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EDITORIAL

Obesity in China: its characteristics, diagnostic criteria, and implications

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Introduction

The rising prevalence of overweight and obesity in several countries has been described as a global pandemic. Obesity and obesity-related diseases are increasing dramatically and have become a massive burden on world economy and global health. In 2010, overweight and obesity were estimated to cause 3.4 million deaths, with 4% of years of life lost and 4% of disability-adjusted life-years worldwide [1]. Abdominal obesity, also known as central obesity, refers to the presence of excess fat in the abdominal area. Epidemiological studies have demonstrated that obesity, especially central obesity, is associated with many metabolic disorders, such as impaired glucose tolerance, hypertension, dyslipidemia, and proinflammatory status. This editorial mainly discusses the prevalence of obesity, associated changes over the past decade, the criteria of central obesity, and its implications on cardiovascular disease (CVD).

The epidemiology of obesity and associated changes over the past decade

The prevalence of obesity has increased dramatically worldwide over the last decades and has now reached epidemic proportions. Worldwide, the age-standardized prevalence of obesity nearly doubled from 6.4% in 1980 to 12.0% in 2008, and the age-standardized prevalence of overweight increased from 24.6% to 34.4% during the same 28-year period [2]. In some regions, such as Europe, the Eastern Mediterranean, and the Americas, more than 50% of women are overweight. China and the United States experienced the largest absolute increase in the number of overweight and obese people between 1980 and 2008 [3]. Another recently published paper in the *Lancet* estimated the global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013. The number of overweight ($25\,kg/m^2 \leqslant$ body mass index (BMI) $< 30\,kg/m^2$) and obese (BMI $\geqslant 30\,kg/m^2$) individuals increased from 857 million in 1980 to 2.1 billion in 2013. The prevalence of combined overweight and obesity rose by 27.5% for adults and 47.1% for children between 1980 and 2013 [4].

Similarly, the prevalence rates of overweight, obesity, and central obesity have also increased greatly over the past decade in China [5]. The analysis from the China National Diabetes and Metabolic Disorders Study [6] showed that 31.4% and 12.2% (approximately 299.5 and 116.2 million, respectively) of Chinese adults are overweight and obese in 2012, respectively, according to the Chinese WGOC definition (overweight and obese are defined as BMI between 24 and $28\,kg/m^2$ and BMI $\geqslant 28\,kg/m^2$, respectively [7]). On the contrary, the prevalence of overweight and obesity in Chinese adults was 16.4% and 3.6% in 1992 [8], and 22.8% and 7.1% in 2002, respectively [9]. The Shanghai Diabetes Study [10] conducted in 1998–2001 and in 2007–2008 found that the standardized mean BMI in men increased from $23.5\,kg/m^2$ in the 1998–2001 survey to $24.1\,kg/m^2$ in the 2007–2008 survey. The standardized mean waist circumference was 77.7 cm and 79.9 cm in the 1998–2001 and 2007–2008 survey, respectively. The increases in obesity prevalence in China could be attributed to the environmental changes that promote excessive food intake and discourage physical activity. Conclusively, because of the established health risks and substantial increases in prevalence, obesity has become a major global health challenge. Urgent global action and leadership are needed to address this problem.

Central obesity and cardiovascular disease

Obesity is strongly associated with metabolic disorders, CVD, and an increased risk of morbidity and mortality [11–13]. Each year, 28 million individuals are dying from the

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consequences of overweight or obesity worldwide [14]. The relationship between obesity and the development of CVD is now overwhelmingly clear. Large prospective studies, such as the Framingham Heart Study, the Manitoba Study, and the Harvard School of Public Health Nurses Study, have documented obesity as an independent predictor of CVD [15–17].

The relationship between obesity and CVD depends not only on the amount of total body fat but also on its distribution [18]. Compared with total body fat, visceral fat accumulation is more important for the development of insulin resistance, metabolic syndrome, type 2 diabetes, and CVD [19,20]. The famous Framingham Heart Study revealed that the prevalence of hypertension impaired fasting glucose, whereas increased the metabolic syndrome linearly and significantly across increasing visceral adipose tissue volume quartiles among overweight and obese individuals. Compared with subcutaneous abdominal adipose tissue, visceral adipose tissue volume remains more strongly associated with an adverse metabolic risk profile [21]. A Japanese study, the VACATION-J study, found a similar result. The coexistence of visceral fat (visceral adipose tissue volume $\geqslant$ 100 cm^2) and risk factor accumulations (i.e., hypertension, glucose intolerance, and/or dyslipidemia) is strongly associated with coronary artery disease in the Japanese population [22]. Moreover, the study in Shanghai by Zhang *et al.* [23] revealed that the CVD incidence was independently related to increased waist circumference in the middle-aged group and to elevated blood glucose in the elderly group. Our group previously found that after a 10.5 cm increment of waist circumference, a 1.7-fold or 2.2-fold greater risk of having diabetes or diabetes plus dyslipidemia exists compared with BMI alone [6].

The presence of obesity throughout lifetime is positively related to atherosclerosis development as measured by carotid intimal-medial thickness (C-IMT). The quantitative assessment of C-IMT is accepted as an indicator of preclinical atherosclerosis and may be used as a marker for cardiovascular morbidity and mortality [24,25]. Recently, some studies have discussed obesity, specifically central obesity, and its relation to C-IMT [26]. A study by Wang *et al.* [27] revealed that visceral fat accumulation, but not BMI, was independently correlated with C-IMT in men free of CVD.

Waist circumference is known to be one of the independent risk factors of C-IMT. Thus, research has been performed to explore the optimal waist circumference cut-off in identifying C-IMT elevation. One study carried out in women [28] found that the C-IMT was significantly higher in those with a waist circumference $\geqslant$ 85 cm than in those with a waist circumference $<$ 85 cm. C-IMT significantly increased with increasing waist circumference and reached a platform of about 85 cm. Zhang *et al.* [29] tracked Chinese male patients with newly diagnosed diabetes after an average of almost two years and concluded that a significant elevation of C-IMT exists in the group of patients with a baseline waist circumference greater than 90 cm. Collectively, a waist circumference greater than 85 cm in women and 90 cm in men is associated with preclinical atherosclerosis. These two cut-off values are also the criteria of central obesity in China, as we will discuss in the next section.

Criteria of central obesity

In 2005, the International Diabetes Federation (IDF) proposed a unified worldwide definition of the metabolic syndrome. In this definition, central obesity was regarded as a prerequisite and incorporated element with different waist circumference cut-offs by gender and ethnicity, in which a waist circumference of 90 cm and 80 cm was proposed for Chinese men and women, respectively; however, the IDF left the cut-offs flexible until better data validated these values [30].

An important study led by Bao *et al.* [31] explored the appropriate cut-offs for the visceral fat area measured by magnetic resonance imaging, which links the risk of metabolic syndrome and the corresponding waist circumference in a Chinese population. The study found that the optimal visceral fat area cut-off in identifying the metabolic syndrome with two or more components was near 80 cm^2, and the optimal waist circumference cut-off for visceral obesity is 90 cm and 85 cm in men and women, respectively. These results were included in the Chinese Joint Committee for Developing Chinese Guideline [32].

The above cut-off results in the Chinese population are consistent with other studies in Asian populations. Ye *et al.* [33] carried out a 7.8-year follow-up study in a Shanghai urban area and observed that the appropriate waist circumference cut-offs for central obesity are 88 cm and 82 cm for men and women in the Chinese population, respectively. A Korean study has defined 84 cm as the optimal waist circumference cut-off in women [34]. Kashihara *et al*. [35] from Japan found that the discriminated values of the visceral fat area were 103.0 cm^2 and 69.0 cm^2, whereas the waist circumference values corresponding to the visceral fat area were 89.1 cm and 86.3 cm for men and women, respectively. Nakamura *et al.* [36] found that the optimal waist circumference cut-off to detect the clustering cardiovascular risk factors for the metabolic syndrome in Japan was 88 cm and 82 cm for men and women, respectively.

Obesity assessment

The most commonly used anthropometric tool to assess relative weight and classify obesity is the BMI, which is expressed as the ratio of total body weight over height squared (kg/m^2). The parameter of BMI is not very discriminant to distinguish lean from fat body mass, particularly among patients with a BMI $\geqslant$ 30 kg/m^2 [37]. The BMI alone seems to present a U- or a J-shaped association with clinical outcomes and mortality [38]. Such an inverse relationship fuels a controversy in the literature, named the "obesity paradox," which associates better survival and fewer CVD events in patients with mildly elevated BMI afflicted with chronic diseases [37,39]. A possible explanation for this paradox could be found in body fat distribution. For instance, markers of absolute and relative accumulation of abdominal fat, such as elevated waist circumference and waist-to-hip ratio (WHR), have been associated with an increased risk of myocardial infarction, heart failure, and total mortality in patients with CVD [40].

Therefore, waist circumference is a widely accepted, simple, and non-invasive method to assess central obesity compared with BMI [41,42]; however, waist circumference cannot distinguish visceral adiposity from subcutaneous adiposity. The standard methods for quantifying visceral fat amount recommended by the IDF are magnetic resonance imaging and computed tomography to measure the visceral fat area as a precise indicator for visceral obesity [30], but the inconvenience and high cost limit its use. In addition to waist circumference, various anthropometric measures of obesity have been observed to be related to cardiovascular and all-cause mortality. In a recent study in Europeans [43], BMI, waist circumference, waist-to-height ratio, body shape index, and waist-to-hip-to-height ratio were measured. Over a median follow-up of 7.9 years, the authors found that the BMI had a J-shaped relationship with CVD mortality, whereas anthropometric measures of central obesity had positive linear relationships. Accordingly, a threshold value was detected at 29.29 kg/m^2 and 30.98 kg/m^2 for BMI, and 96.4 cm and 93.3 cm for waist circumference with CVD mortality in men and women, respectively; and at 29.88 kg/m^2 and 29.50 kg/m^2 for BMI, and 104.3 cm and 105.6 cm for waist circumference in men and women, respectively, with all-cause mortality.

Therefore, BMI, waist circumference, visceral fat area measurement, and other anthropometric measures of obesity are all widely used measurements of obesity; each has its own merits and shortcomings. Researchers can choose among the above measurements according to their study design and practical condition.

Perspectives

Despite the efforts devoted in recent years, an urgent need for obesity monitoring and control still exists. Currently, we understand that obesity, specifically central obesity, is a very important risk factor for the metabolic syndrome, type 2 diabetes and CVD. As an initial step, we need to emphasize the identification of "at risk" overweight/obese individuals in clinical practice to better assess and manage patients' care and to use our limited health care resources optimally.

Second, simple tools and strategies are required. Perhaps, the time has come to consider a new paradigm in which simple tools are used to redefine higher risk overweight/obesity (such as waist circumference) and new therapeutic objectives. A new model such as this can be experimentally tested.

Third, ideally, nationally representative surveys in countries should be repeated at regular intervals. In managing overweight/obese children and adult populations, continuing the collection of information regarding body weight and height, at a minimum, to monitor obesity trends over time is required to compare data across different countries. Over the past few decades, the global emergence of overweight and obesity is confounded by the simultaneous aging of the population [44]. A high prevalence of overweight and obesity occurs in elder adults. Thus, population aging may contribute independently to the rising prevalence of overweight and obesity in adults. Population aging may differ by country and over time. Therefore, the age-adjusted prevalence for overweight and obesity is needed to allow the comparisons of prevalence and trends across countries. Increased investment in population obesity monitoring would improve the accuracy of forecasts and evaluations.

Finally, a comprehensive understanding of obesity is important to recognize the common pathophysiology of CVD or diabetes and to motivate people to take appropriate interventions aimed at risk reduction of CVD and diabetes. Governments and health providers should regard this important health risk as a key global health priority in both developing and developed countries because obesity has become a major public health challenge in many middle-income countries.

Compliance with ethics guidelines

Weiping Jia declares that she has no conflict of interest. This manuscript is an editorial and does not involve a research protocol requiring approval by the relevant institutional review board or ethics committee.

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