ORIGINAL ARTICLE

Prevalence of Obesity and Metabolic Syndrome in Taiwan

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Background/Purpose: Obesity and metabolic syndrome (MS) are major risk factors for the development of type 2 diabetes and cardiovascular diseases (CVD). This study estimated the prevalence of obesity and MS in Taiwan.

Methods: Data from a nationwide cross-sectional population-based survey of 5936 participants (2815 men, 3121 women; age range, 20–79.9 years) in 2002 were analyzed. Obesity was defined as a body mass index (BMI) ≥ 27 kg/m^2 according to the criteria of the Department of Health in Taiwan. The prevalence of MS was estimated using the definitions of the modified Adult Treatment Panel III (ATP III), the International Diabetes Federation for Chinese (MS-IDF(C)) and the MS criteria for Taiwanese (MS-TW).

Results: The overall prevalence of obesity in men was significantly greater than in women (19.2% *vs.* 13.4%, $p < 0.0001$). The age-standardized prevalence of MS was 15.7% by the modified ATP III criteria, 14.3% by the MS-IDF(C) criteria and 16.4% by the MS-TW criteria. The prevalence of obesity and MS significantly increased with age (trend test, $p < 0.0001$) in men and women. The risk of MS and its components increased significantly with BMI, and showed a marked increase with BMI ≥ 24 kg/m^2. MS as classified by the MS-IDF(C) criteria failed to identify subjects at high risk of CVD who did not have abdominal obesity, including those with hypertension, type 2 diabetes and dyslipidemia.

Conclusion: This study found a high prevalence of obesity and MS in Taiwan. The definitions of MS by the modified ATP III and MS-TW criteria were better able to detect high CVD risk than the MS-IDF(C) criteria. [*J Formos Med Assoc* 2006;105(8):626–635]

Key Words: body mass index, metabolic syndrome, obesity, prevalence

Obesity is an epidemic problem in the industrialized world and is also a growing problem in Taiwan.[1] The metabolic syndrome (MS) is a clustering of cardiovascular disease risk factors including dyslipidemia, hypertension, hyperglycemia and abdominal obesity.[2–5] Individuals with MS or obesity have increased incidence of diabetes mellitus and coronary heart disease, and increased mortality from cardiovascular diseases (CVD).[6–11] A widely used definition of this syndrome was originally released in the Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III [ATP III]) in 2000.[3] The waist circumference cutoff point in the ATP III criteria was subsequently revised as suggested by the 2000 World Health Organization (WHO) Asia Pacific Guidelines because the absolute risk of diabetes and CVD is higher in Asians who are less obese.[12–15] Two other definitions of MS from the Bureau of Health Promotion in Taiwan[16] and

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a consensus statement from the International Diabetes Federation[17] for Chinese were released in 2005. The recent Diabetes Prevention Program[18] demonstrated the effectiveness of lifestyle modification, changes in diet and physical activity in the resolution of MS. These findings illustrate the importance of identifying affected individuals and intervention to prevent disease progression. Assessment of the available diagnostic criteria sets for MS allows accurate identification of high risk clusters related outcomes, such as CVD or diabetes in different populations.

Data on the relationship between obesity and MS, and comparative study of the three different definitions of MS in Taiwanese adults are lacking. This study estimated the prevalence of MS and obesity in Taiwanese by age and sex, and examined the association between overweight, obesity and each of the components of MS. Results obtained using the modified ATP III, International Diabetes Federation Chinese version (MS-IDF(C)) and the MS criteria for Taiwanese (MS-TW) were compared and differences in the characteristics of patients meeting these different criteria sets for MS were assessed.

Methods

Subjects

In 2002, a total of 7566 subjects participated in a nationwide cross-sectional population-based survey, named the Taiwanese Survey on Prevalence of Hyperglycemia, Hyperlipidemia and Hypertension (TwSHHH). The sample of the TwSHHH was based on the National Health Interview Survey (NHIS) in 2001 that employed a multistaged, stratified and clustering sampling scheme.[19] The NHIS' Sampled Household Registration List covered 359 administrative districts that were divided into seven different strata according to geographic proximity. Households were sampled within strata using the probabilities proportional to size method. The final sample size was 26,685 non-institutionalized residents from 6592 households in 1648 communities. Half of the NHIS' Sampled Household Registration List (824 communities with 3296 households) in each stratum were randomly selected for the TwSHHH. All subjects gave written informed consent for participation. Subjects were excluded if they lacked a blood specimen ($n=973$), were older than 80 years ($n=100$) or younger than 20 years ($n=557$). The remaining 5936 subjects were included in the analyses. No significant differences in the prevalence of metabolic disorders were found between the study subjects and excluded subjects.

Data collection

Data on sociodemographic characteristics including sex, age, physical activity, menopausal status, dietary habits, family history of cardiovascular-related diseases, physician-diagnosed diseases and medication history were collected by nurses who administered a questionnaire during a home visit. During the visit, sitting blood pressure (BP) and anthropometric measurements were made. Two BP readings were taken 30 seconds apart in the right arm after the participant had sat and rested for 5–10 minutes. A third BP measurement was made if the first two BP readings differed by more than 10 mmHg. The average of the two closest readings was calculated and used in the analysis. Waist circumference was measured at the narrowest point with a tape measure placed parallel to the floor at the end of a relaxed expiration with the participants standing akimbo. NaF plasma was collected for fasting GLU analysis, and serum was collected for measurement of lipids. Blood samples were transported at −10°C in dry ice to the central laboratory, stored at −20°C and analyzed within 2 weeks. Fasting total cholesterol (Lieberman–Burchard method), triglyceride (TG) (Bucolo method) and fasting plasma glucose (FPG) (glucose oxidase method) were measured by an automated system (Vitros 550/750, Ortho-Clinical Diagnostics Inc., a Johnson and Johnson Company, Rochester, NY, USA). Electrophoresis was performed to measure high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C). Body mass index (BMI) was calculated as weight in kilograms divided by the square of the height in meters. BMI cutoffs

were adopted as suggested by the Department of Health in Taiwan including normal ($18.5 \leq$ BMI < 24), overweight ($24 \leq$ BMI < 27) and obese (BMI ≥ 27) categories.

Diagnostic criteria for MS

The definition of abdominal obesity was modified according to the 2000 WHO Asia Pacific Guidelines[20] as a waist circumference > 90 cm in men and > 80 cm in women. In this study, classification of MS according to the modified ATP III criteria for Asians[21] required meeting at least three of the following component risk factors: (1) waist circumference > 90 cm for men and > 80 cm for women; (2) TG ≥ 150 mg/dL; (3) HDL-C < 40 mg/dL for men and < 50 mg/dL for women; (4) systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg or current use of antihypertensive drugs; (5) FPG ≥ 110 mg/dL or current use of antihyperglycemic drugs. The components and criteria of the MS-TW[17] in this study were similar to the modified ATP III but in the component of obesity included BMI ≥ 27 kg/m^2, waist circumference > 90 cm for men and > 80 cm for women.

In this study, the MS-IDF(C)[18] criteria were abdominal obesity (defined as waist circumference > 90 cm for men and > 80 cm for women and any two of the following four factors: (1) TG ≥ 150 mg/dL; (2) HDL-C < 40 mg/dL for men and < 50 mg/dL for women; (3) systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg, or treatment of previously diagnosed hypertension; (4) FPG ≥ 100 mg/dL or a previous diagnosis of type 2 diabetes. We did not include dyslipidemia therapy in the criteria because of the inability to collect accurate information regarding this parameter by personal interview.

Statistical analysis

Data were analyzed using SAS version 8.02 (SAS Institute Inc., Cary, NC, USA). The criteria for statistical significance were $p < 0.05$ and a 95% confidence interval of odds ratios (OR) that excluded 1.

In 2001, the prevalence of MS was age-standardized by the Taiwanese population using a direct standardization method. The trend of prevalence of obesity or MS in different age groups was tested by Cochran–Armitage trend test. Comparison of the prevalence of MS and its components among different BMI categories was performed by logistic regression analyses with adjustment for age, serum LDL-C level, exercise habit, alcohol drinking and smoking status. Logistic regression was also used to test for trends of ORs of BMI categories of MS and its components. Study subjects with normal BMI served as controls.

Results

Sample characteristics

The number of subjects with adequate data for inclusion in all of the statistical analyses was 5936 (men/women, 2815/3121). The mean age of these subjects was 44.7 ± 15.0 years (range, 20–79.9 years) and mean BMI was 23.7 ± 3.7 kg/m^2 (24.3 ± 3.5 in men and 23.1 ± 3.8 in women). The characteristics of the study sample are summarized in Table 1. There was a high prevalence of individual components of MS in this study sample, including abdominal obesity in 30.2%, high TG in 27.6%, low HDL-C in 23.8%, high BP in 29.9%, impaired FPG (FPG ≥ 110 mg/dL) or taking antihyperglycemic medication in 10.6%, and FPG > 100 mg/dL or previously diagnosed type 2 diabetes in 18.4% (Table 1). High BP was the most commonly identified metabolic component in men, while abdominal obesity was the most common in women. Men had a higher prevalence of high TG ($p < 0.0001$), high BP ($p < 0.0001$) and high FPG ($p < 0.05$) than women. The frequencies of low HDL-C concentration ($p < 0.0001$) were higher in women than men. The majority of participants (61.4%) had one or more metabolic risk factors.

Prevalence of overweight, obesity and abdominal obesity

Figure 1 shows the sex- and age-specific prevalence of abdominal obesity, overweight and obesity. Men had significantly higher prevalence of

Table 1. Characteristics of the study sample

	Total subjects ($n = 5936$)	Men ($n = 2815$)	Women ($n = 3121$)	p
Age (yr)	44.7 ± 15.0	45.0 ± 15.4	44.4 ± 14.7	0.1013
BMI (kg/m^2)	23.7 ± 3.7	24.3 ± 3.5	23.1 ± 3.8	< 0.0001
Overweight (%), 24 ≤ BMI < 27	25.8	30.5	21.3	< 0.0001
Obesity (%), BMI ≥ 27	16.4	19.2	13.4	
Waist circumference (cm)	80.5 ± 10.9	84.4 ± 10.2	76.3 ± 10.0	< 0.0001
W/H ratio	0.83 ± 0.08	0.87 ± 0.07	0.79 ± 0.07	< 0.0001
Systolic BP (mmHg)	116 ± 18.2	119.3 ± 16.6	112.9 ± 18.9	< 0.0001
Diastolic BP (mmHg)	75.5 ± 11.3	78.4 ± 10.9	72.8 ± 10.9	< 0.0001
FPG	95.3 ± 30.0	96.1 ± 30.5	94.6 ± 29.4	0.0593
TG	130.7 ± 87.0	148.3 ± 97.5	115.1 ± 72.9	< 0.0001
HDL-cholesterol (mg/dL)	55.4 ± 15.3	51.3 ± 15.1	59.2 ± 14.4	< 0.0001
Abdominal obesity* (%)	30.2	29.5	30.8	0.2606
High TG level (%)	27.6	35.2	20.7	< 0.0001
Low HDL-cholesterol level (%)	23.8	22.5	25.1	0.019
High BP (%) or taking medication	29.9	36.6	23.9	< 0.0001
High FPG ≥ 110 mg/dL (%) or taking medication	10.6	11.5	9.8	0.0362
High FPG ≥ 100 mg/dL (%) or taking medication	18.7	20.0	17.5	0.0143

**Asian criteria: waist circumference > 90 cm in men, > 80 cm in women. BMI = body mass index; W/H ratio = waist/hip circumference ratio; BP = blood pressure; FPG = fasting plasma glucose; TG = triglyceride; HDL = high-density lipoprotein (< 40 mg/dL in men, < 50 mg/dL in women).*

overweight (BMI 24–26.9 kg/m^2) and obesity (BMI ≥ 27 kg/m^2) than women (overweight, 30.5% *vs.* 21.3%, $p < 0.0001$; obesity, 19.2% *vs.* 13.4%, $p < 0.0001$). However, the overall prevalence of abdominal obesity in men and in women was similar. Based on the 2000 WHO Asia Pacific Guidelines, the age-standardized prevalence of abdominal obesity was 28.3% in men and 28.7% in women, and increased with age in men and women (trend test, $p < 0.0001$). The prevalence of abdominal obesity in women increased rapidly after the menopausal period and was higher in men, but showed a crossover beyond the age group of 50–59 years, becoming higher in women. The prevalence of abdominal obesity differed from that of the obesity categories of BMI. In young and middle-aged adults, the frequency of overweight and obesity (BMI ≥ 24 kg/m^2) was greater than that of abdominal obesity, but this relationship was opposite beyond the age group of 50–59 years in women. The cutoff values of waist circumference corresponding to the highest sensitivity and specificity in BMI ≥ 27 kg/m^2 were 89.6 cm in men and 80.2 cm in women, respectively. These cutoff values of waist circumference were similar to the criteria of the 2000 WHO Asia Pacific Guidelines as a waist circumference > 90 cm in men and > 80 cm in women.

Prevalence of MS

The age-standardized prevalence of MS using the three different criteria sets was as follows: modified ATP III criteria, 15.7% (18.3% in men, 13.6% in women); MS-TW, 16.4% (19.5% in men, 13.8% in women); MS-IDF(C), 14.3% (16.1% in men, 13.3% in women). The prevalence of MS increased with age (trend test, $p < 0.0001$), reaching peak levels in the 7th decade of life for both men and women. The prevalence of MS in the overall group increased from 5.2% in the 20–29-year-old group to 36.5% in the 70–79-year-old group. Figure 2 shows the sex- and age-specific prevalence of MS as well as the overall frequencies using the three different definitions of the modified ATP III, MS-TW and MS-IDF(C) criteria. The prevalence of MS in women increased

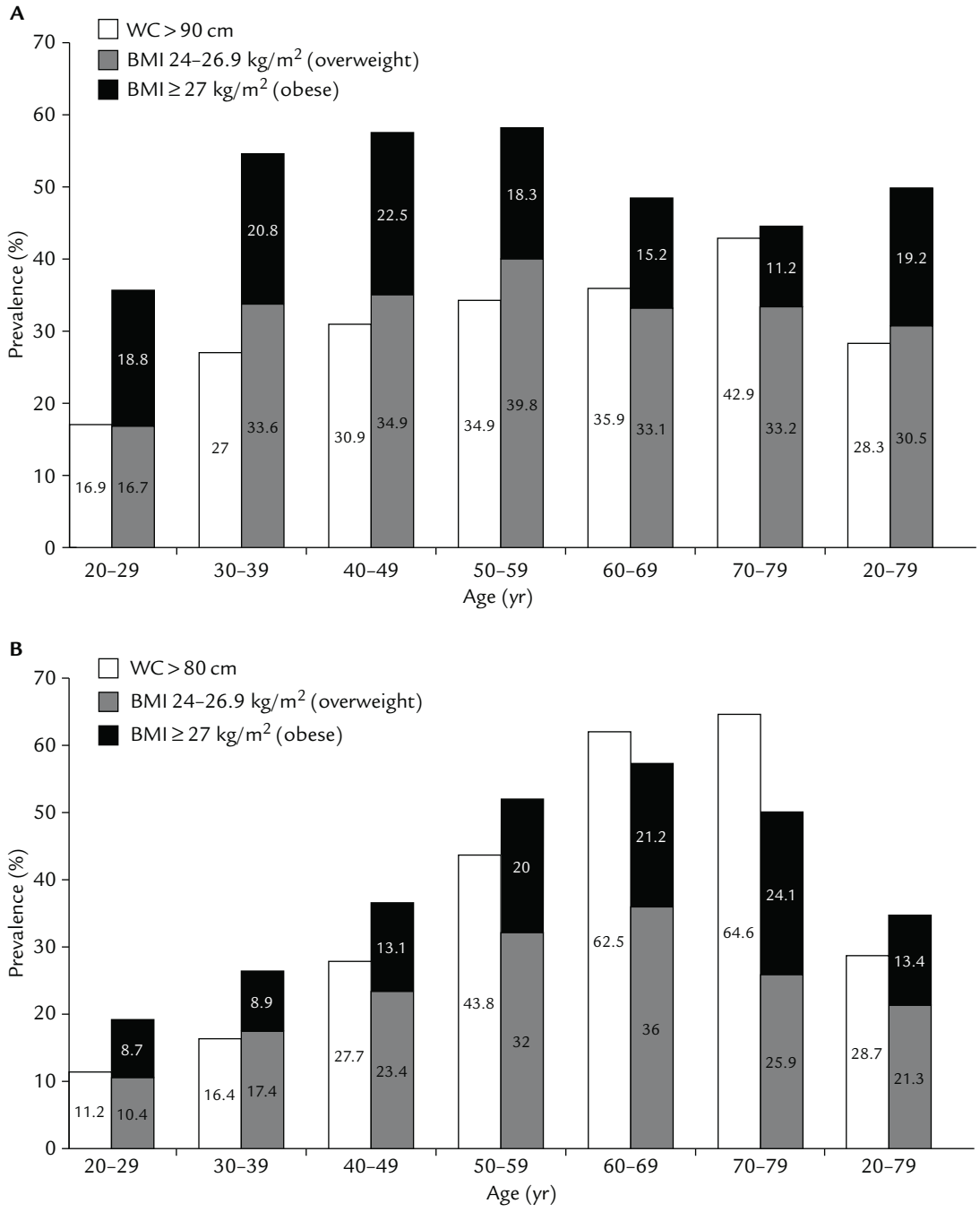

Figure 1. Age-specific prevalence of overweight, obesity and abdominal obesity in (A) men, and (B) women. Abdominal obesity = waist circumference > 90 cm in men and > 80 cm in women. BMI = body mass index; WC = waist circumference.

rapidly after the menopausal period becoming higher than in men, resulting in a crossover point at the age group of 60–69 years by gender.

The relative frequencies of the individual components of MS by sex and BMI are shown in Table 2. Higher categories of BMI were significantly associated with a greater proportion of MS and with each component, including abdominal obesity, high TG, low HDL-C, high BP and high FPG in both men and women.

MS was found primarily in those subjects who were overweight or obese. Only 6.5% of subjects with a healthy body weight ($18.5 \leq$ BMI < 24 kg/m^2) had MS according to MS-TW criteria,

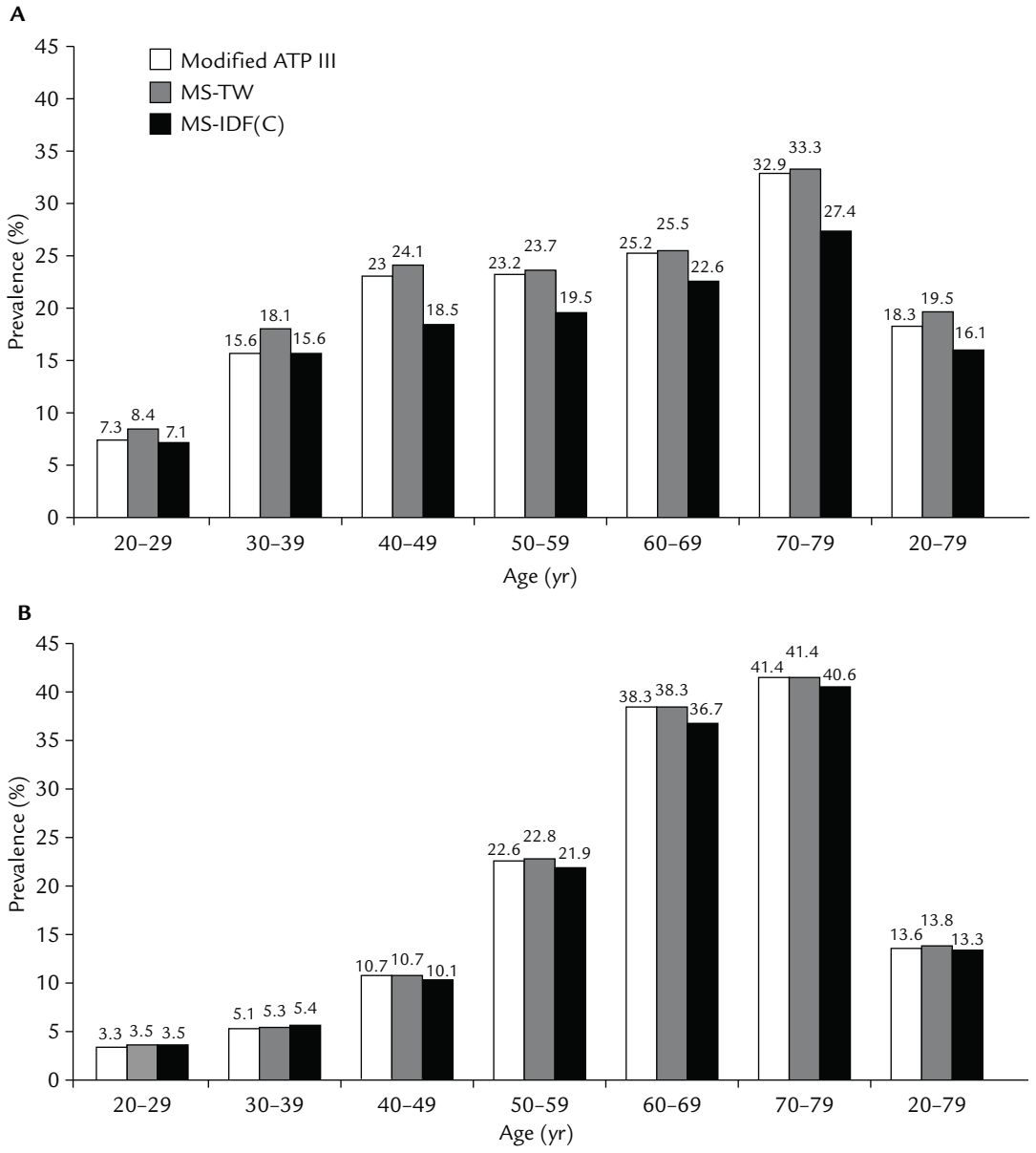

Figure 2. Age-specific percentage of the metabolic syndrome in (A) men, and (B) women according to three criteria sets. ATP III = Adult Treatment Panel III; MS-TW = metabolic syndrome definition by Taiwan criteria; MS-IDF(C) = metabolic syndrome definition by the International Diabetes Federation criteria for Chinese.

in contrast to rates of 50.2% among subjects with BMI > 27. A substantial increase in the prevalence odds of MS was observed with increasing levels of BMI. ORs of MS and its components increased progressively in association with BMI ≥ 24 kg/m^2. If the risk of MS with BMI of 18.5–24 kg/m^2 was defined as 1.0, then the ORs were 2.07–3.79 with BMI of 24–26.9 kg/m^2, and 6.24–17.3 with BMI > 27. ORs of overweight or obesity for MS in women were higher than in men, regardless of the criteria used.

Comparison of the three definitions of MS

The characteristics of subjects with discordant classification among the three different criteria sets for MS are shown in Table 3. The modified ATP III and MS-TW criteria for MS were met by 173 subjects who did not meet the MS-IDF(C) criteria. These subjects did not meet the abdominal obesity requirement of the MS-IDF(C), but had other risk components, a history of hypertension or type 2 diabetes, which led to the MS classification by the other criteria sets. In contrast, the

Table 2. Prevalence and age-adjusted odds ratios for metabolic syndrome and its components by categories of body mass index (kg/m^2)

	BMI categories						*p* for trend
	18.5–23.9		24.0–26.9		≥ 27		
	%	OR (95% CI)	%	OR (95% CI)	%	OR (95%CI)	
Men							
Abdominal obesity* (%)	6.5	1.0	34.8	5.33 (4.18–6.78)	79.2	51.04 (37.39–69.66)	< 0.0001
High TG (%)	23.2	1.0	43.3	2.18 (1.79–2.64)	56.7	3.41 (2.72–4.28)	< 0.0001
Low HDL-C (%)	15.0	1.0	27.9	2.25 (1.82–2.79)	34.6	3.25 (2.55–4.15)	< 0.0001
High blood pressure (%)	27.4	1.0	41.4	1.59 (1.31–1.94)	48.7	2.77 (2.20–3.50)	< 0.0001
High FPG ≥ 110 mg/dL (%)	6.5	1.0	14.2	1.92 (1.45–2.60)	16.9	2.80 (2.03–3.87)	< 0.0001
High FPG ≥ 100 mg/dL (%)	13.0	1.0	23.3	1.72 (1.37–2.17)	29.7	2.81 (2.17–3.65)	< 0.0001
Modified ATP III (%)	6.5	1.0	23.7	3.09 (2.40–3.99)	44.1	9.22 (6.98–12.16)	< 0.0001
MS-TW (%)	6.5	1.0	23.7	3.06 (2.38–3.95)	50.5	11.97 (9.08–15.77)	< 0.0001
MS-IDF(C) (%)	3.3	1.0	18.5	3.79 (2.81–5.11)	45.5	17.3 (12.62–23.72)	< 0.0001
Women							
Abdominal obesity* (%)	8.9	1.0	48.6	5.08 (4.05–6.36)	88.9	61.44 (41.89–90.10)	< 0.0001
High TG (%)	12.2	1.0	28.0	1.74 (1.38–2.19)	39.5	2.87 (2.21–3.73)	< 0.0001
Low HDL-C (%)	21.6	1.0	27.3	1.26 (1.02–1.55)	32.1	1.60 (1.25–2.04)	< 0.0001
High blood pressure (%)	14.1	1.0	31.0	1.53 (1.21–1.94)	42.4	2.80 (2.13–3.68)	< 0.0001
High FPG ≥ 110 mg/dL (%)	4.7	1.0	11.3	1.26 (0.92–1.74)	21.1	2.68 (1.94–3.69)	< 0.0001
High FPG ≥ 100 mg/dL (%)	10.0	1.0	22.5	1.49 (1.16–1.90)	33.6	2.63 (2.01–3.45)	< 0.0001
Modified ATP III (%)	4.5	1.0	20.2	2.08 (1.58–2.71)	40.2	6.24 (4.68–8.31)	< 0.0001
MS-TW (%)	4.5	1.0	20.2	2.07 (1.58–2.72)	41.0	6.48 (4.87–8.63)	< 0.0001
MS-IDF(C) (%)	2.8	1.0	21.6	2.95 (2.24–3.89)	48.4	10.00 (7.45–13.45)	< 0.0001

**Asian criteria: waist circumference > 90 cm in men, > 80 cm in women. BMI = body mass index; OR = odds ratio; CI = confidence interval; TG = triglyceride; HDL-C = high-density lipoprotein cholesterol (< 40 mg/dL in men, < 50 mg/dL in women); FPG = fasting plasma glucose; ATP III = Adult Treatment Panel III; MS-TW = metabolic syndrome by Taiwan criteria; MS-IDF(C) = metabolic syndrome by International Diabetes Federation criteria for Chinese.*

MS-IDF(C) criteria were met by 81 subjects with abdominal obesity and with FPG in the range of 100–109 mg/dL who did not meet the requirements of the modified ATP III and MS-TW criteria.

The MS-TW criteria were met by 35 more subjects than the modified ATP III, including 11 with a history of hypertension, one with a history of diabetes, one with a history of stroke and four with a history of heart disease.

Discussion

This cross-sectional population study found that overweight, obesity and MS were common among Taiwanese adults. BMI ≥ 27 kg/m^2 was found in 19.2% of men and 13.4% of women. The three criteria sets for MS were met by the following percentages of subjects: modified ATP III criteria by 18.3% of men and 13.6% of women; MS-IDF(C) by 16.1% of men and 13.3% of women; MS-TW by 19.5% of men and 13.8% of women. The prevalence of MS increased directly with the degree of obesity. Moreover, each component of this syndrome significantly decreased with increasing BMI categories. Comparison of the findings using the three criteria sets for MS revealed that the MS-IDF(C) criteria underestimated the combination of all risk components of the modified ATP III or MS-TW criteria except for abdominal obesity.

Prevalence of obesity

An increase in the prevalence of overweight and obesity has been noted in most Asian countries during the last two decades.[13,14] There is currently an epidemic of obesity in Taiwan. The BMI ranges

Table 3. Characteristics of subjects with discordant metabolic syndrome (MS) classification by the three criteria sets

	Discordant MS classification ($n = 289$)						
Modified ATP III	(+)	(+)	(–)	(+)	(–)	(–)	*p*
MS-TW	(–)	(–)	(+)	(+)	(–)	(+)	
MS-IDF(C)	(–)	(+)	(+)	(–)	(+)	(–)	
n	0	0	0	173	81	35	
Female (%)				30.6	54.3	8.6	< 0.001
Age ≥ 50 yr (%)				55.5	62.9	14.3	< 0.001
Obesity, BMI ≥ 27 kg/m^2 (%)				6.7	47.2	100.0	< 0.001
History of DM (%)				34.1	0.0	2.9	< 0.001
History of HTN (%)				68.2	50.6	31.4	< 0.001
Increased WC (%)				0.0	100.0	0.0	< 0.001
Increased TG (%)				95.9	27.2	91.4	< 0.001
Low HDL-C (%)				82.7	11.1	51.4	< 0.001
High blood pressure (%)				89.0	61.7	45.7	< 0.001
FPG ≥ 110 mg/dL (%)				45.7	0.0	11.4	< 0.001
FPG ≥ 100 mg/dL (%)				54.3	100.0	22.9	< 0.001

ATP III = Adult Treatment Panel III; MS-TW = metabolic syndrome by Taiwan criteria; MS-IDF(C) = metabolic syndrome by International Diabetes Federation criteria for Chinese; BMI = body mass index; DM = diabetes mellitus; HTN = hypertension; Increased WC = waist circumference > 90 cm in men and > 80 cm in women; TG = triglyceride; Low HDL-C = low high-density lipoprotein cholesterol (< 40 mg/dL in men and < 50 mg/dL in women); FPG = fasting plasma glucose.

for overweight and obesity recommended by the Department of Health in Taiwan are 24–26.9 and ≥ 27 kg/m^2, respectively, and are lower than the ranges of 25–29.9 and ≥ 30.0 kg/m^2 in the WHO classification. The National Nutrition and Health Survey in Taiwan conducted from 1993 to 1996 reported that the prevalence of obesity was 10.5% for men and 13.2% for women.[1] The results of this cross-sectional survey conducted in 2002 show that the prevalence in men has increased dramatically to 19.2% while remaining comparatively unchanged in women at 13.4%. Whereas the peak prevalence of obesity in men was in the age group of 40–49 and then declined slightly, women showed a continuously increasing prevalence of obesity with age. In general, the prevalence of abdominal obesity increased until the age of 70–79 years in both men and women, and this increase was most obvious in postmenopausal women.

In comparison with Caucasians, Asians have a much lower reported prevalence of obesity, but the clustering of cardiovascular risk factors is thought to occur in this relatively lean population as well.[22–26] Reported clustering metabolic conditions include BMI > 23 kg/m^2 in China,[12,15] BMI 25–29.9 kg/m^2 in Japan,[25] BMI 21.9–23.8 kg/m^2 in Korea,[26] and BMI ≥ 23.6 in men and ≥ 22.1 kg/m^2 in women in Taiwan.[24]

Prevalence of MS

A wide variation in the prevalence of MS has been reported in different studies. The Bruneck Study in Italy found that 34.1% of subjects met the WHO criteria for MS, while only 17.8% met the ATP III criteria.[27] The Third National Health and Nutrition Examination Survey (NHANES III), which included 8608 participants, found that the prevalence of MS was 23.9% using the ATP III definition and 25.1% using the WHO definition, resulting in an 86.2% agreement rate.[28] The discrepancies in the prevalence of MS in various studies are mainly attributable to differences in the definitions of this syndrome and also in its components, as well as to differences in the characteristics of the populations studied.[29–32] A study in Shanghai found that the low prevalence of MS of 10.2% using the WHO diagnostic criteria was attributable to the low prevalence of obesity.[12] The prevalence of MS might increase if the Asian criteria for abdominal obesity were adopted. Studies of MS prevalence in other countries using the modified ATP III criteria found rates of 19.2%

in men and 16.4% in women in Singapore,[33] and 20.8% in men and 26.9% in women in Korea.[34] In this nationwide cross-sectional study from Taiwan, the age-standardized prevalence of MS was 15.7% by the modified ATP III criteria, 14.3% by the MS-IDF(C) criteria, and 16.4% by the MS-TW criteria. These prevalences are all slightly lower than those reported from other Asian countries.[15,26,33,34] A new diagnostic criteria for MS recently released by the American Heart Association (AHA) and the National Heart, Lung and Blood Institute[35] is similar to the ATP III criteria, but criteria of high FPG is ≥ 100 mg/dL. In this study, analyzing with a version of the AHA definition modified using Asian criteria for waist circumference resulted in a prevalence of MS in Taiwan of 20.4% in men and 15.3% in women aged 20–79 years.

Regardless of which of the three criteria sets for MS was used, MS prevalence increased with age and reached its peak in the 7th decade of life for men and for women. This finding is in agreement with the results of the NHANES III survey in the United States and a study of nondiabetic European men and women by the DECODE Study Group.[36] The prevalence of MS in women increased rapidly after the menopausal period and became higher than in men, with a crossover point in the 50–59 years age group and with a more obviously increasing slope in women in the age range of 50–69 than in men. The increase in CVD risk after menopause[37] may be related to the substantial metabolic changes that occur as women transition from premenopause to postmenopause. In many women, the features of MS (abdominal adiposity, insulin resistance and dyslipidemia) emerge in conjunction with estrogen deficiency.

Relationship between obesity and MS

This study found that the degree of excess weight as measured by BMI was a strong predictor of MS, with strong associations observed between BMI and the individual components of MS. The risks of MS and its components significantly increased with BMI categories in men and women, and were markedly increased in adults with BMI ≥ 24 kg/m^2. A strong association between obesity and CVD risk factors was also found in the Elderly Nutrition and Health Survey in Taiwan conducted from 1999 to 2000.[38]

Comparison of MS prevalence using different criteria

Comparison of the different criteria sets for MS in this study revealed that, due to the absence of abdominal obesity, 173 subjects with clustering of CVD risk factors including type 2 diabetes (34.1%) and hypertension (68.2%) did not meet the MS-IDF(C) criteria. Thus, use of these criteria in Taiwan might lead to underestimation of the risk of CVD. The prevalence of MS was the highest with the MS-TW criteria, which included BMI ≥ 27 kg/m^2 and waist circumference criteria for obesity, thereby identifying more subjects with clustering of CVD risk factors than the modified ATP III or MS-IDF(C) criteria.

In conclusion, this study of a representative cross-sectional sample of adult Taiwanese showed that overweight, obesity and MS are common and that these conditions are strongly associated. These findings underscore the urgent need to develop comprehensive efforts directed at controlling the obesity epidemic in Taiwan.

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