Prevalence of the Metabolic Syndrome Among Employees in Northeast China

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Abstract

Background: The metabolic syndrome is a clustering of metabolic abnormalities and has been associated with increased risk of type 2 diabetes mellitus and cardiovascular disease. This study aimed to estimate the prevalence of the metabolic syndrome among employees in Northeast China.

Methods: Totally, 33,149 employees who received health screening in the International Health Promotion Center in the First Hospital of Jilin University were enrolled. Height, weight, waist circumference, blood pressure, fasting plasma glucose, triglyceride, high-density lipoprotein, and low-density lipoprotein were recorded. Three definitions for the metabolic syndrome were applied, revised National Cholesterol Education Program's Adult Treatment Panel III (NCEP ATP III) criteria, the International Diabetes Federation (IDF) criteria, and the Chinese Diabetes Society (CDS) criteria.

Results: Overall, the age-standardized prevalence of the metabolic syndrome was 22.9%, 20.6%, and 15.3% based on definitions of revised NCEP ATP III criteria, the IDF criteria, and the CDS criteria, respectively. Men had higher age-standardized prevalence than women in all three definitions ($P < 0.05$). The prevalence was 27.1%, 24.5%, and 20.4% for men; 17.1%, 15.4%, and 8.3% for women, respectively. The most common metabolic component with the metabolic syndrome was overweight (54.7% of men had an elevated body mass index, and 35.9% of women had central obesity).

Conclusions: A large proportion of employees among Northeast China have the metabolic syndrome. These findings place emphasis on the need to develop aggressive lifestyle modification for patients with the metabolic syndrome and population level strategies for the prevention, detection, and treatment of cardiovascular risk.

Key words: China; Metabolic Syndrome; Prevalence

INTRODUCTION

The metabolic syndrome is characterized by a clustering of metabolic risk factors including abdominal obesity, dyslipidemia, high blood pressure (BP), and increased fasting plasma glucose (FPG). The syndrome is associated with increased risk of type 2 diabetes mellitus, cardiovascular disease (CVD), and all-cause mortality.[1-3] Since 1998, the World Health Organization proposed a set of criteria as a first attempt to define the syndrome.[4] Several expert groups have formulated different definitions including the National Cholesterol Education Program's Adult Treatment Panel III (NCEP ATP III) (2002),[5] the International Diabetes Federation (IDF) criteria in 2005,[6] and the joint interim statement in 2009.[7] The NCEP ATP III in 2002 is widely used in clinical practice, but its applicability to different ethnic groups has been a problem, especially in its relation to obesity cut-offs.[8] The IDF criteria require central obesity as one obligatory component and ethnic-specific waist circumference (WC) cut-offs are incorporated into the definition in 2005. Later on, the American Heart Association/National Heart, Lung, and Blood Institute updated the ATP III the metabolic syndrome criteria using ethnic-specific WC cut-offs as well, known as the revised NCEP ATP III criteria.[9] In 2004, the Chinese Diabetes Society (CDS) proposed a definition for Chinese adults,[10] which used body mass index (BMI) rather than WC as one index to define obesity and the cut-offs for other components were different, except for the cut-off of triglycerides (TGs).

As a result of rapid economic growth and associated socioeconomic changes, lifestyle and diet transitions

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have led to an increased burden of CVD and other chronic diseases in China.[11] Also, clustering of cardio-metabolic risk factors (and thus, the metabolic syndrome) is becoming more common. The prevalence of the metabolic syndrome was reported to vary from 7.3% to 31.5% in previous studies conducted in different parts of China,[12-15] which might partially be due to the use of different definitions and true regional differences. These epidemiological studies about the metabolic syndrome in China were mostly sampled from the general population with little emphasis on the employees. Since employees represent the main workforce in the society and their health awareness, healthy behaviors, and cardiovascular profiles reflect the overall productivity and the disease burden, it is important to identify employees with the metabolic syndrome. Because of a documented high relative risk of CVD events and type 2 diabetes, the metabolic syndrome undoubtedly carries a relatively high lifetime risk for these disorders.[9] Thus, even though shorter-term (10-year) risk is low in relatively younger population, like employees, these individuals with the syndrome need aggressive lifestyle modifications to prevent type 2 diabetes mellitus and CVD. So far, little is known about the prevalence of the metabolic syndrome among employees in Northeast China while this region has a relatively high incidence of CVD within China.[16,17] The aim of our study was to investigate the prevalence of the metabolic syndrome among employees in Northeast China. In addition, to facilitate comparison with other prevalence estimates, three prevailing definitions, revised NCEP ATP III, IDF, and CDS criteria, were applied.

METHODS

Study population

The International Health Promotion Center in the International Health Promotion Center in the First Hospital of Jilin University provides health examinations for residents in Changchun, the capital and largest city of Jilin Province, located in the northeast of China. Participants for the health examinations were mainly current and retired employees from government institutions, universities or companies in Jilin Province. In general, almost all employees will participate since the health screening is considered as the welfare offered by their employers. Therefore, a retrospective database of the health screening program information for employees was available. Data of 37,141 individuals aged 18 years or older who received a health screening program at their first visit to the International Health Promotion Center in First Hospital of Jilin University from 2003 to 2010 were derived from the database; 3992 persons were excluded since they did not provide WC data. In total, 33,149 participants were included in the final data analysis. Written informed consent was obtained from every participant. Participants with newly detected conditions during the examination were referred to the relevant outpatient clinic. The Ethics Committee of the First Hospital of Jilin University approved the protocol for this study.

Blood pressure and anthropometric measurements

Blood pressure was measured twice when participants were in the seated position after 5 min of rest using a computerized sphygmomanometer, Omron BP-203RV IIIC. The mean of these two readings was used in the analysis. Participants were advised to avoid cigarette smoking, alcohol, caffeine beverages, and exercise for at least 30 min before measurement.

Body weight and height were measured by an auto-anthropometer, Biospace BSM 330. Height was recorded to the nearest 0.1 cm. Weight was measured in light indoor clothing without shoes and recorded to the nearest 0.1 kg. WC was measured in a standing position using a measuring tape at the level of the participant's navel to the nearest 0.5 cm.

Laboratory measurements

Overnight fasting blood samples were collected by venipuncture. Participants who did not meet the overnight fasting criterion were asked to visit the center later when their fasting time was more than 12 h. Concentrations of TG, high-density lipoprotein (HDL) were measured enzymatically on the Hitachi 7600-210 auto analyzer (Hitachi, Tokyo, Japan). FPG level was measured on the same auto analyzer. The central laboratory of the First Hospital of Jilin University analyzed all specimens.

Definitions of the metabolic syndrome

We used three definitions to define the metabolic syndrome. They are the revised NCEP ATP III criteria for Asians,[9] IDF criteria for Asians[6] and CDS criteria.[10] Detailed information on the three definitions is listed in Table 1.

Statistical analysis

For continuous variables, results were calculated as mean ± standard deviation (SD). For categorical variables, proportions were calculated. Differences in continuous variables were estimated using t-test and prevalence values for categorical variables were compared using Pearson's Chi-square test. The prevalence of the metabolic syndrome was standardized to the age distribution of the Chinese population from the 2000 census. A two-tailed $P < 0.05$ was considered statistically significant. All data were analyzed with SPSS 20.0 for Windows (SPSS Inc., Chicago, IL, USA).

RESULTS

From 2003 to 2010, 33,149 employees undergoing the health screening program were enrolled, comprising 19,337 men and 13,812 women. The average age of all participants was 43.8 ± 12.8 years; 43.4 ± 12.6 years for men and 43.5 ± 13.2 years for women. Statistically significant differences between men and women were found for mean WC, BMI, FPG, TG, HDL, systolic BP, and diastolic BP [Table 2].

The most common metabolic component within the metabolic syndrome was overweight/obesity: for men based on elevated BMI (prevalence 54.7%) and for women based on elevated WC (and thus, central obesity) with a prevalence of 35.9% [Table 3].

Table 1: Definitions of the metabolic syndrome

Risk factors	Revised NCEP ATP III 2005	IDF 2006	CDS 2004
	Any three or more of	Mandatory elevated WC	Any three or more of
Elevated WC or BMI	≥90 cm (men) or ≥80 cm (women)	≥90 cm (men) or ≥80 cm (women)	BMI ≥25 kg/m²
		Plus two or more of	
Elevated FPG	≥5.6 mmol/L or drug treatment for elevated blood glucose	≥5.6 mmol/L or diagnosed diabetes	≥6.1 mmol/L or drug treatment for elevated blood glucose
Elevated TGs	≥1.7 mmol/L or drug treatment for elevated TGs	≥1.7 mmol/L or drug treatment for elevated TGs	≥1.7 mmol/L
Reduced HDL	<1 mmol/L (men) or <1.3 mmol/L (women) or drug treatment for reduced HDL	<1 mmol/L (men) or <1.3 mmol/L (women) or drug treatment for reduced HDL	<0.9 mmol/L (men) or <1.0 mmol/L (women)
Elevated BP	≥130/85 mmHg or drug treatment for hypertension	≥130/85 mmHg or drug treatment for hypertension	≥140/90 mmHg or drug treatment for hypertension

NCEP ATP III: National cholesterol education program-third adult treatment panel; IDF: International diabetes federation; CDS: Chinese diabetes society; WC: Waist circumference; BMI: Body mass index; FPG: Fasting plasma glucose; HDL: High-density lipoprotein; BP: Blood pressure; TG: Triglyceride.

Table 2: Characteristics of the study population

Variables	Men (n = 19,337)	Women (n = 13,812)	t (df = 33,147)	P
Age, years	43.4 ± 12.6	43.5 ± 13.2	3.63	<0.001
WC, cm	89.2 ± 9.0	77.0 ± 8.7	123.17	<0.001
BMI, kg/m²	25.4 ± 3.4	23.0 ± 3.3	63.49	<0.001
FPG, mmol/L	5.5 ± 1.3	5.2 ± 1.1	23.02	<0.001
TG, mmol/L	2.0 ± 1.7	1.3 ± 0.9	44.83	<0.001
HDL, mmol/L	1.4 ± 0.4	1.6 ± 0.4	−51.18	<0.001
SBP, mmHg	124.1 ± 17.4	116.7 ± 19.1	37.04	<0.001
DBP, mmHg	83.1 ± 11.2	76.5 ± 10.7	53.26	<0.001

Data are expressed as mean ± SD. P value is for the comparison between men and women. WC: Waist circumference; BMI: Body mass index; FPG: Fasting plasma glucose; TG: Triglyceride; HDL: High-density lipoprotein; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; df: Degrees of freedom; SD: Standard deviation.

Table 4 shows the prevalence of the metabolic syndrome among employees in Northeast China by sex and age. Overall, the age-standardized prevalence of the metabolic syndrome was 22.9%, 20.6%, and 15.3% based on definitions of revised NCEP ATP III, IDF, and CDS criteria, respectively. The prevalence of the metabolic syndrome increased with age among men and women until age 60 years. In participants ≥60 years old, the prevalence of the metabolic syndrome increased more dramatically in women than in men, regardless of definitions used. In total, men had a higher age-standardized prevalence of the metabolic syndrome than women in all three definitions (P < 0.05).

DISCUSSION

The present study provides information on the prevalence of the metabolic syndrome based on a large sample from employees in Northeast China, a region in China with a relatively high incidence of CVD. Our findings suggest a large proportion of employees among Northeast China have the metabolic syndrome regardless of definitions used.

Direct comparisons of the prevalence of the metabolic syndrome between studies are generally impossible in light of different age and sex distributions in the population samples. The prevalence estimates of the metabolic syndrome we observed among employees in Northeast China are somewhat lower than those reported for the southern Chinese population, which were 28.5%, 21.9%, and 17.8% based on definitions of revised NCEP ATP III, IDF, and CDS criteria.[15] Our estimates are a little bit higher than those reported in the national survey in 2009, which were 21.3% (revised NCEP ATP III), 18.2% (IDF), and 10.5% (CDS).[14] Using the revised NCEP ATP III criteria, the prevalence of the metabolic syndrome was 41.4% in urban Asian Indian adults[18] and was around 15% in South Koreans.[19] In Singapore, the prevalence was 20.9% and 15.5% in men and women using NCEP ATP III criteria.[20] Apart from different age and sex distributions, variability in the prevalence between studies can also be explained by the different definitions of the metabolic syndrome.

Another important finding is that men had higher prevalence of the metabolic syndrome than women, which is in line with other studies conducted in China,[12,14] in some Asian countries,[20,21] and the United States.[22,23] In Chinese men, the prevalence of the metabolic syndrome reached a peak during their middle ages and beyond, while the prevalence in Chinese women increased more dramatically over 60 years old. Menopause might be a contributing factor for this increase. Also, the observed sex difference in the prevalence of the metabolic syndrome after 60 years old might be related to the higher prevalence of obesity in older women compared with older men in China.[24]

In our study, the most common metabolic component with the metabolic syndrome was overweight for men based on elevated BMI and central obesity for women based on elevated WC. The components of the metabolic syndrome differ between genders among studies. Results from the inter-Asia study based on a nationally representative sample of the Chinese population showed that hypertension and decreased HDL were the most frequent component for men and women, respectively.[25] Data from the China Health and Nutrition Survey indicated that the most frequent individual

Table 3: Prevalence of the individual components of the metabolic syndrome based on definitions of revised NCEP ATP III, IDF, and CDS criteria among employees in Northeast China

Items	95% CI, %		χ^2 (df = 1)	P
	Men	**Women**		
Elevated WC, ≥90 cm (men) and ≥80 cm (women)	50.7 (50.0–51.5)	35.9 (35.1–36.7)	720.24	<0.001
Elevated BMI, BMI ≥5 kg/m²	54.7 (54.0–55.4)	24.6 (23.8–25.3)	3002.36	<0.001
Elevated FPG				
≥5.6 mmol/L	30.5 (30.0–31.2)	17.8 (17.2–18.4)	693.71	<0.001
≥6.1 mmol/L	15.2 (14.7–15.7)	8.0 (7.6–8.5)	380.82	<0.001
Elevated TG				
≥1.7 mmol/L	45.2 (44.5–45.9)	20.2 (19.5–20.9)	2223.49	<0.001
Reduced HDL				
<1.0 mmol/L (men) or <1.3 mmol/L (women)	6.9 (6.5–7.2)	19.7 (19.0–20.3)	1231.47	<0.001
<0.9 mmol/L (men) or <1.0 mmol/L (women)	4.4 (4.1–4.7)	3.7 (3.4–4.1)	9.42	<0.001
Elevated BP				
≥130/85 mmHg	45.2 (44.5–45.9)	27.3 (26.6–28.1)	1095.95	<0.001
≥140/90 mmHg	37.2 (36.6–37.9)	21.2 (20.5–21.8)	980.50	<0.001

P value is for the comparison between men and women. NCEP ATP III: National cholesterol education program-third adult treatment panel; IDF: International diabetes federation; CDS: Chinese diabetes society; WC: Waist circumference; BMI: Body mass index; FPG: Fasting plasma glucose; TG: Triglyceride; HDL: High-density lipoprotein; BP: Blood pressure; df: Degrees of freedom; *CI*: Confidence interval.

Table 4: Prevalence of the metabolic syndrome based on definitions of revised NCEP ATP III, IDF, and CDS criteria among employees in Northeast China

Age groups, years	*n*	The metabolic syndrome prevalence (95% *CI*), %		
		Revised ATP III	**IDF**	**CDS**
All				
18–29	4853	7.4 (6.6–8.1)	6.8 (6.1–7.5)	4.7 (4.1–5.3)
30–44	13,351	20.1 (19.4–20.8)	18.2 (17.5–18.8)	14.2 (13.6–14.8)
45–59	11,097	34.7 (33.8–35.6)	30.9 (30.0–31.7)	23.5 (22.7–24.3)
≥60	3848	42.3 (40.8–43.9)	38.4 (36.9–39.9)	26.7 (25.3–28.1)
Total (crude)	33,149	25.7 (25.2–26.2)	23.1 (22.7–23.6)	17.4 (17.0–17.8)
Total (age and sex-standardized)	33,149	22.9 (22.0–23.8)	20.6 (19.8–21.5)	15.3 (14.6–16.1)
Men				
18–29	2504	12.0 (10.8–13.3)	11.4 (10.2–12.7)	8.5 (7.4–9.6)
30–44	8013	28.3 (27.4–29.3)	25.9 (24.9–26.9)	21.7 (20.8–22.6)
45–59	6672	39.9 (38.7–41.0)	35.4 (34.2–36.5)	30.7 (29.6–31.8)
≥60	2148	34.6 (32.6–36.6)	30.2 (28.3–32.2)	25.0 (23.2–26.9)
Subtotal (crude)	19,337	30.9 (30.3–31.6)	27.8 (27.1–28.4)	23.5 (22.9–24.1)
Subtotal (age-standardized)	19,337	27.1 (25.9–28.4)	24.5 (23.3–25.7)	20.4 (19.3–21.5)
Women				
18–29	2349	2.4 (1.8–3.1)	1.9 (1.3–2.4)	0.6 (0.3–0.9)
30–44	5338	7.7 (7.0–8.4)	6.6 (6.0–7.3)	3.0 (2.5–3.4)
45–59	4425	27.0 (25.7–28.3)	24.1 (22.8–25.4)	12.7 (11.7–13.7)
≥60	1700	52.1 (49.7–54.4)	48.7 (46.3–51.1)	28.7 (26.6–30.9)
Subtotal (crude)	13,812	18.4 (17.8–19.1)	16.6 (16.0–17.2)	8.9 (8.4–9.3)
Subtotal (age-standardized)	13,812	17.1 (16.0–18.1)	15.4 (14.4–16.4)	8.3 (7.5–9.1)

NCEP ATP III: National cholesterol education program-third adult treatment panel; IDF: International diabetes federation; CDS: Chinese diabetes society; ATP III: Adult treatment panel III; *CI*: Confidence interval.

component with the metabolic syndrome was hypertension for men and central obesity for women.[14] Elevated body weight and decreased HDL level were more prevalent in women than in men, while BP and apolipoprotein were more prevalent in men.[26] These gender differences of components of the metabolic syndrome might due to different cut-off points set as criteria of the metabolic syndrome like WC and HDL between men and women. Also, abdominal

obesity, insulin resistance, and physical inactivity might be underlying risk factors between genders.[27] More studies into the sex difference of developing the components of the metabolic syndrome are required to fully understand these findings.

A main strength of our study is the fact that its results are based on findings in a large sample of Chinese employees, and to

the best of our knowledge, that is the first study that provides scientific evidence about the prevalence of the metabolic syndrome among employees in Northeast China, a region with a high incidence of CVD. A limitation of the study is that the definitions of the metabolic syndrome did not include patients with known hypertension and diabetes due to lack of information in our database. Hence, the prevalence estimates in our study might underestimate the true prevalence of the metabolic syndrome among employees in Northeast China.

In conclusion, our results indicate that a large proportion of employees among Northeast China have the metabolic syndrome. Since employees represent the main workforce in any community and contribute largely to the disease burden, these findings place emphasis on the need to develop aggressive lifestyle modification for patients with the metabolic syndrome and population level strategies for the prevention, detection, and treatment of cardiovascular risk, focusing on weight reduction and increased physical activity.

REFERENCES

1. Ford ES, Li C, Sattar N. Metabolic syndrome and incident diabetes: Current state of the evidence. Diabetes Care 2008;31:1898-904.
2. Galassi A, Reynolds K, He J. Metabolic syndrome and risk of cardiovascular disease: A meta-analysis. Am J Med 2006;119:812-9.
3. Gami AS, Witt BJ, Howard DE, Erwin PJ, Gami LA, Somers VK, et al. Metabolic syndrome and risk of incident cardiovascular events and death: A systematic review and meta-analysis of longitudinal studies. J Am Coll Cardiol 2007;49:403-14.
4. Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabet Med 1998;15:539-53.
5. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). JAMA 2001;285:2486-97.
6. Alberti KG, Zimmet P, Shaw J. Metabolic syndrome – A new world-wide definition. A Consensus Statement from the International Diabetes Federation. Diabet Med 2006;23:469-80.
7. Alberti KG, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, et al. Harmonizing the metabolic syndrome: A joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 2009;120:1640-5.
8. Alberti KG, Zimmet P, Shaw J, IDF Epidemiology Task Force Consensus Group. The metabolic syndrome – A new worldwide definition. Lancet 2005;366:1059-62.
9. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, et al. Diagnosis and management of the metabolic syndrome: An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation 2005;112:2735-52.
10. Metabolic Syndrome Study Cooperation Group of Chinese Diabetes Society. Suggestions about metabolic syndrome of Chinese Diabetes Society (in Chinese). Chin J Diabetes 2004;12:156-61.
11. Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases: Part I: General considerations, the epidemiologic transition, risk factors, and impact of urbanization. Circulation 2001;104:2746-53.
12. Gu D, Reynolds K, Wu X, Chen J, Duan X, Reynolds RF, et al. Prevalence of the metabolic syndrome and overweight among adults in China. Lancet 2005;365:1398-405.
13. Lao XQ, Zhang YH, Wong MC, Xu YJ, Xu HF, Nie SP, et al. The prevalence of metabolic syndrome and cardiovascular risk factors in adults in southern China. BMC Public Health 2012;12:64.
14. Xi B, He D, Hu Y, Zhou D. Prevalence of metabolic syndrome and its influencing factors among the Chinese adults: The China Health and Nutrition Survey in 2009. Prev Med 2013;57:867-71.
15. Li J, Shi YM, Yan JH, Xu W, Weng JP. The prevalence and risk factors of metabolic syndrome among adult residents in Guangdong and Jiangsu Provinces in China (in Chinese). Chin J Intern Med 2013;52:659-63.
16. Xu G, Ma M, Liu X, Hankey GJ. Is there a stroke belt in China and why? Stroke 2013;44:1775-83.
17. Chen CM, Kong LZ. The prevention and control guide of Chinese adults overweight and ovesity. Beijing: People's Medical Publishing House; 2006.
18. Ramachandran A, Snehalatha C, Satyavani K, Sivasankari S, Vijay V. Metabolic syndrome in urban Asian Indian adults – A population study using modified ATP III criteria. Diabetes Res Clin Pract 2003;60:199-204.
19. Park HS, Oh SW, Cho SI, Choi WH, Kim YS. The metabolic syndrome and associated lifestyle factors among South Korean adults. Int J Epidemiol 2004;33:328-36.
20. Tan CE, Ma S, Wai D, Chew SK, Tai ES. Can we apply the National Cholesterol Education Program Adult Treatment Panel definition of the metabolic syndrome to Asians? Diabetes Care 2004;27:1182-6.
21. Chow CK, Naidu S, Raju K, Raju R, Joshi R, Sullivan D, et al. Significant lipid, adiposity and metabolic abnormalities amongst 4535 Indians from a developing region of rural Andhra Pradesh. Atherosclerosis 2008;196:943-52.
22. Ford ES. Prevalence of the metabolic syndrome defined by the International Diabetes Federation among adults in the U.S. Diabetes Care 2005;28:2745-9.
23. Meigs JB, Wilson PW, Nathan DM, D'Agostino RB Sr, Williams K, Haffner SM. Prevalence and characteristics of the metabolic syndrome in the San Antonio Heart and Framingham Offspring Studies. Diabetes 2003;52:2160-7.
24. Wu YF, Ma GS, Hu YH, Li YP, Li X, Cui ZH, et al. The current prevalence status of body overweight and obesity in China: Data from the China National Nutrition and Health Survey (in Chinese). Chin J Prev Med 2005;39:316-20.
25. Gu D, Gupta A, Muntner P, Hu S, Duan X, Chen J, et al. Prevalence of cardiovascular disease risk factor clustering among the adult population of China: Results from the International Collaborative Study of Cardiovascular Disease in Asia (InterAsia). Circulation 2005;112:658-65.
26. Dallongeville J, Cottel D, Arveiler D, Tauber JP, Bingham A, Wagner A, et al. The association of metabolic disorders with the metabolic syndrome is different in men and women. Ann Nutr Metab 2004;48:43-50.
27. Regitz-Zagrosek V, Lehmkuhl E, Weickert MO. Gender differences in the metabolic syndrome and their role for cardiovascular disease. Clin Res Cardiol 2006;95:136-47.