Original Article

Evaluation of the Appropriateness of the Japanese Metabolic Syndrome Diagnostic Criteria on Routine Medical Health Checkups in a Rural Area.

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Abstract

Objective : The diagnostic criteria for the metabolic syndrome (MetS) were published in Japan in April 2005. However, there have been no large-scale studies in rural areas to confirm these criteria. We examined the prevalence of MetS in subjects who had undergone a routine medical health checkup at our hospital, located in a rural area. This data was used to investigate the appropriateness of the diagnostic criteria for MetS.

Subjects and Methods : The MetS status was examined retrospectively in 2340 subjects (1408 men, 932 women ; mean age 49.6 ± 9.7 years) who underwent a routine medical health checkup at our hospital between April 2004 and March 2005.

Results : Of the 1408 men and 932 women, 209 men (14.8%) and 23 women (2.5%) were diagnosed with MetS. Forty-four men (3.1%) and 4 women (0.4%) met all three diagnostic criteria for metabolic disorders. In the female group, only 8.7% of the 932 women met the waist circumference criterion of 90 cm. Because this waist circumference criterion was used during the first screening but was not met by most of the women,

they were eliminated from our study. Using receiver operating characteristic (ROC) analysis, the cutoff values for waist circumference were 85.0 cm (sensitivity 0.750, specificity 0.564) in men and 79.5 cm (sensitivity 0.787, specificity 0.709) in women. If the women's waist circumference criterion had been set at the value of 79.5 cm, this would have resulted in 48 (5.2%) women meeting the criterion.

Conclusion : From the viewpoint of preventive medicine, the Japanese male MetS diagnostic criteria are fairly appropriate. However, for the women, the waist circumference criterion of 90 cm has been set too high and was not met by most of the female subjects. Therefore, the Japanese MetS criteria for women, particularly the cutoff value for waist circumference, requires further verification.

Keywords : metabolic syndrome, medical health checkup, waist circumference

1. Introduction

The prevalence of ischemic heart disease (IHD) is increasing in the Japanese elderly population, particularly among those living in rural areas. This trend is due to the increasing urbanization of lifestyles among these people, especially their eating habits¹⁾. To prevent the increase in atherosclerotic heart diseases in rural areas, it is

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very important to detect individuals with the metabolic syndrome (MetS) during routine medical checkups and provide early guidance such as improvement in lifestyle. The concept of MetS was proposed by the World Health Organization (WHO) in 1999². The criteria of the National Cholesterol Educational Program-Adult Treatment Program III (NCEP-ATP III) is now the most popular and widely used criteria worldwide³. In 2005, the International Diabetes Federation (IDF) proposed a new definition that is applicable to populations around the world⁴. Using these international definitions, in April 2005 the diagnostic criteria for Japanese subjects were reported in a joint publication of eight societies including the Japanese Society for Internal Medicine and the Japan Atherosclerosis Society⁵.

In the current study, we examined the appropriateness of these diagnostic criteria by retrospectively determining the prevalence of MetS in subjects who had undergone a routine medical health checkup at our hospital.

2. Method

Subjects and Characteristics

The study was conducted at Mizunami City in Gifu prefecture, an ordinary rural area surrounded by mountains, which is located in the center of Japan. Using to beginning of sentence the Japanese metabolic syndrome diagnostic criteria (Table 1), the prevalence of the metabolic syndrome was evaluated in 2340 individuals (1408 men, 932 women ; mean age 49.6 ± 9.7 years) who underwent a routine medical checkup at our hospital in a one-year period between April 2004 and March 2005. All of the subjects who take daily medication for hypertension, hypercholesterolemia, hypertriglyceridemia, or diabetes mellitus did not take these medications before the medical health checkup. The age distribution of all subjects is shown in Table 2.

Measurements

The height (measured to the nearest 0.1 cm),

Table 1. The definition and diagnostic criteria of Metabolic syndrome (MetS) in Japan

Abdominal obesity is defined as a waist circumference of	85 cm (male) 90 cm (female)
The metabolic syndrome is defined with reference to abdominal obesity in combination with any two of the following conditions	
Elevated triglycerides and / or	150 mg/dL
Lowered HDL cholesterol	< 40 mg/dL
Elevated blood pressure	systolic blood pressure 130 mmHg and / or diastolic blood pressure 85 mmHg
Raised fasting glucose level	110 mg/dL

Table 2. Age distribution of all subjects

Age Range	Men	Women	Total
16 – 19	0	1	1
20 – 29	12	9	21
30 – 39	205	149	354
40 – 49	451	308	759
50 – 59	491	332	823
60 – 69	229	114	343
70 – 79	20	19	39
Overall	1408	932	2340
Mean age (yr)	50.0±9.8	49.3±9.8	49.6±9.7

weight (measured to the nearest 0.1 kg), and waist circumference (measured to the nearest 0.1 cm) of each subject were measured by trained staff. The waist circumference was measured horizontally at the level of the umbilicus. A fasting venous blood sample was obtained to measure laboratory data such as the plasma levels of triglycerides, HDL cholesterol, and glucose. These assays were performed using an automated analyzer (TBA-120 FR, Toshiba, Tokyo, Japan).

Statistical Analysis

Each set of data is presented as the mean $\pm$ SD. The significance level was set at 5%. Unpaired Student's t tests were used to compare laboratory data of the MetS group and the non-MetS group (Table 6). Receiver operating characteristic (ROC) analysis was used to evaluate the cutoff values for the waist circumference in both the Japanese MetS criteria and the IDF criteria. Statistical analyses

were carried out using JMP version 5.1.2 (SAS Institute Inc., Cary, NC, USA).

3. Results

3.1 .Subjects that Met a Single MetS Diagnostic Criterion

We investigated the number of subjects out of the 1430 men and 932 women who met one of the MetS diagnostic criteria presented in Table 1 (Table 3). In the male group, more than 45% of the subjects met the waist circumference criterion, resulting in an appropriate first screenig. On the

Table 3. Number of subjects that met one of the Japanese MetS criteria

	Male Group (n=1408)		Female Group (n=932)	
	n	%	n	%
Waist measurement	637	(45.2)	82	(8.7)
TG	399	(28.3)	62	(6.7)
HDL-C	165	(11.7)	22	(2.4)
Blood pressure	470	(33.4)	187	(20.1)
Fasting glucose	177	(12.6)	36	(3.9)

n : numbers ; TG : Triglyceride ; HDL-C : HDL-cholesterol.

Table 4. Number of subjects diagnosed with MetS

	Male Group		Female Group	
	n	%	n	%
MetS	209	(14.8)	23	(2.5)
Conditions met				
A+B+C	44	(3.1)	4	(0.4)
A+B	114	(8.1)	11	(1.2)
A+C	28	(2.0)	1	(0.1)
B+C	23	(1.6)	7	(0.8)

Condition A : elevated triglycerides and/or lowered HDL cholesterol.

Condition B : elevated blood pressure.

Condition C : raised fasting glucose.

Table 5. Prevalence of metabolic syndrome (MetS) in each age group

Age Range	MetS (male)		MetS (female)	
	n	%	n	%
20–29	1	8.3	0	0
30–39	14	6.8	2	1.3
40–49	47	10.4	5	1.6
50–59	93	18.9	6	1.8
60–69	47	20.5	8	7
70–79	7	35	0	0

other hand, in the female group, only 8.7% of the subjects met the waist circumference criterion.

3.2. Subjects Diagnosed with Metabolic Syndrome

Of the 1430 men and 932 women, 209 (14.8%) and 23 (2.5%), respectively, were diagnosed with MetS based on the Japanese MetS diagnostic criteria presented in Table 1. The number of subjects who met each MetS condition are presented in Table 4. The prevalence by age range of MetS diagnosed during a routine medical checkup is presented in Table 5. The prevalence of MetS increased with age.

3.3. Comparison between the MetS and Non-MetS Groups

Table 6 compares the MetS and non-MetS groups for significant differences in non-MetS diagnostic criteria items. Total cholesterol, LDL-cholesterol, uric acid, AST, ALT, γ -GTP, and ALP were significantly higher in the male and female MetS groups than in the non-MetS groups (Table 6).

3.4. Evaluation of Cutoff Value of Waist Circumference Using the ROC Analysis

In order to evaluate the most appropriate cutoff values for waist circumferences in men and women, receiver operating characteristic (ROC) analysis was used. Subjects who met two or more of the Japanese MetS diagnostic criteria, excluding waist circumference, were regarded as positive. According to this ROC analysis, the maximum area under the curves using the Japanese MetS criteria were 0.708 (sensitivity 0.750 and specificity 0.564) for men and 0.805 (sensitivity 0.787 and specificity 0.709) for women, with the cutoff values for waist circumference 85.0 cm and 79.5 cm, respectively. If the waist circumference criterion for women (presently 90 cm) were set at the value of 79.5 cm, there by nearly equaling that of the IDF criteria (80 cm), this would result in 48 women (5.2%) meeting the criterion. On the other hand, using ROC analysis with the IDF criteria resulted in a maximum area of 0.699

Table 6. Comparison of laboratory data between the MetS and non-MetS groups

	Normal Range	MetS	Male Subjects Non-MetS	p value	MetS	Female Subjects Non-MetS	p value
n (%)		209 (14.8)	1199 (85.2)		23 (2.5)	909 (97.5)	
Mean Age (yr)		50.0±9.8	48.87±10.00	p < 0.001	53.4±10.6	49.2±9.7	p=0.041
T. Cho (mg/dl)	130 – 220	207.1±37.1	198.3±32.5	p=0.001	216.6±37.2	201.9±35.7	NS
LDL-C (mg/dl)	70 – 140	131.2±32.5	122.4±32.4	p < 0.001	133.0±33.1	117.7±33.2	p=0.042
Uric Acid (mg/dl)	4.0 – 7.0	6.48±1.34	6.23±1.30	p=0.030	5.17±1.06	4.48±0.96	p < 0.001
AST (IU/L)	8 – 38	28.0±15.0	23.2±9.1	p < 0.001	23.9±10.0	19.6±6.6	p=0.002
ALT (IU/L)	4 – 43	39.4±27.9	28.1±20.3	p < 0.001	29.9±17.9	18.3±11.7	p < 0.001
γ-GTP (IU/L)	12 – 75	79.7±83.9	53.6±62.4	p < 0.001	29.9±15.1	22.4±21.3	p=0.009
ALP (IU/L)	180 – 257	249.4±67.9	230.5±63.1	p < 0.001	253.2±55.6	213.3±70.0	p=0.068
Creatinine (mg/dL)	0.4 – 1.1	0.81±0.17	0.81±0.42	NS	0.88±0.24	0.57±0.10	NS
BUN (mg/dL)	8 – 23	14.2±3.2	14.5±1.3	NS	13.6±2.8	13.4±3.4	NS
RBC (x10 ⁶ /μL)	400 – 550	499.9±34.1	488.8±38.6	NS	477.2±30.2	440.2±34.1	NS
WBC (/μL)	3800 – 9500	6228.6±1611.6	5633.2±1523.1	p < 0.001	6156.5±1414.2	4936.1±1347.8	p < 0.001
Plt (x10 ³ /μL)	13.0 – 16.0	23.2±5.0	23.0±5.3	NS	25.7±5.5	24.5±5.4	NS

MetS : Metabolic syndrome ; T. Cho : Total cholesterol ; LDL-C : LDL-cholesterol ; AST : Aspartate aminotransferase ; ALT : Alanine aminotransferase ; γ-GTP : Gamma-glutamyl transpeptidase ; BUN : Blood urea nitrogen ; RBC : Red blood cells ; WBC : White blood cells ; Plt : Platelets ; NS : no significance.

Figure 1 The result of the Receiver Operating Characteristic (ROC) analysis to evaluate the cutoff values of the waist circumference in the Japanese Mets criteria.

(sensitivity 0.717 and specificity 0.591) for men and 0.772 (sensitivity 0.739 and specificity 0.683) for women, with the cutoff values for waist circumference 85.0 cm and 78.0 cm, respectively. These results are also shown in Figure 1.

4. Discussion

From the viewpoint of preventive medicine, it is critically important to detect and prevent factors that increase the risk of atherosclerosis, such as IHD, as early as possible, and also to establish a diagnostic framework for identifying patients with MetS during routine medical health checkups. By

applying the Japanese criteria, 14% of the men who underwent a checkup were diagnosed with MetS, making it possible to provide positive and selective guidance to change their lifestyle. In contrast, only 2.5% of all of the women subjects were classified as having MetS. However, we do not believe that this lower incidence in women was only due to a sex difference. It was clearly caused by the fact that the main Japanese criterion for waist circumference of 90 cm, the first screening cutoff value, has been set too high. This ascertainment will require further debate, but a recent Japanese study in other rural areas also indicated the current cutoff value for waist circumference in women is problematic⁶⁾. In the current prevalence study, we evaluated the appropriateness of the Japanese MetS criteria, using ROC analysis. The cutoff value for waist circumference during routine medical health checkups in a rural area was of particular interest. ROC analysis showed that the most appropriate cutoff values for waist circumference in men and women groups in this study were 85.0 cm and 79.5 cm, respectively. This indicates that the current Japanese waist circumference criterion for men is appropriate, while that for women should be reconsidered. As discussed in the results, if the waist circumference criterion for women (presently 90 cm) were set at the value of 79.5 cm, thereby nearly equal to the IDF criteria (80 cm), 48 of the women (5.2%) would have met the criterion, a two-fold increase from the initial value. From the viewpoint of preventive medicine, it is preferable to identify a greater proportion of women who meet the MetS criteria. Because of this, we suggest colleagues in clinical practices. Reconsider the current cutoff value for waist circumference criterion for women.

In addition, as shown in Table 6, our study demonstrated that the levels of various liver function tests (AST, ALT, γ -GTP) and uric acid were significantly higher in the MetS group than in the non-MetS group. Recently, non-alcoholic steatohepatitis (NASH) has attracted considerable attention^{7,8)}, and it has been suggested that the presence of MetS may be a protective factor

against NASH⁹⁾. Serum uric acid levels are a marker of visceral fat accumulation and act as an indicator of risk for MetS. Hyperuricemia is an independent risk factor for hypertension¹⁰⁾, cardiovascular death and ischemic heart disease¹¹⁾. As this study demonstrates, detecting patients with MetS during medical health checkups is very important as this leads to the prevention and slower progression of diseases such as IHD and NASH.

5. Conclusion

We used the current Japanese MetS diagnostic criteria to determine the prevalence of MetS in rural inhabitants and then investigated the appropriateness of these diagnostic criteria. The results of this study suggest that all of the MetS criteria are appropriate with the exception of the waist circumference criterion for women.

However, further investigation is necessary to determine whether this result is peculiar to the rural area served by our hospital.

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