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Original Article

## Prevalence of abdominal obesity among Chinese adults in 2011

Pei Du <sup>a, b, d</sup>, Hui-Jun Wang <sup>c, d</sup>, Bing Zhang <sup>c</sup>, Su-Fen Qi <sup>a</sup>, Ying-Jun Mi <sup>a</sup>, Dian-Wu Liu <sup>a</sup>, Qing-Bao Tian <sup>a, \*</sup><sup>a</sup> Department of Epidemiology and Statistics, School of Public Health, Hebei Medical University, China<sup>b</sup> Department of Infection Control and Prevention, The Third Hospital of Hebei Medical University, China<sup>c</sup> National Institute for Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, China

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## ABSTRACT

**Background:** The prevalence of abdominal obesity is increasing dramatically worldwide. This study aimed to estimate the current prevalence of abdominal obesity from the 2011 China Health and Nutrition Survey (CHNS) and compare the data with other countries.**Methods:** Waist circumference (WC) of 12,326 Chinese adults (aged 20 years or older) from the 2011 CHNS were analyzed by age group and region. Abdominal obesity was defined as a WC  $\geq 90$  cm for men and WC  $\geq 80$  cm for women based on World Health Organization (WHO) recommendations for Asians. **Results:** In 2011, the age-adjusted mean WC was 85.9 cm (95% confidence interval [CI], 85.6–86.2 cm) for men and 80.7 cm (95% CI, 80.4–80.9 cm) for women. Based on the WHO recommendations, the age-adjusted prevalence of abdominal obesity was 44.0% (95% CI, 43.1%–44.8%) overall, 35.3% (95% CI, 34.1%–36.6%) in men, and 51.7% (95% CI, 50.5%–52.9%) in women. Moreover, the age-adjusted prevalence was 44.0% (95% CI, 42.7%–45.2%) in rural populations, 42.5% (95% CI, 40.7%–44.2%) in urban populations, and 45.2% (95% CI, 43.5%–46.9%) in megacity populations. The prevalence in China (35.3% for men and 51.7% for women) was lower than in Japan (50.8% for men) and the United States (43.5% for men and 64.7% for women). Similar results were observed when applying the criteria suggested by the Working Group on Obesity in China.**Conclusions:** In 2011, the age-adjusted prevalence of abdominal obesity in China was 35.3% in men and 51.7% in women.© 2017 The Authors. Publishing services by Elsevier B.V. on behalf of The Japan Epidemiological Association. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

Obesity is a major risk factor for hypertension, type 2 diabetes, coronary heart disease, and certain types of cancer.<sup>1–6</sup> Obesity is classified as general obesity (defined as body mass index  $\geq 30$  kg/m<sup>2</sup>) and abdominal obesity (defined as waist circumference [WC]  $\geq 90$  cm for men and WC  $\geq 80$  cm for women), based on World Health Organization (WHO) recommendations for Asians.<sup>7,8</sup> In particular, abdominal obesity has a close relationship with central

fat localization and cardiovascular disease, independently of general obesity.<sup>9–11</sup>

The prevalence of abdominal obesity is increasing dramatically worldwide.<sup>12–14</sup> In the United States, the overall age-adjusted prevalence of abdominal obesity increased significantly from 46.4% (95% confidence interval [CI], 42.1%–50.8%) in 1999–2000 to 54.2% (95% CI, 51.3%–57.0%) in 2011–2012.<sup>12</sup> Similarly, there has also been a large increase in the number of adults with abdominal obesity in China.<sup>15,16</sup> For example, in Shanghai, the prevalence of abdominal obesity increased from 17.3% (95% CI, 16.2%–18.4%) in 1998–2001 to 22.4% (95% CI, 21.2%–23.7%) in 2007–2008.<sup>16</sup> However, most previous studies primarily focused on specific cities. The China Health and Nutrition Survey (CHNS) was a recent large-scale longitudinal, household-based survey in China.<sup>17</sup> Data from the CHNS for 1993–2009 show that mean WC values increased from 76.5 cm to 83.5 cm among men and from 74.5 cm to 79.2 cm among women.<sup>18</sup> Additionally, the prevalence of abdominal obesity

\* Corresponding author. Department of Epidemiology and Statistics, School of Public Health, Hebei Medical University, 361 East Zhongshan Road, Shijiazhuang, Hebei Province, China.

E-mail address: [tqb1980@hebm.u.edu.cn](mailto:tqb1980@hebm.u.edu.cn) (Q.-B. Tian).

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<sup>d</sup> The first two authors should be regarded as joint First Authors.

significantly increased in all sex and age groups.<sup>18</sup> In 2011, Gordon-Larsen et al.<sup>19</sup> reported that the Chinese age-adjusted mean WC was 83.2 cm for men and 78.1 cm for women.

However, the detailed prevalence of abdominal obesity in different regions among Chinese adults remains unknown. Until now, data from the 2011 CHNS are the most recent data available. Therefore, we report the regional prevalence of abdominal obesity in 2011 and compare the recent WC distribution with data from 1993 to 2009. In addition, the prevalences of abdominal obesity among adults in China and other countries are also compared.

## Methods

### Study design

The CHNS was designed to measure the nutritional status and health of the Chinese population.<sup>20</sup> This program was a multipurpose, longitudinal, household-based survey that was established as a joint project of the University of North Carolina at Chapel Hill and the China Center for Disease Control and Prevention.<sup>17</sup> The CHNS data were first collected in 1989 and have since then been collected in 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011 (<http://www.cpc.unc.edu/projects/china>). The original survey in 1989 used a multistage, random cluster design in eight provinces (Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, and Guizhou). Heilongjiang province was added in 1997, and three megacities, including Beijing, Shanghai, and Chongqing, were added in 2011. By 2011, the provinces included in the CHNS sample constituted 47% of China's population (according to the 2010 census).<sup>20</sup> Zhang et al described the details of the surveys elsewhere.<sup>20</sup> Written informed consent was obtained. This study was approved by the ethical standards committee of the University of North Carolina at Chapel Hill (approval Number: 07-1963).

### Study population

Since WC was initially collected in 1993, analysis was based on data from CHNSs conducted in 1993, 1997, 2000, 2004, 2006, 2009, and 2011. This study only focused on adults aged 20 years or older in each survey; the data provided information on age, gender, urban-rural status, and WC. To limit biases caused by pre-existing factors, this analysis excluded participants who were diagnosed with pregnancy or who were lactating. In addition, participants with missing information on WC or extreme or implausible WC (<45.0 cm or >150.0 cm) values were excluded.

### Anthropometric methods and definitions of abdominal obesity

WC was measured at a point midway between the lowest rib and the iliac crest in a horizontal plane using non-elastic tape (Seca North America, Chino, CA, USA).<sup>18</sup> According to WHO recommendations, abdominal obesity was defined as a WC  $\geq 90$  cm for men and a WC  $\geq 80$  cm for women<sup>8</sup>; alternately, according to the Working Group on Obesity in China (WGOC) criteria, abdominal obesity was defined as a WC  $\geq 85$  cm for men and a WC  $\geq 80$  cm for women.<sup>21</sup>

### Statistical analysis

Statistical analyses were performed using SPSS software version 19.0 (IBM 19.0, IBM Corp., Armonk, NY, USA). All of the participants included in our analysis were grouped by age: 20–39 years, 40–59 years, and  $\geq 60$  years. Taking into account different sample designs, prevalence of abdominal obesity was adjusted using the direct method for the China Census population in 2010. Comparisons of

age-adjusted prevalence estimates of abdominal obesity between men and women in the 2011 CHNS were conducted using a  $\chi^2$  test. The statistical significance was determined as a two-tailed  $p < 0.05$ . Spearman rank correlation was applied to assess the trends in WC. To further track trends in WC, selected percentiles were graphed by gender and age group. Comparisons of the prevalence estimates were conducted between eight countries, including China (2011), the United States (2011–2012),<sup>12</sup> Japan (2009),<sup>22</sup> England (2008),<sup>23</sup> Spain (2008–2010),<sup>24</sup> Canada (2007–2009),<sup>25</sup> Korea (2011),<sup>26</sup> and Portugal (2008–2009).<sup>27</sup> All comparisons used the most recent data available.

## Results

Pregnant or lactating ( $n = 93$ ) women were excluded from data analysis. Additionally, participants with missing data ( $n = 366$ ), or extreme WC values of <45.0 cm or >150.0 cm ( $n = 23$ ) were also excluded. Ultimately, a total of 12,326 participants in 2011 were included in the analysis. The unweighted sample sizes of the 2011 CHNS for analyses are presented in Table 1.

To estimate the most recent prevalence of abdominal obesity and mean WC in different regions, we analyzed data in the 2011 CHNS. Based on the WHO recommendations for Asians, age-adjusted abdominal obesity prevalence was 44.0% (95% CI, 43.1%–44.8%) overall; age-adjusted abdominal obesity prevalence was 35.3% (95% CI, 34.1%–36.6%) for men and 51.7% (95% CI, 50.5%–52.9%) for women (both  $p < 0.001$ ) (Table 2). The prevalence among women was higher than that among men (odds ratio [OR] 1.96; 95% CI, 1.83–2.11). Compared with the prevalence among 20- to 39-year-olds, the ORs for 40–59-year-olds and those aged  $\geq 60$  years were 1.99 (95% CI, 1.81–2.19) and 2.19 (95% CI, 1.98–2.42), respectively. Prevalence among men was 33.3% (95% CI, 31.6%–35.1%) in rural populations, 34.5% (95% CI, 32.0%–36.9%) in urban populations, and 39.4% (95% CI, 36.9%–41.8%) in megacity populations ( $p < 0.001$ ). Prevalence among women was 53.4% (95% CI, 51.7%–55.1%) in rural populations, 49.8% (95% CI, 47.4%–52.2%) in urban populations, and 51.0% (95% CI, 48.6%–53.3%) in megacity populations ( $p = 0.043$ ). Of note, the prevalence for men was higher in megacity populations than in rural populations ( $p < 0.001$ ); in contrast, the prevalence for women was lower in urban populations than in rural populations ( $p = 0.018$ ). Similar results were observed when using the WGOC criteria (eTable 1).

The age-adjusted mean WC was 83.1 cm (95% CI, 82.9–83.3 cm) overall; 85.9 cm (95% CI, 85.6–86.2 cm) for men and 80.7 cm (95% CI, 80.4–80.9 cm) for women (all  $p < 0.001$ ) (eTable 2). Among men, mean WC was 85.0 cm (95% CI, 84.6–85.4 cm) in rural populations,

**Table 1**

Unweighted sample sizes (and weighted percentages of total) for adults aged 20 years and older: CHNS 2011.

	Unweighted number (weighted %)			
	Total	Rural	Urban <sup>a</sup>	Megacity
All	12,326 (100)	5965 (100)	3050 (100)	3311 (100)
Men				
$\geq 20$ years	5786 (46.9)	2790 (46.8)	1443 (47.3)	1553 (46.9)
20–39 years	1288 (10.4)	572 (9.6)	311 (10.2)	405 (12.2)
40–59 years	2751 (22.3)	1366 (22.9)	650 (21.3)	735 (22.2)
$\geq 60$ years	1747 (14.2)	852 (14.3)	482 (15.8)	413 (12.5)
Women				
$\geq 20$ years	6540 (53.1)	3175 (53.2)	1607 (52.7)	1758 (53.1)
20–39 years	1540 (12.5)	674 (11.3)	327 (10.7)	539 (16.3)
40–59 years	3077 (25.0)	1538 (25.8)	729 (23.9)	810 (24.5)
$\geq 60$ years	1923 (15.6)	963 (16.1)	551 (18.1)	409 (12.3)

CHNS, China Health and Nutrition Survey.

<sup>a</sup> Does not include the three megacities added in 2011.

**Table 2**  
Prevalence of abdominal obesity (WC  $\geq 90^a$  for men and WC  $\geq 80^a$  for women) for adults aged 20 years and older: CHNS 2011.

	% (95% CI)			
	Total	Rural	Urban <sup>c</sup>	Megacity
All				
$\geq 20$ years	47.7 (46.9–48.6)	47.7 (46.4–49.0)	47.4 (45.6–49.2)	48.1 (46.4–49.8)
Age adjusted $\geq 20$ years <sup>b</sup>	44.0 (43.1–44.8)	44.0 (42.7–45.2)	42.5 (40.7–44.2)	45.2 (43.5–46.9)
Men				
$\geq 20$ years	36.7 (35.5–38.0)	34.6 (32.9–36.4)	36.9 (34.4–39.4)	40.2 (37.8–42.7)
Age adjusted $\geq 20$ years <sup>b</sup>	35.3 (34.1–36.6)	33.3 (31.6–35.1)	34.5 (32.0–36.9)	39.4 (36.9–41.8)
20–39 years	31.4 (28.8–33.9)	29.5 (25.8–33.3)	27.7 (22.7–32.7)	36.8 (32.1–41.5)
40–59 years	39.2 (37.4–41.0)	37.6 (35.1–40.2)	40.6 (36.8–44.4)	41.0 (37.4–44.5)
$\geq 60$ years	36.7 (34.4–39.0)	33.2 (30.0–36.4)	38.0 (33.6–42.3)	42.4 (37.6–47.2)
Women				
$\geq 20$ years	57.5 (56.3–58.7)	59.2 (57.5–60.9)	56.8 (54.4–59.2)	55.0 (52.7–57.3)
Age adjusted $\geq 20$ years <sup>b</sup>	51.7 (50.5–52.9)	53.4 (51.7–55.1)	49.8 (47.4–52.2)	51.0 (48.6–53.3)
20–39 years	36.6 (34.2–39.0)	39.3 (35.6–43.0)	35.5 (30.3–40.7)	33.8 (29.8–37.8)
40–59 years	61.3 (59.5–63.0)	62.9 (60.5–65.4)	56.9 (53.3–60.5)	62.0 (58.6–65.3)
$\geq 60$ years	68.2 (66.1–70.3)	67.2 (64.2–70.2)	69.3 (65.5–73.2)	69.2 (64.7–73.7)

CHNS, China Health and Nutrition Survey; CI, confidence interval; WC, waist circumference.

<sup>a</sup> Calculated in centimeters.

<sup>b</sup> Age adjusted using the direct method to the year 2010 Census population using the age groups 20–39 years, 40–59 years, and  $\geq 60$  years.

<sup>c</sup> Does not include the three megacities added in 2011.

85.9 cm (95% CI, 85.4–86.4 cm) in urban populations, and 87.3 cm (95% CI, 86.8–87.8 cm) in megacity populations; among women, it was 81.0 cm (95% CI, 80.7–81.4 cm) in rural populations, 80.0 cm (95% CI, 79.5–80.5 cm) in urban populations, and 80.7 cm (95% CI, 80.2–81.2 cm) in megacity populations. The results of mean WC were in accordance with the prevalence of abdominal obesity.

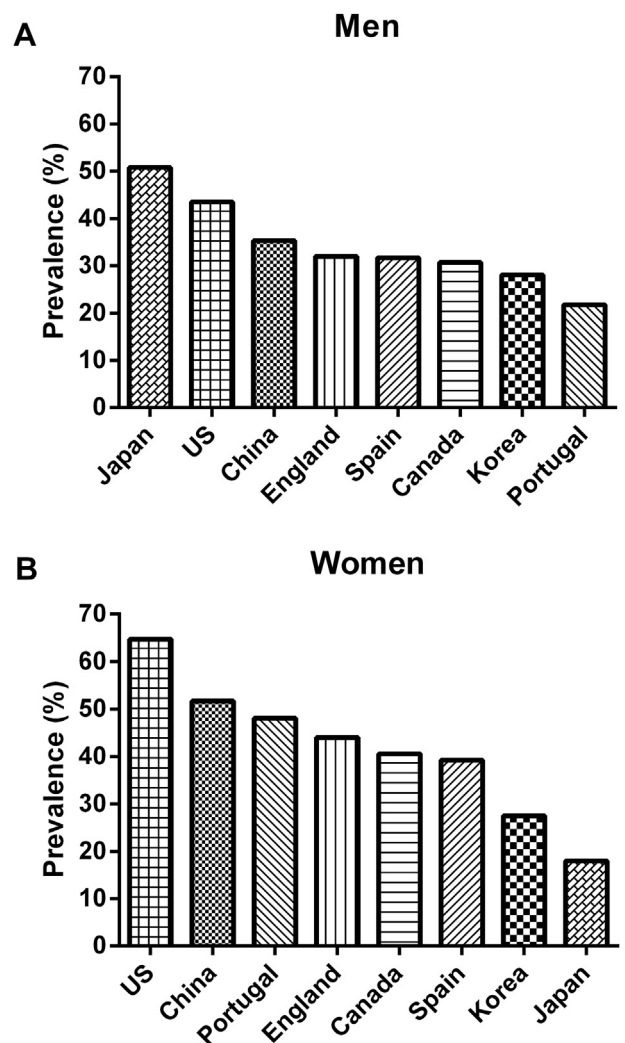
To study the differences in abdominal obesity among different countries, we compared the prevalence of abdominal obesity among adults in eight countries. Among men, Japan (50.8%) had the highest prevalence, and Portugal (21.8%) had the lowest. The prevalence in China (35.3%) was lower than in Japan (50.8%) and the United States (43.5%). Among women, prevalence was highest in the United States (64.7%) and lowest in Japan (18.0%). The prevalence in the United States was almost four times that in Japan. The prevalence in China (51.7%) was the second-highest, after the United States (Fig. 1).

Results of the median WC (50th percentile) trends from 1993 through 2011 showed significant increases both in men ( $p < 0.01$ ) and women ( $p < 0.01$ ), indicating that WC trends were similar to the abdominal obesity trends. The increment was 10.2 cm in men and 7.7 cm in women. To describe changes in the distribution of WC by gender, we calculated selected percentiles (Fig. 2). The age-specific changes in the distribution of WC are presented in Fig. 3. A similar trend was observed after including three megacities.

## Discussion

In this study, we reported that the age-adjusted mean WC was 85.9 cm for men and 80.7 cm for women in China in 2011. Based on the WHO recommendations, the age-adjusted prevalence of abdominal obesity was 44.0% overall, 35.3% in men, and 51.7% in women. From 1993 to 2011, mean WC significantly increased among men and women. The prevalence of abdominal obesity was similar when applying the criteria that were suggested by the WGOC.

Xi et al reported that the prevalence of abdominal obesity in 2009 was 37.4% overall, 27.8% in men, and 45.9% in women.<sup>18</sup> Notably, we included data from the 2011 CHNS, so our results are much more recent and representative. The prevalence in 2011 was much higher than that in 2009. However, Xi et al and other studies<sup>19,28</sup> mainly reported trends in the prevalence of abdominal obesity. Particularly, we report trends in the distribution of WC,



**Fig. 1.** Comparison of the prevalence of abdominal obesity between China and other countries 2009–2011.

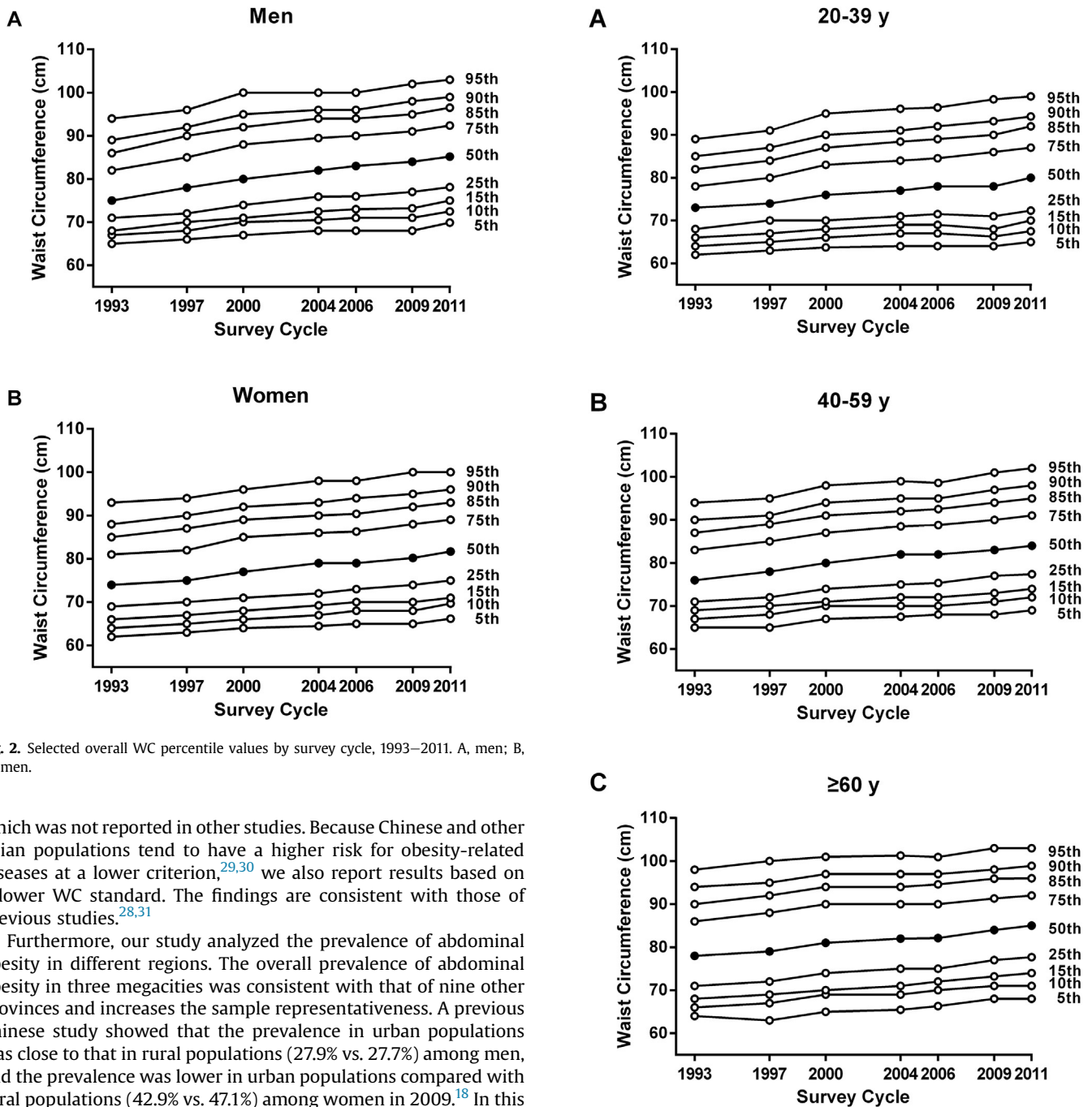


Fig. 2. Selected overall WC percentile values by survey cycle, 1993–2011. A, men; B, women.

which was not reported in other studies. Because Chinese and other Asian populations tend to have a higher risk for obesity-related diseases at a lower criterion,<sup>29,30</sup> we also report results based on a lower WC standard. The findings are consistent with those of previous studies.<sup>28,31</sup>

Furthermore, our study analyzed the prevalence of abdominal obesity in different regions. The overall prevalence of abdominal obesity in three megacities was consistent with that of nine other provinces and increases the sample representativeness. A previous Chinese study showed that the prevalence in urban populations was close to that in rural populations (27.9% vs. 27.7%) among men, and the prevalence was lower in urban populations compared with rural populations (42.9% vs. 47.1%) among women in 2009.<sup>18</sup> In this study, the prevalence for women is in accordance with that of the previous study. Of note, our finding revealed that the prevalence for men is higher in megacity populations than in rural populations. An explanation regarding the cause of these findings maybe the decline in physical activity among men in megacity populations, as well as the differences in eating and cooking behaviors among women in urban populations.<sup>32</sup>

WC and abdominal obesity criteria are not uniformly applicable to all populations and ethnic groups,<sup>33</sup> which makes international comparisons difficult. However, among men, the prevalence of abdominal obesity in China is 35.3%, which is lower than in Japan.<sup>22</sup> Among women, the prevalence in China is 51.7%, which is higher than the estimate in Japan.<sup>22</sup> These differences may be a result of a restricted definition of abdominal obesity for Japanese men, as well as a loose definition for Japanese women. Abdominal obesity is defined as a WC  $\geq 85$  cm for men and a WC  $\geq 90$  cm for women in

Fig. 3. Selected overall WC percentile values by survey cycle, 1993–2011. A, age group of 20–39-year-olds; B, age group of 40–59-year-olds; C, age group of 60-year-olds and older.

Japan.<sup>22</sup> Based on Japanese criteria, the prevalence among adults in China (53.66% for men and 19.32% for women) is slightly higher than adults in Japan. This may be due to Japanese having healthier eating patterns and more effective abdominal obesity prevention strategies than adults in China.<sup>34,35</sup> Additionally, for estimates based on measured data, the prevalence of abdominal obesity among Chinese is lower than that among the United States population based on WHO recommendations.<sup>12</sup> Data from the National Health and Nutrition Examination Survey for the United States showed that the overall prevalence of abdominal obesity continuously increased from 46.4% to 54.2% over 13 years.<sup>12</sup> If the prevalence of abdominal

obesity among the Chinese reaches the same level as the United States population, it will continue increasing over a long period. In other words, if the increase in abdominal obesity continues without any effective interventions, China will follow the steps of the United States into the abdominal obesity crisis.

With rapid social and economic development, China is facing a growing threat from obesity and other chronic diseases. This study offers a realistic depiction of abdominal obesity prevalence that varies in timing and geography in China, which is helpful for predicting trends of changes, as well as for understanding the effects of modernization and urbanization. Our results suggest a great requirement for abdominal obesity prevention programs, including courses about building health behaviors, regular health checks for community residents, and the establishment of residents' health records, for the purpose of preventing obesity-related health outcomes in China. Additionally, there is an urgent need to enhance health awareness for men in urban populations and women in rural populations. Gender- and region-specific public health policy on diet and physical activity is required.

### Conflicts of interest

None declared.

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### Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.je.2017.03.001>.

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