Short Communication

Prevalence and characteristics of the metabolic syndrome among adults in Beijing, China

Gang Li MD[^1,3], Maximilian de Courten MPH[^2], Shufang Jiao MD[^3], Yan Wang PhD[^1]

[^1]: Division of Maternal and Child Health, School of Public Health, Peking University, Beijing, PRChina
[^2]: Department of Epidemiology & Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, Sydney, Australia
[^3]: Beijing Center for Disease Prevention and Control, Beijing, PRChina

This study was performed to investigate the prevalence of the metabolic syndrome using a large representative sample in Beijing. Data from a total of 16442 adults (6489 men and 9953 women) aged ≥18 years from a survey of behavioral risk factors for chronic diseases in Beijing, in 2005, was analyzed. The prevalence of the metabolic syndrome increased with age and the age-standardized prevalence of the metabolic syndrome defined by International Diabetes Federation IDF and National Cholesterol Education Program Adult Treatment Panel III ATPIII criteria were 23.2% (24.5% in men and 22.7% in women) and 16.2% (16.1% in men and 16.6% in women), respectively. The metabolic syndrome was higher in semi-urban areas and associated with higher rates of hypertension, central obesity, salt intake and smoking.

Key Words: metabolic syndrome, prevalence, current smoking, China

INTRODUCTION

The metabolic syndrome (MS) is a combination of several metabolic components including insulin resistance, glucose intolerance, hypertension, and dyslipidemia (increased triglycerides, low-HDL cholesterol, or both) in the same person. Subjects with this condition are at increased risk for developing diabetes[^1] and cardiovascular disease as well as increased mortality from cardiovascular disease and other causes. The prevalence of the MS varies worldwide depending on age, ethnicity, and definition. In Western countries, the prevalence varies from 4–36%[^2-4]. The prevalence of the MS is reported to increase with age[^5,7] but seems to decline in the oldest population (>70 years).[^5] The MS is also becoming more prevalent in developing countries in recent years.

There is limited information about the prevalence of the MS in Beijing using population-based representative samples conducted in recent years. Our study was conducted to investigate the prevalence and characteristics of the MS using a representative sample from a survey in Beijing, in 2005.

MATERIALS AND METHODS

The survey of behavioral risk factors for chronic diseases in Beijing was conducted by the Beijing Center for Diseases Prevention and Control between August and October 2005. The study was a representative cross-sectional survey using multi-stage, stratified, cluster sampling in Beijing. The target sample size was 19216 residents aged 18 years or older, selected from each of the 18 districts or counties in Beijing proportional to the resident size of each district or county. The final survey sample comprised of 17020 individuals or 89.5% of the target sample size who lived in 162 communities in 54 sub-districts in Beijing. The current analysis is based on 16442 individuals with complete information, out of the 17020 participating individuals (96.6%). Participants were asked to fast for 8-12 hours before venipuncture. The study protocol was approved by the Beijing Center for Diseases Prevention and Control, which is an organization reporting to the Beijing Municipal Health Bureau. After written informed consent was obtained from each subject, data collection including social-demographic and lifestyle information was carried out. Salt intake was estimated by a five-category rating scale for salt preference[^9] and current smokers by the number of cigarettes smoked each day > 0 in questionnaires.

Obesity was defined using the criteria recommended by the Working Group on Obesity in China (WGOC) at a body mass index ≥28.0 for adults[^10,11]. Dyslipidemia was defined using the National Cholesterol Education Program Adult Treatment Panel III NCEP-ATPIII criteria[^12]. The MS was defined using criteria by International Diabetes Federation IDF and NCEP-ATPIII as follows: the IDF-defined MS requires central obesity as a mandatory component, using ethnic-specific values plus any two of the four components: (1) triglyceride ≥1.7 mmol/L; (2) HDL cholesterol <1.03 mmol/L in men and <1.29 mmol/L in women; (3) systolic and/or diastolic blood pressure
and ATPIII criteria was 23.2% and 16.2%, respectively. The prevalence of IDF-defined MS for men increased with age from 18 to 59 years old, but seemed to be lower in the population ≥60 years. For women, the prevalence increased with age from 18 to 69 years and was lower again in the population ≥70 years. Overall, the prevalence of the MS in men was similar to women when using IDF criteria (27.8% vs. 28.0%, \( p = 0.730 \)), whereas the MS was more common in women than in men when using ATPIII criteria (20.4% vs. 18.2%, \( p = 0.001 \)).

Table 1 also displays the prevalence of individual components of the MS in relation to gender and age group. Hypertension was the most common condition contributing to the MS definition in both men and women. Central obesity when defined with IDF criteria was the second most common component of the MS, especially in women (47.2%). Using the IDF criteria, hypertension, central obesity, and hypertriglyceridemia contributed most to the diagnosis of the MS in men (n=1059, 58.8%), while in women it was hypertension, central obesity, and low HDL cholesterol (n=1593, 57.2%). Presence of one or more components of the MS was more common in both genders using the IDF definition than with the ATP III criteria (Table 2).

When analyzing the results separately for those living in semi-urban areas and those in urban Beijing, the prevalence of the MS and its individual components as defined by IDF and ATPIII criteria is shown in Table 1. The prevalence of IDF-defined MS for men increased with age from 18 to 59 years old, but seemed to be lower in the population ≥60 years. For women, the prevalence increased with age from 18 to 69 years and was lower again in the population ≥70 years. Overall, the prevalence of the MS in men was similar to women when using IDF criteria (27.8% vs. 28.0%, \( p = 0.730 \)), whereas the MS was more common in women than in men when using ATPIII criteria (20.4% vs. 18.2%, \( p = 0.001 \)).

Table 1 also displays the prevalence of individual components of the MS in relation to gender and age group. Hypertension was the most common condition contributing to the MS definition in both men and women. Central obesity when defined with IDF criteria was the second most common component of the MS, especially in women (47.2%). Using the IDF criteria, hypertension, central obesity, and hypertriglyceridemia contributed most to the diagnosis of the MS in men (n=1059, 58.8%), while in women it was hypertension, central obesity, and low HDL cholesterol (n=1593, 57.2%). Presence of one or more components of the MS was more common in both genders using the IDF definition than with the ATP III criteria (Table 2).

When analyzing the results separately for those living in semi-urban areas and those in urban Beijing, the prevalence...
Prevalence of the metabolic syndrome in Beijing

The prevalence of the metabolic syndrome (MS) in Beijing was higher irrespective of the definition used in the semi-urban area (Table 3). This was reflected by higher rates of hypertension and central obesity in participants from semi-urban Beijing as well as by higher smoking rates in men and higher reported salt intake in women (Table 3).

In multiple regression models with the MS as a dependent variable using either the IDF or the ATP III definition with adjustments for age and sex, residential site, reported salt intake and smoking status were all independently related to the syndrome (data not shown).

DISCUSSION

There are several large epidemiologic studies on the prevalence of the MS in China. Gu et al. reported that the prevalence of the revised-ATPIII-defined MS was in 2000, 9.8% in men and 17.8% in women aged 35–74 years in China. In a community-based cross-sectional survey of 8320 men and women aged 30–92 years in Taiwan, the prevalence of the metabolic syndrome, as defined by ATPIII, was 15.4% (11.2% in men and 18.6% in women). The prevalence of the MS in a cohort study of 27739 men and women aged 35–64 years from 11 provinces in China was, in 1992, 13.3% (12.7% in men and 14.2% in women). Our more recent study, using data collected from a large representative sample of adult residents of Beijing in 2005, demonstrated that the prevalence of the MS was higher than those previously reported in China.

In our study, the overall prevalence of the MS was higher when using the IDF definition than when using the ATPIII definition, which is consistent with studies reported from Greece, Australia, the US, Mexico, and on participants of Asian origin (including Chinese, Japanese and Indian). When using the IDF definition of the MS, only 22.3% of men and 31.0% of women in Beijing did not have any component of the syndrome. Hypertension and central obesity were common components of the MS in both men and women in Beijing. Strategies aimed at the control and prevention of hypertension and central obesity should therefore be prioritized to reduce the occurrence of the MS and coronary heart disease in Beijing and other areas in China.

When comparing the rates of the MS between semi-urban and urban districts of Beijing, an inverse pattern was observed compared to that of other studies reported from China: the residents of semi-urban areas had higher rates of the MS than their urban counterparts, which can be ascribed to higher prevalence of hypertension and central obesity- key determinants of the MS in the Beijing population. Our data also suggest higher reported salt intake in women and higher smoking rates in men from the semi-urban group. There is increasing evidence that tobacco smoking is correlated with the MS, and that

<table>
<thead>
<tr>
<th>Number of components</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IDF criteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>22.3%</td>
<td>25.5%</td>
<td>22.9%</td>
<td>16.3%</td>
<td>9.9%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Women</td>
<td>31.0%</td>
<td>26.2%</td>
<td>17.8%</td>
<td>13.1%</td>
<td>8.3%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Total</td>
<td>27.5%</td>
<td>26.0%</td>
<td>20.0%</td>
<td>14.3%</td>
<td>8.8%</td>
<td>3.3%</td>
</tr>
<tr>
<td><strong>ATP III</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>28.2%</td>
<td>34.7%</td>
<td>21.0%</td>
<td>11.7%</td>
<td>3.8%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Women</td>
<td>36.9%</td>
<td>31.1%</td>
<td>15.4%</td>
<td>9.8%</td>
<td>5.1%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Total</td>
<td>33.5%</td>
<td>32.6%</td>
<td>17.6%</td>
<td>10.5%</td>
<td>4.5%</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

**Table 2.** Age-standardized prevalence of the number of components of the metabolic syndrome using IDF or ATP III criteria

**Table 3.** Components and risk factors for the metabolic syndrome

<table>
<thead>
<tr>
<th></th>
<th>Urban</th>
<th>Semi-urban</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Total</td>
</tr>
<tr>
<td>N†</td>
<td>3872</td>
<td>6487</td>
<td>10359</td>
</tr>
<tr>
<td>Central obesity‡</td>
<td>IDF</td>
<td>42.6</td>
<td>45.7**</td>
</tr>
<tr>
<td></td>
<td>ATP</td>
<td>6.3**</td>
<td>18.8**</td>
</tr>
<tr>
<td>High FPG</td>
<td>IDF</td>
<td>30.4</td>
<td>25.9*</td>
</tr>
<tr>
<td></td>
<td>ATP</td>
<td>17.5</td>
<td>13.8</td>
</tr>
<tr>
<td>Low HDL-C</td>
<td>IDF/ATP</td>
<td>26.7**</td>
<td>37.8**</td>
</tr>
<tr>
<td>Hyper TG</td>
<td>IDF/ATP</td>
<td>32.3</td>
<td>19.5</td>
</tr>
<tr>
<td>Hypertension</td>
<td>IDF/ATP</td>
<td>56.1**</td>
<td>42.7**</td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>IDF</td>
<td>27.0</td>
<td>26.9**</td>
</tr>
<tr>
<td></td>
<td>ATP</td>
<td>17.9</td>
<td>19.2**</td>
</tr>
<tr>
<td>Smoking</td>
<td>IDF</td>
<td>55.8**</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>ATP</td>
<td>40.9</td>
<td>29.8**</td>
</tr>
</tbody>
</table>

† N indicates number of subjects investigated
‡ Prevalence of components of metabolic syndrome defined by the IDF or ATP III (%)
§ High salt intake as reported in questionnaire through self-rating salt consumption habits (%)
* t-test or chi-square test between urban and semi-urban areas with p value <0.05
** t-test or chi-square test between urban and semi-urban areas with p value <0.01
hyperinsulinenia and abnormalities of lipoprotein metabolism such as seen in the MS could be the link between smoking and cardiovascular disease. However, when adjusting for age and sex in a logistic regression model, place of residence remained an independent correlate with the MS in addition to salt intake and smoking. Hence these two risk factors cannot fully explain the higher rates of the MS seen in the semi-urban population.

In conclusion, our results show a high prevalence of the MS in Beijing independent of the definition applied. Economic development and subsequent changes in lifestyle and diet might explain this high and increasing prevalence in comparison to earlier studies. Our survey data indicate that salt intake might play a role in the high levels of hypertension/metabolic syndrome seen and should together with anti-tobacco campaigns become a key target for health promotion. Since Beijing is highly developed in terms of economy in China, the results of our study can be indicative of the future of other developing areas in China.

ACKNOWLEDGEMENT
The surveillance study was funded by Beijing Municipal Health Bureau.

AUTHOR DISCLOSURES
None declared.

REFERENCES
Short Communication

Prevalence and characteristics of the metabolic syndrome among adults in Beijing, China

Gang Li MD\textsuperscript{1,3}, Maximilian de Courten MPH\textsuperscript{2}, Shufang Jiao MD\textsuperscript{3}, Yan Wang PhD\textsuperscript{1}

\textsuperscript{1}Division of Maternal and Child Health, School of Public Health, Peking University, Beijing, PRChina
\textsuperscript{2}Department of Epidemiology & Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, Sydney, Australia
\textsuperscript{3}Beijing Center for Disease Prevention and Control, Beijing, PRChina

北京市成年人代谢综合征的患病率和患病特征

本研究通过北京市有代表性的大样本数据来分析代谢综合征的患病率和患病特征。数据来源于2005年北京市成年人慢性病及相关行为危险因素调查，共计16,442名年龄大于18岁的成年人（其中男性6,489人，女性9,953人）进入本研究的分析。代谢综合征的患病率随着年龄的升高而升高，年龄标准化患病率采用国际糖尿病联盟（IDF）和美国国家第三次胆固醇教育计划（ATPIII）诊断标准分别为23.2%（男性24.5%；女性22.7%）和16.2%（男性16.1%；女性16.6%）。代谢综合征在郊区有更高的患病率，并与高血压、中央型肥胖、高盐摄入和吸烟有相关联。

关键词：代谢综合征、患病率、现行吸烟、中国