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ORIGINAL ARTICLE

A Body Shape Index and Body Roundness Index: Two New Body Indices to Identify left Ventricular Hypertrophy among Rural Populations in Northeast China

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Background Recently, two new anthropometric indices, the A Body Shape Index (ABSI) and Body Roundness Index (BRI) have been developed as possible improved alternatives to body mass index (BMI) and waist circumference (WC). The main research aim is to assess the capacity of the ABSI and BRI to identify subjects with left ventricular hypertrophy (LVH) and the secondary aim is to determine whether ABSI and / or BRI is superior to BMI, WC, and waist-to-height ratio (WHtR).

Methods and Results This cross-sectional study was conducted among the rural population in northeast China and finally included 10,907 participants. Pearson rank test showed that BRI showed the highest correlation coefficient for LVH. Body Roundness Index had the highest AUCs for eccentric and concentric LVH (AUC: 0.74, 95% CI: 0.72-0.75; AUC: 0.67, 95% CI: 0.64-0.70, respectively). A multivariate logistic regression analysis also showed that BRI was the best predictor of eccentric and concentric LVH (OR: 5.11, 95% CI: 3.62-7.22; OR: 2.48, 95% CI: 1.40-4.40, respectively). In the five anthropometric indices, only BRI had predictive ability for concentric LVH.

Conclusions We have shown that BRI, not ABSI was superior measure compared to BMI, WC and WHtR for determining the presence of LVH, especially for eccentric LVH.

Keywords A Body Shape Index • Body Mass Index • Body Roundness Index • Waist circumference • Waist to height ratio • Left ventricular hypertrophy

Introduction

The prevalence of obesity is increasing rapidly worldwide [1]; in China, a similar rapid increase is now occurring, which parallels the rapid development of the Chinese economy of recent years [2], and poses heavy public health and economic burdens. Obesity is mainly due to the disproportionate growth of adipose tissue and lean body mass [3]. Subcutaneous fat is almost metabolically silent, but visceral fat (including abdominal, mediastinal and epicardial adipose tissue) is metabolically active and could produce a lot of compounds that have autocrine, paracrine and endocrine activities and could influence the metabolism and cardiovascular system [4,5]. Therefore, obesity is a very important risk factor for cardiovascular diseases (CVD), such as hypertension, coronary heart disease, and stroke, and for other chronic

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diseases [6–9]. Furthermore, obesity could increase cardiac fat accumulation which is frequently associated with left ventricular hypertrophy (LVH) and LV systolic dysfunction [10,11].

In epidemiological studies, anthropometric measures have been accepted for the evaluation of obesity for their simplicity and usefulness [12]. The body mass index (BMI) has been long used as a diagnostic index of general obesity and could reflect the overall distribution of body fat [13]. At the same time, waist circumference (WC) has been used to measure abdominal obesity and could reflect the distribution of abdominal fat [14]. However, people have gradually found that neither BMI nor WC could discriminate fat and muscle mass and therefore left pregnant women, athletes, and body builders categorised incorrectly [15,16]. So, controversy arises over which anthropometric parameter best defines obesity and conveys the highest risk of obesity-related diseases [17]. Hence, researchers are exploring new anthropometric indices in an attempt to improve the above limitations.

In 2012, Krakauer and Krakauer [18] developed a new anthropometric index named a body shape index (ABSI), and found that it was more associated with mortality hazards than BMI and WC. In the following year, Thomas et al. [19] developed another new anthropometric index known as body roundness index (BRI). As they stated, BRI could predict the percentage of % body fat and % visceral adipose tissue (VAT) and could be applied as a visual tool for health status evaluations.

To our knowledge, there are no studies on the association between ABSI or BRI and LVH so far. Additionally, ABSI, BMI, BRI, WC and waist-to-height ratio (WHtR) reflect the % body fat and % visceral adipose tissue differentially. For this reason, we conducted this population-based cross-sectional study to assess the capacity of the two new anthropometric indices to identify individuals with LVH in rural populations of northeast China and attempted to determine whether the ABSI and BRI were superior to traditional measurements of BMI, WC and WHtR.

Methods

Study Population

From January 2012 to August 2013, a representative sample aged ≥ 35 years was selected to assess two new body indices (ABSI and BRI) to identify LVH in rural areas of Liaoning Province in northeast China. The study adopted a multistage, stratified randomly cluster-sampling scheme. A total of 14,016 individuals were invited and 11,956 participants (i.e. response rate of 85.3%) agreed to participate and completed the present study. Participants with pregnancy, malignant tumour or a mental disorder were excluded from the present study. Finally, a total of 10,907 individuals were available for analysis (as shown in Figure 1). The study was approved by the Ethics Committee of China Medical University (Shenyang, China). All procedures were performed in accordance with ethical standards.

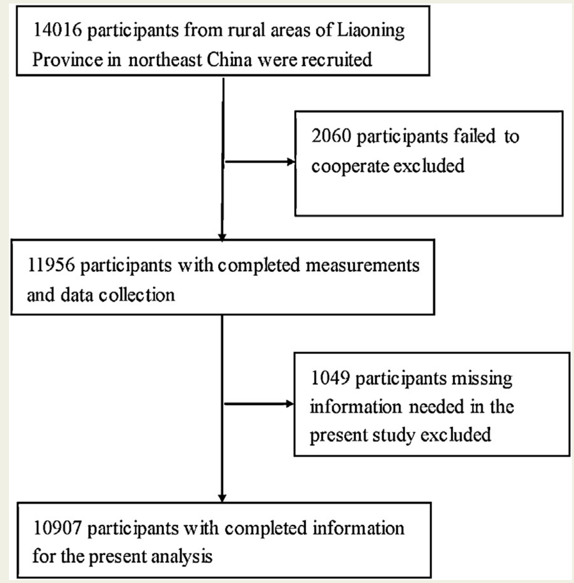

Figure 1 Flow chart of our study.

Echocardiography Measurements

Echocardiograms were obtained using a commercially available Doppler echocardiograph (Vivid, GE Healthcare, United States), with a 3.0-MHz transducer. Echocardiogram analyses and readings were performed by three doctors specialising in echocardiography. The parasternal acoustic window was used to record two-dimensional and M-mode images of the left ventricular (LV) internal diameter and wall thickness. The apical acoustic window was used to record four- and five-chamber images. Correct orientation of planes for imaging and Doppler recordings was verified using previously described procedures [20,21]. Left ventricular internal dimensions and interventricular septal thickness (IVST) and posterior wall thickness (PWT) were measured at end diastole and end systole according to American Society of Echocardiography recommendations [21,22].

Left ventricular mass was calculated according to the equation LVM (g) = $0.81\ (1.04 \times [\text{LVED} + \text{IVS} + \text{PWT}])^{3} - (\text{LVED})^{3} + 0.06$ [23]. Left ventricular mass index (LVMI) was calculated by dividing LVM by height in metres$^{2.7}$ to correct LVM for body size [24]. LVH was defined as the LV mass indexed for height$^{2.7}$ > 46.7 g/m$^{2.7}$ in women and > 49.2 g/m$^{2.7}$ in men [24]. The relative wall thickness was calculated as 2×the posterior wall thickness/LV internal diameter at end-diastole and considered increased if > 0.43 [25]. Left ventricular geometry was assessed from the LV mass/height$^{2.7}$ combined with the relative wall thickness [23,25] grouping patients with normal LV mass/height$^{2.7}$ into normal geometry or concentric remodelling patterns, and patients with elevated LV mass/height$^{2.7}$ into eccentric or concentric LV hypertrophy patterns.

Covariate Measurements and Definitions

Information on covariates, such as age, gender and lifestyle, was collected during a single clinic visit by face-to-face interview by cardiologists and trained nurses using a standard