The Best Criteria to Diagnose Metabolic Syndrome in Hypertensive Thai Patients

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The metabolic syndrome (MS) is commonly found in clinical practice. There are many criteria to diagnose MS. The authors did a cross-sectional study to study the difference among the WHO criteria, the National Cholesterol Educational Program (NCEP) Adult Treatment Panel (ATP III), and the International Diabetes Foundation (IDF) in hypertensive patients. Between July and September 2005, 100 patients (62 women) treated at the hypertension clinic, Srinagarind Hospital were included. The WHO, NCEP ATP III and IDF criteria gave the diagnosis of MS in 37, 33, 60 cases, respectively. The IDF criteria had the significantly highest yield among those three criteria ($p < 0.0001$). Body mass index (BMI) was the only significant correlated with the diagnosis of MS by the IDF criteria (p-value = 0.04). It also had moderately positive correlated with waist circumference, WC ($p < 0.0001$, Pearson Correlation 0.58). At the cut point of BMI 23 kg/m^2, we suggested the appropriate WC cut-point for Thai hypertensive men and women was 82.5 cm (32.5") and 79.5 cm (31.3"), respectively.

Keywords: *Metabolic syndrome, WHO, IDF, NCEP ATP III, Body mass index, Waist circumference, Hypertension*

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The metabolic syndrome (MS) is a cluster of metabolic risk factors including central obesity, hypertension, impaired glucose tolerance, diabetes mellitus and dyslipidemia[1,3,8-10]. It has a high prevalence around the world. Around 47 million adults in the United States met the criteria for diagnosis of MS[1,2]. The previous studies found that the prevalence of MS increased with age and it affected at least one out of every five overweight people[3]. One study in the United States reported that the prevalence of MS dramatically increased from 6.7% to 43.5% in people between of the age 20-29 years old and 60-69 years old. Furthermore, its prevalence was up to 42% in people over 70 years old[4]. In Asian countries, the prevalence of MS varied depending on ethnic groups and the criteria for diagnosis. For instance, the prevalence of MS in the Philippines[5], Japanese males[6] and Chinese[7] was 28.0%, 25.3% and 13.2%, respectively. The report from Thailand also showed the prevalence of MS was 35.1% and 17.5% in men and women aged 50 and over[8]. The dominant affected gender also varied. Some studies found that females were diagnosed with MS almost double than males while some had the opposite result[2,9].

The clinical criteria for metabolic syndrome are slightly different among WHO criteria, the National Cholesterol Educational Program (NCEP) Adult Treatment Panel (ATP III), and the criteria by the International Diabetes Foundation (IDF). The waist circumference (WC) and body mass index (BMI) are the two main issues. Therefore, the authors aimed to study the difference between those three criteria to diagnose metabolic syndrome in hypertensive patients. In addition, the authors also studied the correlation between WC and BMI.

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Material and Method

The hypertension clinic, Srinagarind Hospital, Khon Kaen University was established in April 2003. The authors did a cross-sectional study to compare the prevalence of MS in hypertensive treated patients at the authors' clinic based on the definition of the IDF criteria during July to September 2005. In addition, the MS was also defined by WHO and NCEP ATP III criteria in each patient. The authors studied the demographic and laboratory characteristics among subjects including BMI, WC, types and side effects of antihypertensive drug, complication of long-standing hypertension and associated medical conditions by chart review. The WHO criteria[10] are the identification of insulin resistance (type 2 DM or impaired fasting plasma glucose or impaired glucose tolerance) plus any two of the following: elevated blood pressure ($\geq$ 140/90 mmHg or drug therapy), plasma triglyceride $\geq$ 150 mg/dL, HDL < 35 mg/dL (men) or < 40 mg/dL (women), BMI > 30 kg/m^2 and/or waist/hip ratio > 0.9 (men) or > 0.85 (women), urinary albumin > 20 mg/min; Alb/Cr > 30 mg/g. The NCEP ATP III[11] defines MS by the presence of three or more of the following risk determinants: central obesity (waist circumference > 102 cm or > 40 inches (men), > 88 cm or > 35 inches (women); elevated triglycerides ($\geq$ 150 mg/dl); low HDL cholesterol (< 40 mg/dl in men, < 50 mg/dl in women); hypertension ($\geq$ 130/$\geq$ 85 mmHg); impaired fasting glucose ($\geq$ 110 mg/dl)[12]. Patients were defined as MS by IDF[12] if they had the presence of central obesity and plus at least two of the rest as defined in the NCEP III criteria. The WC $\geq$ 90 cm in men or $\geq$ 80 cm in women indicated central obesity for Thai patients. The WC was measured by a tape in a horizontal plane, midway between the inferior margin of the ribs and the superior border of the iliac crest[12-14]. To make a fair comparison among the three criteria, the authors used the same criteria for HDL-cholesterol (< 40 mg/dl in men, < 50 mg/dl in women) and defined obesity if BMI $\geq$ 25 kg/m^2. T-test and Chi-square were used to describe baseline characteristics. McNemar test was used to identify the difference among the three criteria to diagnose MS. In addition, Pearson correlation identified the correlation between WC and BMI. The authors identified the appropriate WC by using BMI 23 kg/m^2. Logistic regression was used to find out the risk factor for metabolic syndrome. The significant statistic was demonstrated if p-value was less than 0.05. Data analyses were performed by NCSS and R statistic program.

Results

There were 100 cases (62 women and 38 men) enrolled in the present study. The average duration after being diagnosed with hypertension was 4.4 years. The mean age $\pm$ SD; mean BMI (kg/m^2) $\pm$ SD; and mean WC (cm) $\pm$ SD in men and women were 57.4 $\pm$ 10.6,

Table 1. Baseline characteristics and associated diseases between hypertensive patients who had and not had metabolic syndrome by IDF criteria

Variables	Not metabolic syndrome (n = 40)	Metabolic syndrome (n = 60)	p-value
Baseline characteristics			
Male (n)	17	21	0.449
Age	58.05, 11.00	58.88, 9.60	0.690
Duration hypertension (yr)	3.64, 3.49	5.05, 5.36	0.145
Body weight (kg)	64.06, 11.63	68.88, 12.13	0.051
Height (meters)	1.59, 0.08	1.57, 0.06	0.996
BMI (kg/m^2)	25.17, 3.77	27.71, 4.01	0.002
Waist circumference (cm)	91.98, 8.84	95.62, 7.67	0.031
Associated diseases			
Diabetes mellitus (n)	3	26	0.0001
IFG (n)	1	15	0.002
High TG (n)	1	23	<0.0001
High LDL-C (n)	1	7	0.200
Low HDL-C (n)	0	6	0.102
Gout (n)	2	2	0.916

Note: data presented in mean, SD was number of cases, IFG; impaired fasting glucose, TG; triglyceride, LDL-C; low density lipoprotein-cholesterol, HDL-C; high density lipoprotein-cholesterol

59.0 ± 17.7; 27.2 ± 0.6, 26.3 ± 0.9; 94.8 ± 0.8, 92.9 ± 5.6, respectively. The average BMI and WC of both sexes were higher than the criteria for obesity (BMI > 25 kg/m^2) and metabolic syndrome (WC > 90 cm in men and > 80 cm in women) for South Asians. The baseline characteristics and associated diseases between hypertensive patients who had and with not have metabolic syndrome by IDF criteria were presented in Table 1.

Most of the patients (92%) had well-controlled blood pressure by one or two medications (blood pressure less than 140/90 mmHg and less than 130/80 mmHg if diabetics). The most common used antihypertensive drug was ACEI (38%). Side effects of antihypertensive agents were found in 18 patients, the two most common were ACEI induced cough (10%) and diuretic induced hypokalemia (5%). The complications of hypertension were found in 34 patients; left ventricular hypertrophy (20%), chronic kidney disease (6%), microalbuminuria (3%), ischemic heart disease (3%), stroke (1%), atrial fibrillation (1%), peripheral vascular disease (1%), carotid bruit (1%) and non-alcoholic steatohepatitis (1%).

There were 60 of 100 cases diagnosed by the IDF criteria. The factors that contribute to the diagnosis of MS were body weight, BMI, WC, Diabetes mellitus, IFG and hypertriglyceridemia. However, BMI was the only significant factor correlated with the diagnosis of MS (p-value = 0.04) by multivariate logistic regression. Additionally, BMI had a moderately positive correlated with WC (p-value < 0.0001, Pearson Correlation 0.58). The Pearson correlation was 0.64 and 0.55 in males and females, respectively (both p < 0.0001). The scatter plot (Fig. 1) between BMI (kg/m^2) and WC (cm) was shown separately by gender. At the cut point of BMI 23 kg/m^2, the WC was approximately 82.5 and 79.5 cm or 32.5 and 31.3 inches in men and women respectively.

The WHO, NCEP ATP III and IDF criteria gave the diagnosis of MS in 37, 33, 60 cases, respectively. The WHO and NCEP ATP III criteria was not different from each other (p = 0.34) but they were both significantly different from the IDF criteria (both p < 0.0001).

Discussion

The metabolic syndrome was characterized by a group of metabolic risk factors in each person, including central obesity; upon definition of ethnic criteria, a high blood pressure (more than 130/85 mm Hg), a high plasma triglyceride level more than 150 mg/dl, a fasting blood glucose level greater than 100 mg/dl, and a plasma high density lipoprotein level (HDL) less than 40 mg/dl in men or under 50 mg/dl in women[12,13]. It has a high prevalence and influence on the cardiovascular morbidity and mortality[1,2,8-11,15-17] such as coronary heart disease, stroke, peripheral vascular disease and diabetes[8-11]. Recent studies in the US showed that MS evidently increased the risk for atherosclerosis about 1.5-3 fold and raised the risk for type 2 diabetes by 3-5 fold[1]. The definite pathophysiology of this syndrome remains unknown. Most researchers believe that the etiology of MS is due to a combination of genetic influence and sedentary lifestyle. Individual's types of diet and level of physical activities play a role in causing insulin resistance that is believed to be a cause of abnormal metabolic profiles and certain conditions such as type 2 diabetes mellitus and cardiovascular diseases[8-10].

The present data represented primary hypertensive patients that were recently diagnosed (mean duration of hypertension 4 years) and had less serious complications such as stroke or coronary artery disease. Therefore, most patients controlled their blood pressure by one or two medications. The prevalence of metabolic syndrome by WHO, NCEP ATP III and IDF criteria was 37, 33, 60 percent, respectively. The IDF criteria showed significant higher prevalence because of the lower WC cut point. Even though body weight, BMI and WC were all significantly different between non-MS and MS group, BMI was the only positive

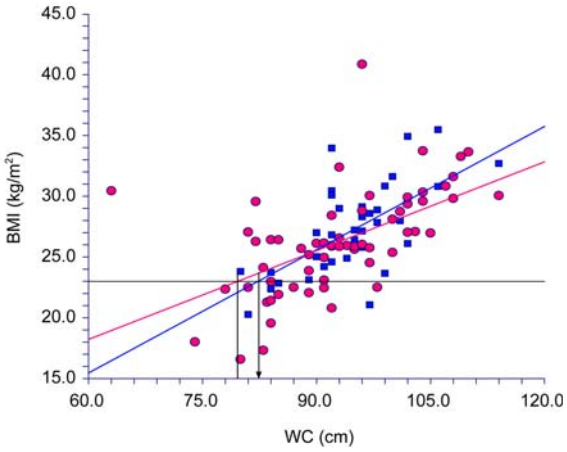

Fig. 1 Scatter plot between body mass index, BMI (kg/m^2) on y-axis and waist circumference, WC (cm) on x-axis by gender, each circle represented each female patient and each box represented each male patient. The vertical line without arrow and with arrow indicated female and male WC cut-point at BMI 23 kg/m^2, respectively

associated factor to the diagnosis of MS by the IDF criteria in logistic regression model. That means BMI is still a useful parameter to diagnose MS. Excessive fat in the abdomen was an independent risk factor of developing of type 2 diabetes mellitus, dyslipidemia, hypertension, and cardiovascular diseases[18-23]. Either Magnetic resonance imaging (MRI) or computed tomography (CT) are now the most accurate tools for visceral fat measurement. However, these methods are expensive and impractical in general practice. Nevertheless, recent studies also showed that the simple anthropometric indexes of central obesity such as waist circumference (WC), body mass index (BMI), abdominal saggital diameter and waist-to-hip ratio[24-27] can be used to estimate the abdominal fat. In addition, the present study showed good correlation between WC and BMI especially in men. Therefore, either WC or BMI can be used in clinical practice for newly diagnosed hypertensive patients. To identify the appropriate WC for Thai hypertensive patients, the authors used the scatter plot between BMI and WC by gender. The BMI of 23 kg/m^2 was used because it was the cut-point for overweight in Asians and it will also increase awareness of MS[8]. The scatter plot showed that the WC values for overweight person was 82.5 and 79.5 cm or 32.5 and 31.3 inches in men and women, respectively. The WC value in women was very close to the IDF criteria; however, the appropriate WC cut-point for men should be lower to 82.5 cm for recently diagnosed hypertensive Thai patients.

The first three associated conditions that contributed to the diagnosis of MS in the present study were type 2 DM, IFG and hypertriglyceridemia (Table 1). These occurred because of high prevalence of diabetes in the present series. In addition, diabetes mellitus is strongly associated with insulin resistance, hypertriglyceridemia and IFG. All of these factors are in a vicious cycle and play an important role in the pathogenesis of insulin resistance and metabolic syndrome. These results supported prior studies that hyperglycemia was the most important metabolic risk[28,29] that leads to cardiovascular complications.

Conclusion

MS has a high prevalence in recently diagnosed primary hypertensive patients. The IDF criteria provided highest diagnostic yield. Both WC and BMI were the useful parameters to diagnose MS and highly correlated to each other. The appropriate WC cut-point for Thai hypertensive men and women was 82.5 cm (32.5") and 79.5 cm (31.3"), respectively.

References

1. American Heart Association. Metabolic syndrome. Available from: http://www.a mericanheart. org/presenter.jhtml?identifier=4756.
2. Boehm BO, Claudi-Boehm S, Yildirim S, Haenle MM, Hay B, Mason RA, et al. Prevalence of the metabolic syndrome in southwest Germany. Scand J Clin Lab Invest Suppl 2005; 240: 122-8.
3. American Diabetes Association. The metabolic syndrome. Available from: http://www.diabetes.org/weightloss-and-exercise/weightloss/metabolicsyndrome.jsp
4. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. JAMA 2002; 287: 356-9.
5. Tanchoco CC, Cruz AJ, Duante CA, Litonjua AD. Prevalence of metabolic syndrome among Filipino adults aged 20 years and over. Asia Pac J Clin Nutr 2003; 12: 271-6.
6. Takeuchi H, Saitoh S, Takagi S, Ohnishi H, Ohhata J, Isobe T, 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.
7. Li ZY, Xu GB, Xia TA. Prevalence rate of metabolic syndrome and dyslipidemia in a large professional population in Beijing. Atherosclerosis 2006; 184: 188-92.
8. Lohsoonthorn V, Lertmaharit S, Williams MA. Prevalence of metabolic syndrome among professional and office workers in Bangkok, Thailand. J Med Assoc Thai 2007; 90: 1908-15.
9. Alexander CM, Landsman PB, Teutsch SM, Haffner SM. NCEP-defined metabolic syndrome, diabetes, and prevalence of coronary heart disease among NHANES III participants age 50 years and older. Diabetes 2003; 52: 1210-4.
10. World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications: report of a WHO consultation. Part 1: diagnosis and classification of diabetes mellitus. Geneva: WHO; 1999.
11. 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.
12. Ford ES. Risks for all-cause mortality, cardiovas-

cular disease, and diabetes associated with the metabolic syndrome: a summary of the evidence. Diabetes Care 2005; 28: 1769-78.
13. International Diabetes Federation. The IDF consensus worldwide definition of the metabolic syndrome. Available from: http://www.idf.org/webdata/docs/MetS_def_FINAL.pdf.
14. Boehm BO, Claudi-Boehm S. The metabolic syndrome. Scand J Clin Lab Invest Suppl 2005; 240: 3-13.
15. Scarsella C, Almeras N, Mauriege P, Blanchet C, Sauve L, Dewailly E, et al. Prevalence of metabolic alterations predictive of cardiovascular disease risk in the Quebec population. Can J Cardiol 2003; 19: 51-7.
16. Chuang SY, Chen CH, Chou P. Prevalence of metabolic syndrome in a large health check-up population in Taiwan. J Chin Med Assoc 2004; 67: 611-20.
17. Hu G, Qiao Q, Tuomilehto J, Balkau B, Borch-Johnsen K, Pyorala K. Prevalence of the metabolic syndrome and its relation to all-cause and cardiovascular mortality in nondiabetic European men and women. Arch Intern Med 2004; 164: 1066-76.
18. Albu JB, Murphy L, Frager DH, Johnson JA, Pi-Sunyer FX. Visceral fat and race-dependent health risks in obese nondiabetic premenopausal women. Diabetes 1997; 46: 456-62.
19. Ross R, Fortier L, Hudson R. Separate associations between visceral and subcutaneous adipose tissue distribution, insulin and glucose levels in obese women. Diabetes Care 1996; 19: 1404-11.
20. Nicklas BJ, Penninx BW, Ryan AS, Berman DM, Lynch NA, Dennis KE. Visceral adipose tissue cutoffs associated with metabolic risk factors for coronary heart disease in women. Diabetes Care 2003; 26: 1413-20.
21. Lopatynski J, Mardarowicz G, Szczesniak G. A comparative evaluation of waist circumference, waist-to-hip ratio, waist-to-height ratio and body mass index as indicators of impaired glucose tolerance and as risk factors for type-2 diabetes mellitus. Ann Univ Mariae Curie Sklodowska [Med] 2003; 58: 413-9.
22. Jia WP, Lu JX, Xiang KS, Bao YQ, Lu HJ, Chen L. Prediction of abdominal visceral obesity from body mass index, waist circumference and waist-hip ratio in Chinese adults: receiver operating characteristic curves analysis. Biomed Environ Sci 2003; 16: 206-11.
23. Dalton M, Cameron AJ, Zimmet PZ, Shaw JE, Jolley D, Dunstan DW, et al. Waist circumference, waist-hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian adults. J Intern Med 2003; 254: 555-63.
24. Pouliot MC, Despres JP, Lemieux S, Moorjani S, Bouchard C, Tremblay A, et al. Waist circumference and abdominal sagittal diameter: best simple anthropometric indexes of abdominal visceral adipose tissue accumulation and related cardiovascular risk in men and women. Am J Cardiol 1994; 73: 460-8.
25. Jia WP, Lu JX, Xiang KS, Bao YQ, Lu HJ, Chen L. Prediction of abdominal visceral obesity from body mass index, waist circumference and waist-hip ratio in Chinese adults: receiver operating characteristic curves analysis. Biomed Environ Sci 2003; 16: 206-11.
26. Chan DC, Watts GF, Barrett PH, Burke V. Waist circumference, waist-to-hip ratio and body mass index as predictors of adipose tissue compartments in men. QJM 2003; 96: 441-7.
27. Wang W, Wang K, Li T, Xiang H, Ma L, Fu Z, et al. A discussion on utility and purposed value of obesity and abdomen obesity when body mass index, waist circumference, waist to hip ratio used as indexes predicting hypertension and hyperblood glucose. Zhonghua Liu Xing Bing Xue Za Zhi 2002; 23: 16-9.
28. Isomaa B, Almgren P, Tuomi T, Forsen B, Lahti K, Nissen M, et al. Cardiovascular morbidity and mortality associated with the metabolic syndrome. Diabetes Care 2001; 24: 683-9.
29. Bruno G, Merletti F, Biggeri A, Bargero G, Ferrero S, Runzo C, et al. Metabolic syndrome as a predictor of all-cause and cardiovascular mortality in type 2 diabetes: the Casale Monferrato Study. Diabetes Care 2004; 27: 2689-94.

เกณฑ์ที่ดีที่สุดในการวินิจฉัยภาวะเมตะบอลิกในผู้ป่วยโรคความดันโลหิตสูงชาวไทย

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ภาวะเมตะบอลิกเป็นภาวะที่พบได้บ่อยในเวชปฏิบัติ เกณฑ์การวินิจฉัยมีหลายเกณฑ์ที่แตกต่างกัน คณะผู้วิจัยได้ทำการศึกษาแบบตัดขวางในผู้ป่วยโรคความดันโลหิตสูงที่ได้รับการรักษาที่คลินิกโรคความดันโลหิตสูง โรงพยาบาลศรีนครินทร์ ระหว่างเดือนกรกฎาคม ถึง กันยายน พ.ศ. 2548 โดยใช้เกณฑ์การวินิจฉัยขององค์การอนามัยโลก (WHO), National Cholesterol Educational Program (NCEP) Adult Treatment Panel (ATP III) และ International Diabetes Foundation (IDF) พบว่า จากจำนวนผู้ป่วยจำนวน 100 ราย เกณฑ์ของ WHO, NCEP ATP III และ IDF ให้การวินิจฉัยผู้ป่วยจำนวน 37, 33 และ 60 รายตามลำดับ โดยเกณฑ์การวินิจฉัยของ IDF ให้การวินิจฉัยผู้ป่วยมากที่สุดและแตกต่างจากทั้งสองเกณฑ์ที่เหลือ ($p < 0.0001$) BMI เป็นปัจจัยเดียวที่สัมพันธ์กับการวินิจฉัยภาวะเมตะบอลิกโดยเกณฑ์ของ IDF (p-value = 0.04) และที่ระดับ BMI 23 กิโลกรัมต่อตารางเมตร มีความสัมพันธ์กับระดับเส้นรอบเอว 82.5 (32.5") และ 79.5 (31.3") เซนติเมตร (นิ้ว) ในผู้ป่วยโรคความดันโลหิตสูงชายและหญิงตามลำดับ โดยในเพศชายมีค่าต่ำกว่าเกณฑ์ของ IDF