Prevalence of Metabolic Syndrome and Its Relationship to Weight in the Thai Population

Chatlert Pongchaiyakul MD*,
Tuan V Nguyen PhD**, Ekgaluck Wanothayaroj MD*,
Napaporn Krusun BSc***, Virat Klungboonkrong MD****

** Division of Endocrinology and Metabolism, Faculty of Medicine, Khon Kaen University, Khon Kaen*
*** Garvan Institute of Medical Research, St Vincent's Hospital, Sydney, NSW, Australia*
**** Department of Community Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen*
***** Division of Cardiology, Department of Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen*

Background: *Although the prevalence of the metabolic syndrome (MetS) has been well-documented in Western Caucasian populations, there are few studies in non-Caucasian populations. The objectives of the present study were to estimate the prevalence of MetS and to find an optimal BMI cut-off value for defining obesity in the Thai population.*
Material and Method: *A sample of 307 men and 295 healthy women aged between 20 and 90 years (average age of 45 years) who came for a health check-up clinic in Khon Kaen, a northeast province of Thailand, were studied. The present study was conducted between 2003 and 2004. The modified ATP III criteria were used to estimate the age-and-sex specific prevalence of MetS, in which a BMI of $\geq$ 27 kg/m^2 for men and 25 kg/m^2 for women were used in place of waist circumference. In the Thai population, these BMI cut-offs were equivalent to a percent body fat of 25% and 35% in men and women respectively.*
Results: *The overall prevalence of MetS was 15%, with no significant differences between men (15.3%) and women (14.6%). In men, the prevalence increased from 9.5% among the 20-39 age group to 24.7% among the 50+ age groups. In women, the respective prevalence was 7% and 29.5%. When BMI was removed from the classification of MetS, the overall prevalence of "MetS-without-BMI" (still defined by the presence of at least 3 abnormalities) in both men and women was 7.8%. However, the prevalence of MetS-without-BMI increased with higher BMI levels: among those with BMI < 25, the prevalence was 4.6% in men and 5.0% in women; among those with BMI $\geq$ 25, the prevalence was 13% in men and 16% in women.*
Conclusion: *The prevalence of MetS in this semi-rural Thai population was 15%, which is as common as in Caucasian populations. In the Thai population, obesity was a major component of MetS.*

Keywords: *Metabolic syndrome, Body mass index, Body weight, Prevalence, Thai, Epidemiology*

J Med Assoc Thai 2007; 90 (3): 459-67
Full text. e-Journal: *http://www.medassocthai.org/journal*

Metabolic syndrome (MetS) is a collection of abnormalities or impairment related to central obesity, glucose intolerance, hypertension, and dyslipidemia(1-3). Individuals with MetS have an increased risk of cardiovascular disease, diabetes mellitus, and mortality(4-9). The quantitative definition of MetS is a contentious issue due to lack of agreements among experts(10-13). However, the Adult Treatment Panel III (ATP III) has proposed criteria for classification of MetS(14), and these criteria are widely considered useful for assessing the magnitude of MetS in the general population. Furthermore, The International Diabetes federation (IDF) has recently proposed new criteria for MetS(15).

Using the ATP III criteria, the prevalence of MetS is highly variable among populations around the world, with Western Caucasian populations generally

Correspondence to : Wanothayaroj E, Division of Endocrinology and Metabolism, Department of Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand. Phone: 043-363-664, Fax: 043-347-542, E-mail: ekgaluck @yahoo.com

having higher prevalence than non-Western populations. For example, in the US, approximately 24% of adult men and women had the syndrome[16], whereas in Koreans, this prevalence was 9.8% in men and 12.4% in women[17], in the Hong Kong Chinese population: 20% in men and 22% in women[18], in the Singaporean population: 13% in men and 11% in women. However, for Asian Indians, the prevalence of MetS varied from 5% to 50%, depending on the assessment methodologies, age group, and socioeconomic status[19,20].

One of the major issues in the study of obesity in Asian countries such as Thailand is the lack of an accepted and validated BMI criterion for defining obesity. Indeed, there is a concern that the ATP III recommended cut-off value for waist circumference in Caucasian populations is inappropriate in Asian populations, because Asians as a group have a more slender body build than Caucasians[21-23]. Moreover, it is well-known that the BMI criteria for defining obesity in Western Caucasian populations are not necessarily applicable to Asian populations because, for a given level of body mass index (BMI), Asians tend to have a higher percent of body fat[24]. Indeed, WHO Expert Consultation could not arrive at a specific cut-off value for defining obesity in Asian populations, primarily because of lack of empirical data, and they call for further study[25]. One approach to define obesity is by examining the prevalence of MetS or its components across BMI ranges, and then derived a cut-off BMI level that is highly discriminatory between MetS and non-MetS.

Therefore, the present study was designed to estimate first the prevalence of MetS and second, to relate the prevalence to various BMI categories for developing new optimal BMI criteria for defining obesity in Thai men and women.

Material and Method

Subjects and setting

The present study was conducted in Khon Kaen, a northeast rural province of Thailand (about 445 km from Bangkok), with a population of 1.8 million. The setting was a health check-up clinic at Srinagarind Hospital, which is a teaching hospital of the University of Khon Kaen. Although the clinic was set up to serve the entire provincial population, the majority of clients who visit the clinic lived around the capital city of the province.

The present study was designed as a cross-sectional investigation. The present study was formally approved by the Ethics Committee of Khon Kaen University and written informed consent was obtained from each individual. From 2003, all men and women who came to the clinic for a health check-up were invited to provide basic clinical information for the present study. A total of 334 men and 350 women were included in the present study. Subjects who were taking medications for hypertension, diabetes, or dyslipidemia were excluded from the analysis. Ultimately, 307 men and 295 women were used in this analysis.

Measurements

Anthropometric data

Body weight (including light indoor clothing) was measured using an electronic balance (accuracy 0.1 kg) and standing height (without shoes) using a stadiometer (nearest 0.1 cm). Body mass index (BMI) was calculated the ratio of weight in kg divided by height in m^2.

Blood pressure

Systolic blood pressure was measured twice in the left arm and recorded after a participant had been seated and rested for 5 minutes. The average of the two measurements was then used for all analyses. Diastolic blood pressure was recorded at the fifth Korotkoff sound.

Laboratory measurements

Serum samples were collected in the morning after a participant had fasted for 12 hours prior to the clinic visit. Blood samples were immediately centrifuged. Measurements included fasting plasma glucose (FPG), total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C). Fasting plasma glucose levels were measured the glucose oxidase method. Serum total cholesterol, TG and HDL-C were measured by enzymatic methods using an automatic auto-analyzer (Cobas Integra 800; Roche Diagnostics, Mannheim, Germany).

Classification of MetS

The classification of MetS was based on the modified Adult Treatment Panel III (ATP III) Guidelines[14]. According to the APT III guideline, an individual is classified as having the syndrome if 3 or more of the following criteria were present: triglycerides $\geq$ 150 mg/dl, HDL cholesterol < 40 mg/dl in men or < 50 mg/dl in women, systolic blood pressure $\geq$ 130 mmHg or diastolic blood pressure $\geq$ 85 mmHg, fasting glucose $\geq$ 110 mg/dl, and waist circumference > 102 cm in men or > 88 cm in women. However, because waist circumference (WC) was not measured in all participants, therefore the IDF criterion could not be used in the present study. The authors decided to use the criterion of BMI $\geq$ 27 kg/m^2 for men and BMI $\geq$ 25 kg/m^2 for women in place of waist circumference criteria as specified in the ATP III[26]. These BMI criteria correspond to a percentage body fat of 25% in men and 35% in women, which are considered obese by international experts[26-28].

Statistical analysis

Descriptive statistics (e.g. mean and standard deviation) of each MetS components were calculated for each sex. The difference in each component between men and women was tested by unpaired t-test. The association among components of MetS was assessed by the Pearson's product moment correlation coefficient. The prevalence of MetS was estimated as the proportion of individuals with MetS within each age and sex stratum. Ninety-five percent confidence interval (95%CI) of the prevalence was constructed based on the assumption of binomial distribution. A p-value of less than 0.05 was considered statistically significant difference.

In a further analysis, a new MetS was defined without the BMI component, and the prevalence of the new MetS was estimated for each BMI category. The categorization of BMI was based on a previous paper[29], in which normal weight individuals were subdivided into four BMI groups: less then 18.5, between 18.5 and 20.9, between 21.0 and 24.9, 25.0 and 29.9 and $\geq$ 30 kg/m^2. All analyses were performed with the SAS system version 8.1 (SAS Institute, Cary: NC).

Results

Characteristics of study sample

Descriptive statistics on basic demographic characteristics (Table 1) show that there was no significant difference in age between men and women; however, as commonly observed, men were significantly taller and heavier than women. Nevertheless, BMI in men was not significantly different between men and women. Although fasting glucose, triglycerides, systolic and diastolic blood pressure were significantly higher in men, women had significantly higher HDL cholesterol than men.

When analyzed simultaneously, most components of the MetS were, in various magnitudes, correlated with one another (Table 2). In either men or women, while HDL cholesterol was negatively and significantly correlated with BMI and triglycerides, systolic and diastolic blood pressures were positively correlated with BMI, triglycerides and fasting glucose. Although fasting glucose was inversely related to HDL cholesterol, there was no significant correlation between fasting glucose and BMI in either gender.

Prevalence of various MetS components

When each component of the MetS was analyzed separately, the overall prevalence of BMI $\geq$ 27 kg/m^2 (men) and $\geq$ 25 kg/m^2 (women) was 21.8%, hypertriglyceridemia 32.7%, low HDL cholesterol 15.5%, high blood pressure 36.7%, and high fasting glucose 8% (Table 3). However, the prevalence varied according to gender, with men having a significantly higher prevalence of hypertriglyceridemia and higher fasting glucose, and women having a significantly higher prevalence of obesity, and low HDL cholesterol than

Table 1. Descriptive statistics of components of the metabolic syndrome for men and women in the sample

Variables	Men (n = 307)	Women (n = 295)	Difference and 95% confidence interval
Age (yr)	45.2 (9.9)	45.3 (9.9)	-0.1 (-1.7, 1.5)
Weight (kg)	66.2 (9.9)	56.4 (9.7)	9.7 (8.2, 11.3)
Height (cm)	166.0 (5.4)	154.9 (6.6)	11.1 (10.0, 12.0)
BMI (kg/m^2)	24.0 (3.3)	23.5 (4.2)	0.5 (-0.1, 1.1)
Triglycerides (mg/dL)	173.1 (113.5)	116.2 (88.9)	56.9 (40.5, 73.3)*
HDL-cholesterol (mg/dL)	52.5 (11.1)	57.5 (13.3)	-6.5 (-8.4, -4.5)*
Fasting glucose (mg/dL)	96.6 (28.6)	88.5 (14.8)	8.1 (4.4, 11.8)*
Systolic BP (mmHg)	121.7 (16.0)	117.9 (16.3)	3.8 (1.2, 15.3)*
Diastolic BP (mmHg)	80.1 (11.5)	77.9 (10.7)	2.2 (0.4, 10.5)*

Values shown in men and women are mean and standard deviation (in brackets)
* Statistically significance at $p < 0.05$

Table 2. Correlations between age and components of the metabolic syndrome

	Age	BMI	TG	HDL-C	FPG	Systolic BP	Diastolic BP
Age	.	0.05	-0.00	-0.13*	0.19*	0.24*	0.16*
BMI	_0.13*_	.	0.33*	-0.30*	0.09	0.30*	0.32*
TG	_0.36*_	_0.26*_	.	-0.38*	0.29*	0.23*	0.16*
HDL-C	_-0.19*_	_-0.23*_	_-0.38*_	.	-0.07	-0.08	-0.05
FPG	_0.28*_	_0.06_	_0.40*_	_-0.14*_	.	0.19*	0.12*
Systolic BP	_0.32*_	_0.28*_	_0.35*_	_-0.17*_	_0.11_	.	0.85*
Diastolic BP	_0.15*_	_0.32*_	_0.31*_	_-0.16*_	_0.10_	_0.80*_	.

Note: Correlation coefficients that are significantly different from 0 (at the p<0.05 level) is denoted by "*"
Normal figures: Men, Italic figures: women

Table 3. Prevalence of individual components of the metabolic syndrome stratified by sex and age

	N	BMI ≥ 27.0 (men) or ≥ 25.0 (women)	TG ≥ 150	HDL < 40 (men) or HDL < 50 (women)	BP ≥130/85	FPG ≥110
Total	602	21.8 (18.5-25.3)	32.7 (29.0-36.6)	15.5 (12.7-18.6)	36.7 (32.9-40.7)	8.0 (5.9-10.4)
Men	307	17.9 (13.8-22.7)	45.3 (39.6-51.0)	8.1 (5.3-11.8)	38.8 (33.3-44.5)	11.4 (8.1-15.5)
Women	295	25.8 (20.9-31.2)	19.7 (15.2-24.7)	23.1 (18.4-28.3)	34.6 (29.2-40.3)	4.4 (2.4-7.4)
Men						
20-39	95	14.7 (8.3-23.5)	42.1 (32.0-52.7)	6.3 (2.4-13.2)	30.5 (21.5-40.8)	7.4 (3.0-14.6)
40-49	127	18.1 (11.8-25.9)	47.2 (38.3-56.3)	6.3 (2.8-12.0)	33.9 (25.7-42.8)	10.2 (5.6-16.9)
50-59	52	26.9 (15.6-41.0)	51.9 (37.6-66.0)	15.4 (6.9-28.1)	51.9 (37.6-66.0)	13.5 (5.6-25.7)
60+	33	12.1 (3.4-28.2)	36.4 (20.4-54.9)	9.1 (1.9-24.3)	60.6 (42.1-77.1)	24.2 (11.1-42.3)
Women						
20-39	86	20.9 (12.9-31.0)	7.0 (2.6-14.6)	11.6 (5.7-20.3)	24.4 (15.8-34.9)	0.0
40-49	126	20.6 (13.9-28.7)	14.3 (8.7-21.6)	21.4 (14.6-29.6)	25.4 (18.1-33.9)	1.6 (0.2-5.6)
50-59	53	49.1 (35.1-63.2)	41.5 (28.1-50.2)	35.9 (23.1-50.2)	58.5 (44.1-71.9)	11.3 (4.3-23.0)
60+	30	20.0 (7.7-38.6)	40.0 (22.6-59.4)	40.0 (22.6-59.4)	60.0 (40.6-77.43)	16.7 (5.6-34.7)

Values are percentage and 95%CI

men. In each component, the prevalence generally increased with advancing age for either gender. For example, the prevalence of hypertension was 30% in men and 24% in women aged between 20 and 39 years, however among those aged 60+ years, the prevalence increased to 60% in men and women.

Prevalence of MetS

Based on the ATP III criteria (i.e. at least 3 abnormalities), the prevalence of MetS was 15%, with men having a higher prevalence (15.3%) than women (14.6%). The prevalence increased from 9.5% (in men) and 7% (women) among those aged 20-39 years to 24.7% (men) and 29.5% (women) among those aged 50 years or more (Table 4).

When the BMI component was excluded from the classification of MetS, the overall prevalence of "MetS-without-BMI" (defined by the presence of at least three abnormalities) was 7.8% (24/307) in men, virtually identical to women: 7.8% (23/295). However, the prevalence of MetS-without-BMI increased with higher BMI levels. The break-point of this gradient of increase was most pronounced when BMI was greater than 25 kg/m^2 (Fig. 1). Among those of BMI ≥ 25 kg/m^2, the prevalence of at least three MetS-without-BMI components was 34.2% in men and 42.1% in women, approximately 7-fold higher than that observed in those with BMI < 25 kg/m^2.

Discussion

Thailand is a typical developing country with rapid urbanization taking place in the entire nation. However, the documentation of health consequences in the population has been rather limited. To the au-

Table 4. Prevalence of one or more abnormalities of the metabolic syndrome stratified by sex and age

	N	≥ 1 abnormality	≥ 2 abnormalities	≥ 3 abnormalities	≥ 4 abnormalities	5 abnormalities
Total	602	64.6 (60.7-68.4)	31.4 (27.7-35.3)	15.0 (12.2-18.0)	3.7(2.3-5.5)	0.0
Men	307	70.4 (64.9-75.4)	33.2 (28.0-38.8)	15.3 (11.5-19.8)	2.6 (1.1-5.1)	0.0
Women	295	58.6 (53.0-64.3)	29.5 (24.3-35.0)	14.6 (10.7-19.1)	4.7 (2.6-7.8)	0.0
Men: Age						
20-39	95	64.2 (53.7-73.8)	26.3 (17.8-36.3)	9.5 (4.4-19.2)	1.1 (0.03-5.7)	0.0
40-49	127	68.5 (59.7-76.4)	30.7 (22.8-39.5)	13.4 (8.0-20.6)	3.1 (0.9-7.9)	0.0
50-59	52	78.8 (65.3-88.9)	50.0 (35.8-64.2)	26.9 (15.6-41.0)	3.8 (0.5-13.2)	0.0
60+	33	81.8 (64.5-93.0)	36.4 (20.4-54.9)	21.2 (15.6-41.0)	3.0 (0.1-15.7)	0.0
Women: age						
20-39	86	45.3 (34.6-56.4)	10.5 (4.9-18.9)	7.0 (2.6-14.6)	1.2 (0.1-6.3)	0.0
40-49	126	50.0 (41.0-59.0)	22.2 (15.3-30.5)	8.7 (4.4-15.1)	2.4 (0.5-6.8)	0.0
50-59	53	86.8 (74.7-94.5)	64.2 (49.8-76.9)	34.0 (21.5-48.3)	11.3 (4.3-23.0)	0.0
60+	30	83.3 (65.2-94.3)	53.3 (34.3-71.1)	26.7 (12.3-45.9)	13.3 (3.8-30.7)	0.0

Note: Figures in the first row were used BMI ≥ 27 kg/m^2 for men and ≥ 25 kg/m^2 for women
Values are percentage and 95%CI

Table 5. Prevalence of one or more abnormalities of the metabolic syndrome (without the obesity component) stratified by sex, age and BMI categories

Sex and BMI category	N	≥ 1 abnormality	≥ 2 abnormalities	≥ 3 abnormalities
Men				
< 18.5	51	45.1 (31.1-59.7)	9.8 (3.3-21.4)	3.9 (0.5-13.4)
18.5-20.9	71	60.6 (48.3-72.0)	16.9 (9.0-27.7)	2.8 (0.3-9.8)
21.0-24.9	73	65.8 (53.7-76.5)	23.3 (14.2-34.6)	6.8 (2.3-15.3)
25.0-29.9	101	85.1 (76.7-91.4)	44.6 (34.7-54.8)	10.9 (5.6-18.6)
≥ 30.0	11	81.8 (42.2-97.7)	45.5 (16.7-76.6)	36.4 (10.9-69.2)
All groups	307	68.1 (62.5-73.3)	27.4 (22.4-32.7)	7.8 (5.1-11.4)
Women				
< 18.5	79	31.6 (21.6-43.1)	8.9 (3.6-17.4)	1.3 (0.03-6.8)
18.5-20.9	71	40.8 (29.3-53.2)	12.7 (6.0-22.7)	5.6 (1.6-13.8)
21.0-24.9	69	62.3 (49.8-73.7)	24.6 (15.0-36.5)	8.7 (3.3-18.0)
25.0-29.9	58	70.7 (57.3-81.9)	41.4 (28.6-55.1)	15.5 (7.3-27.4)
≥ 30.0	18	72.2 (46.5-90.3)	44.4 (21.5-69.2)	16.7 (3.6-57.0)
All groups	295	51.2 (45.3-57.0)	22.0 (17.4-27.2)	7.8 (5.0-11.5)

Values are percentage and 95%CI

thors' knowledge, the present study was the first ever attempt to estimate the prevalence of MetS in the Thai population. By using the ATP III criteria, approximately 15% of men and women were classified as having MetS. However, among those aged 50+ years, almost a-quarter of men and a-third of women had the syndrome. With rapid urbanization taking place, it is expected that the prevalence of MetS is going to increase in the near future. The fact that a relatively high prevalence of at least 2 risk factors even in younger age groups (e.g. < 50 years old) is a cause for concern, because this group will have a prolonged exposure to proatherosclerotic risk factors associated with MetS.

The authors' estimate of MetS prevalence is very comparable to that from the Korean population (10% of men and 12% of women)[17], but is lower than that in the Chinese Hong Kong population among whom the prevalence was about 20%[18], or in the Malay population in Singapore whose prevalence was 25% in men and 24% in women[13]. Differences in

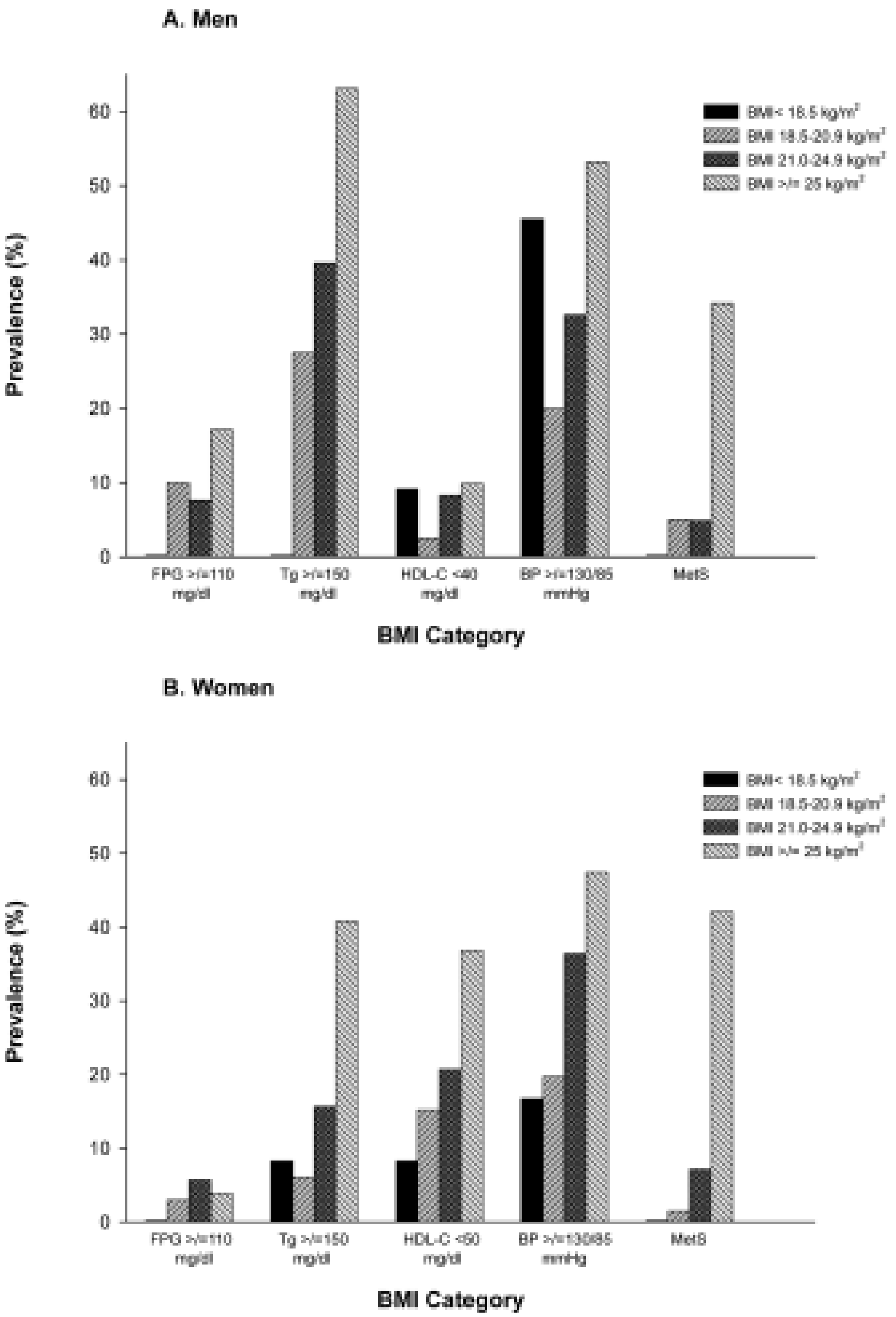

Fig. 1 Prevalence of various MetS components classified by BMI category for men (panel A) and women (panel B)

lifestyle factors and other ecologic factors could also account for part of the inter-ethnic difference in MetS prevalence. However, the difference is also likely due to the difference in definition of MetS, particularly in terms of the BMI cut-off. In the Korean study, the BMI $\geq$ 25 kg/m^2 criterion was used for both sexes with a resulting prevalence of 31% in men and 21% in women. In the present study, based on the authors' previous work[26,30], the authors used a BMI $\geq$ 27 kg/m^2 in men and BMI $\geq$ 25 kg/m^2 in women for defining obesity, which resulted in a prevalence of 18% in men and 26% in women. Had the authors used the BMI $\geq$ 25 criterion for both sexes, the prevalence of obesity in men and women would have been 36% and 26%, respectively and the prevalence of MetS would have been 18.9% in men and 14.6% in women.

Given the well-known association between obesity and metabolic disorders, it is perhaps not surprising to observe that the prevalence of hypertension, hyperlipidemia, hyperglycemia, and hypertriglyceridemia increased with higher BMI. The present data, however, further suggest that the increase was not linear, such that the break-point of the relationship was around the BMI of 25 kg/m^2. This confirms that the cut-off value for defining obesity in the Thai population should be lowered as has been suggested by previous studies[31-33]. The fact that only 5% of men and women with BMI < 25 kg/m^2 had MetS-without-BMI may suggest that BMI can be a useful replacement of waist circumference for the classification of MetS.

Nevertheless, the present findings must be interpreted within the context of a number of potential strengths and weaknesses. A major strength of the present study lies in its validity and sampling scheme. The sample size was reasonably large to allow for estimation of the prevalence of MetS. However, the study participants were Thai, among whom body size, lifestyles, cultural backgrounds and environmental living conditions are different from other populations. Since most of the participants came from semi-rural areas of Thailand, care should be taken when extrapolating these results to other populations. The measurement error of BMI could result in misclassification of obesity. In addition, BMI was measured at a single time point, which may not reflect a true long-term weight of a subject. Other laboratory measurements were also measured at a single time point. These two sources of measurement errors, albeit inevitable, could have affected the results, despite the fact that such a limitation is present in any study of this type.

In conclusion, the prevalence of MetS in this semi-rural Thai population, after allowing for sampling variability, is 15%, which is as common as in Caucasian populations. These data also confirmed that the BMI cut-off for defining obesity for Asian populations, particularly for the Thai population, should be lower than those in Caucasian populations.

Acknowledgements

The authors wish to thank the technicians at Srinagarind Hospital for the laboratory measurements.

References

1. Reaven GM. Role of insulin resistance in human disease. Diabetes 1988; 37: 1595-607.
2. Kaplan NM. The deadly quartet. Upper-body obesity, glucose intolerance, hypertriglyceridemia, and hypertension. Arch Intern Med 1989; 149: 1514-20.
3. Defronzo RA, Ferrannini E. Insulin resistance. A multifaceted syndrome responsible for NIDDM, obesity, hypertension, dyslipidemia, and atherosclerotic cardiovascular disease. Diabetes Care 1991; 14: 173-94.
4. Haffner SM, Valdez RA, Hazuda HP, Mitchell BD, Morales PA, Stern MP. Prospective analysis of the insulin-resistance syndrome (syndrome X). Diabetes 1992; 41: 715-22.
5. Isomaa B, Almgren T, Tuomi T, Forsen B, Lahti K, Nissen M, et al. Cardiovascular mobidity and mortality associated with the metabolic syndrome. Diabetes Care 2001; 24: 683-9.
6. Scuteri A, Najjar SS, Morrell CH, Lakatta EG. The metabolic syndrome in older individuals: prevalence and prediction of cardiovascular events: the Cardiovascular Health Study. Diabetes Care 2005; 28: 882-7.
7. Lakka HM, Laaksonen DE, Lakka TA, Niskanen LK, Kumpusalo E, Tuomilehto J, et al. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA 2002; 288: 2709-16.
8. Tenerz A, Norhammar A, Silveira A, Hamsten A, Nilsson G, Ryden L, et al. Diabetes, insulin resistance, and the metabolic syndrome in patients with acute myocardial infarction without previously known diabetes. Diabetes Care 2003; 26: 2770-6.
9. Malik S, Wong ND, Franklin SS, Kamath TV, L'Italien GJ, Pio JR, et al. Impact of the metabolic syndrome on mortality from coronary heart disease, cardiovascular disease, and all causes in United States adults. Circulation 2004; 110: 1245-50.
10. Bonora E, Kiechl S, Willeit J, Oberhollenzer F, Egger G, Bonadonna RC, et al. Metabolic syndrome: epidemiology and more extensive phenotypic description. Cross-sectional data from the Bruneck Study. Int J Obes Relat Metab Disord 2003; 27: 1283-9.
11. Rantala AO, Kauma H, Lilja M, Savolainen MJ, Reunanen A, Kesaniemi YA. Prevalence of the metabolic syndrome in drug-treated hypertensive patients and control subjects. J Intern Med 1999; 245: 163-74.

12. 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.
13. Tan CE, Chew SK, Ma S, Tai ES, Wai D. Can we apply the National Cholesterol Education Program Adult Treatment Panel definition of the metabolic syndrome to Asians? Diabetes Care 2004; 27: 1182-6.
14. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP). Expert Panel of Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). JAMA 2001; 285: 2486-97.
15. Alberti KG, Zimmet P, Shaw J, IDF Epidemiology Task Force Consensus Group. The metabolic syndrome - a new worldwide definition. Lancet 2005; 366: 1059-62.
16. 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.
17. Lee WY, Park JS, Noh SY, Rhee EJ, Kim SW, Zimmet PZ. Prevalence of the metabolic syndrome among 40,698 Korean metropolitan subjects. Diabetes Res Clin Pract 2004; 65: 143-9.
18. Chan JC, Cheung JC, Lau EM, Wooa J, Chan AY, Swaminathan R, et al. The metabolic syndrome in Hong Kong Chinese. The interrelationships among its components analyzed by structural equation modeling. Diabetes Care 1996; 19: 953-9.
19. Misra A, Vikram NK: Insulin resistance syndrome (Metabolic syndrome) and obesity in Asian Indians: Evidence and implications. Nutrition 1994; 20: 482-91.
20. Gupta R, Deedwania PC, Gupta A, Rastogi S, Panwar RB, Kothari K. Prevalence of metabolic syndrome in an Indian urban population. Int J Cardiol 2004; 97: 257-61.
21. Lear SA, Chen MM, Frohlich JJ, Birmingham CL. The relationship between waist circumference and metabolic risk fators: cohorts of European and Chinese descent. Metabolism 2002; 51: 1427-32.
22. Lin WY, Lee LT, Chen CY, Lo H, Hsia H, Liu IL, et al. Optimal cut-off values for obesity: using simple anthropometric indices to predict cardiovascular rik factors in Taiwan. Int J Obes Relat Metab Disord 2002; 26: 1232-8.
23. Li G, Chen X, Jang Y, Wang J, Xing X, Yang W, et al. Obesity, coronary heart disease risk factors and diabetes in Chinese: an approach to the criteria of obesity I the Chinese population. Obes Rev 2002; 3: 167-72.
24. Wang J, Thorton JC, Russell M, Burastero S, Heymsfield SB, Pierson RN Jr. Asians have lower body mass index (BMI) but higher percent body fat than do whites: comparisons of anthropometric measurements. Am J Clin Nutr 1994; 60: 23-8.
25. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004; 363: 157-63.
26. Pongchaiyakul C, Nguyen TV, Kosulwat V, Rojroongwasinkul N, Charoenkiatkul S, Pongchaiyakul C, et al. Defining obesity by body mass index in the Thai population: an epidemiologic study. Asia Pac J Clin Nutr 2006;15: 293-9.
27. World Health Organization. Obesity. Preventing and managing the global epidemic. Report on a WHO consultant on Obesity, Geneva, 3-5 June, 1997.
28. AACE/ACE Obesity Task Force. AACE/ACE position statement on the prevention, diagnosis, and treatment of obesity. Endocr Pract 1998; 4:297-330.
29. St-Onge MP, Janssen I, Heymsfield SB. Metabolic syndrome in normal-weight Americans. Diabetes Care 2004; 27:2222-8.
30. Pongchaiyakul C, Kosulwat V, Rojrungwasinsul N, Charoenkiatkul S, Thepsuthammarat K, Laopaiboon M, et al. Prediction of percent body fat in rural Thais using simple anthropometric measurements. Obesity Res 2005; 13:729-38.
31. Misra A, Wasir JS, Pandey RM. An evaluation of candidate definitions of the metabolic syndrome in adult Asian Indians. Diabetes Care 2005; 28: 398-403.
32. Chan WB, Tong PC, Chow CC, So WY, Ng MC, Ma RC, et al. The associations of body mass index, C-peptide and metabolic status in Chinese Type 2 diabetic patients. Diabet Med 2004; 21: 349-53.
33. Jia WP, Xiang KS, Chen L, Lu JX, Wu YM. Epidemiological study on obesity and its comorbidities in urban Chinese older than 20 years of age in Shanghai, China. Obes Rev 2002; 3: 157-65.

ความชุกของภาวะอ้วนลงพุงและความสัมพันธ์กับน้ำหนักในประชากรไทย

ฉัตรเลิศ พงษ์ไชยกุล, ทวน วี เหงี่ยน, เอกลักษณ์ วโนทยาโรจน์, นภาพร ครุสันธิ์, วิรัตน์ คลังบุญครอง

ภาวะอ้วนลงพุงเป็นปัญหาที่สำคัญในปัจจุบัน ซึ่งภาวะนี้เป็นปัจจัยเสี่ยงที่สำคัญของการเกิดไขมันอุดตันในหลอดเลือดและเกิดโรคทางระบบหัวใจและหลอดเลือดตามมา มีการศึกษาถึงความชุกของภาวะนี้อย่างมากมายในประชากรทางตะวันตก แต่ในประเทศไทยมีการศึกษาภาวะนี้น้อย ปัญหาสำคัญของการวินิจฉัยภาวะนี้ คือ เกณฑ์การวินิจฉัยที่แตกต่างกันตามแต่ละองค์กร โดยค่าเส้นรอบเอวเป็นเกณฑ์วินิจฉัยที่ยังมีปัญหาเนื่องจากค่ามีความแตกต่างกันตามเชื้อชาติ ปัจจุบันค่าที่ใช้ในแต่ละพื้นที่จึงแตกต่างกัน โดยข้อมูลส่วนใหญ่เป็นข้อมูลในคนตะวันตก สำหรับประเทศในทวีปเอเชียมีข้อมูลแตกต่างไปในแต่ละประเทศซึ่งมีความหลากหลายมาก ในประเทศไทยยังมีการรวบรวมข้อมูลน้อย เนื่องจากข้อมูลค่าเส้นรอบเอวไม่มีการบันทึกอย่างแพร่หลาย

ค่าดัชนีมวลกายปัจจุบันใช้เป็นเกณฑ์วินิจฉัยภาวะอ้วน ซึ่งสัมพันธ์โดยตรงกับค่าเส้นรอบเอวและความเสี่ยงในการเกิดโรคหัวใจและหลอดเลือดตามมาเช่นกัน การศึกษานี้จึงต้องการหาความชุกของภาวะอ้วนลงพุงในประชากรไทย โดยทำการศึกษาในผู้ที่มารับการตรวจสุขภาพที่คลินิกตรวจสุขภาพโรงพยาบาลศรีนครินทร์ ปี พ.ศ. 2546 - พ.ศ. 2547 โดยใช้ค่าดัชนีมวลกาย $\geq$ 27 kg/m^2 ในเพศชายและ $\geq$ 25 kg/m^2 ในเพศหญิงแทนค่าเส้นรอบเอว ซึ่งในประเทศไทยค่าดังกล่าวเทียบเท่ากับปริมาณไขมันในร่างกาย 25% ในเพศชายและ 35% ในเพศหญิงตามลำดับ

ผลการศึกษาพบความชุกของภาวะอ้วนลงพุง 15% ซึ่งไม่มีความแตกต่างระหว่างเพศชาย (15.3%) และเพศหญิง (14.6%). ค่าความชุกนี้เพิ่มตามอายุที่มากขึ้นทั้งในเพศชายและเพศหญิง เมื่อตัดค่าดัชนีมวลกายออกจากเกณฑ์วินิจฉัย ความชุกรวมโดยใช้เกณฑ์มากกว่า 3 ข้อที่เหลือจะพบความชุกเท่ากับ 7.8% อย่างไรก็ตามความชุกของภาวะอ้วนลงพุงที่ตัดเกณฑ์ดัชนีมวลกายออกยังสัมพันธ์กับค่าดัชนีมวลกายที่เพิ่มขึ้น โดยค่าดัชนีมวลกายที่ < 25 กก./ม^2 จะพบความชุก 4.6% ในเพศชายและ 5% ในเพศหญิง เทียบกับ 13% ในเพศชายและ 16% ในเพศหญิงเมื่อค่าดัชนีมวลกาย $\geq$ 25 กก./ม^2 โดยสรุปพบภาวะนี้ในประชากรไทย 15% ซึ่งพบบ่อยเช่นเดียวกับทางตะวันตก และความอ้วนเป็นส่วนประกอบที่สำคัญของภาวะอ้วนลงพุงในประชากรไทย