Body Mass Index and the Prevalence of Prehypertension and Hypertension in a Chinese Rural Population

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Abstract

Background To evaluate the status of overweight and obesity in a Chinese rural adult population and describe relationships between body mass index (BMI) and blood pressure according to JNC-7.

Methods The study was conducted in 2004-2006, used a multistage cluster sampling method to select a representative sample. A total of 45,925 adults, age 35 years or older, were examined. Height, weight and blood pressure were obtained by trained doctors. Overweight and obesity were defined according to the World Health Organization classification and Chinese definition.

Results The prevalence of overweight and obesity were 16.3% and 1.3% in males, and 24.4% and 2.7% in females (p for gender differences <0.05) according to the World Health Organization classification; The prevalence of overweight and obesity were 29.5% and 5.3% according to the Chinese definition. The prevalence of elevated blood pressure (prehypertension and hypertension) and mean levels of systolic and diastolic blood pressure increased as BMI increased. Multivariate logistic regression revealed that overweight and obesity were risk factors for prehypertension and hypertension whether in males or females.

Conclusions Overweight and obesity has become very prevalent in the Chinese rural adult population. It is a great health problem. Our study quantifies the strong associations of BMI and elevated blood pressure. It is time to pay more attention to overweight and obese in the county of China.

Key words: body mass index, prehypertension, hypertension, rural adult people

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Introduction

Overweight and obesity are now considered as serious health problems, with an increasing prevalence worldwide (1-7). Overweight and obesity are related to a number of health consequences, including type two diabetes, coronary heart disease, stroke, hypertension, gallbladder disease, and certain types of cancer, sleep apnea, psychosocial disturbances and osteoarthritis (8). Some recent studies also revealed that overweight and obesity are the main risk factors for prehypertension (9-12). There are few data on the epidemiology of overweight and obesity in the county of China.

In the current study, we aimed to examine the prevalence rate of overweight and obesity and its association with elevated blood pressure (prehypertension and hypertension) according to JNC-7 in a rural population of China.

Methods

Study subjects

The procedures followed were in accordance with ethical standards of the responsible committee on human experimentation of China Medical University. This investigation was based on a large-scale epidemiological study in China with a cross-sectional survey that adopted a multi-stage, stratified clustering sampling scheme in rural areas of Fuxin County, Liaoning province, China. 45,925 subjects that were over 35 years old were examined between 2004 and 2006.

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For most age-related comparisons, participants were separated into four groups according to age (35-44 years, 45-54 years, 55-64 years, ≥65 years).

Height was measured, to the nearest 0.5 cm, without shoes, back square against the wall tape, eyes looking straight ahead with a right-angle triangle resting on the scalp and against the wall. Weight was measured to the nearest 100 grams, without shoes. BMI was calculated as weight (in kilograms) divided by height (in meters) squared. Two definitions of obesity were used in this study. By the definition proposed by the World Health Organization (WHO), subjects with BMI ≥25 kg/m² and <30 kg/m² were classified as overweight and those with BMI ≥30 kg/m² were classified as obese; By the definition proposed by Department of Health in China, subjects with BMI ≥24 kg/m² and <28 kg/m² were classified as overweight and those with BMI ≥28 kg/m² were classified as obese.

Blood pressure was measured after the subject had rested for at least 5 minutes, using an electric sphygmomanometer (OMRON, HEM-741C) by doctors. The subject’s arm was placed at the heart level. Three measurements were taken. Systolic blood pressure (SBP) was defined as the average of the three SBP readings. Diastolic blood pressure (DBP) was defined as the average of the three DBP readings. We defined prehypertension as which SBP was between 120 and 139 mmHg or DBP between 80 and 89 mmHg according to JNC-7 (10). Hypertension was defined as an average SBP ≥140 mmHg, an average DBP ≥90 mmHg, and/or self-reported current treatment for hypertension with antihypertensive medication (13).

**Statistical analysis**

Continuous variables were presented as mean values and standard deviation. Categorical variables were presented as frequencies. Associations between categorical variables were tested by the use of contingency tables and the χ² test. Comparisons between continuous variables between groups were performed by analysis of t test. Odds ratios were calculated using logistic regression analyses performed separately for male and female. Statistical analysis was performed using SPSS version 11.5 software and values of p<0.05 were considered to indicate statistical significance.

**Results**

The characteristics of the survey participants in this study, as stratified by gender, are shown in Table 1. Mean BMI was 23.03±2.85 kg/m² in males and 23.43±3.35 kg/m² in females. The prevalence rates of overweight and obesity were 16.3% and 1.3% in males and 24.4% and 2.7% in females using WHO’s definitions, respectively (p for gender difference <0.05). The prevalence rate of hypertension was higher in females than in males (38.6% vs 37.0%), whereas the prevalence rate of prehypertension was lower in females than in males (39.6% vs 48.7%).

Table 2 shows the distribution of population by BMI according to Chinese definitions. The prevalence of overweight and obesity were 26.6% and 3.5% in males and 32.5% and 7.0% in females, respectively. Specifically, the age-specific peak prevalence of overweight in males and females both was observed between 45 and 54 years old as compared with younger or older adults. Similarly, the peak prevalence of obesity in females was observed between 55 and 64 years old and in males was observed between 35 and 44 years old.

Compared to normal weight people, people with overweight or obesity had high mean systolic blood pressure (136.30±22.96 mmHg vs. 132.18±22.07 mmHg; 145.10±25.54 vs.132.18±22.07 mmHg p<0.05) and diastolic blood pressure (84.43±12.95 mmHg vs. 81.42±12.19 mmHg; 89.88±13.98 mmHg vs. 81.42±12.19 mmHg p<0.05).

Among males, the prevalence of elevated blood pressure increased progressively with increasing BMI, from 83.8% at a BMI <24 to 93.6% at a BMI ≥28 kg/m² (Table 3). The prevalence of elevated blood pressure increased progressively with increasing BMI at all age groups. The prevalence of hypertension increased with age and the prevalence of prehypertension decreased with age among males at all...

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### Table 1. Basic Characteristics of the Study Population

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>51.23±11.79</td>
<td>51.20±11.84</td>
<td>51.22±11.82</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169.22±5.62</td>
<td>160.19±5.67</td>
<td>164.66±7.23</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>65.97±8.82</td>
<td>60.12±9.09</td>
<td>63.02±9.42</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.03±2.85</td>
<td>23.43±3.35</td>
<td>23.23±3.12</td>
</tr>
<tr>
<td>Overweight 1 (24&lt;BMI&lt;28), %</td>
<td>26.60</td>
<td>32.50</td>
<td>29.50</td>
</tr>
<tr>
<td>Overweight 2 (25≤BMI&lt;30), %</td>
<td>16.30</td>
<td>24.40</td>
<td>20.40</td>
</tr>
<tr>
<td>Obesity 1 (BMI≥28), %</td>
<td>3.50</td>
<td>7.00</td>
<td>5.30</td>
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<tr>
<td>Obesity 2 (BMI≥30), %</td>
<td>1.30</td>
<td>2.70</td>
<td>2.00</td>
</tr>
<tr>
<td>Prehypertension, %</td>
<td>48.70</td>
<td>39.60</td>
<td>44.10</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>37.00</td>
<td>38.60</td>
<td>37.80</td>
</tr>
</tbody>
</table>

*Mean±SD. AI=anthropometric indices.
Male is the reference group.
†The difference is statistically significant (p<0.05).*
levels of BMI. The increased in prevalence of hypertension with increasing BMI was greater in the two younger age groups (Table 3). Among male aged 35 to 44 years, the prevalence of hypertension was nearly three higher at the highest (≥28) BMI compared with the lowest (<25) BMI category. Among older males (≥65) there was a less steep in hypertension prevalence with increasing BMI category.

Females showed a pattern similar to that of males with respect to prevalence and relationship of high blood pressure to BMI (Table 3). The prevalence of elevated blood pressure increased progressively with increasing BMI, from 74.4% at a BMI <24 to 90.1% at a BMI ≥28 kg/m² (Table 3). The prevalence of elevated blood pressure increased progressively with increasing BMI at all age groups. The prevalence of hypertension increased with age and the prevalence of prehypertension decreased with age among females at all levels of BMI. The increased in prevalence of hypertension with increasing BMI was greater in the younger age groups (Table 3).

Table 4 shows the relationships between BMI and the prevalence of prehypertension and hypertension by sex through multivariate logistic regression adjusted for race, age, education status, smoking, drinking, salt intake, lipid disorder. We can see that overweight and obesity were risk...
factors for prehypertension and hypertension whether in males or females. For males, people with BMI ≥28 had 2.145-fold risk to get prehypertension and had 4.219-fold risk to get hypertension compared to people with BMI <24, the same for females, people with BMI ≥28 had 1.608-fold risks to get prehypertension and had 4.243-fold risk to get hypertension compared to people with BMI <24.

Discussion

The prevalence of obesity is increasing at an alarming rate in worldwide. In China, the combined prevalence of overweight and obesity has increased by 49.3%, from 14.6% in 1992 to 21.8% in 2002 (14). China InterAsia study showed that, in the urban population in China, the prevalence of overweight was 28.2%, 26.1% in males and 30.5% in females (15). In the Japanese rural population, the prevalence of combined overweight and obesity was 24.0% in males and 20.0% in females (16). In the western countries, the prevalence was significantly higher for example in the Greece (overweight: 53.0% in males, and 31.0% in females; obesity: 20.0% in males, and 15.0% in females) (17). In the present study, we demonstrated that the prevalence of combined overweight and obesity was 22.4% (overweight: 16.3% in males and 24.4% in females; obesity: 1.3% in males and 2.7% in females) according to the WHO definitions and 34.8% according to Chinese definitions. We can see that the prevalence of weight and obesity in Chinese rural adult people make quick development with rapid economic developing. Although the figure was lower than Chinese urban adult people and western developed countries, the figure is near to other Asian developed countries such as Japan. If according to Chinese definitions, the figure may be even exceed some developed countries. Although in the present study, the prevalence of obese was low, the prevalence of overweight was relatively high especially in age group 45-54 years. We believe that with the fast economic and social developments, more overweight people will become obesity. So we should pay more attention to overweight people especially in the younger group (18, 19). In our study, the prevalence of overweight and obesity was higher in females than in males. Similar to our study, in Ghana the prevalence of obesity was found to be higher among females 7.4% compared to males 2.8% (17). However, in Japan obesity was more prevalent in males than in females (20). The differences in various lifestyles and sex hormones, additionally, other genetic or behavioral factors could explain the observed gender differences.

According to China definitions, we evaluated the relationship of BMI and blood pressure. Consistent with other studies, our analysis shows that overweight and obesity is an important predictor of elevated BP: overweight and obesity people had more high mean systolic and diastolic blood pressure than normal weight people. 93.6% of obese people had prehypertension or hypertension and 61.6% had hypertension in males, whereas these figures were only 83.8% and 33.3% among nonoverweight people. The same in females, 90.1% of obese people had prehypertension or hypertension and 62.4% had hypertension, whereas these figures were only 74.4% and 33.6% among nonoverweight people. Multiple logistic regression analysis revealed that overweight and obesity were main risk factors whether in females and males, so control of weight was very important for blood pressure (21). In the Framingham Study, it was found that a 10% rise in body weight explains a 7 mmHg rise in SBP in the population at large (22). It has also been found that every kilogram excess body weight that is lost is associated with decreases of 0.33 and 0.43 mmHg in SBP and DBP, respectively (23). The long-term effect of weight control has demonstrated that weight reduction could lower the odds of hypertension by 77% (24). The JNC-7 report recommends lifestyle modifications for all patients with prehypertension, including losing weight, increasing physical activity. Together, these findings suggest that the potential health benefits from obesity prevention are of considerable public health importance.

As for the limitations of this report, this is a cross-sectional study, and postulated relationships cannot be causally interpreted; the prevalence of obesity and overweight in China was based on the information provided by a single region, thus the exact figures of obesity or overweight in Chinese rural adult people could be over- or underestimated.

Overweight and obesity have become very prevalent in a China rural adult population. It is a great health problem. Our study quantifies the strong associations of BMI and elevated blood pressure. Our study also indicated that blood pressure measurement is important for overweight and obese people. It is time to pay more attention to overweight and obese in the county of China.

Acknowledgement

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