607 for women, 0.578 for men; OR: 1.049 for women, 1.034 for men) had the lowest predictive power for hyperuricemia in both sex categories.

Conclusions: ABSI, BRI, BMI, WC and WHtR were all significantly associated with hyperuricemia in both sexes. In addition, BRI rather than ABSI showed a superior predictive ability for identifying hyperuricemia than BMI in female and similar capabilities as those of WC and WHtR in the female, but not in the male gender.

1. Introduction

Hyperuricemia, which is an important independent predictor of morbidity and mortality in many cardiovascular disease, is strongly correlated to coronary heart disease (CHD) [1,2], congestive heart failure (HF) [3], atrial fibrillation (AF) [4] and ventricular hypertrophy [5,6]. What's more, hyperuricemia is also contributing to the development of gout which is considered as a major public health issue for its great impact on quality of life [7,8]. Therefore, it is essential to identify the risk factors for hyperuricemia and adopt primary preventions.

Obesity, a major independent risk factor associated with chronic diseases, has been ascertained to be an important factor that determines serum uric acid levels. Several obesity measurements, such as body mass index (BMI), waist circumference (WC) and waist-to-height ratio (WHtR), have been identified as a predictor of hyperuricemia [9–12]. However, comparing the relative strength of association between obesity measurements and hyperuricemia is rarely mentioned. Though BMI, WC and WHtR were noticeable to measure adiposity for a long time, some studies still suggested that they provide limited information on fat distribution [13–15].

Standardizing WC for height and BMI, Krakauer NY and Krakauer JC have proposed a new index known as A Body Shape Index (ABSI) [16]. The study showed a significant association between ABSI and abdominal adipose tissue, and ABSI appeared to be more associated with premature death than WC and BMI did. In some cohort studies, ABSI had a positive correlation with morbidity and mortality hazard [17,18],while, some other studies found a controversial point. Compared to BMI, ABSI seemed to be a weaker index of hypertension and cardiovascular disease (CVD) after adjusting for confounding variables [19,20].

BRI, another new index proposed by Thomas et al. [21], was based on WC and height. The values of BRI ranged from 1 to 16 and the values of BRI were 4.64 $\pm$ 1.88 (men) and 5.16 $\pm$ 2.24 (women). BRI was a new index and limited studies were about BRI. Thomas et al. showed that BRI improved predictions of body fat compared to the traditional indices. However, Maessen found that BRI was a weaker prediction compared to established indices like BMI and WC [22].

As far as we know, no evidence illustrates whether two new anthropometric indices (ABSI and BRI) are significantly associated with hyperuricemia. In addition, there hasn't been any relevant study to compare

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the relative strength of association between obesity measurements and hyperuricemia. Therefore, this population-based cross-sectional study aims, firstly, to examine whether two new anthropometric measurements ABSI and BRI could identify hyperuricemia among rural populations in northeast China. Secondly, it compares the relative strength of association between anthropometric indices (ABSI, BMI, BRI, WC, WHtR) and hyperuricemia.

2. Methods

2.1. Study population

The study was conducted from January 2012 to August 2013. A representative sample from the participants aged over 35 years old was selected to present the prevalence, incidence and natural history of cardiovascular risk factors in rural areas of Liaoning Province. The study adopted a multi-stage, stratified, random-cluster sampling scheme. At the first stage, three areas of Dawa, Zhangwu and Liaoyang County were randomly selected from Liaoning province. At the second stage, one town was randomly selected from each county (for a total of three towns). At the third stage, 8 to 10 rural villages from each town were randomly selected (for a total of 26 rural villages). In total, there are 14,016 satisfactory participants enrolled in this survey. Among those, 11,956 participants finished this study and the response rate was 85.3%. The participants who were pregnant or had malignant tumors or mental disorders or had missing serum uric acid variables were excluded. Finally, a sample size of 11,345 is accepted. The study was approved by the Ethics Committee of China Medical University, Shenyang, China and all procedures were conducted under ethical standards. Written consent was obtained from all participants after they had been informed of the objectives, benefits, medical items and confidentiality agreement regarding their personal information. For the participants who were illiterate, written informed consents were obtained from their proxies.

2.2. Data collection

Data was collected during a single clinic visit by cardiologists and trained nurses using a standard questionnaire by face-to-face interview. Before the survey was performed, we invited all eligible investigators to attend the organized training. The training contents included the purpose of this study, how to administer the questionnaire, the standard method of measurement, the importance of standardization, and the study procedures. A strict test was evaluated after this training, only those who scored perfectly on the test could become investigators. During data collection, our inspectors had further instructions and support.

Race was classified as Han or others (including some ethnic minorities in China, such as Mongol and Manchu). Family income was classified as ≤5000, 5000–20,000 and >20,000 CNY/year. Educational levels were categorized as primary school or below, middle school and high school or above. Current drinking status was defined as one or more alcoholic drinks in the previous year. Current smoking status was defined as at least 1 cigarette a day, continued or accumulative total within more than 6 months and continued use.

According to American Heart Association protocol, blood pressure was measured three times at 2-min intervals after at least 5 min of rest using a standardized automatic electronic sphygmomanometer (HEM-907; Omron). The participants were advised to avoid caffeinated beverages and exercise for at least 30 min before the measurement. During the measurement, the participants were seated with the arm supported at the level of the heart. The mean of three blood pressure measures was calculated and used in all analyses.

Fasting blood samples were collected in the morning after at least 10 h of fasting. Blood samples were obtained from an antecubital vein into BD Vacutainer tubes containing ethylenediaminetetraacetic acid. Serum was subsequently isolated from the whole blood, and all serum samples were frozen at −20 °C for testing at a central, certified laboratory. Serum uric acid (SUA) was analyzed using an uricase/peroxidase method implemented in an Olympus AU640 autoanalyzer (Olym-pus, Kobe, Japan). Fasting plasma glucose, triglycerides, total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol and other blood biochemical indexes were analyzed enzymatically using the above mentioned autoanalyzer. All blinded duplicate samples were used for these analyses.

2.3. Definitions

Weight and height were measured to the nearest 0.5 kg and 0.1 cm respectively with the participants in light weight clothing. WC was measured at the umbilicus using a nonelastic tape to the nearest 0.1 cm and with the participants standing at the end of normal expiration. BMI

Table 1
Descriptive characteristics of the study population on the basis of tertiles of serum uric acid and gender.

Characteristics	Women				Men			
Mean ± SD	I Tertile N = 2030	II Tertile N = 2013	III Tertile N = 2049	P value	I Tertile N = 1751	II Tertile N = 1743	III Tertile N = 1759	P value
Age (years)	51.2 ± 9.8	53.4 ± 10.3	55.5 ± 10.4	<0.001	55.9 ± 10.5	54.0 ± 10.9	53.2 ± 10.9	<0.001
Race (Han) (%)	93.3	94.8	96.6	<0.001	94.6	94.6	95.1	0.524
Current smoking status (%)	15.6	15.9	18.0	0.043	59.1	58.7	53.7	0.001
Current drinking status (%)	2.7	2.8	3.2	0.284	39.2	46.6	50.5	<0.001
Educational status (%)				<0.001				<0.001
Primary school or below	50.8	57.3	62.1		46.3	39.6	39.5	
Middle school	40.9	35.3	30.5		44.7	48.0	47.8	
High school or above	8.3	7.4	7.4		9.0	12.4	12.7	
Height (cm)	155.6 ± 6.2	155.6 ± 6.0	155.7 ± 6.0	0.867	165.4 ± 6.5	166.5 ± 6.3	167.3 ± 6.0	<0.001
Weight (cm)	58.2 ± 9.6	59.7 ± 9.9	62.9 ± 10.3	<0.001	65.5 ± 10.1	68.1 ± 10.5	72.1 ± 11.6	<0.001
Systolic blood pressure (mm Hg)	137.9 ± 24.1	138.9 ± 22.9	143.3 ± 24.6	<0.001	143.5 ± 22.9	142.8 ± 22.4	144.6 ± 22.6	0.061
Diastolic blood pressure (mm Hg)	79.0 ± 11.2	80.1 ± 11.2	82.5 ± 11.9	<0.001	81.9 ± 11.2	83.3 ± 11.4	86.0 ± 12.5	<0.001
Low-density lipoprotein cholesterol (mmol/L)	2.8 ± 0.8	3.0 ± 0.8	3.1 ± 0.9	<0.001	2.8 ± 0.8	2.9 ± 0.8	3.0 ± 0.8	<0.001
High-density lipoprotein cholesterol (mmol/L)	1.5 ± 0.4	1.4 ± 0.3	1.3 ± 0.3	<0.001	1.5 ± 0.4	1.4 ± 0.4	1.3 ± 0.4	<0.001
Triglyceride (mmol/L)	1.3 ± 0.8	1.6 ± 1.2	2.0 ± 1.7	<0.001	1.3 ± 0.9	1.6 ± 1.4	2.1 ± 2.3	<0.001
Total cholesterol (mmol/L)	5.1 ± 1.1	5.1 ± 1.1	5.5 ± 1.2	<0.001	5.0 ± 0.9	5.1 ± 1.0	5.3 ± 1.1	<0.001
Fasting plasma glucose (mmol/L)	5.8 ± 1.7	5.8 ± 1.5	6.0 ± 1.5	<0.001	6.0 ± 2.0	5.9 ± 1.6	5.9 ± 1.4	0.987
Obesity (%)	12.4	16.6	26.8	<0.001	9.8	15.6	24.8	<0.001
Abdominal obesity (%)	42.6	53.5	70.8	<0.001	17.0	25.1	40.8	<0.001
Hypertension (%)	41.4	46.9	57.5	<0.001	51.5	51.6	58.4	<0.001
Diabetes (%)	8.8	9.5	14.2	<0.001	10.3	10.2	9.4	0.372