Journal of
Health Education Research & Development

Shuto, et al., J Health Edu Res Dev 2015,3:3
DOI: 10.4172/2380-5439.1000139

Case Report Open Access

# Assessment of Waist Circumference Index as a New Screening Parameter for Pre-Metabolic Syndrome

**Shuto H[1,2*], Shuto C[1], Inoue T[1], Nishikata H[1], Tokutake E[2], Sakai H[2], Otsu H[2], Aida K[2], Morino K[2], Aoki N[2], Kiyomatsu Y[2], Ohba T[2], Matsuo H[3], Inukai T[4] and Suzuki H[5]**

[1]*Medical Corporation Kenshinkai, Japan*

[2]*Working group for lifestyle related disease in Saitama, Japan*

[3]*Matsuo Clinic for cardiology, Tokyo, Japan*

[4]*Department of Internal Medicine, Koshigaya Hospital, Dokkyo Medical University, Mibu, Tochigi, Japan*

[5]*Department of nephrology, Saitama Medical University, Japan*

[*]**Corresponding author:** Hiroshi Shito, Chairman and Director, Medical Corporation Kenshinkai and Minami-Koshiagya Kenshinkai Clinic,1-304-1, Shichizacho, Koshigaya 343-0851, Saitama, Japan, Tel: +81-48-990-0777; E-mail: Shuto@maple.ocn.ne.jp

**Rec date:** Oct 12, 2015; **Acc date:** Oct 19, 2015; **Pub date:** Oct 21, 2015



## Abstract

**Aim:** The concept of metabolic syndrome (MetS) is useful in encouraging modification of patient's lifestyle. In order to detect prophase in MetS (pre-MetS), we evaluated waist circumference index (WCI) that was calculated by division of waist circumference (WC) by height in meter squared.

**Methods:** A multiple logistic regression analysis was performed a the prevalence of risk factors for MetS (high blood pressure, abnormal lipid metabolism, high blood glucose) and age, WC, body mass index, WCI and intra-abdominal fat area (IAFA) in 111 subjects in whom IAFA was measured at umbilicus level by CT scan.

**Results:** WCI was the second most strongly correlated factor with the prevalence of risk factors after IAFA in terms of P values, and according to the odds ratios WCI was the most significantly correlated.

**Conclusion**: The results suggested that the WCI might be capable of serving as an index that can substitute for a CT scan as a means of detecting pre-MetS.

**Keywords:** Waist circumference index; Intra-abdominal fat; Metabolic syndrome Pre-metabolic syndrome

## Introduction

Intra-abdominal fat accumulation is a major pathophysiological cause of metabolic syndrome (MetS) [1], and a computed tomographic (CT) scan at the umbilicus level on abdominal is utilized to measure intra-abdominal fat accumulation as intra-abdominal fat area (IAFA) [2]. Those who had an IAFA over 100 cm$^2$ were defined as intra-abdominal obesity, and those with intra-abdominal obesity showed a tendency to have showed two or more of cardiovascular risks [3]. It was reported that waist circumference of 85 cm in male and 90 cm in female in Japan is corresponding to an IAFA of 100 cm$^2$ [4]. So, measurement of waist circumference (WC) is essential for diagnosis of MetS.

The standard WC value varies with the country, and these values set in all countries other than Japan are lower for females, whereas in the Japanese version of the diagnostic criteria for MetS, lower values are set for males than for females. Recently, the International Diabetes Federation has raised a divergence of opinion, stating that it is only in the Japanese criteria that the standard WC is greater for women than for men, and published new criteria of " 90 cm for men and 80 cm for women" for Asians/Japanese in order to determine the risk of cardiovascular events, such as myocardial infarction [5]. Further, several cohort studies in Japan have provided a divergence of opinion concerning the criteria on WC for MetS [6-8].

These findings mean that the criteria of WC for the diagnosis of MetS may be needed for further investigation. For determining MetS or abdominal obesity, weight to height ratio (WHtR; body weight divided by height, kg/m), body mass index (BMI; body weight divided by square height, kg/m$^2$), and Rohrer's index (body weight divided by cube height, kg/m$^3$) are proposed. Among these parameters, BMI is commonly utilized for determining obesity, since BMI is corrected body weight by height and well correlation between BMI and IAFA has been reported [9].

For more effective prevention of cardiovascular diseases, pre-MetS which is considered as a pathophysiological status between MetS and normal subjects should be detected by easier diagnostic method for treatment to them. In addition to BMI, it was considered that waist circumference index (WCI) calculated from WC and height would be as a modified WC in order to avoid gender difference on the determination of abdominal obesity. We evaluated if WCI could be a powerful parameter to detect pre-MetS in this study.

## Subjects and Methods

This study was a cross-sectional survey to assess whether WCI showed relationship with IAFA, and which parameter showed more detectable for pre-MetS. Among subjects for medical care or medical checkup at our clinic, successive subjects who underwent a CT scan at the umbilicus level for measurement of IAFA were enrolled after explaining the aim of this study and obtaining informed consent. The following parameters were determined beside CT scan, anthropometric measurements (height, weight, and WC), demographic factors (sex, age), and lifestyle factors (smoking habits, physical activity, and alcohol consumption). Also, triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), blood pressure, fasting blood glucose and HbA1c were simultaneously measured. Blood pressure was measured using a validated digital electronic tensiometer in either upper limb in a seated position after 15 minutes of rest.

According to the criteria of the diagnosis of MetS [4], the presence of the following factors was used to categorize MetS, pre-MetS or normal groups. Abdominal obesity was defined as WC of over 85 cm in male or over 90 cm in female at the umbilicus level in a standing position. High blood pressure was defined as systolic blood pressure of over 130 mmHg or diastolic blood pressure of over 85 mmHg, or antihypertensive treatment. Abnormal lipid metabolism was defined as TG of over 150 mg/dL and HDL-C of below 40 mg/dL in male or below 50 mg/dL in female, or antidyslipidemiic treatment. High blood glucose was defined as fasting blood glucose of over 110 mg/dL or antidiabetic medications.

All persons were divided into three groups; subjects who were abdominal obesity with more than two factors as MetS group, subjects who non-abdominal obesity with no factors as normal group, and other subjects as pre-MetS group. Thus, subjects who were abdominal obesity with below one factor, or who were abdominal obesity with below one factor were categorized as pre-MetS group.

BMI was calculated as body weight (in kilograms) divided by the square of body height (in meters). WCI was calculated as WC divided by the square of body height.

At first, we compared three correlation coefficients between IAFA and WCI. Then, to evaluate whether WCI was a well predictive parameter for a subject who has one or more cardiovascular risk factors among high blood pressure, high TG level, low HDL-C level, or high glucose level, a logistic regression model was employed for detecting pre-MetS by using age, sex, BMI, IAFA and WCI as covariates.

## Results

As shown table 1, 111 subjects (39 in male and 72 in female, 55 year-old in mean age) were enrolled. Out of 111, 14 subjects fulfilled the criteria for the diagnosis of MetS, 54 subjects were defined as pre-MetS, and 43 subjects were not corresponded as the criteria of MetS. In pre-MetS subjects, 21 subjects had WC less than the criteria of MetS. Thus, 44 subjects were defined as abdominal obesity.

| Sex | n |
|---|---|
| male | 39 |
| female | 72 |
| Age (years) | 32-85 (mean: 55) |
| Type | |
| normal | 43 (M:16/F:27) |
| pre MetS | 54 (M:15/F:39) |
| MetS | 14 (M:8/F:6) |

**Table 1:** Patient profile. MetS: metabolic syndrome, M: male, F: female.

The relationship between IAFA and WCI in 111 subjects was statistically significant (r=0.44, p<0.001). The logistic multi regression revealed that the strongest correlation of IAFA, followed by WCI, with the percentage of subjects positive for the risk factors. In terms of the odds ratio, the WCI showed the most significant correlation (Table 2).

| | P value | exp (β) | 95% CI for exp (β) |
|---|---|---|---|
| Age | 0.7228 | 0.991 | 0.943 - 1.041 |
| WC | 0.7168 | 1.028 | 0.885 - 1.194 |
| BMI | 0.0394 | 0.692 | 0.488 - 0.982 |
| WCI | 0.0143 | 1.253 | 1.046 - 1.501 |
| IAFA | 0.0108 | 1.035 | 1.008 - 1.063 |
| IAFR | 0.0575 | 0.909 | 0.824 - 1.003 |

**Table 2:** Logistic regression in pre-MetS. WC: waist circumference, BMI: body mass index, WCI: waist circumference index, IAFA: intra-abdominal fat area.

## Discussion

For developed countries, it would be serious issues to prevent cardiovascular death due to illness ascribable to overeating. The guideline on MetS is being utilized in those countries in order to detect more high risk subjects for cardiovascular diseases and/or cardiovascular death.

Based on the concept that expression and secretion of pro-inflammatory cytokines is associated with intra-abdominal fat accumulation, IAFA is frequently measured in obesity subjects [9]. CT scan is considered as a method for more precise measurement of IAFA, however, measurement of WC instead of CT scan method is recommended due to convenient and cheaper method.

In addition to reduction of medical economics, maintenance of healthy life is a key issue in developed counties. As a solution of this issue, intensive education to change life style and/or mild medical intervention seems to be appropriate for subjects who have relatively mild risk factors on cardiovascular diseases. In this study, the above-mentioned subjects were categorized as pre-MetS. Thus, pre-MetS in this study consisted of three types; 1) subjects with normal WC who were positive for one risk factor among high blood pressure, dyslipidemia, and high blood glucose, 2) subjects with abnormal WC who were positive for one risk factor, and 3) subjects with normal WC who were positive for two risk factors.

This study revealed that WCI was more suitable parameter than WC for estimation of IAFA. It was considered for merits of WCI that WCI was adjusted for the height factor, like body surface as same as BMI. This means that WCI is considered more convenient predictive parameter for abdominal obesity regardless of height.

Also, this study revealed WCI was a parameter for detection of subjects with pre-metabolic syndrome. As a result of a logistic regression analysis, WCI showed a strong relationship to the present of subject with MetS as a following to IAFA, In subjects with two or more risk factors, WCI showed stronger correlations as compared with the IAFA (date not shown).

The reasons why WCI (division of WC by height in meters squared) was chosen as a primary parameter is that it would be easy to compare it with the BMI (division of BW by height in meter squared), which is established as a useful index throughout the world. Also, the difference in WCI between groups with a height of 160 cm and height of 180 cm was greater as compared with that in WC divided by height in meters or height in meters cubed, as seen in Table 3. It should be considered that muscle mass and bone mass are inversely impacting to BMI.

| WC | height | WCI1 | WCI2 | WCI3 |
|---|---|---|---|---|
| 70 cm | 160 cm | 43.75 | 27.34 | 17.09 |
| | 180 cm | 38.89 | 21.60 | 12.00 |
| Difference | | 4.86 | 5.74 | 5.09 |
| 80 cm | 160 cm | 50.00 | 31.25 | 19.53 |
| | 180 cm | 44.44 | 24.69 | 13.72 |
| Difference | | 5.56 | 6.56 | 5.81 |
| 90 cm | 160 cm | 56.25 | 35.16 | 21.97 |
| | 180 cm | 50.00 | 27.78 | 15.43 |
| Difference | | 6.25 | 7.38 | 6.54 |
| 100 cm | 160 cm | 62.50 | 39.06 | 24.41 |
| | 180 cm | 55.56 | 30.86 | 17.15 |
| difference | | 6.94 | 8.20 | 7.27 |

**Table 3:** Differences in WCI divided WC by height, height squared, or cubed. WC: waist circumference, WCI1: divided WC by height, WCI2: divided WC by height squared, WCI3: divided WC by height cubed.

Taken together, WCI was considered as the most effective indicator for the screening of subjects to be taken cares more bearing risk factors. On account of the results showing a stronger correlation of the WCI than of the IAFA, it was considered that calculation of the WCI may replace the IAFA measured on abdominal CT as an index of screening for MetS, especially pre-MetS individuals.

## References

1. Kissebah AH, Vydelingum N, Murray R, Evans DJ, Hartz AJ, et al. (1982) Relation of body fat distribution to metabolic complications of obesity. J Clin Endocrinol Metab 54: 254-260.
2. Tokunaga K, Matsuzawa Y, Ishikawa K, Tarui S (1983) A novel technique for the determination of body fat by computed tomography. Int J Obes 7: 437-445.
3. Examination Committee of Criteria for 'Obesity Disease' in Japan; Japan Society for the Study of Obesity (2002) New criteria for 'obesity disease' in Japan. Circ J 66: 987-992.
4. Nihon Naika Gakkai Zasshi (2005) Committee on Assessment of diagnostic criteria for metabolic syndrome, Definition and diagnostic criteria of metabolic syndrome 94:794-809
5. Alberti KG, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, et al. (2009) International Diabetes Federation Task Force on Epidemiology and Prevention; Hational Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; International Association for the Study of Obesity. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 120:1640-1645
6. Hara K, Matsushita Y, Horikoshi M, Yoshiike N, Yokoyama T, et al. (2006) A proposal for the cutoff point of waist circumference for the diagnosis of metabolic syndrome in the Japanese population. Diabetes Care 29: 1123-1124.
7. Nishimura R1, Nakagami T, Tominaga M, Yoshiike N, Tajima N (2007) Prevalence of metabolic syndrome and optimal waist circumference cut-off values in Japan. Diabetes Res Clin Pract 78: 77-84.
8. Narisawa S, Nakamura K, Kato K, Yamada K, Sasaki J, et al. (2008) Appropriate waist circumference cutoff values for persons with multiple cardiovascular risk factors in Japan: a large cross-sectional study. J Epidemiol 18: 37-42.
9. Nakao YM, Miyawaki T, Yasuno S, Nakao K, Tanaka S, et al. (2012) Intra-abdominal fat area is a predictor for new onset of individual components of metabolic syndrome: MEtabolic syndRome and abdominaL ObesiTy (MERLOT study). Proc Jpn Acad Ser B Phys Biol Sci 88: 454-461.