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Prevalence of metabolic syndrome and factors associated with its components in Chinese adults

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Abstract

The purpose of this study was to assess the prevalence of metabolic syndrome (MetS) and its components among middle-aged and elderly adults in Jiangsu province, China. Moreover, factors associated with MetS were also assessed. A population-based cross-sectional survey was conducted with 4 randomly selected areas including both urban and rural areas from Jiangsu province, China. After the procedure, 3914 adults aged 35 to 74 years were included in the study. *Metabolic syndrome* was defined by the modified National Cholesterol Education Program Adult Treatment Panel III report. Data were collected by interviewer-administered questionnaire, biophysical assessment, and biochemical examination. Crude and age-standardized prevalence of MetS was 31.5% and 30.5%, respectively. Prevalence rate increased significantly with age in female but not in male subjects, whereas this was true for both sexes with increased body mass index. High blood pressure was the most prevalent component of MetS (45.2%), followed by elevated triglycerides (40.1%) and low high-density lipoprotein cholesterol (40.1%). Multivariate ordinal regression analysis revealed that women had significantly higher risk of MetS than men (odds ratio = 1.72, $P < .001$). Older age, living in urban area, income, family history of diabetes, and family history of hypertension were positively associated with MetS risk. However, higher education and tea drinking everyday were found to be negatively associated with MetS ($P < .05$). Moreover, substantial agreement ($\kappa = 0.79$) was found between the International Diabetes Federation and modified Adult Treatment Panel III criteria among 3 comparisons of MetS definitions. Metabolic syndrome was highly prevalent in middle-aged and elderly Chinese population in Jiangsu province. Community-based strategies for diet and lifestyle modifications are strongly suggested, especially in women and the elderly.

1. Introduction

In the last 2 decades, a great deal of concern has been focused on a cluster of metabolic abnormalities including abdominal obesity, hyperglycemia, hypertension, and adipose metabolic disorder identified as *metabolic syndrome* (MetS). It is regarded as an independent risk factor of cardiovascular disease and type 2 diabetes mellitus [1-3]. Although debate on the use of the term *metabolic syndrome* is still going on [4,5], its impact on public health has been considerable. Criteria proposed by the World Health Organization (WHO) [6], International Diabetes Federation (IDF) [7], and National Cholesterol Education Program Adult Treatment Panel III (ATP III) [8] were often used in publications.

Metabolic syndrome is becoming epidemic worldwide [7]. It is increasing rapidly in all ages and is considered one of the important public health challenges in China [9-11].

Nevertheless, the disparity in economic development is very large in China. Few studies on prevalence and determinants of MetS in China were done in economic booming areas. The current study was conducted in Jiangsu province, which is economically developed. It has a population of 74 million and has the highest population density in China. In the present study, our aims were to evaluate the prevalence of MetS and to assess the factors associated with MetS risk. This may serve as a basis to

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design necessary intervention programs for the prevention of cardiocerebrovascular diseases and diabetes.

2. Methods

2.1. Participants

This population-based study was conducted on a random sample of residents aged 35 to 74 years in urban and rural areas from Jiangsu province, China. Only 1 person was selected in each family to reduce the problem associated to clustering of some risk factors related to genetic predisposition, food habits, and environmental factors. Exclusion criteria were pregnant women, and physically or mentally disabled person unable to follow simple questions and examinations. Four investigation sites were selected by multistage stratified cluster random sampling method including both urban and rural areas in 2002. The stratification factors were sex and age (35~74 years, 10-year difference between near age groups). The selected sites were 1 community of Suzhou City and 3 villages of Changshu, Jintan, and Ganyu County, respectively. The response rate was 92.0%.

After the procedure, a total of 1748 men and 2166 women were included. Data were collected through questionnaire interviews, anthropometry examination, and blood analysis. Anthropometric test and blood sampling were conducted at the time of interview. Ethical clearance was obtained both from the Norwegian Research Ethical Committee and Jiangsu Provincial Center for Disease Prevention and Control, China. Participants were included only after receipt of informed written consent.

2.2. Procedures

All the randomly selected subjects were requested to appear before the local health service centers in the morning after overnight fasting. Face-to-face interviews were conducted by well-trained investigators using structured questionnaire. The questionnaire mainly included information of sociodemographic variables like sex; age; education; economics status; medical history of hypertension, diabetes, hyperlipidemia, and obesity; family history of related diseases; and lifestyles like smoking, tea drinking, and physical activity.

In the questionnaire, education was classified into 5 levels; and then it was defined as low level (<middle school) and high level (≥middle school). Physical activity during both leisure time and work was assessed by using the questionnaire. Participants were asked the following question: average hours per day for exercise/activity during weekday and weekend, respectively (heavy, moderate, light, very low, and nothing)? Each category of activity was defined and given corresponding examples in the questionnaire. *Sedentary lifestyle* was then defined as "not exercise everyday or sedentary ≥8 hours per day."

Height was measured by using wall-mounted stadiometer without shoes to the nearest 0.1 cm. Weight was measured with light clothing and without shoes by an adjusted scale and recorded to the nearest 0.5 kg. The body mass index (BMI) was calculated as the weight (in kilograms) divided by the square of the height (in meters). Height, weight, and waist and hip circumference were taken twice. Waist circumference was measured at 1 cm above the level of navel at minimal respiration touching the iliac crest, and hip circumference was measured at the level of maximum posterior extension of the buttocks with a tape that was calibrated weekly. Waist and hip circumference was recorded to the nearest 0.1 cm. Blood pressure was measured on the right arm in the sitting position for 3 times by using standard mercury sphygmomanometer, after 5 minutes of rest. The first and fifth Korotkoff sounds were recorded, and the mean value of 3 measurements was used for analysis. All measurements were taken by trained health investigators in examination rooms.

All participants were requested to provide 10 mL venous blood for biochemical analysis. The fasting time was further verified before the blood specimen was taken. All samples were then refrigerated and stored at −20°C until laboratory assays could be done. Fasting plasma glucose (FPG), total triglycerides (TG), total cholesterol, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were measured. They were measured by enzymology method using an automatic HITACHI 7020 Biochemical Analyzer (Hitachi, Ltd, Tokyo, Japan). Quality control of the laboratory was assessed internally and externally. The coefficient of variation was 1.6% for FPG, 2.5% for TG, 1.9% for total cholesterol, 2.8% for HDL-C, and 3.0% for LDL-C.

2.3. Identification of MetS and its components

Metabolic syndrome and its components were identified by a modified definition proposed by the ATP III [8]. Metabolic syndrome was identified when 3 or more of the following 5 components were present: (1) elevated waist circumference (≥90 cm in men, ≥80 cm in women for Asian populations), (2) elevated TG (≥1.7 mmol/L), (3) reduced HDL-C (<1.03 mmol/L in men, <1.29 mmol/L in women), (4) elevated blood pressure (≥130/85 mm Hg), and (5) elevated fasting glucose (≥5.6 mmol/L). Moreover, IDF and WHO definitions were also applied when evaluating their agreements between each other [6,7]. The IDF criteria were the same as those of the modified ATP III except that an elevated waist circumference was obligatory.

2.4. Statistical analysis

All statistical analyses were conducted using the SAS system (version 8.1; SAS Institute, Cary, NC). Data of socioeconomic characteristics, MetS components, lipid profile, and lifestyle parameters were presented for subjects with and without the syndrome. Student *t* test was used to

Table 1
Anthropometric, metabolic, and lifestyle characteristics of the study sample by MetS using modified ATP III definition

Variables	Without MetS	With MetS	Total
n	2680	1234	3914
Sex (male/female)	1337/1343	411/823*	1748/2166
Age (y)	52.6 ± 10.9	55.7 ± 10.6*	53.5 ± 10.9
Education (high level)[a]	1095 (40.9)	450 (36.5) *	1545 (39.5)
Waist circumference (cm)	76.6 ± 8.1	87.1 ± 8.9*	79.9 ± 9.7
Hip circumference (cm)	92.0 ± 6.7	98.8 ± 7.0*	94.0 ± 7.5
BMI (kg/m^2)	22.3 ± 2.9	25.8 ± 3.2*	23.5 ± 3.4
SBP (mm Hg)	121.7 ± 18.4	137.2 ± 20.7*	126.6 ± 20.5
DBP (mm Hg)	76.0 ± 10.1	82.5 ± 10.7*	78.1 ± 10.7
FPG (mmol/L)	5.23 ± 1.14	6.15 ± 2.12*	5.52 ± 1.58
Cholesterol (mmol/L)	5.25 ± 1.27	5.65 ± 1.37*	5.37 ± 1.32
TG (mmol/L)	1.45 ± 0.70	2.61 ± 1.56*	1.82 ± 1.18
HDL-C (mmol/L)	1.42 ± 0.43	1.17 ± 0.41*	1.34 ± 0.44
LDL-C (mmol/L)	3.15 ± 1.06	3.28 ± 1.12*	3.19 ± 1.08
Smoking (yes)[b]	979 (36.6)	296 (24.1) *	1275 (32.6)
Alcohol drinking (yes)[b]	834 (31.1)	279 (22.6)*	1113 (28.5)
Sedentary lifestyle (yes)[c]	313 (15.2)	224 (21.5) *	537 (17.3)
Tea drinking (yes)[d]	903 (33.7)	351 (28.4) *	1254 (32.0)

Data were mean ± SD or number (percentage); DBP indicates diastolic blood pressure; SBP, systolic blood pressure.
[a] At least middle school.
[b] Included both current and former status.
[c] Not exercising everyday or sedentary for at least 8 hours per day.
[d] At least 1 cup of tea drinking everyday.
* The values were significantly different between MetS and non-MetS group at $P < .01$ by Student t test or χ^2 test.

compare the mean difference. χ^2 test was used to compare the frequency difference. The prevalence of MetS and its components was calculated and adjusted by using the data of the fifth National Census in 2000 [12]. Body mass index was categorized according to the WHO classification [13]. Metabolic syndrome score was calculated as the sum of

Table 2
Prevalence of MetS and its components using modified ATP III definition among 3914 subjects aged 35 to 74 years

	n	MetS (95% CI)	MetS components				
			Central obesity	High TG	Low HDL-C	High BP	High FPG
Overall	3914	31.5 (30.1-33.0)	33.2	40.1	40.1	45.2	30.7
Overall adjusted[a]		30.5	32.3	38.5	42.3	40.5	27.8
Male	1748	23.5 (21.5-25.5)	17.9	36.9	29.1	49.1	28.0
Male adjusted[a]		24.0	19.5	38.3	32.9	45.0	24.9
Female	2166	38.0 (36.0-40.0)*	45.5	42.7	49.0	42.0	32.9
Female adjusted[a]		34.2*	42.9	39.4	50.0	37.3	30.3
Age group (y)[†]							
35-44	1012	24.0 (21.4-26.6)	30.3	35.7	48.4	28.2	19.5
45-54	1074	27.8 (25.1-30.4)	31.3	35.4	43.0	37.5	27.6
55-64	1097	37.7 (34.9-40.6)	36.7	44.9	36.0	56.4	38.2
65-74	731	38.2 (34.7-41.7)	34.8	45.8	30.6	63.1	39.7
Area							
Urban	762	39.8 (36.3-43.2)	34.0	36.2	68.9	40.2	33.2
Rural	3152	29.5 (28.0-31.1)	33.0	41.0	33.2	46.4	30.1
Income							
Low (<6000)	2581	29.3 (27.5-31.1)	32.4	37.1	39.6	45.1	28.2
Middle (6000-15 000)	1121	36.5 (33.7-39.3)	35.6	45.1	42.5	44.8	35.6
High (≥15 000)	212	32.6 (26.2-38.9)	30.2	49.5	34.9	48.6	34.9
BMI status[†]							
Underweight	209	5.7 (2.6-8.9)	1.4	16.3	26.8	24.9	22.5
Normal	2551	19.5 (17.9-21.0)	15.9	32.9	36.2	39.1	28.1
Overweight	1002	60.1 (57.1-63.1)	74.3	59.7	50.6	60.0	37.1
Obesity	152	80.9 (74.7-87.2)	96.7	63.8	55.3	77.0	44.1

[a] Adjusted by direct standardization to the sex and age distribution (categorized as 35-44, 45-54, 55-64, and 65-74 years) of the 2000 Chinese census population.
* $P < .01$; χ^2 test for the prevalence of MetS between male vs female group.
[†] $P < .01$; χ^2 trend test for the prevalence of MetS among different age groups or BMI status.

scores of 5 components, that is, abdominal obesity, high TG, low HDL-C, high blood pressure, and high fasting blood glucose. Every subject got a score of 1 if present or 0 if absent for each component. Correspondingly, the total score varied from 0 to 5, which was used as dependent variable in regression model. Ordinal logistic regression was performed to identify associated factors for the syndrome. Potential confounders including sex, age, area, yearly income, education level, BMI, smoking, alcohol drinking, family history of diabetes, family history of hypertension, sedentary lifestyle, and tea consumption were controlled. The multivariate-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were presented. Agreement between different MetS definitions was evaluated by the κ statistic (poor, $\kappa \leq 0.20$; fair, κ = 0.21-0.40; moderate, κ = 0.41-0.60; substantial, κ = 0.61-0.80; very good, κ >0.80) [14]. *P* less than .05 was considered significant, and probability values were 2-sided.

3. Results

3.1. Basic characteristics of study sample

Description of anthropometric, metabolic, and lifestyle characteristics of 3914 subjects in the study according to the absence or presence of MetS are shown in Table 1. The mean age of the sample was 53.5 ± 10.9 years. Two thousand six hundred eighty subjects were free of MetS, whereas 1234 subjects had the syndrome. More women than men had MetS. The proportions of smoking, alcohol drinking, and tea drinking were significantly lower in the MetS group compared with the non-MetS group ($P < .01$). Sedentary lifestyle was more common in the MetS group ($P < .01$).

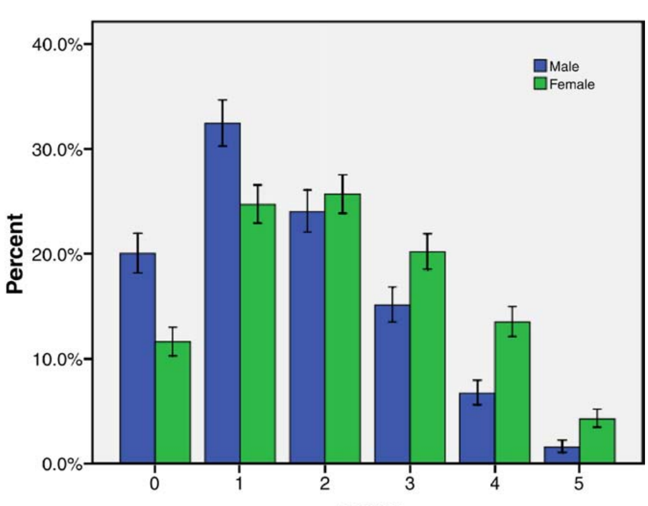

Fig. 1. Distribution of MetS component score by sex among 3914 participants in Jiangsu, China (MetS score: number of positive components of MetS).

Table 3
Multivariate ordinal regression results for association between MetS component score (modified ATP III definition) and sociodemographic and lifestyle variables among adults in Jiangsu, China

Variables	OR[a]	95% CI	*P*
Sex			
Male	1 (Reference)		
Female	1.72	1.41-2.09	<.001
Age group (y)			
35-44	1		
45-54	1.40	1.17-1.69	<.001
55-64	2.38	1.97-2.88	<.001
65-74	3.06	2.46-3.82	<.001
Area			
Rural	1		
Urban	1.51	1.26-1.81	<.001
Yearly income			
Low (<6000)	1		
Middle (6000-15000)	1.17	1.01-1.36	.036
High (≥15 000)	1.29	0.98-1.69	.067
Education			
<Middle school	1		
≥Middle school	0.85	0.72-1.00	.046
Smoking			
Never	1		
Former	1.33	0.92-1.92	.125
Current	1.13	0.93-1.38	.234
Alcohol drinking			
Never	1		
Former	0.84	0.54-1.30	.428
Current	0.97	0.81-1.17	.774
Sedentary lifestyle			
No	1		
Yes	1.03	0.86-1.24	.772
Tea consumption			
No	1		
Yes	0.85	0.72-1.00	.047
Family history of diabetes			
No	1		
Yes	1.40	1.04-1.87	.025
Family history of hypertension			
No	1		
Yes	1.44	1.22-1.70	<.001

[a] Adjusted OR for sex, age, area, yearly income, education, BMI, smoking, alcohol drinking, family history of diabetes, family history of hypertension, sedentary lifestyle, and tea consumption.

3.2. Prevalence and distribution of MetS components

Table 2 shows the prevalence of MetS components defined by modified ATP III definition. High blood pressure was the most prevalent component of MetS (45.2%), followed by elevated TG (40.1%) and low HDL-C (40.1%). In the younger age group (35-54 years), low HDL was the most prevalent component, followed by high TG, central obesity, and high BP, respectively. The prevalence of all MetS components except increased blood pressure was higher in women in the study population. Prevalence of all MetS components unanimously increased with increasing BMI status.

Fig. 1 displays the distribution of MetS component score (presence of 0, 1, 2, 3, 4, or 5 components of MetS) in male and female subgroups, respectively. In men, presence of only 1 MetS component was dominant (32.4%), followed by a score of 2 (24.0%). By contrast, in female participants, a score of 2 was dominant (25.7%), whereas a score of 1 was on the second position (24.7%).

3.3. Prevalence of MetS

As presented in Table 2, the overall prevalence of MetS defined by the modified ATP III criteria was 31.5%. The standardized prevalence was 30.5%. The MetS was more common in female than in male subjects. The adjusted prevalence of MetS was higher in women than in men (34.2% vs 24.0%). The prevalence of MetS significantly increased with age in the female group. However, the same trend did not exist in the male group (data not shown). The prevalence significantly increased with BMI status for both sexes (P for trend < .01). In addition, 301 were cases of diabetes among those participants according to the latest recommendations of the American Diabetes Association [15].

3.4. Determinants of Mets components

Multivariate ordinal regression analysis revealed that women had significantly more risk of MetS components than men (OR = 1.72; 95% CI, 1.41-2.09) (Table 3). Age, living in urban area, yearly income, family history of diabetes, and family history of hypertension were positively associated with MetS components. However, higher education and habit of tea drinking everyday were negatively associated with MetS components (P < .05).

3.5. Agreement for different definitions of MetS

Substantial agreement (κ = 0.79) was found between IDF and modified ATP III definitions (Table 4). They agreed with each other with the highest degree among 3 comparisons. All of the positive subjects, who were diagnosed by IDF definition, were also identified as positive following modified ATP III definition. Fair agreement (κ = 0.34) was found between WHO and modified ATP III definitions. The lowest agreement was found between WHO and IDF definition (κ = 0.27).

Table 4
Agreement between the WHO, IDF, and modified ATP III criteria in diagnosing MetS in Jiangsu province, China

		Modified ATP III			κ (95% CI)
		+	−	Total	
WHO	+	416	134	550	0.34 (0.31-0.37)
	−	818	2546	3364	
	Total	1234	2680	3914	
IDF	+	902	0	902	0.79 (0.77-0.81)
	−	332	2680	3012	
	Total	1234	2680	3914	
		WHO			
		+	−	Total	
IDF	+	289	613	902	0.27 (0.24-0.31)
	−	261	2751	3012	
	Total	550	3364	3914	

4. Discussion

In the study, we found a high prevalence of MetS in a province with rapid economic development. A positive association between urban residence, high income, and MetS was found. Education level and tea drinking were inversely associated with MetS.

Our data showed that 30.5% of adult population aged 35 to 74 years residing in both urban and rural areas in Jiangsu province had MetS following the modified ATP III criteria. There was a noteworthy increase of MetS since 1992 when the prevalence was 13.3% among subjects aged 35 to 64 years using their own criteria referred to ATP III definitions [9]. Despite possible flaw in comparison, the robust change in the prevalence from 1992 was convincingly forceful. Metabolic syndrome was more common in female than in male subjects in the current study, which was consistent with other studies both in China and other countries [16-18].

Urban residence and high income were positively associated with MetS risk in our study, which was in accordance with other studies [11,19,20]. Generally, these 2 situations mean higher socioeconomic level, which is in line with the risk of many chronic diseases in developing countries. Dwelling in urban areas may indicate higher dietary fat intake and lower physical activity than living in rural areas [10]. Education level was negatively associated with the risk, which was also supported by results from other studies [19].

In our study, sedentary lifestyle did not have a significant effect on MetS by ordinal logistic regression using MetS score as dependent variable in the model, which was discrepant with some previous studies [21,22]. However, the trend to be identified as positively associated with MetS risk existed here. It became significant if we use MetS as dependent variable in the model (adjusted OR, 1.47; P < .05).

One interesting finding was that the prevalence of MetS increased with age in women, but not in men. This was possibly due to the prevalence of MetS components like central obesity (waist circumference) and low HDL-C decreasing with age in male subjects. Similar report on no association between MetS and age in men cannot be found so far. However, 1 study from China reported that age was negatively associated with obesity in middle-aged and elderly people [23]. Such an association between MetS and age in men may be due to the effect of androgen levels on adipose distribution and metabolism. In addition, Westernized lifestyle may have less effect on old men compared with youngsters. Old men are likely to prefer traditional

Chinese food and exercise more frequently, whereas young men may possibly consume more Westernized food and spend most time staying in office or at home.

Another interesting finding in our study was that habitual tea drinking was found as a protective factor for MetS risk after adjusting for potential confounders. To our knowledge, no study has reported this association. Accumulating evidence indicates that consumption of tea, especially green tea, has potential protective effect on the prevention of many diseases especially cancer [24]. Consumption of green tea was also inversely associated with risk for diabetes, which was reported in Japan [25]. In animal experiment, whole teas significantly reduced abdominal white adipose tissue both in female and male mice [26]. However, its protective effect still needs to be further investigated.

Poor agreement among the definitions for MetS has raised concern of the reliability of the results. The prevalence of MetS differed from each other when different criteria were used in the same population. The highest κ agreement was observed between IDF and modified ATP III definition in our population. This is in agreement with a number of studies [27-30]. Actually, it would be expected that there was close agreement between IDF and modified ATP III because there is only 1 difference between them, that is, the obligatory nature of waist measurement for IDF. Both of them put more focus on central obesity, whereas the WHO definition is based primarily on a prerequisite for insulin resistance. Despite of a number of suggestions from different populations [31-33] to overcome the enigma, there is no consistent opinion on the validity or applicability of various definitions. In few prospective studies, risk predictive ability by different definitions were also compared in the United States [34].

Along with the rapid development of economics in Jiangsu province, nutrition was gradually shifting from traditional Chinese diet toward a diet with high fat, high energy density, and low dietary fiber [35]. Meanwhile, sedentary lifestyle was becoming prevalent [36]. Unfortunately, such a trend is still going on. To combat the MetS epidemic, interventions on diet and lifestyle modification in community play an important role in the prevention and control of the syndrome. Intervention studies have demonstrated that diet and lifestyle modification is an effective and efficient approach to cope with MetS [37-39].

In conclusion, our study indicated that MetS was highly prevalent in middle-aged and elderly Chinese population in Jiangsu province. However, caution should be taken to generalize the results because of the limitation of the sample collected from Jiangsu and to establish causality as a consequence of the design of the study. Aging process, living in urban area, household income, family history of diabetes, and hypertension increased the MetS risk, whereas higher education and habitual tea drinking could have protective effect on MetS. Diet and lifestyle modifications are strongly suggested in the community, especially in women and the elderly.

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References

[1] Lao XQ, Thomas GN, Jiang CQ, et al. Association of the metabolic syndrome with vascular disease in an older Chinese population: Guangzhou Biobank Cohort Study. J Endocrinol Invest 2006;29:989-96.

[2] Stern MP, Williams K, Gonzalez-Villalpando C, et al. Does the metabolic syndrome improve identification of individuals at risk of type 2 diabetes and/or cardiovascular disease? Diabetes Care 2004;27:2676-81.

[3] Cugati S, Wang JJ, Rochtchina E, et al. Ten-year incidence of diabetes in older Australians: the Blue Mountains Eye Study. Med J Aust 2007; 186:131-5.

[4] Gale EA. The myth of the metabolic syndrome. Diabetologia 2005;48: 1679-83.

[5] Alberti KG, Zimmet PZ. Should we dump the metabolic syndrome? No. BMJ 2008;336:641.

[6] World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications. Report of a WHO consultation. Geneva: World Health Organization; 1999.

[7] Alberti KG, Zimmet P, Shaw J. The metabolic syndrome—a new worldwide definition. Lancet 2005;366:1059-62.

[8] Grundy SM, Cleeman JI, Daniels SR, et al. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. Circulationfs 2005;112:2735-52.

[9] Cooperation group. Further study of risk factors for stroke and coronary heart disease. The prevalence of metabolic syndrome in 11 provinces cohort in China. Chin J Prev Med 2002;36:298-300.

[10] Weng X, Liu Y, Ma J, et al. An urban-rural comparison of the prevalence of the metabolic syndrome in Eastern China. Public Health Nutr 2007;10:131-6.

[11] Li Y, Yang X, Zhai F, et al. Prevalence of the metabolic syndrome in Chinese adolescents. Br J Nutr 2008; 99:565-70.

[12] National Bureau of Statistics of China. National population structure by age and sex. 2000 cited; Available from: http://www.stats.gov.cn/tjsj/ndsj/renkoupucha/2000pucha/html/t0301.htm.

[13] World Health Organization. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser 1995;854:1-452.

[14] Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159-74.

[15] American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2008;31(Suppl 1):S55-S60.

[16] Feng Y, Hong X, Li Z, et al. Prevalence of metabolic syndrome and its relation to body composition in a Chinese rural population. Obesity (Silver Spring) 2006;14:2089-98.

[17] Feng Y, Liu C, Tang W, et al. Epidemiological survey on metabolic syndrome in Jiangsu adults. Natl Med J China 2006;86(Suppl):68-9.

[18] Fakhrzadeh H, Ebrahimpour P, Pourebrahim R, et al. Metabolic syndrome and its associated risk factors in healthy adults: a population-based study in Iran. Metab Syndr Relat Disord 2006;4:28-34.

[19] Erem C, Hacihasanoglu A, Deger O, et al. Prevalence of metabolic syndrome and associated risk factors among Turkish adults: Trabzon MetS study. Endocrine 2008;33:9-20.

[20] Prabhakaran D, Chaturvedi V, Shah P, et al. Differences in the prevalence of metabolic syndrome in urban and rural India: a problem of urbanization. Chronic Illn 2007;3:8-19.

[21] Fogelholm M. How physical activity can work? Int J Pediatr Obes 2008;3(Suppl 1):10-4.
[22] Kruk J. Physical activity in the prevention of the most frequent chronic diseases: an analysis of the recent evidence. Asian Pac J Cancer Prev 2007;8:325-38.
[23] Hao W, Xu S, Hu T. The relationship between age and metabolic syndrome as well as MS prevention and care. Journal Of Health Care And Medicine in Chinese Pla 2007;9:21-3.
[24] Chen L, Zhang HY. Cancer preventive mechanisms of the green tea polyphenol (−)-epigallocatechin-3-gallate. Molecules 2007; 12: 946-57.
[25] Iso H, Date C, Wakai K, Fukui M, et al. The relationship between green tea and total caffeine intake and risk for self-reported type 2 diabetes among Japanese adults. Ann Intern Med 2006;144: 554-62.
[26] Zhou JR, Li L, Pan W. Dietary soy and tea combinations for prevention of breast and prostate cancers by targeting metabolic syndrome elements in mice. Am J Clin Nutr 2007;86:s882-8.
[27] Zabetian A, Hadaegh F, Azizi F. Prevalence of metabolic syndrome in Iranian adult population, concordance between the IDF with the ATP III and the WHO definitions. Diabetes Res Clin Pract 2007;77: 251-7.
[28] Lee CM, Huxley RR, Woodward M, et al. Comparisons of metabolic syndrome definitions in four populations of the Asia-Pacific region. Metab Syndr Relat Disord 2008;6:37-46.
[29] Yang W, Reynolds K, Gu D, et al. A comparison of two proposed definitions for metabolic syndrome in the Chinese adult population. Am J Med Sci 2007;334:184-9.
[30] Guerrero-Romero F, Rodriguez-Moran M. Concordance between the 2005 International Diabetes Federation definition for diagnosing metabolic syndrome with the National Cholesterol Education Program Adult Treatment Panel III and the World Health Organization definitions. Diabetes Care 2005;28:2588-9.
[31] Maggi S, Noale M, Zambon A, et al. Validity of the ATP III diagnostic criteria for the metabolic syndrome in an elderly Italian Caucasian population The Italian Longitudinal Study on Aging. Atherosclerosis 2008;197:877-82.
[32] Moon JY, Park S, Rhee JH, et al. The applicability of the Asian modified criteria of the metabolic syndrome in the Korean population. Int J Cardiol 2007;114:83-9.
[33] Takeuchi H, Saitoh S, Takagi S, et al. Metabolic syndrome and cardiac disease in Japanese men: applicability of the concept of metabolic syndrome defined by the National Cholesterol Education Program-Adult Treatment Panel III to Japanese men—the Tanno and Sobetsu Study. Hypertens Res 2005;28:203-8.
[34] Lorenzo C, Williams K, Hunt KJ, et al. The National Cholesterol Education Program–Adult Treatment Panel III, International Diabetes Federation, and World Health Organization definitions of the metabolic syndrome as predictors of incident cardiovascular disease and diabetes. Diabetes Care 2007;30:8-13.
[35] Du S, Lu B, Zhai F, et al. A new stage of the nutrition transition in China. Public Health Nutr 2002;5:169-74.
[36] Ma G, Kong L. Nationwide nutrition and health survey report in China, 2002—behavior and lifestyle. Beijing: People's Medical Publishing House; 2006.
[37] Ilanne-Parikka P, Eriksson JG, Lindstrom J, et al. Effect of lifestyle intervention on the occurrence of metabolic syndrome and its components in the Finnish Diabetes Prevention Study. Diabetes Care 2008;31:805-7.
[38] Orchard TJ, Temprosa M, Goldberg R, et al. The effect of metformin and intensive lifestyle intervention on the metabolic syndrome: the Diabetes Prevention Program randomized trial. Ann Intern Med 2005; 142:611-9.
[39] Fappa E, Yannakoulia M, Pitsavos C, et al. Lifestyle intervention in the management of metabolic syndrome: could we improve adherence issues? Nutrition 2008; 24:286-91.