Comparison of the Prevalence of Metabolic Syndrome Between the Criteria for Taiwanese and Japanese and the Projected Probability of Stroke in Elderly Hypertensive Taiwanese

Ta-Chuan Hung[1,2], Chun-Yen Chen[1,2], Shih-Jung Cheng[1,3], Chung-Hsiang Liu[3], Hung-I Yeh[1,4]*

[1]Department of Internal Medicine, Mackay Memorial Hospital, [2]Mackay Medicine, Nursing and Management College, [3]Faculty and Institute of Physical Therapy, National Yang-Ming University, Taipei, [4]Department of Neurology, China Medical University Hospital, Taichung, and [5]Mackay Medical College, Taipei, Taiwan.

SUMMARY

Background: The cutoff of abdominal circumference for metabolic syndrome (MS) defined by the Bureau of Health Promotion (BHP) of Taiwan for Taiwanese (men, 90 cm; women, 80 cm) and by the International Diabetes Federation (IDF) for Japanese (men, 85 cm; women, 90 cm) differs. This study aimed to examine the impact of this difference on the prevalence of MS and the impact of an MS diagnosis on the projected risk of stroke in hypertensive Taiwanese.

Methods: MS was examined in a sample of 3,472 hypertensive patients (aged 55–80 years; 1,709 women) across Taiwan. The 10-year probability of stroke estimated from the Framingham equation was compared between MS and non-MS patients.

Results: The prevalence of MS using the BHP criteria was 59.2% using the BHP criteria (95% confidence interval, CI, 57.6–60.8%; men, 52.5%; women, 66.1%) and 48.9% by the IDF criteria (95% CI, 47.2–50.5%; men, 61.3%; women, 36.1%). Both criteria showed that, compared with non-MS, MS has higher predicted 10-year probability of stroke (BHP, 0.153 ± 0.115 vs. 0.133 ± 0.105; IDF, 0.159 ± 0.109 vs. 0.132 ± 0.112; both $p < 0.001$) because of the difference in women (BHP, 0.143 ± 0.124 vs. 0.102 ± 0.091; IDF, 0.147 ± 0.121 vs. 0.118 ± 0.110; both $p < 0.001$) rather than men (BHP, $p = 0.21$; IDF, $p = 0.29$).

Conclusion: Both criteria demonstrate that MS is highly prevalent in elderly hypertensive patients in Taiwan. Additionally in women, but not men, the predicted probability of stroke is higher in MS than in non-MS patients. The diagnosis of MS is potentially useful for identifying elderly hypertensive females with an elevated risk of stroke in Taiwan. [International Journal of Gerontology 2009; 3(4): 233–240]

Key Words: elderly, hypertension, metabolic syndrome

Introduction

The definition of metabolic syndrome (MS) helps to identify people at risk for cardiovascular diseases in the western world[1–4] as well as in Taiwan[5,6]. Recent studies showed that the prevalence of MS among a number of Asian populations has been increasing rapidly[7,8]. However, the criteria used by different countries are not the same. Since the introduction of five components for MS in 2001 by the National Cholesterol Education Program[9], major changes in the evolution of the MS criteria defined by different societies/organizations have lowered the cutoff point for fasting glucose and the ethnic-specific cutoff point of waist circumference for central (abdominal) obesity[10,11]. In addition, the criteria

**Correspondence to:* Dr Hung-I Yeh, Department of Internal Medicine, Mackay Memorial Hospital, 92, Section 2, Chung San North Road, Taipei 10449, Taiwan.
E-mail: hiyeh@ms1.mmh.org.tw
Accepted: October 23, 2009

updated by the International Diabetes Federation (IDF) in 2005 emphasized central obesity as a mandatory component[10]. For the same population at the same time period when the cutoff point for fasting glucose is lowered, the prevalence of MS should increase, but the relative risk of MS to predict cardiovascular diseases may decrease. However, the effects of ethnic-specific criteria for waist circumference on the prevalence of MS and the impact of an MS diagnosis on the projected risk for stroke in elderly hypertensive patients remain unclear.

Geographically, Taiwan and Japan are close and have similar cultures, in terms of food and lifestyle, which are intimately linked to the pathogenesis of cardiovascular disease. In addition, in both countries, the burden of cerebrovascular disease exceeds that of ischemic heart disease. However, the 2005 IDF cutoff point of waist circumference for central obesity varies between the two countries[12]. In addition, the official criteria currently used in Taiwan do not consider central obesity a mandatory component. Since age and hypertension are well-known risk factors for stroke and MS has been shown useful for risk stratification of cardiovascular disease[13], it is important to examine which criteria of MS predicts stroke better in elderly people with hypertension. To this end, we compared the prevalence of MS, the risk factor distribution, and the projected probability of stroke using the Framingham equation[14] in elderly hypertensive Taiwanese between the two criteria.

Methods

The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in *a priori* approval by the Joint Institution Review Board, Taiwan. Informed consent was obtained from each patient.

Subjects

From November 2005 to July 2006, a total of 3,775 patients participating in the LIFE in life survey constituted the database of this study. Entry criteria into the survey included men or women who were Taiwanese residents, aged 55–80 years, and had been diagnosed hypertension, and were routinely taking antihypertensive medications, or with objective evidence of target organ damages. Patients were excluded from the survey if they had secondary hypertension of any etiology. All participants were receiving care in the outpatient department of 35 study sites, including eight medical centers, 19 regional hospitals and eight area hospitals, and involving 24 cardiology specialists, 13 neurology specialists and one internist. At each site, participants were randomly selected by the doctor from his/her outpatient hypertensive patient pool.

Data collection

Baseline characteristic data, including sex and age, and duration of hypertension or antihypertensive therapy as well as other medication and exercise habit were collected. Height, weight, waist circumference, and blood pressure were measured. Heart murmur and carotid bruit were checked. All participants underwent standard 12-lead electrocardiographic examination. Overnight fasting blood was analyzed to determine the levels of sugar, high-density lipoprotein (HDL)-cholesterol, triglycerides, uric acid, and creatinine, all of which were examined no earlier than 3 months before the enrollment. Traditional cardiovascular risk factors, including smoking, diabetes and family history of premature cardiovascular disease, were sought. In addition, previous diagnoses of stroke and/or transient ischemic attack, congestive heart failure, myocardial infarction, angina, murmur, left ventricular hypertrophy, and atrial fibrillation were recorded.

Comparison of risk burden according to different MS criteria

The presence of MS was defined by the Bureau of Health Promotion (BHP), Department of Health, Taiwan, according to the current Taiwan criteria updated in 2007, which require three or more of the five components listed below, and by the International Diabetes Federation (IDF) for Japanese, as announced in 2005 using central obesity as a mandatory component plus two other components. The presence of central obesity according to the BHP definition is a waist circumference ≥ 90 cm for men and ≥ 80 cm for women, in contrast to ≥ 85 cm for men and ≥ 90 cm for women by the IDF definition (Table 1). All the other cutoff points are the same and are as follows: (1) fasting glucose ≥ 100 mg/dL or use of antidiabetic drugs; (2) HDL-cholesterol < 40 mg/dL for men and < 50 mg/dL for women; and (3) triglycerides ≥ 150 mg/dL. For blood pressure, all the enrolled subjects had hypertension or were treated with antihypertensive drugs. The 10-year probabilities of stroke, estimated from the Framingham study[14], were compared between MS and non-MS patients using both

Table 1. *Components distribution and prevalence of metabolic syndrome (MS)**

	Men ($n=1,763$)	Women ($n=1,709$)	Total ($n=3,472$)	p
Abdominal circumference†				
BHP (men, ≥90 cm; women, ≥80 cm)	62.2	81.3	71.6	<0.001
IDF (men, ≥85 cm; women, ≥90 cm)	82.8	44.2	63.7	<0.001
Triglyceride ≥ 150 mg/dL‡	35.7	40.2	37.9	0.11
HDL-cholesterol (men, <40 mg/dL; women, <50 mg/dL)§	29.7	41.2	35.5	<0.001
Systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg, or current use of antihypertensive drugs	100	100	100	
Fasting blood sugar ≥ 100 mg/dL‖	64.5	66.6	65.6	0.20
MS definition				
BHP (any three of above five components)	52.5	66.1	59.2	<0.001
IDF (central obesity plus any two of the other four components)	61.3	36.1	48.9	<0.001

*Data are presented as percentage; †*data available in 1,748 men and 1,701 women;* ‡*data available in 575 men and 562 women;* §*data available in 1,172 men and 1,198 women;* ‖*data available in 1,734 men and 1,681 women. BHP = Bureau of Health Promotion; IDF = International Federation of Diabetes; BP = blood pressure.*

the BHP and IDF criteria. Information regarding the risk equation, the broad study subject characteristics, locale of Framingham participants, and time period when the risk equation was developed has been published[14,15].

Statistical analysis

Statistical analyses were performed using SAS version 8.2 (SAS Institute, Cary, NC, USA). Data are presented as mean ± standard deviation for continuous variables and proportions for categorical variables. The difference in mean continuous variables between patients with and without MS was compared using two sample *t* tests. The comparison of proportions between groups was performed using χ^2 test. For all tests, two-tailed $p < 0.05$ was required for statistical significance.

Results

In the 3,775 persons registered in the present survey, 303 persons were not in the age range of 55–80 years, leaving 3,472 persons (1,709 women) to enter the final analysis. Of them, 932 (26.8%) were cared for at medical centers, 1,881 (54.2%) at regional hospitals, and 659 (19.0%) at area hospitals. Regarding their care providers, 2,285 (65.8%) were cared for by cardiology specialists, 1,089 (31.4%) by neurology specialists, and 98 (2.8%) by internists. There was an even age and sex distribution; 1,763 (50.8%) were men and the percentages of participants in each 5-year age section was approximately 20% (17.7–22.8%).

The components distribution and the prevalence of MS are shown in Table 1. As a whole, the BHP criteria defined 59.2% (95% confidence interval, CI, 57.6–60.8%) and the IDF criteria defined 48.9% (95% CI, 47.2–50.5%) of the study population with MS. When each component of MS was taken into account, significant sex differences were found for central obesity, defined by either the BHP or IDF cutoff point (both $p < 0.001$). In addition, the level of HDL-cholesterol varied between men and women ($p < 0.001$). As expected, while the BHP cutoff point defined more central obesity in women (81.3%) than men (62.2%), the IDF cutoff point has a reverse result. More central obesity in men (82.8%) was found compared with women (44.2%). Apart from the central obesity, although more women had a level of HDL-cholesterol below the sex-specific cutoff point than men (41.2% vs. 29.7%), the mean levels were higher in women (54.2 ± 14.1 mg/dL vs. 46.9 ± 12.6 mg/dL; $p < 0.001$). For both sexes, more than one-third had high triglyceride levels, and about two-thirds had high glucose levels. As a result and similar to the sex difference in central obesity, the BHP criteria defined more MS in women (66.1%; 95% CI, 63.9–68.4%) than men (52.5%; 95% CI, 50.1–54.8%), while the IDF criteria defined more men (61.3%; 95% CI, 59.0–63.5%) than women (36.1%; 95% CI, 33.8–38.4%). The sex difference of MS prevalence defined by

Table 2. *Distribution of risk factors for stroke according to different criteria of metabolic syndrome (MS)**

	BHP			IDF		
	MS present ($n=2,055$)	MS absent ($n=1,417$)	p	MS present ($n=1,697$)	MS absent ($n=1,775$)	p
CHF	168/2,003 (8.4)	94/1,377 (6.8)	0.10	134/1,651 (8.1)	128/1,729 (7.4)	0.44
Angina	435/1,996 (21.8)	246/1,380 (17.8)	0.005	381/1,646 (23.1)	300/1,730 (17.3)	< 0.001
MI	124/1,999 (6.2)	71/1,381 (5.1)	0.19	120/1,648 (7.3)	75/1,732 (4.3)	< 0.001
Diabetes	821/2,035 (40.3)	216/1,409 (15.3)	< 0.001	647/1,678 (38.6)	390/1,766 (22.1)	< 0.001
Smoking	271/2,051 (13.2)	204/1,413 (14.4)	0.30	291/1,692 (17.2)	184/1,772 (10.4)	< 0.001
Murmur	156/2016 (7.7)	100/1,393 (7.2)	0.54	133/1,663 (8.0)	123/1,746 (7.0)	0.29
LVH	106/2,055 (5.2)	99/1,417 (7.0)	0.02	88/1,697 (5.2)	117/1,775 (6.6)	0.08
AF	73/2,046 (3.6)	52/1,402 (3.7)	0.83	64/1,693 (3.8)	61/1,755 (3.5)	0.63
Prior CVA/TIA	441/2,027 (21.8)	273/1,397 (19.5)	0.12	410/1,670 (24.6)	304/1,754 (17.3)	< 0.001

**Data presented as n (%). CHF = congestive heart failure; MI = myocardial infarction; LVH = left ventricular hypertrophy; AF = atrial fibrillation; CVA = cerebrovascular disease; TIA = transient ischemic attack.*

each of the two criteria reaches statistical significance (both $p < 0.001$).

The distribution of risk factors is shown in Table 2. For history of angina and diabetes, both criteria showed that each of the risk factors was significantly more frequently seen in people with MS than those without MS. For congestive heart failure and heart murmur, although both criteria demonstrated that the percentage for each risk factor was higher in people with MS than those without MS, the difference did not reach statistical significance. For myocardial infarction and cerebrovascular disease and/or transient ischemic attack, both criteria demonstrated that the percentage of each risk factor in people with MS was higher than those without MS, but only the difference defined by the IDF criteria reached statistical significance. On the other hand, although both criteria demonstrated that people without MS had a higher percentage of left ventricular hypertrophy than those with MS, only the difference defined by the BHP criteria reached statistical significance. In contrast, for smoking and atrial fibrillation, the IDF criteria showed that the values were higher in people with MS than those without MS, while the BHP criteria demonstrated that the values were higher in people without MS, compared with those with MS. However, only the difference of smoking defined by the IDF criteria reached statistical significance.

When sex was considered, for men determined by the BHP criteria, only diabetes was significantly higher and left ventricular hypertrophy was significantly lower in the persons with MS, compared with non-MS (Table 3). For men with MS as determined by the IDF criteria, in addition to diabetes and left ventricular hypertrophy, angina and myocardial infarction were also significantly higher (Table 4). For women with MS, both the BHP and IDF criteria defined significantly more angina, diabetes and prior stroke/transient ischemic attack (Tables 3 and 4). On the other hand, only the BHP criteria, but not the IDF criteria, defined a higher percentage of congestive heart failure (Tables 3 and 4).

The 10-year probability of stroke of the study sample as estimated from the Framingham equation is shown in Table 5. For both criteria, as a whole, patients with MS had a higher 10-year probability of stroke compared with non-MS (BHP criteria, 0.153 vs. 0.133; IDF criteria, 0.159 vs. 0.132; both $p < 0.001$). However, the differences were unequally contributed by the sexes. For men, regardless of the BHP or IDF criteria, the probability of stroke did not differ significantly between those with MS and those without MS. In contrast, in women for both criteria, those with MS had higher risk compared with those without MS (both $p < 0.001$).

Discussion

In this study, we showed that in our outpatient hypertensive population seeking care from hospitals and aged 55–80 years, the prevalence of MS defined by the current BHP criteria was 59.2%, which is nearly twice as high as that of the general population of the same age section in Taiwan as defined by different criteria[16]. Hwang et al.[16] reported that in the general population of Taiwan, based on a nationwide cross-sectional

Table 3. *Sex-specific distribution of risk factors for stroke according to the definition of metabolic syndrome (MS) for Taiwanese**

	Men			Women		
	MS present (n = 925)	MS absent (n = 838)	p	MS present (n = 1,130)	MS absent (n = 579)	p
CHF	63/901 (7.0)	60/811 (7.4)	0.75	105/1,102 (9.5)	34/566 (6.0)	0.01
Angina	205/898 (22.8)	157/814 (19.3)	0.07	230/1,098 (20.9)	89/566 (15.7)	0.01
MI	82/839 (9.8)	57/814 (7.0)	0.11	42/1,100 (3.8)	14/567 (2.5)	0.15
Diabetes	361/917 (39.4)	135/831 (16.2)	< 0.001	460/1,118 (41.1)	81/578 (14.0)	< 0.001
Smoking	249/924 (26.9)	199/834 (23.9)	0.14	22/1,127 (2.0)	5/579 (0.9)	0.09
Murmur	68/907 (7.5)	62/820 (7.6)	0.96	88/1,109 (7.9)	38/573 (6.6)	0.34
LVH	46/925 (5.0)	69/838 (8.2)	0.006	60/1,130 (5.3)	30/579 (5.2)	0.91
AF	38/924 (4.1)	40/829 (4.8)	0.47	35/1,122 (3.1)	12/573 (2.1)	0.22
Prior CVA/TIA	264/910 (29.0)	218/823 (26.5)	0.24	177/1,117 (15.8)	55/574 (9.6)	< 0.001

**Data are presented as n (%). CHF = congestive heart failure; MI = myocardial infarction; LVH = left ventricular hypertrophy; AF = atrial fibrillation; CVA = cerebrovascular disease; TIA = transient ischemic attack.*

Table 4. *Sex-specific distribution of risk factors according to the definition of metabolic syndrome (MS) for Japanese**

	Men			Women		
	MS present (n = 1,080)	MS absent (n = 683)	p	MS present (n = 617)	MS absent (n = 1,092)	p
CHF	74/1,050 (7.0)	49/662 (7.4)	0.78	60/601 (10.0)	79/1,067 (7.4)	0.07
Angina	242/1,048 (23.1)	120/664 (18.1)	0.01	139/598 (23.2)	180/1,066 (16.9)	0.002
MI	96/1,049 (9.2)	43/664 (6.5)	0.048	24/599 (4.0)	32/1,068 (3.0)	0.27
Diabetes	389/1,071 (36.3)	107/677 (15.8)	< 0.001	258/607 (42.5)	283/1,089 (26.0)	< 0.001
Smoking	279/1,078 (25.9)	169/680 (24.9)	0.63	12/614 (2.0)	15/1,092 (1.4)	0.36
Murmur	78/1,057 (7.4)	52/670 (7.8)	0.77	55/606 (9.1)	71/1,076 (6.6)	0.06
LVH	57/1,080 (5.3)	58/683 (8.5)	0.008	31/617 (5.0)	59/1,092 (5.4)	0.74
AF	45/1,078 (4.2)	33/675 (4.9)	0.48	19/615 (3.1)	28/1,080 (2.6)	0.55
Prior CVA/TIA	308/1,064 (28.9)	174/669 (26.0)	0.18	102/606 (16.8)	130/1,085 (12.0)	0.005

**Data are presented as n (%). CHF = congestive heart failure; MI = myocardial infarction; LVH = left ventricular hypertrophy; AF = atrial fibrillation; CVA = cerebrovascular disease; TIA = transient ischemic attack.*

population-based survey in 2002, the prevalence of MS, defined by either criteria of modified Adult Treatment Panel III, the Taiwan criteria updated in 2004 or the IDF criteria for Chinese, for each 10-year interval from 50 to 79 years is 21.9–41.4% for women and 19.5–33.3% for men. Consistent with the nationwide survey, the prevalence of MS in women in the present study is higher compared with that in men. A higher prevalence in women is also reported in two other large-scale cohorts investigating adults in different Taiwan communities[5,17] In contrast, a screening program recruiting residents aged 40 years or older in another Taiwan community showed that the prevalence of MS is lower in women[18]. On the other hand, the prevalence of MS defined by the current BHP criteria is lowered by 10.3% (from 59.2% to 48.9%) and the ratio between sexes reversed by the IDF criteria, which increased the prevalence of men by less than 10% (from 52.5% up to 61.3%) but markedly decreased that in women by 30% (from 66.1% down to 36.1%).

Nevertheless, in the present study, although both BHP and IDF criteria consistently showed that a higher percentage of individuals with MS had a history of stroke and/or transient ischemic attack than those without MS, only the difference defined by the IDF reached statistical significance. When sex is considered, only women with MS had a significantly higher percentage of history of stroke and/or transient ischemic attack,

Table 5. *Ten-year probability of stroke estimated from the Framingham equation according to different criteria of metabolic syndrome (MS)*

Criteria	MS	Non-MS	*p*
BHP criteria for Taiwanese			
Total			< 0.001
n	1,599	1,124	
Mean ± SD	0.153 ± 0.115	0.133 ± 0.105	
95% CI	(0.147, 0.158)	(0.127, 0.139)	
Men			0.21
n	652	607	
Mean ± SD	0.168 ± 0.101	0.160 ± 0.109	
95% CI	(0.160, 0.175)	(0.151, 0.169)	
Women			< 0.001
n	947	517	
Mean ± SD	0.143 ± 0.124	0.102 ± 0.091	
95% CI	(0.135, 0.151)	(0.094, 0.110)	
IDF criteria for Japanese			
Total			< 0.001
n	1,273	1,450	
Mean ± SD	0.159 ± 0.109	0.132 ± 0.112	
95% CI	(0.153, 0.165)	(0.127, 0.138)	
Men			0.29
n	761	498	
Mean ± SD	0.167 ± 0.100	0.160 ± 0.112	
95% CI	(0.159, 0.174)	(0.150, 0.170)	
Women			< 0.001
n	512	952	
Mean ± SD	0.147 ± 0.121	0.118 ± 0.110	
95% CI	(0.137, 0.158)	(0.111, 0.125)	

BHP = Bureau of Health Promotion; SD = standard deviation; CI = confidence interval; IDF = International Federation of Diabetes.

compared with those without MS, regardless of either criteria. Such a sex difference also existed in the probability of risk for stroke predicted by the Framingham equation. The increased predicted risk for stroke in patients with MS shown in the present study is in accordance with two recent reports based on more than 10 years' follow-up in Taiwan communities, one of which demonstrated a hazard ratio of 4.3 for ischemic stroke[17] and the other revealed of 2.1 for ischemic and non-ischemic stroke[5]. However, unlike the sex-specific difference in the probability of risk for stroke predicted in the present study, in both the mentioned reports, the presence of MS defined according to the original National Cholesterol Education Program–Adult Treatment Panel III criteria increased both sexes' risk for stroke and the risk in men is more than 1.5-fold that of women[5].

The individuals studied here, hypertensive patients aged 55–80 years, represent a substantial portion of the general population in Taiwan within this age range, given that 34.1% of the population is aged 35–64 years and 58.1% of the population aged older than 64 years had hypertension, as revealed by the nationwide survey[19]. Although participants in the present study were all hypertensive, the high prevalence of MS is not only attributed to the existence of hypertension. Compared with the data from the nationwide survey, the prevalence of central obesity in the present study exceeds that of the general population by approximately 20%[16], based on the same cutoff point of ≥ 90 cm in men and ≥ 80 cm in women. In addition, the percentage of women with HDL-cholesterol < 50 mg/dL in the present study is more than twice that in our general population of the same age range[20].

The findings of the present study have clinical implications. In Taiwan, cerebrovascular disease has been one of the three leading causes of death in the past four decades and has constituted a huge economic burden[21]. Since 1995, the health expenditure has been reimbursed mainly by the National Health Insurance under a restricted global budget policy. Because the aim to treat hypertension is to prevent the occurrence of future cardiovascular events and, in the present study, women with MS possess higher risk than those without, regardless of the definition, female MS patients may be a target for population-based risk factor modification strategies, which may in turn reduce their projected risk of stroke and reduce stroke costs to the National Health Insurance in Taiwan. In addition, diagnosis and management of MS and its related diseases demand major health expenditure. From the findings of the present study, the IDF criteria defines MS 30% less (BHP, 66.1%; IDF, 36.1%) in women, but the 10-year probability for stroke only increases by 0.4% (BHP, 14.3%; IDF, 14.7%), compared with the current BHP definition. Therefore, the IDF criteria should be more cost-effective in terms of treating the female population studied here. In contrast, for men, both MS criteria gave rather similarly predicted stroke risk for MS and non-MS, and are not helpful for stroke risk stratification.

On the other hand, for each risk factor for cardiovascular disease examined in the present study, the percentage distribution in people with MS is not always higher than those without MS, regardless of whether the BHP or IDF criteria was used. For example, heart failure in men, which is known to be more common in obese people[22], was not higher in men with MS than in those without MS. Some risk factors were even seen more frequently in patients without MS, such as left ventricular hypertrophy, compared with those with MS. This suggests that the increased cardiovascular risk associated with MS is not evenly caused by the traditional risk factors.

One limitation of the present study is that the Framingham equation for stroke was developed from data collected over 36 years of follow-up in the general population sample at Framingham, Massachusetts, USA. The risk equation has not been validated in an elderly, hypertensive Taiwanese patient population. More recent collection of the follow-up clinical data of all the participants in the present study would be helpful.

In conclusion, hypertensive people aged 55–80 years in Taiwan have a high prevalence of MS, as defined by either the current BHP criteria for Taiwanese or the IDF criteria for Japanese. With the use of the Framingham equation for stroke, both criteria consistently showed that the females in the population with MS have a higher risk for stroke, compared with those without MS. These findings suggest that the definition of MS is promising for risk stratification of stroke in our elderly hypertensive women.

Acknowledgments

This study was supported by MSD Taiwan. The authors appreciate the support from Mackay Memorial Hospital and the contribution of doctors at each site, as follows: Chih-Yen Chiang (Cardinal Tien Hospital, Yung Ho Branch), Heng-Chia Chang (Buddhist Xindian Tzu Chi General Hospital), Hsing-Ya Chang (Wen Gong Memorial Hospital), Cheng-Yun Chen (Chia-Yi Christian Hospital), Chi-Li Chen (Maio-Li General Hospital, Department of Health, Executive Yuan), Chung-Hung Chen (Chung-Ho Memorial Hospital, Kaohsiung Medical University), Hsien-An Cheng (Yuan's General Hospital), Jung-Sheng Chen (Chu Shang Show Chwan Hospital), Li-Ping Chou (Sin Lau Hospital, The Presbyterian Church of Taiwan), Tzy-Wei Chou (Da Chien General Hospital), Yung-Hua Chu (Taichung Hospital, Department of Health, Executive Yuan), Chih-Yuan Fang (Chang Gung Memorial Hospital, Kaohsiung Branch), Bih-Fang Guo (Chang Gung Memorial Hospital, Kaohsiung Branch), Sen-Chu Hong (Shu-Lin Ren-Ai Hospital), Chih-Ping Hsia (Kuang Tien General Hospital), Kuang-Nan Hsu (Mackay Memorial Hospital, Taitung Branch), Yi-Chen Hsu (Tao Shin Hospital), Shih-Chung Huang (Kuang Tien General Hospital), Wen-Pin Huang (Cheng Hsin Rehabilitation Medical Center), Teng-Yao Ke (Kaohsiung Municipal Min-Sheng Hospital) Gim-Thean Khor (Chung-Ho Memorial Hospital, Kaohsiung Medical University), Yu-Lin Ko (Buddhist Xindian Tzu Chi General Hospital), Chao Lee (Da-Li Jen-Ai Hospital), Jiann-Der Lee (Chang Gung Memorial Hospital), Siu-Pak Lee (Far Eastern Memorial Hospital), Zhi-Guan Liao (Cathay General Hospital), Chun Liang Lin (Lo-Tung Pohai Hospital), Hsiu-Fen Lin (Chung-Ho Memorial Hospital, Kaohsiung Medical University), Jih-Min Lin (Keelung Hospital, Department of Health, Executive Yuan), Min-Ren Lin (Tainan Hospital, Department of Health, Executive Yuan), Ruey-Tay Lin (Chung-Ho Memorial Hospital, Kaohsiung Medical University), Zi-Xing Lin (Lin Shin

Hospital), An-Bang Liu (Buddhist Tzu Chi General Hospital), Chung-Hsian Liu (China Medical University Hospital), Yan-Ming Liu (Chutung Veterans Hospital), Hung-Shun Lo (Cathay General Hospital), Helen L. Po (Mackay Memorial Hospital), Kwo-Chang Ueng (Chung Shan Medical University Hospital), Xin-Fan Wang (Tung's Taichung MetroHarbor Hospital), Jung-Chou Wu (PingTung Christian Hospital), Ping-Chang Yang (Pao Chien Hospital), and Hung-I Yeh (Mackay Memorial Hospital). Statistical support by Miss Ya-Chuan Wang (MSD Taiwan) is highly appreciated.

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