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Original Article

Comparing associations of different metabolic syndrome definitions with ischemic stroke in Chinese elderly population

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ABSTRACT

Objectives: Studies have showed the associations between different definitions of metabolic syndrome (MetS) and risk of ischemic stroke were inconsistent. In this study, we compared associations of different MetS definitions with ischemic stroke in Chinese elderly population.

Methods: A total of 1713 individuals aged 70–84 years from Rugao Longevity and Ageing Study were analyzed. The MetS was defined by four different criteria: Chinese Adult Dyslipidemia Prevention Guide, International Diabetes Federation (IDF), Updated ATPIII (Updated ATPIII) by American heart association/American heart, lung and blood institute (AHA/NHLBI), and Joint Interim Statement (JIS) recommended by IDF and the American heart association/American national institutes of health/American heart, lung and blood institute (AHA/NIH/NHLBI).

Results: Prevalence of MetS in the whole population was 24.0% (Chinese guide), 32.5% (IDF), 38.8% (Updated ATPIII) and 24.0% (JIS) and in stroke population was 27.1% (Chinese guide), 41.1% (IDF), 48.8% (Updated ATPIII) and 27.1% (JIS), respectively. The agreement between definitions was highest in Updated ATPIII vs. IDF ($\kappa = 0.863$). It showed that only definitions of IDF (OR 1.55, 95%CI 1.04–2.31, $p = 0.031$) and Updated ATPIII (OR 1.64, 95%CI 1.11–2.42, $p = 0.013$) were independently associated with risk of ischemic stroke in multivariable logistic regression analysis. The risk of ischemic stroke increased with the increasing of numbers of MetS components in Updated ATPIII ($p < 0.05$).

Conclusion: In this population, Updated ATPIII criteria was a more suitable definition of MetS than definitions of Chinese guide, IDF and JIS for screening high-risk individuals of ischemic stroke, and the additive effects of MetS components might play a greater role than its composition alone in ischemic stroke.

In recent years, the prevalence of cardiovascular disease increased greatly all over the world with the development of economy and changes of lifestyle. And it was often found the risk factors of cardiovascular disease concentrated in an individual at one time, which gradually put forward a concept of metabolic syndrome (MetS) [1–2]. MetS refers to a pathological state that various vascular risk factors and metabolic abnormalities gathered and mutually connected, mainly including hyperglycemia, raised blood pressure, elevated triglycerides, low high-density lipoprotein cholesterol, and obesity (particularly central obesity) [3]. Epidemiological studies have shown an increased rate of MetS in the world, especially increased with the population ageing [4–5]. In addition, as an aggregation of risk factors, MetS is also

an important independent risk factor of cardiovascular disease, and closely related to the progression and poor prognosis of cardiovascular disease [6–7]. Brota's study showed the prevalence of MetS in acute ischemic stroke patient was significantly higher than in patients with other neurologic disorders (61.2% vs. 18.1%), which indicated MetS was strongly associated with ischemic stroke [8]. Moreover, studies have reported that individuals with MetS could have more than two fold increased the risk of ischemic stroke, and the risk for ischemic stroke also increased with the increasing of MetS components [9–10]. However, there were studies showing that the predicted risk for ischemic stroke was inconsistent in different definitions of MetS [11–13]. And previous study has shown that specific definition of the MetS

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predicts cardio-cerebrovascular events in elderly population while other definition does not [14]. Therefore, this study was aimed to compare the associations of different definitions of Mets with ischemic stroke, which endeavored to identify a more favorable definition of Mets for Chinese ischemic stroke patient.

The academic organizations and authorities in many countries have put forward and constantly updated their own diagnostic criteria of Mets according to their understanding about the Mets and their people's characteristics. Almost all those criteria include obesity, hyperglycemia, hypertension, dyslipidemia and insulin resistance as its evaluation contents, and the main disparities lie in the different thresholds for obesity and whether the abdominal obesity should be treated as a prerequisite [15]. The Mets definitions of international diabetes federation (IDF) [16] and the updated ATP III criteria by American heart association/American heart, lung and blood institute (AHA/NHLBI) in 2005 [17] were the most widely recognized and used in the world nowadays [18–19]. The Joint Interim Statement (JIS) was jointly recommended by international diabetes federation (IDF) and the American heart association/American national institutes of health/American heart, lung and blood institute (AHA/NIH/NHLBI) in 2009, which remained the components of Updated ATP III criteria but further put forward different cut points of waist circumference for different regions and ethnic groups [1,20–21]. The main difference between IDF and Updated ATP III was whether the abdominal obesity should be a prerequisite for Mets [17], and between Updated ATP III and JIS was different thresholds for abdominal obesity [1]. Our revised Chinese Adult Dyslipidemia Prevention Guide (Chinese guide) in 2016 was an update for Chinese Adult Dyslipidemia Prevention Guide 2007, whose cut points of waist circumference, high-density lipoprotein cholesterol and hyperglycemia differed from the IDF and JIS, and were considered more favorable for Chinese individuals [22].

In the ageing arm of the RuLAS, we explored the prevalence of four different Mets definitions (Chinese guide, IDF, updated ATP III and JIS) and their association with ischemic stroke in the elderly, which aimed to determine a more favorable definition of Mets for Chinese ischemic stroke patient.

1. Materials and methods

1.1. Study population and procedure

We obtained the data from the ageing arm of the RuLAS, a population-based observational cohort study conducted in Rugao, a typical, medium-sized city of Jiangsu province, China, between November 13, 2014 and December 21, 2014. A total of 1788 elderly were randomly selected according to 5-year age and sex strata, among which 1713 participants who fulfilled the data of stroke history and Mets definitions were included in this study.

During the field survey, detailed structured questionnaire and physical examinations were administered by trained physicians from the Rugao People's Hospital. More detailed information about the study was provided in our previous publication [23]. Written informed consent was obtained from participants. The Human Ethics Committee of Fudan University School of Life Sciences approved the research.

1.2. Data collection

A standard questionnaire was administered by trained staff to obtain information on demographic characteristics. The past medical history and drug using history were recorded. Height, weight and waist circumference were measured and a blood sample was collected for biochemical measurements. The blood specimens were drawn after overnight fasting, immediately subjected to centrifugation, and analyzed within 8 h for glucose (Glu), serum uric, C-reactive protein (CRP), serum total cholesterol (TC), high-density lipoproteins (HDL), low-density lipoproteins (LDL), triglyceride (TG). Smoking was defined as

participants who smoked at least 1 cigarette per day or used to smoke > 5 years. Drinking was defined as participants who drank > 3 drinks per week within 5 years. Blood pressure was measured twice at interval of 5 min in the right arm in a sitting position, and the mean value of the two measurements was taken as the final blood pressure recording. Body height and weight were measured with subjects not wearing shoes or outerwear. Waist circumference (WC) was measured by placing a soft tape horizontally midway between the lower border of the ribs and iliac crest on the mid-axillary line. Body mass index (BMI) was calculated using body weight (kilograms) divided by the square of body height (m^2). According to the 2016 revised Chinese Adult Dyslipidemia Prevention Guide, cut-off points for general obesity were with $BMI \geq 28 \text{ kg/m}^2$ for both genders, and cut-off points for central obesity was with $WC \geq 90$ for male and ≥ 85 cm for female [22]. Also, according to the 2016 revised Chinese Adult Dyslipidemia Prevention Guide, the dyslipidemia were divided into two categories: serum total cholesterol (TC) $\geq 5.2 \text{ mmol/l}$ was defined as high total cholesterol (H-T-C), high-density lipoproteins (HDL) $< 1.0 \text{ mmol/l}$ was defined as low high-density lipoproteins (L-HDL), low-density lipoproteins (LDL) $\geq 3.4 \text{ mmol/l}$ was defined as high low-density lipoproteins (H-LDL) and triglyceride (TG) $\geq 1.7 \text{ mmol/l}$ was defined as high triglyceride (H-TG), while otherwise above were classified as normal [22].

1.3. Definition of metabolic syndrome and stroke

In the present study, we defined MetS using the following four definitions: revised Chinese Adult Dyslipidemia Prevention Guide in 2016 [22], IDF in 2005 [16], Updated ATP III in 2005 [17] and JIS in 2009 [1] (more details see Table 1).

Ischemic stroke was diagnosed according to past ischemic stroke medical history with typical symptoms or brain imaging of computed tomography (CT) and magnetic resonance imaging (MRI). Those with a specific symptoms or infarction imaging were divided into stroke group, and otherwise were control group.

1.4. Statistical analysis

Descriptive statistics were given as percentages or mean \pm standard deviation (SD). Independent numeric variables were compared using independent *t*-test. Chi-squared test was used for comparing categorical variables in groups. The Kappa analysis was used to identify the agreement between four Mets definitions. The Logistic regression analysis was used to analyze associations between different Mets definition and their components and ischemic stroke. The odds ratio (OR) values and its 95% confidence interval (95%CI) in Model 1 (original model) and Model 2 (adjusting for gender, age, smoking and alcohol consumption) were recorded. All statistical tests were two-sided. A *p* value of < 0.05 was considered statistically significant. All statistical tests were carried out using SPSS 19 (Statistical Package for the Social Sciences, Inc., Chicago, IL, USA).

2. Results

2.1. Demographic characteristics of participants

Among 1713 individuals aged 70–84 years old, (129 cases in stroke group and 1584 cases in control group), prevalence of MetS was 27.1% (Chinese guide), 41.1% (IDF), 48.8% (Updated ATP III) and 27.1% (JIS) in stroke group, respectively. The prevalence of Mets in stroke group were higher than control group in all four definitions, but the statistically significance only remained in the IDF and Updated ATP III definitions ($p < 0.05$) (see Table 2).

2.2. The agreement between four definitions of Mets

Among four definitions of Mets, the agreement was highest between

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