Metabolic Syndrome in Type 2 Diabetes

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Abstract

Metabolic syndrome is a cluster of conditions related to insulin resistance, which increased risk of atherosclerosis and type 2 diabetes. This cross sectional study was conducted on 1171 type 2 diabetes in Lampang hospital's out patient department using IDF Consensus 2005 and NCEP ATP III criteria for diagnosing metabolic syndrome. The prevalence of metabolic syndrome was higher when diagnosed with NCEP ATP III criteria than with IDF criteria ((80.79% vs 54.57%, p <0.001). The metabolic syndrome was higher in women for both diagnostic criteria (84.65% vs 72.18%, p <0.001, NCEP ATP III ; 61.51% vs 39.12%, p<0.001, IDF). Abdominal obesity was found in 76.36 % of women and 40.77 % of men, while low HDL cholesterol was found in 68.81 % and 47.93% of women and men respectively. The prevalence of hypertriglycerides was 56.19% in women and 58.68% in men. Meanwhile, hypertension was diagnosed in 61.88% of women and 63.09% of men. Higher prevalence of coronary artery disease was observed for the metabolic syndrome patients (NCEP ATP III, 53 out of 56, p = 0.005; IDF, 39 out of 56, p = 0.027). HbA1c was also higher for the metabolic syndrome patients (NCEP ATP III: 7.71 $\pm$ 1.76% vs 7.40 $\pm$ 1.66%, p = 0.017; IDF 7.83 $\pm$ 1.84% vs 7.43 $\pm$ 1.59%, p <0.001). Type 2 diabetes had high prevalence of metabolic syndrome, which increased risk of coronary artery disease ; so comprehensive care was required for these patient to mitigate the risks.

Key words : type 2 diabetes, metabolic syndrome

Metabolic Syndrome is a cluster of conditions related to insulin resistance and consists of obesity, abnormal level of blood lipids such as high triglycerides and low HDL cholesterol, high blood pressure, prothrombotic state, and abnormal glucose tolerance leading to high blood sugar [1]. The metabolic syndrome patients are estimated to be at an increased risk of atherosclerotic cardiovascular diseases by 30-400%, depending on demographics, diseases definition, and duration of studies [2, 3, 4] and are at high risk of type 2 diabetes [5, 6]. Several criteria have been adopted for the diagnosis for metabolic syndrome such as the World Health Organization criteria in 1999 [7], the Third Report of the National Cholesterol Education Program's Adult Treatment Panel III (NCEP ATP III) [8, 9] and the International Diabetes Federation (IDF) in 2005 [10]. Criteria in common usage are NCEP ATP III and IDF Consensus 2005, both of which are described below.

NCEP ATP III

Classification as metabolic syndrome requires that fulfillment of at least 3 of the followings:

1. Waist circumference:
   European: men >102 cm, women > 88 cm
   Asian: men > 90 cm, women > 80 cm
2. Triglycerides ≥ 150 mg/dl or on specific treatment for this lipid
3. HDL cholesterol < 40 mg/dl in men or on specific treatment for this lipid
   HDL cholesterol < 50 mg/dl in women or on specific treatment for this lipid
4. Blood pressure ≥ 130 / 85 mmHg or have been treated for hypertension
5. Fasting plasma glucose ≥ 100 mg/dl or previously diagnosed with diabetes

IDF Consensus 2005

Classification as metabolic syndrome requires fulfillment of the central obesity criteria:
Waist circumference:

European: men ≥ 94 cm , women ≥80 cm
Asian: men ≥ 90 cm , women ≥ 80 cm
in conjunction with 2 of the followings:

1. Triglycerides ≥ 150 mg/dl or on specific treatment for this lipid
2. HDL cholesterol < 40 mg/dl in men or on specific treatment for this lipid
   HDL cholesterol < 50 mg/dl in women or on specific treatment for this lipid
3. Blood pressure ≥ 130 / 85 mmHg or have been treated for hypertension
4. Fasting plasma glucose ≥ 100 mg/dl or previously diagnosed with diabetes

Metabolic Syndrome is prevalent in adult population. For example, according to the criteria of WHO and NCEP ATP III, it is estimated that 23-25% of adult population in USA are with metabolic syndrome, while 15-20% of those diagnosed with metabolic syndrome by one criteria may not be diagnosed with metabolic syndrome using another criteria [11]. A study in South Korea by Jee-Yong Oh et al. determined the prevalence of metabolic syndrome in men at 29% and in women at 16.8% [12]. In Thailand, the prevalence of metabolic syndrome in type 2 diabetes is around 59% according to NCEP ATP III criteria [13]. Type 2 diabetic patients with metabolic syndrome are at an elevated risk of mortality from coronary artery disease (CAD) compared to those diabetic patients without metabolic syndrome [12, 14, 15].

Material and Methods

Between September 2006 and November 2006, type 2 diabetic patients at the Out Patient Department, Department of Medicine, Lampang Hospital, were enrolled in a cross sectional study. Two criteria for metabolic syndrome used were that of NCEP ATP III and IDF Consensus 2005 described earlier. The following patient statistics were recorded in addition to those used directly for metabolic syndrome diagnosis: age, gender, weight in kilograms (kg), height in meter (m), and body mass index (BMI). Measurement of waist circumference was carried out at the midpoint between the 10^{th} rib and iliac crest under normal garment with units in centimeters (cm). Blood pressure (BP) was measured using Mercury sphygmomanometer in a sitting position; an average value of two measurements 5 minutes apart was recorded. High blood pressure condition was defined according to 'The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC-7) [16] or alternatively as having a history of high blood pressure and receiving anti-hypertensive drugs. HbA1c quantification was carried out by immunoassay method. Serum triglycerides after 12 hours fasting was measured using enzymatic method, whereas HDL cholesterol was measured using direct method. Data on atherosclerotic cardiovascular diseases such as coronary artery disease (CAD) and cerebrovascular disease (CVD) was based on prior diagnosis as indicated in the patient's medical records. Peripheral arterial disease (PAD) was diagnosed by pulse palpation at dorsalis pedis artery. Ankle-brachial index was measured with a minidoppler when pulse cannot be detected.

Statistical Analysis

Descriptive analysis using chi-square test and Fisher's exact test was carried out using SPSS version 13.0

Results

The number of type 2 diabetic patients in this cross-sectional study was 1171, with the number of men at 363 (31.0%), and women at 808 (69.0%). Mean waist circumference, triglycerides, HDL cholesterol, systolic blood pressure, and diastolic blood pressure of total men and women were shown in table 1. The number of patients diagnosed with metabolic syndrome using IDF Consensus 2005 criteria was 639 (54.57%), with 142 men (39.12%) and 497 women (61.51%). Using the criteria of NCEP ATP III, the number of patients with metabolic syndrome was 946 (80.79%). Of this metabolic syndrome group, 262 patients were men (72.18%) and 684 were women (84.65%), as shown in table 1. The average age, BMI, systolic and diastolic blood pressure of metabolic syndrome patients according to IDF Consensus 2005 and NCEP ATP III were shown in table 2. The average value of waist circumference was 90.16 ± 8.16 cm for the IDF Consensus 2005 group and 86.21 ± 9.49 cm for the NCEP ATP III group. For the IDF consensus 2005 patient group, the average level of HbA1c was 7.83 ± 1.84%, while the average HDL cholesterol was 46.05 ± 11.03 mg/dl, and the average level of triglycerides was 194.03 ± 122.83 mg /dl. For the NCEP ATP III patient group, the average value of HbA1c was 7.71 ± 1.76%, whereas the average level of HDL cholesterol was 49.90 ± 10.80 mg/dl, and the average level of triglycerides was 195.50 ± 120.14 mg /dl, as shown in table 2.

Table 1. Characteristic of factors and prevalence of metabolic syndrome, grouped by sex

	Men (363)	Women (808)	P	Total (1171)	p
Metabolic syndrome (IDF defined)	142 (39.12%)	497 (61.51%)	<0.001	639 (54.57%)	<0.001
Metabolic syndrome (NCEP ATPIII defined)	262 (72.18%)	684 (84.65%)	< 0.001	946 (80.79%)	
Waist circumference (cm)	87.92 ± 9.23	83.36 ± 9.21	<0.001	84.78 ± 9.45	-
Triglycerides (mg/dl)	194.83 ± 128.76	176.16 ± 110.11	0.011	181.95 ± 116.47	-
HDL cholesterol (mg/dl)	43.75 ± 10.51	47.62 ± 11.88	<0.001	46.42 ± 11.61	-
Systolic BP (mmHg)	134.50 ± 86.05	129.41 ± 15.53	0.104	130.99 ± 49.62	-
Diastolic BP (mmHg)	79.39 ± 9.61	78.49 ± 10.02.	0.150	78.77 ± 9.90	-

Table 2 - Baseline characteristics of study subjects, grouped by metabolic syndrome status

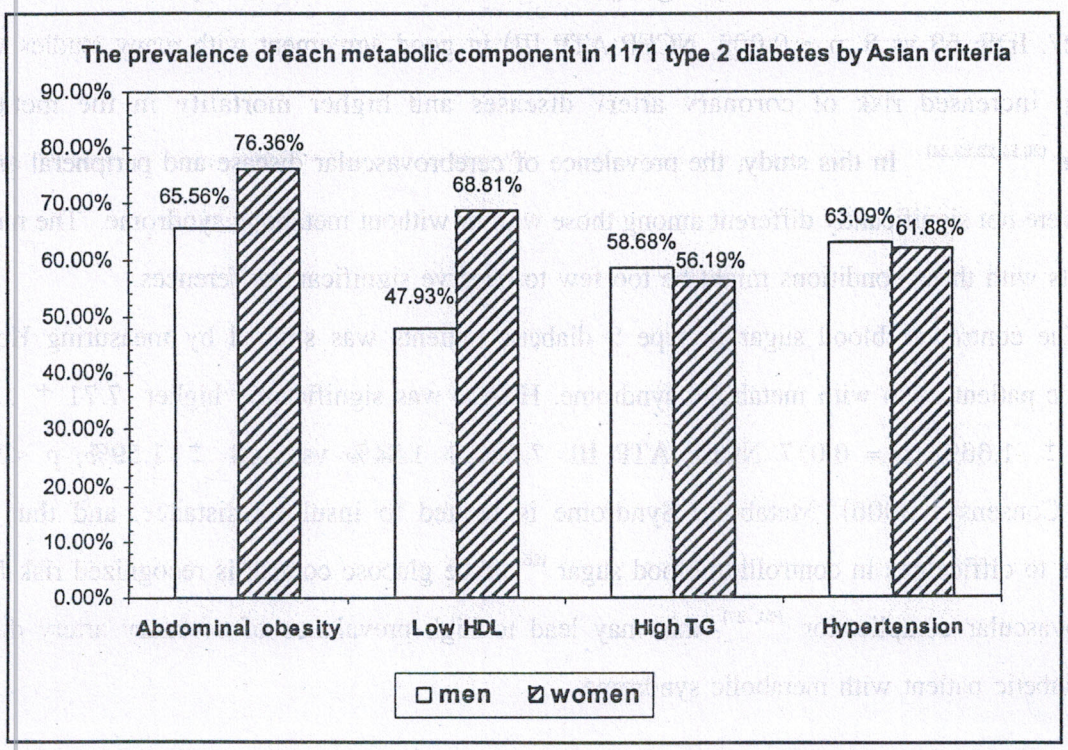
	IDF-defined metabolic syndrome			NCEP-defined metabolic syndrome		
	With	Without	P	With	Without	P
n						
Total (1,171)	639 (54.57%)	532 (45.43%)	-	946 (80.79%)	225 (19.21%)	-
Men (363)	142 (39.12%)	221 (61.88%)	-	262 (72.18%)	101 (27.81%)	-
Women (808)	497 (61.51%)	311 (39.49%)	-	684 (84.65%)	124 (15.35%)	-
Age (years)						
Total	56.56 ± 10.21	56.75 ± 10.33	0.485	56.87 ± 10.36	56.25 ± 10.23	0.420
Men	56.40 ± 10.45	57.08 ± 9.91	-	56.59 ± 10.12	57.39 ± 10.13	-
Women	56.60 ± 10.16	56.91 ± 10.88	-	56.97 ± 10.45	55.32 ± 10.26	-
BMI (kg/m2)						
Total	25.74 ± 3.66	21.65 ± 2.51	< 0.001	24.37 ± 3.86	21.86 ± 2.60	< 0.001
Men	27.30 ± 3.34	22.48 ± 2.41	-	25.20 ± 3.74	22.22 ± 2.36	-
Women	25.29 ± 3.63	21.06 ± 2.41	-	24.05 ± 3.86	21.56 ± 2.76	-
Waist (cm)						
Total	90.16 ± 8.16	78.31 ± 6.33	< 0.001	86.21 ± 9.49	78.73 ± 6.44	< 0.001
Men	96.50 ± 6.82	82.41 ± 5.67	-	90.49 ± 8.95	81.27 ± 6.11	-
Women	88.35 ± 7.58	75.39 ± 5.03	-	84.58 ± 9.18	76.65 ± 5.96	-
Systolic BP (mmHg)						
Total	133.89 ± 64.46	127.50 ± 15.99	0.028	133.11 ± 54.46	122.05 ± 15.81	0.003
Men	143.82 ± 135.90	128.52 ± 15.95	-	138.20 ± 100.59	124.91 ± 16.31	-
Women	131.05 ± 15.00	126.78 ± 16.01	-	131.16 ± 14.96	119.73 ± 15.07	-
Diastolic BP (mmHg)						
Total	79.92 ± 9.80	77.40 ± 9.85	< 0.001	79.60 ± 9.83	75.31 ± 9.43	< 0.001
Men	81.59 ± 10.05	77.98 ± 9.06	-	80.54 ± 9.70	76.42 ± 8.74	-
Women	79.44 ± 9.68	76.98 ± 10.37	-	79.23 ± 9.87	74.40 ± 9.90	-
HbA1C (%)						
Total	7.83 ± 1.84	7.43 ± 1.59	< 0.001	7.71 ± 1.76	7.40 ± 1.66	0.017
Men	7.67 ± 2.06	7.32 ± 1.65	-	7.53 ± 1.87	7.26 ± 1.71	-
Women	7.88 ± 1.77	7.51 ± 1.54	-	7.78 ± 1.71	7.51 ± 1.62	-
HDL cholesterol (mg/dl)						
Total	46.05 ± 11.03	46.86 ± 12.25	0.234	49.90 ± 10.80	52.80 ± 12.68	< 0.001
Men	42.51 ± 9.02	44.55 ± 11.31	-	41.58 ± 9.53	49.40 ± 10.88	-
Women	47.06 ± 11.35	48.50 ± 12.64	-	46.18 ± 10.99	55.56 ± 13.39	-
Triglycerides (mg/dl)						
Total	194.03 ± 122.83	167.44 ± 106.66	< 0.001	195.50 ± 120.14	124.97 ± 77.01	< 0.001
Men	212.17 ± 132.40	183.70 ± 125.40	-	215.23 ± 131.53	141.94 ± 104.63	-
Women	188.85 ± 119.19	155.88 ± 89.47	-	187.95 ± 114.69	111.15 ± 38.36	-

By Asian criteria, 617 women (76.36%) and 148 men (40.77%) had abdominal obesity. Low HDL cholesterol (<50 mg/dl for women, < 40 mg/dl for men) was found in 556 (68.81%) and 174 (47.93%) of women and men respectively. Around half of both sexes had high triglycerides (454 women; 56.19 %, 213 men ; 58.68 %). The prevalence of hypertension, abdominal obesity, low HDL cholesterol and high triglycerides were shown in figure 1. The number of patients diagnosed with coronary artery disease (CAD) in this study was 56, consisting of 16 men and 40 women, with cerebrovascular artery disease (CVD) was 40, with 10 men and 30 women, and with peripheral arterial disease was 17, with 6 men and 11 women. For patients with coronary artery disease, 39 out of 56 were diagnosed with metabolic syndrome according to the IDF Consensus 2005 criteria. When using the NCEP ATP III criteria for diagnosis, 53 out of 56 were diagnosed with metabolic syndrome. For patients with cerebrovascular disease, 20 out of 40 were diagnosed with metabolic syndrome using IDF Consensus 2005 criteria, whereas 35 out of 40 were diagnosed with metabolic syndrome using the NCEP ATP III criteria. For patients with peripheral arterial disease, 8 out of 17 were diagnosed with metabolic syndrome using the IDF consensus 2005 criteria, while all 17 patients were diagnosed with metabolic syndrome if the NCEP ATP III was used, as shown in table 3.

Table 3. Atherosclerotic cardiovascular diseases, grouped by metabolic syndrome status

	IDF defined			NCEP ATPIII defined		
	with	without	p	with	without	p
CAD(56)	39(69.64%)	17(30.36%)	0.027	53(94.64%)	3(5.36%)	0.005
CVD(40)	20(50.00%)	20(50.00%)	0.629	35(87.50%)	5(12.5%)	0.412
PAD(17)	8(47.06%)	9(52.94%)	0.626	17(100%)	0	0.056

Figure 1. The prevalence of each metabolic component of metabolic syndrome by Asian criteria



Discussion

The prevalence of metabolic syndrome in type 2 diabetic patients at Lampang Hospital was significantly higher when using the NCEP ATP III criteria for diagnosis compared with the IDF Consensus 2005 criteria (80.79% vs 54.57%, p< 0.001). This result was similar to the observation at Chainat hospital [17] which found the prevalence of metabolic syndrome to be 89.00 % using the NCEP ATP III criteria, compared with 74.10% using the IDF Consensus 2005 criteria. According to IDF Consensus 2005 the metabolic syndrome must be central obesity, so non obese type 2 diabetes with high blood pressure and dyslipidemia were not classified as metabolic syndrome, while with NCEP ATP III criteria central obesity was not the key factor for diagnosis. This might contribute to high prevalence of metabolic syndrome by NCEP ATP III criteria. In this study, for both diagnostic criteria, the percentages of women with metabolic syndrome was higher (84.65 vs 72.18%, NCEP ATP III, p <0.001; and 61.51% vs 39.12%, p <0.001, IDF Consensus 2005) similar to the study in NHANES III [15]. Women with type 2 diabetes in this study had higher prevalence of abdominal obesity and low HDL cholesterol that might result in higher prevalence of metabolic syndrome , similar to the studies in China and Korea[18,19].

The prevalence of coronary artery disease in patients diagnosed with metabolic syndrome using both criteria was significantly higher than those without metabolic syndrome (39 vs 17, p = 0.027, IDF; 53 vs 3, p = 0.005, NCEP ATP III) in good agreement with many studies which found an increased risk of coronary artery diseases and higher mortality in the metabolic syndrome [20,21,22,23,24]. In this study, the prevalence of cerebrovascular disease and peripheral arterial disease were not significantly different among those with or without metabolic syndrome. The number of patients with these conditions might be too few to observe significant differences.

The control of blood sugar in type 2 diabetic patients was studied by measuring HbA1c. In diabetic patients also with metabolic syndrome, HbA1c was significantly higher (7.71 $\pm$ 1.76% vs 7.40 $\pm$ 1.66%, p = 0.017 NCEP ATP III; 7.83 $\pm$ 1.84% vs 7.43 $\pm$ 1.59%, p <0.001 for IDF Consensus 2005). Metabolic Syndrome is related to insulin resistance, and thus may contribute to difficulties in controlling blood sugar [25].Since glucose control is recognized risk factor of macrovascular complication [26, 27], this may lead to high prevalence of coronary artery disease among diabetic patient with metabolic syndrome.

Conclusion

High prevalence of metabolic syndrome was found in type 2 diabetic patients at Lampang Hospital. Diabetic patients with metabolic syndrome were at an elevated risk of atherosclerotic cardiovascular diseases and might have difficulties in controlling blood sugar. The metabolic syndrome may be a simple tool to stratify diabetic patients according to the expected macrovascular complications and therapeutic care for type 2 diabetes which comprehensively targets all metabolic abnormalities may mitigate the risks of atherosclerotic cardiovascular diseases.

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Metabolic syndrome ในเบาหวาน ชนิดที่ 2

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Metabolic syndrome เป็นกลุ่มอาการที่สัมพันธ์กับภาวะดื้อต่ออินซูลิน ซึ่งเพิ่มความเสี่ยงต่อการเกิดโรคหลอดเลือดแดงแข็ง และเบาหวานชนิดที่ 2 การศึกษานี้เป็นการศึกษาภาคตัดขวางในผู้ป่วยเบาหวานชนิดที่ 2 จำนวน 1171 ราย ที่แผนกผู้ป่วยนอก โรงพยาบาลลำปาง ใช้เกณฑ์ วินิจฉัย metabolic syndrome ของ IDF Consensus 2005 และ NCEP ATP III ความชุกของ metabolic syndrome ตามเกณฑ์วินิจฉัยของ NCEP ATP III มากกว่าเกณฑ์ของ IDF Consensus 2005 (80.79% vs 54.57%, p <0.001) เพศหญิงเป็น metabolic syndrome มากกว่าเพศชาย ทั้ง 2 เกณฑ์วินิจฉัย (84.65% vs 72.18%, p <0.001, NCEP ATP III ; 61.51% vs 39.12%, p<0.001, IDF) ภาวะอ้วนลงพุง พบในเพศหญิง 73.63% เพศชาย 40.77% HDL cholesterol ต่ำ พบในเพศหญิง 68.81% เพศชาย 47.93% ความชุกของภาวะ triglycerides สูง พบในเพศหญิง 56.19% เพศชาย 58.68% และพบความดันโลหิตสูงในเพศหญิง 61.88% เพศชาย 63.09% ผู้ที่เป็น metabolic syndrome ทั้ง 2 เกณฑ์ มีความชุกของโรคหลอดเลือดหัวใจสูงกว่า (NCEP ATP III, 53 out of 56, p = 0.005 ; IDF, 39 out of 56, p = 0.027). และมีค่า HbA1c สูงกว่าด้วย (NCEP ATP III : 7.71 ± 1.76 % vs 7.40 ± 1.66 %, p = 0.017 ; IDF 7.83 ± 1.84 % vs 7.43 ± 1.59%, p <0.001) ผู้ป่วยเบาหวานชนิดที่ 2 จะมีความชุกของ metabolic syndrome สูง ซึ่งเพิ่มความเสี่ยงต่อการเกิดโรคหลอดเลือดหัวใจ การดูแลรักษาอย่างเข้าใจและครอบคลุมภาวะโรค จะช่วยลดความเสี่ยงดังกล่าว

คำสำคัญ : เบาหวาน ชนิดที่ 2, metabolic syndrome