Short Communication

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

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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).[8] 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-ATP III 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

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≥130/85 mmHg, or treatment of previously diagnosed hypertension; (4) fasting plasma glucose (FPG) ≥5.6 mmol/L or previously diagnosed type 2 diabetes. The IDF central obesity criterion is defined at a waist circumference ≥90 cm for men and ≥80 cm for women of Chinese or Asian Indian origin. According to the NCEP-ATP III criterion for the MS, subjects have to have three or more of the following abnormalities to meet the definition: abdominal obesity, as defined at a waist circumference >102 cm for men or >88 cm for women; a high fasting plasma glucose level ≥6.1 mmol/L, while the levels of the three other variables (triglycerides, HDL cholesterol and blood pressure) are as defined in the IDF criteria.[12,13] Subjects who did not meet the criterion of high blood pressure or high fasting glucose, but were treated with antihypertensive drugs or had self-reported diabetes mellitus, were also considered to fulfill the criteria for high blood pressure or high fasting glucose, respectively.

RESULTS

Of the 16442 participants 6489 or 39.5% were men. The dominant ethnicity reported was with 95.9% Han and 87.4% of participants reported 9 or more years' of formal education.

The age-standardized prevalence of the MS using IDF and ATPIII criteria was 23.2% and 16.2%, respectively. The prevalence of the MS and its individual components as defined by IDF and ATP III 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 preva-

Table 1. Prevalence of individual components of the metabolic syndrome using IDF or ATP III criteria by sex and age group (%)

Age group	N†	Central obesity‡		High FPG		Low HDL-C	Hyper TG	Hyper-tension	Metabolic syndrome	
		IDF	ATPIII	IDF	ATPIII	IDF/ ATPIII	IDF/ ATPIII	IDF/ ATPIII	IDF	ATPIII
Men										
18-29	1147	20.1	3.2	10.4	3.2	23.2	16.0	34.4	9.1	6.5
30-39	1213	42.8	7.7	21.1	8.6	27.0	36.8	47.4	25.9	16.7
40-49	1771	51.3	8.0	33.8	18.5	27.4	42.6	61.3	33.4	22.1
50-59	1405	50.4	8.6	38.9	22.2	26.1	36.9	69.5	34.2	22.4
60-69	581	47.7	6.7	46.8	27.5	18.8	26.7	83.5	33.2	20.1
≥70	372	47.3	8.3	45.2	24.2	22.8	20.2	88.4	31.7	21.5
Total	6489	43.4	7.1	30.2	15.9	25.3	32.9	59.3	27.8	18.2
Women										
18-29	1385	13.0	3.0	4.8	1.5	34.4	4.0	8.9	3.0	2.0
30-39	2085	28.9	8.3	11.8	4.6	39.7	9.2	22.5	11.7	7.4
40-49	3041	48.7	17.8	23.5	10.7	40.0	18.4	43.9	25.5	17.3
50-59	2012	66.3	31.5	37.0	19.2	42.7	32.3	64.5	44.4	33.2
60-69	872	77.9	46.4	51.1	29.6	42.1	35.9	84.1	59.4	46.0
≥70	558	74.7	48.2	49.9	31.5	36.0	34.4	88.4	56.5	45.2
Total	9953	47.2	20.7	25.1	12.7	39.7	19.7	44.7	28.0	20.4
All										
18-29	2532	16.2	3.1	7.3	2.3	29.3	9.5	20.5	5.8	4.0
30-39	3298	34.0	8.1	15.2	6.1	35.1	19.3	31.7	16.9	10.8
40-49	4812	49.7	14.2	27.1	13.6	35.3	27.3	50.3	28.4	19.1
50-59	3417	59.8	22.1	37.0	20.4	35.9	34.2	66.5	40.2	28.8
60-69	1453	65.8	30.6	47.9	28.8	32.8	32.2	83.8	48.9	35.7
≥70	930	63.8	32.3	46.2	28.6	30.8	28.7	88.4	46.6	35.7
Total	16442	45.7	15.4	26.6	13.9	34.0	24.9	50.5	27.9	19.5

†N indicates number of subjects investigated.
‡Prevalence of components of the metabolic syndrome as defined by IDF or ATP III (%).

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

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

Table 3. Components and risk factors for the metabolic syndrome

		Urban			Semi-urban			All		
		Men	Women	Total	Men	Women	Total	Men	Women	Total
N†		3872	6487	10359	2617	3466	6083	6489	9953	16442
Central obesity‡	IDF	42.6	45.7**	44.6**	44.7	49.8	47.6	43.4	47.2	45.7
	ATP	6.3**	18.8**	14.1**	8.4	24.4	17.5	7.1	20.7	15.4
High FPG	IDF	30.4	25.9*	27.6	29.9	23.5	26.3	30.2	25.1	27.1
	ATPIII	17.5	13.8	15.2*	15.7	12.7	14.0	16.8	13.4	14.7
Low HDL-C	IDF/ATP	26.7**	37.8**	33.7	23.2	43.1	34.5	25.3	39.7	34.0
Hyper TG	IDF/ATP	32.3	19.5	24.3*	33.8	20.1	26	32.9	19.7	24.9
Hypertension	IDF/ATP	56.1**	42.7**	47.7**	63.9	48.5	55.1	59.3	44.7	50.5
Metabolic	IDF	27.0	26.9**	26.9**	28.8	30.1	29.6	27.8	28.0	27.9
syndrome	ATPIII	17.9	19.2**	18.7**	18.6	22.5	20.8	18.2	20.4	19.5
Smoking		55.8**	5.1	24.1**	61.5	4.7	29.1	58.1	5.0	25.9
High Salt Intake§		40.9	29.8**	34.0**	40.6	33.4	36.5	40.8	31.0	34.9

† 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

lence of the MS 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.[14] 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).[15] The prevalence of the MS in a cohort study of 27739 men and women aged 35–64years from 11 provinces in China was, in 1992, 13.3% (12.7% in men and 14.2% in women).[16] 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,[17] Australia,[18] the US,[19] Mexico,[20] and on participants of Asian origin (including Chinese, Japanese and Indian).[21]

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 compare 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.[14] 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,[22,23] and that

hyperinsulinemia and abnormalities of lipoprotein metabolism such as seen in the MS could be the link between smoking and cardiovascular disease.[24] 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.

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AUTHOR DISCLOSURES

None declared.

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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，計16,442 名年龄大於 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。

關鍵字：代谢综合征、患病率、現行吸烟、中国