A Proposal of Combined Evaluation of Waist Circumference and BMI for the Diagnosis of Metabolic Syndrome


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Abstract. We performed a receiver operator characteristic (ROC) curve analysis of 3915 men and 2032 women. Subjects who were diagnosed with two or more factors among high blood pressure, hyperglycaemia or high triglyceride and/or low HDL were classified as the metabolic syndrome group. By performing a ROC curve analysis, we have determined the cut-off point of waist circumference (WC) and BMI to define metabolic syndrome and further calculated the sensitivity and specificity of these two factors for the diagnosis. Cut-off point for the diagnosis of metabolic syndrome was 85cm (men) and 80cm (women) in WC and 24 (men) and 23 (women) in BMI. By combining these two factors, the sensitivity for the diagnosis increased to more than 80%. We conclude that it is beneficial to combine both WC and BMI for diagnosis of metabolic syndrome.

Key words: Metabolic syndrome, BMI, Waist circumference

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AT PRESENT, metabolic syndrome is widely spread in developed countries. Since subjects with the metabolic syndrome are known to have an elevated risk of type 2 diabetes and cardiovascular disease, it is important to establish strategies to prevent an epidemic of this syndrome [1, 2]. However, a precise unified definition of the syndrome has not yet been established.

At present, there are several definitions of metabolic syndrome, namely those of the World Health Organization [3, 4], National Cholesterol Education Program’s Adult Treatment Panel III (NCEP III) [5], European Group for the Study of Insulin Resistance (EGIR) [6], Association of American Clinical Endocrinologist (AACE) [7] and International Diabetes Foundation (IDF) [8]. The recent dramatic increase in the number of patients with diabetes and cardiovascular diseases has directly affected the medical economy in advanced nations including Japan. Therefore, it is important to establish an easy and effective method to diagnose metabolic syndrome. Existing diagnostic criteria emphasize the major importance of central obesity among the risk factors such as raised triglyceride level, raised blood sugar level and raised blood pressure [9]. In order to evaluate central obesity, it is recommended to use either the waist circumference (WC) or the body mass index (BMI). In contrast to other factors (such as triglyceride level, HDL cholesterol level or blood sugar), WC and BMI are easy to measure and they are cost effective. However, previous studies obtained rather variable values for the cut-off level of the WC and BMI.
In addition, IDF also suggested that the values of cut-off levels for the diagnosis of metabolic syndrome should differ for different ethnic groups [11].

In this study, we have investigated the relationship between the cut-off levels used for both WC and BMI in the Japanese population in order to define central obesity and rates of detection of subjects having multiple risk factors of metabolic syndrome. We have determined the optimal cut-off level for both factors. Furthermore, we have found that using both criteria simultaneously significantly increased the sensitivity of the diagnosis of metabolic syndrome.

### Subjects and Methods

#### Subjects

We invited 5947 subjects ranging between 40 to 60 years (3915 men and 2032 women) who enrolled themselves for a health examination in Takasaki, Gunma Prefecture between 2005 to 2007. The mean age of the subjects was 50.8 ± 7.0 years for men and 50.7 ± 7.1 years for women. The prevalence of metabolic syndrome was 29.1 % (1141 subjects among 3915) for men and 9.7 % (198 subjects among 2032) for women.

#### Measurement of WC and BMI

WC and BMI were measured for the evaluation of central obesity. Blood pressure, fasting glucose level, triglyceride and HDL cholesterol levels were measured for the detection of cardiovascular and diabetes risk factors. All blood samples were collected in the fasting stage. The WC was measured midway between the lowest rib and the iliac crest with flexible anthropometric tape. Informed consent was given to all subjects who participated in the study.

#### Definition of the state of risk-factor clustering

Based on Japanese criteria for the diagnosis of metabolic syndrome (Japanese Society of Internal Medicine) [11], subjects with two or more of the following factors were defined as having a risk factor: 1) triglyceride ≥ 150 mg/dL and/or HDL cholesterol < 40 mg/dL, 2) systolic blood pressure ≥ 130 mmHg and/or diastolic blood pressure ≥ 85 mmHg, 3) fasting plasma glucose ≥ 110 mg/dL. Subjects with a history of hypertension, diabetes or hyperlipidemia were considered as having risk factors regardless of the diagnostic values.

### Results

Figure 1 plots the ROC curve for the WC and BMI in relation to the detection of metabolic syndrome. According to the ROC curve, the cut-off level yielding the maximal sensitivity plus specificity for the prediction of metabolic syndrome in WC was 85 cm for men and 80 cm for women. The sensitivity and specificity using these cut-off values were 68 and 70, respectively in men, and 75 and 69 % respectively in women. On the other hand, the cut-off level yielding the maximal sensitivity plus specificity for the prediction of metabolic syndrome in BMI was 24 for men and 23 for women.

The respective sensitivity and specificity using these cut-off values were 70 and 69 % in men, and 73 and 71 % in women. In order for the WC or BMI to be suitable for the first screening for prerequisite diagnosis of the metabolic syndrome, it is necessary to obtain a sensitivity of at least 80% [12]. We therefore tested whether it is possible to obtain high sensitivity by combining WC and BMI. As figure 2 shows, by combining these two factors the sensitivity increased to 82 % for men and 89 % for women. Also, the specificity improved to 86% for men and 98% for women.

### Discussion

There are many reports that studied the criteria for the diagnosis of metabolic syndrome [3-8]. In 2005, Japanese Society for Internal Medicine has proposed the cut-off level for WC [11]. Following this proposal, numerous resources from Japan have reported variable cut-off rates for the WC ranging between 77 to 85 cm for both sexes [13-17].
Fig. 1. ROC curves for the waist circumference and BMI for the prediction of risk factors of the metabolic syndrome, as defined by Japanese Society of Internal Medicine, in men (A) and women (B).

Fig. 2. Overlapping distributions of subjects with risk factors based on waist circumference and BMI and estimation of sensitivity. The sensitivity (true positive/total positive) obtained for the waist circumference was 68% for men and 75% for women, and sensitivity for BMI was 70% for men and 73% for women. By combining waist circumference and BMI (waist circumference ≥ 85 cm and/or BMI ≥ 24 for men; waist circumference ≥ 80 cm and/or BMI ≥ 23 for women), the sensitivity increased to 82% for men and 89% for women.
Dramatic increase in the number of patients with diabetes and cardiovascular disease is becoming nationwide problem that affects the medical economy of Japan. In 2008, Japan has initiated a nationwide strategy for the detection of metabolic syndrome which is known to increase the risk of diabetes and cardiac vascular disease. The most critical factor of this strategy is to possess an easy and effective way to detect metabolic syndrome at an early stage. In the past, usage of either WC or BMI was recommended for the detection of metabolic syndrome.

In the present study, we found that instead of using just one of these parameters, it is possible to increase both sensitivity and specificity of diagnosis of metabolic syndrome by combining both WC and BMI to a practical clinical level. Since the measurement of WC and BMI can be done easily without a time consuming complicated technique, combined analysis which we have proposed in this report can be a powerful and cost-effective tool for initial screening for the detection of metabolic syndrome.

References