Prevalence and Risk Factors of the Rural Adult People Prehypertension Status in Liaoning Province of China

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Background Prehypertension is a new category of blood pressure (BP) classification according to the Seventh Report of The Joint National Committee. Little is known about the epidemiology of prehypertension in rural China. The purpose of the present study is to determine the prevalence of prehypertension and associated risk factors in rural adult people of China.

Methods and Results Through cluster multistage and random sampling method, a resident group of 29,970 people aged ≥35 years old in Liaoning Province was selected from 2004 to 2005. The survey on BP and associated risk factors was carried out. Prehypertension was defined as systolic BP between 120 and 139 mmHg or diastolic BP 80 and 89 mmHg. Overall, the prevalence of prehypertension was 47.0%, males 51.2% and females 42.6%, respectively. The prevalence of hypertension was 36.2%. Multivariable logistic regression showed overweight, obesity and drinking were risk factors of prehypertension. Female and greater than high school education status were shown as protective factors.

Conclusions The prevalence of prehypertension of rural adult people in China is dramatically high and it was associated with many risk factors. Comprehensive lifestyle modifications are needed to be taken to decrease the incidence of prehypertension and to prevent prehypertension people from hypertension and cardiovascular disease. (Circ J 2007; 71: 550–553)

Key Words: Epidemiology; Prehypertension; Risk factors; Rural adult people

The Seventh Report of the Joint National Committee (JNC-7) on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure in 2003 proposed a new classification for individuals between normal blood pressure (BP) and established hypertension. The report detailed that people with systolic BP (SBP) between 120 and 139 mmHg or diastolic BP (DBP) 80 and 89 mmHg were categorized as having ‘prehypertension’ 1 Prehypertension tended to increase in severity over time 2 Prehypertension progressed to clinical hypertension at a rate of 19% over 4 years 3 The relationship between BP and risk of cardiovascular disease events was continuous and consistent 4 Beginning at a SBP/DBP of 115/75 mmHg, the risk of cardiovascular disease was doubled with each increment of 20/10 mmHg 5-7 Lifestyle modification or even medical treatment was recommended for individuals with prehypertension 1 However, little was known about the epidemiology of prehypertension in the countryside of China when the report was released. We investigated rural adult people from 2004 to 2005 in Liaoning Province. The purpose was to determine the prevalence of prehypertension and associated risk factors in the rural adult people of China.

Methods

Study Participants

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 a typical area of China with a cross-sectional survey that adopted a cluster multi-stage and random sampling method in Fuxin County, Liaoning Province. A total of 35,360 participants over 35 years age were in the survey area; however 29,970 individuals were examined between 2004 and 2005, with the response rate 84.8%. Associated factors included age, ethnicity, education, smoking, drinking, salt intake, lipid disorder, diabetes, body mass index (BMI) and waist circumference (WC). For most age-related comparisons, participants were separated into 4 groups according to age (35–44 years, 45–54 years, 55–64 years, ≥65 years). For ethnicity, on the basis of self-reported information, participants were grouped as Han people, Mongolian, and others. We chose to use people’s reported education levels (<high school, high school, >high school) as the indicator of socio-economic status 8 Smoking habits were recorded and the term ‘smoker’ was considered if a person smoked at least 10 cigarettes every day. The weight and height of subjects were measured and BMI was calculated as weight (kg)/height (m)². According to the World Health Organization criteria, BMI were categorized into 3 groups as normal (BMI <25), overweight (25 ≤ BMI <30) and obesity (BMI ≥30). WC was also measured. Salt intake was measured by investigating the total amount of salt consumed in a family for 1
year to calculate salt intake for every person in the family in 1 day. Information on smoking, drinking and education status was self-reported. Diabetes and lipid disorders were based on a history of physician-diagnosed report.

**BP Measurements**

BP was measured after the participant had rested for at least 5 min, using an electric sphygmomanometer (OMRON, HEM-741C) by well-trained doctors. The participant’s arm was placed at the heart level. Two measurements were taken. If the difference between the 2 measurements was greater than 10 mmHg, a third measurement was taken. SBP was defined as the average of the closest 2 SBP readings. DBP was defined as the average of the closest 2 DBP readings.

**BP Classification**

The classification of normotensive, prehypertensive and hypertensive was based on the classification of BP from the JNC-7. Normal BP was defined as not being on antihypertensive medication and having SBP of less than 120 mmHg and DBP of less than 80 mmHg. Prehypertension was defined as not being on antihypertensive medication and having a SBP of 120–139 mmHg or DBP of 80–89 mmHg. Hypertension was defined based on the JNC-7 cut-off point of 140 mmHg and above for SBP and/or 90 mmHg and above for DBP.

**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 $\chi^2$ test. Comparisons between continuous variables between groups were performed by analysis with t-test. Univariate and multivariate logistic regression analyses were used to test significant determinants of prehypertension vs normotension. Statistical analysis was calculated with SPSS version 11.5 software and values of $p<0.05$ were considered to indicate statistical significance.

**Results**

The 29,970 participants included males (n=15,122) and females (n=14,848) aged 35–99 years (mean: 51.25±11.89 years). Among them, 5,044 individuals had normal BP, 14,072 were prehypertensive, and 10,854 were hypertensive. Approximately 47.0% of Chinese rural adult people had prehypertension and 36.2% of Chinese rural adult people had hypertension. The prevalence of prehypertension was higher in males than females (51.2% vs 42.6%), whereas the prevalence of hypertension was higher among females than males (36.7% vs 35.8%). The prevalence of prehypertension decreased with age increasing and the prevalence of hypertension increased with age increasing whether male or female. Table 2 lists the baseline characteristics of prehypertensives and normotensives. 55% of prehypertension individuals and 39.1% of normotension were males ($p<0.001$). Individuals with prehypertension were significantly older than those with normal BP (48.93±10.83 vs 47.15±10.60, $p<0.001$). WC (80.44±8.25 vs 78.29±8.25) and BMI (22.40±2.77 vs 23.00±2.77) were significantly greater in prehypertensives than in normotensives (all $p<0.001$). In these individuals, 0.7% of the normotensives were categorized as obese (BMI $\geq$30) and 11.8% of the normotensives vs 16.4% of the prehypertensives were overweight (25$<\text{BMI}<30$).

Age, ethnicity, education status, lipid disorder, smoking and drinking were significantly different between groups ($p<0.001$). There was no difference in the prevalence of dia-

**Table 1** Prevalence of Prehypertension and Hypertension by Age and Gender Among Rural Adults of Liaoning Province, China

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Male (n=15,122)</th>
<th>Female (n=14,848)</th>
<th>All (n=29,970)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prehypertension (%)</td>
<td>Hypertension (%)</td>
<td>Prehypertension (%)</td>
</tr>
<tr>
<td>35–44</td>
<td>62.1</td>
<td>21.3</td>
<td>49.8</td>
</tr>
<tr>
<td>45–54</td>
<td>53.3</td>
<td>33.4</td>
<td>45.1</td>
</tr>
<tr>
<td>55–64</td>
<td>42.9</td>
<td>47.0</td>
<td>36.3</td>
</tr>
<tr>
<td>≥65</td>
<td>32.4</td>
<td>59.7</td>
<td>29.1</td>
</tr>
<tr>
<td>Total</td>
<td>51.2</td>
<td>35.8</td>
<td>42.6</td>
</tr>
</tbody>
</table>

**Table 2** Baseline Characteristics of Subjects With Normotension and Prehypertension

<table>
<thead>
<tr>
<th>Blood pressure status</th>
<th>Normotension (n=5,044)</th>
<th>Prehypertension (n=14,072)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)*</td>
<td>39.1±10.6</td>
<td>55.0±10.83</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age group (years), %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35–44</td>
<td>47.15±10.6</td>
<td>48.93±10.83</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>45–54</td>
<td>29.4</td>
<td>31.3</td>
<td></td>
</tr>
<tr>
<td>55–64</td>
<td>13.4</td>
<td>16.4</td>
<td></td>
</tr>
<tr>
<td>≥65</td>
<td>7.1</td>
<td>9.9</td>
<td></td>
</tr>
<tr>
<td>Ethnic group, %</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Han people</td>
<td>77.7</td>
<td>75.5</td>
<td></td>
</tr>
<tr>
<td>Mongolian</td>
<td>20.5</td>
<td>23.1</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>1.8</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Education, %</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&lt;High school</td>
<td>38.0</td>
<td>41.5</td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>61.0</td>
<td>58.0</td>
<td></td>
</tr>
<tr>
<td>&gt;High school</td>
<td>1.0</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)*</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&lt;25</td>
<td>22.40±2.77</td>
<td>23.00±2.77</td>
<td></td>
</tr>
<tr>
<td>25–30</td>
<td>87.5</td>
<td>82.5</td>
<td></td>
</tr>
<tr>
<td>≥30</td>
<td>11.8</td>
<td>16.4</td>
<td></td>
</tr>
<tr>
<td>WC (cm)*</td>
<td>25.0</td>
<td>25.0</td>
<td></td>
</tr>
<tr>
<td>Smoking status, %</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Salt intake (g/day)*</td>
<td>15.06±11.20</td>
<td>15.46±11.62</td>
<td>0.034</td>
</tr>
<tr>
<td>Lipid disorder, %</td>
<td>1.0</td>
<td>1.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes, %</td>
<td>0.4</td>
<td>0.3</td>
<td>0.221</td>
</tr>
</tbody>
</table>

*Mean±SD. BMI, body mass index; WC, waist circumference.
betes between prehypertension and normotension. Univariate logistic regression showed that sex, age, ethnicity, education status, smoking, drinking, salt intake in 1 day, lipid disorder, BMI and WC were significantly associated with prehypertension status for the whole sample. After multiple logistic regression analysis, age, ethnicity, drinking, salt intake in 1 day, lipid disorder, BMI and WC were shown as main risk factors (Table 3). Compared with people aged 35–44 years, people aged 45–54, 55–64 and ≥65 years had more risks of getting prehypertension (OR =1.211, 1.376, 1.628). Prehypertension people more frequently had a drinking habit (33.0% vs 23.0%, OR =1.192), lipid disorders (40.8% vs 34.4%, OR =1.371) and high salt intake (15.46±11.62 vs 15.06±11.20, OR =1.075). People with a status of overweight or obese are more likely to get prehypertension compared with people with normal weight (25 ≤ BMI <30, OR =1.465; BMI ≥30, OR =1.593). Male and female participants with the same characteristics apart from WC ≥85 (male) or ≥80 (female) had a higher risk of becoming prehypertensive (OR =1.407) than males measuring <85 and females <80. Mongolian people appeared to have a 1.145-fold higher risk of developing prehypertension than Han people (OR =1.146). No group difference was observed for smoking or no smoking; diabetes or no diabetes. Compared to male people or people with education status of below high school education level, female and education status of over high school were shown as protective factors (female OR =0.506, high school OR =0.891, >high school OR =0.450).

Discussion

Prehypertension is a new category of BP classification. A previous study which showed that individuals with a BP level slightly higher than normal had a higher cardiovascular disease than those with normal BP. This suggests that there was a continual increase in the risk of cardiovascular disease as the BP level increases progressively. This cross-sectional study was a secondary analysis of previously collected data. These data were derived from a multi-stage, stratified survey sample aged 35 years and older in rural adult people of China. Hence, individuals included in this study were representative. Our study found an overall prehypertension prevalence rate of 47% in rural adult people of China, which was higher than the prevalence rate (34%) observed in Taiwanese adults.

Table 3  Factors Associated With Blood Pressure Status (Normotension vs Prehypertension) From Univariate and Multivariate Logistic Regression Models

<table>
<thead>
<tr>
<th>Univariate analysis</th>
<th>Multivariate analysis*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95%CI) p value</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.000 (reference) &lt;0.001</td>
</tr>
<tr>
<td>Female</td>
<td>0.525 (0.492–0.561)</td>
</tr>
<tr>
<td><strong>Age group, years</strong></td>
<td></td>
</tr>
<tr>
<td>35–44</td>
<td>1.000 (reference)</td>
</tr>
<tr>
<td>45–54</td>
<td>1.256 (1.166–1.354)</td>
</tr>
<tr>
<td>55–64</td>
<td>1.448 (1.313–1.596)</td>
</tr>
<tr>
<td>≥65</td>
<td>1.642 (1.449–1.860)</td>
</tr>
<tr>
<td><strong>Ethnic group</strong></td>
<td></td>
</tr>
<tr>
<td>Han people</td>
<td>1.000 (reference)</td>
</tr>
<tr>
<td>Mongolian</td>
<td>1.155 (1.067–1.250)</td>
</tr>
<tr>
<td>Others</td>
<td>0.835 (0.653–1.071)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;High school</td>
<td>1.000 (reference)</td>
</tr>
<tr>
<td>High school</td>
<td>0.872 (0.816–0.932)</td>
</tr>
<tr>
<td>≥High school</td>
<td>0.486 (0.336–0.704)</td>
</tr>
<tr>
<td><strong>Smoking status</strong></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.000 (reference)</td>
</tr>
<tr>
<td>Yes</td>
<td>1.433 (1.340–1.532)</td>
</tr>
<tr>
<td><strong>BMI, kg/m²</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;25</td>
<td>1.000 (reference)</td>
</tr>
<tr>
<td>25–30</td>
<td>1.470 (1.335–1.619)</td>
</tr>
<tr>
<td>≥30</td>
<td>1.643 (1.147–2.354)</td>
</tr>
<tr>
<td><strong>WC, cm</strong></td>
<td></td>
</tr>
<tr>
<td>Male with WC &lt;85 or female with WC &lt;80</td>
<td>1.000 (reference)</td>
</tr>
<tr>
<td>Male with WC ≥85 or female with WC ≥80</td>
<td>1.312 (1.226–1.403)</td>
</tr>
<tr>
<td><strong>Salt intake, g/day</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;15.35</td>
<td>1.000 (reference)</td>
</tr>
<tr>
<td>≥15.35</td>
<td>1.13 (1.033–1.178)</td>
</tr>
<tr>
<td><strong>Lipid disorder</strong></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.000 (reference)</td>
</tr>
<tr>
<td>Yes</td>
<td>1.103 (1.033–1.178)</td>
</tr>
<tr>
<td><strong>Diabetes</strong></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.000 (reference)</td>
</tr>
<tr>
<td>Yes</td>
<td>0.716 (0.415–1.226)</td>
</tr>
</tbody>
</table>

*Adjusted for gender, age, ethnicity, education, smoking status, drinking status, BMI, WC, salt intake, lipid disorder, diabetes. OR, odds ratio; CI, confidence interval. Other abbreviations see in Table 2.
adults (31%)9 and observed in American adults8–12 Consistent with previous reports, we found that in Chinese rural adults the prevalence rate of prehypertension was greater in males than in females8–12. However, the gender difference in the prevalence rate of prehypertension in Chinese rural adults was not as drastic as that seen in American adults9. Our study showed that 51.2% males vs 42.6% females were prehypertensives, compared with 41% vs 23% seen in American adults8. We also found that the prevalence of prehypertension decreased with age increasing, which was different from Taiwanese adults and American adults8,12. In the current study, individuals aged ≥65 years were less likely to have prehypertension than younger individuals (30.7% vs 55.9%), because the majority of individuals in the older age group (61.3%) had progressed to clinical hypertension, and the result was similar with the study group of American people.8

Univariate logistic regression showed that sex, age, ethnicity, education status, smoking, drinking, salt intake in 1 day, lipid disorder, BMI and WC were significantly associated with prehypertension status for the whole sample. Multiple logistic regression analysis showed the same result except for smoking. Female and education status of over high school were shown as protective factors. The prevalence of prehypertension for females was lower than males, we will continue to study for the reason which remained unclear. Compared with people with less than high school education, people with ≥ high school education or greater, had more of a chance to know some information about hypertension and subsequently have a healthier lifestyle, so their prevalence was low. For risk factors, BMI and WC were very important. Evidence suggests that the prevalence of obesity and being overweight had reached an epidemic proportion worldwide.13–17 In the present study, 17.5% of prehypertension people stayed overweight or obese, the long-term effect of weight control had been demonstrated that weight reduction could lower the odds of hypertension by 77%,18 so losing weight was very necessary for prehypertension people.

In Mongolian people, they appeared to have a 1.146-fold higher risk of developing prehypertension than Han people, which might be associated with genetic difference or living habits between Mongolian people and Han people; we will continue to study for the reason. The present study showed that multiple risks contributed to the high prevalence of prehypertension for adult people in the countryside of China. The JNC-7 report recommends lifestyle modifications for all patients with prehypertension, including losing weight, increasing physical activity, adopting the DASH eating plan10–21 and moderate alcohol consumption. Patients who reported adoptions of these lifestyle modifications were found to be 6 times more likely to have their hypertension controlled.22 The current study showed that the rural people of China were facing a serious challenge from high prevalence of prehypertension and multiple associated risk factors, both the general public and health professionals need to be better informed about the new guidelines. The prehypertension people should be told about the seriousness of hypertension and the importance of promoting appropriate lifestyle modification, so as to prevent these people from hypertension and cardiovascular disease.

Acknowledgments

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References