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Risk factor of metabolic syndrome in Javanese population based on determinants of anthropometry and metabolic measurement

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ABSTRACT

The prevalence of metabolic syndrome (MetS) is high worldwide which it can increase the risk of some diseases such as cardiovascular disease, type 2 diabetes mellitus even mortality. The prevalence pattern and determinants of MetS risk factors might differ among ethnics in Indonesia. This study aimed to determine the anthropometry and metabolic measurements determinants to predict the MetS prevalence of the Javanese population in Yogyakarta. It was a case control study conducted from December 2018 to March 2019 involving 214 Javanese subjects aged 20-74 years resided in Yogyakarta Special Region, Indonesia. NCEP ATP III criteria were used to identify MetS as case and not diagnosed with MetS as control. The results showed that BMI, WC, BP, total cholesterol and HDL-C were significantly different between MetS and non MetS patients (p<0.005). In MetS subjects, prevalence of obesity was 75.3%, visceral fat was 75.3%, WC 92.95%, WHtR 97.64% and total cholesterol/HDL-C ratio 553%, which independently increased the risk of MetS 7.30, 5.32, 13.37, 20.75, and 7.16 times, respectively. Result of logistic regression analysis showed central obesity based on WC increased the risk of Met-S by 17.62 time and the ratio of total cholesterol/HDL-C>5 by 9.54 time. In conclusion, WHtR is a better marker for MetS prediction independently. However, the WHtR in combination with WC and total cholesterol/HDL-C ratio are better for MetS prediction in the Javanese population.

ABSTRAK

Prevalensi sindrom metabolic (SM) tinggi di seluruh dunia yang dapat meningkatkan risiko berbagai penyakit seperti kardiovaskular, diabetes melitus tipe 2 bahkan kematian. Pola prevalensi dan determinan faktor risiko SM mungkin berbeda antar etnik di Indonesia. Penelitian ini bertujuan untuk menetapkan determinan pengukuran antopometri danmetabolik untuk memprediksi SM pada etnis Jawa di Yogyakarta. Penelitian ini adalah penelitian kasus control yang dilakukan antra Desember 2018 sampai Maret 2019 dengan melibatkan 214 orang Jawa berumur 20-74 tahun tinggal di Daerah Istimewa Yogyakarta, Indonesia. Kriteria NCEP ATP III digunakan untuk mengidentifikasi SM sebagai kelompok kasus dan tidak mengalami SM sebagai kelompok kontrol. Hasil penelitian menunjukkan bahwa BMI, WC, BP, kolesterol total dan HDL-C antara kelompok SM dan non SM (p<0,005). Pada kelompok SM, prevalensi obesitas adalah 75,3%, lemak visceral adalah 75,3%, WC 92,95%, WHtR 97,64% dan rasio kolesterol total/HDL-C 55,3%, yang secara independen meningkatkan risiko SM masing-masing sebesar 7.30, 5.32, 13.37, 20.75, dan 7.16 kali. Hasil analisis regresi logistik menunjukkan obesitas sentral berdasarkan WC meningkatkan risiko SM sebesar 17,62 kali dan rasio kolesterol total/HDL-C >5 sebesar 9,54 kali. Hasil penelitian menunjukkan bahwa WHtR adalah penanda yang lebih baik untuk memprediksi SM secara independent.Namun, WHtR bersama WC dan rasiokolesterol total/ HDL-C lebih baik untuk mengidentifikasi SM pada populasi Jawa.

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INTRODUCTION

Metabolic syndrome (MetS) is a major public health problem worldwide. The data shows the prevalence of MetS ranges are <10% to 84% depending on the area in an urban or rural setting. The prevalences are the composition (gender, age, race, and ethnicity), the study of population, and the definition of the syndrome used.[1] Metabolic syndrome has characterized with metabolic disorders such as hypertension, central obesity, insulin resistance, and atherogenic dyslipidemia. Itis strongly associated with an increased risk of developing atherosclerotic cardiovascular disease (CVD),[2] type 2 diabetes mellitus (T2DM) and there is twice the risk of dying compared with those without the syndrome.[1]

Risk factors for MetS include psychosocial stress through disturbance of the balance of the homeostatic mechanism, specifically, the hypothalamic - pituitary - adrenal axis (HPA axis) hormone. Increased fat in the visceral area of central obesity sufferers will increase the risk of insulin resistance which is one of the criteria of MetS.[3] Insulin resistance is a metabolic disorder characterized by an increase in insulin levels. This condition causes impaired glucose and fat metabolism, which increases the risk of mortality and morbidity due to MetS, T2DM and CVD.[4] In Korea, low HDL-C cholesterol was the most prevalent determinant of MetS, followed by central obesity, hypertension, high triglyceride level and high fasting plasma glucose level.[5]

The prevalence of MetS in Yogyakarta is 13.19% based on International Diabetic Federation (IDF) with hypertension and dyslipidemia as the most common components.[6] The Ministry of Health of the Republic of Indonesia reported based on basic health research (*Riset Kesehatan Dasar/ Riskesdas*) data 2018 that prevalence of risk factors of non communicable diseases (NCD) in Yogyakarta including hypertension, poor lipid or cholesterol metabolism, high density lipoprotein-cholesterol (HDL-C), low density lipoprotein - cholesterol (LDL-C), triglycerides for ages from 15 to 64 years, and T2DM were 32.68, 19.82, 24.62, 18.98, 12.9, and 2.4%, respectively.[7]

The prevalence pattern of MetS risk factors might differ among ethnics in Indonesia due to different demographic and geographical factors. In addition, it may affect the impact of each component involved in MetS based on different MetS definitions.[8] The aim of this study was to determine the anthropometry and metabolic measurements determinants to predict the MetS prevalence of the Javanese population in Yogyakarta Special Region, Indonesia based on National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III).

MATERIALS AND METODES

Design and subject

It was a case-control study that aimed to examine various factors related with metabolic syndrome in Javanese subjects. This study was a part of the research entitled, "Polymorphism of nicotin amidephos phoribosyl transferase (NAMPT), fat mass and obesity-associated (FTO) and lipoprotein lipase (LPL) in metabolic syndrome sufferers in Yogyakarta, Indonesia". A total of 214 participants selected on December 2018 until March 2019 from Yogyakarta region who met the inclusion and exclusion criteria ware involved in this study. The inclusion criteria were Javanese ethnicity aged 20-70 years who have at least three MetS criteria based on modified NCEP ATP III for the diagnosis of MetS.[9] All participants in this study signed an informed consent form showing a willingness to involved in this study. The study was approved by

the Medical and Health Research Ethics Committee of the Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada / Dr. Sardjito General Hospital, Yogyakarta with registration number KE/FK/0761/EC/2018.

Anthropometry, criteria of MetS and metabolic measurements

Anthropometry measurements included weight (kg), height (cm), visceral fat and waist circumference (WC) (cm). Measurement of body weight and visceral fat percentage using a digital scale by Karada-Scan (Karada Scan HBF 375, by Omron) and WC using a tape meter. Measurement of body weight, height and WC was performed on respondents using thin shirts, after removing sandals/shoes. Waist circumference was measured using a tape meter in horizontal at mid between boundary of kosta inferior and krista superior iliaka. Height and weight were used to body mass index (BMI). Measurements of blood pressure (BP) (mmHg) used a sphygmomanometer and were measured twice at the brachial artery and the intercostal fossa after resting for at least 3 min.

In the Asian sampling, the criteria for metabolic syndrome are based on the NCEP-ATP III modification. As for the Met-S criteria as a combination of three or more components based on the following components: increased waist circumference (WC), increased triglycerides (TG), reduced high-density lipoproteins - cholesterol (HDL-C-Chol), increased blood pressure (BP), and increase fasting plasma glucose (FPG).[10] Waist to height ratio (WHtR) was obtained based on the measurement of WC against height; central obesity based on WC > 80 cm in female and WC > 90 cm in male; and total cholesterol/HDL-C ratio was obtained based on total cholesterol to HDL-C and categorized into two categories <5 and >5.

Metabolic measurements used 5 mL peripheral blood collected in EDTA blood tubes after 8-10 h fasting. Total cholesterol and HDL-C were measured by enzymatic colorimetric techniques based on the manual auto-analyzer procedure using a Cob as c111 analyzer with protocol of HDL-C cholesterol Gen4 and Cholesterol Gen2 (Roche Diagnostic R).

Statistical analysis

The basic characteristics of research subjects with continuing variables were tested for normality using Kolmogorov-Smirnov. If the data were not normal then the transformation and normality tests were performed. Numerical variables are presented as mean mean± standard deviation (SD). Comparison of average age, HDL-C, FPG, BP and BMI used non-parametric tests; sex used Chi-square test; WC and total cholesterol used independent t-test. The frequencies of anthropometry and metabolic measurements were compared by Chi-square tests. Finally, if bivariate analysis results were significant, they were estimated by adjusted odds ratio (OR) with 95% CI from logistic regression analyses. The results of statistical analysis were considered significant if the p value <0.05.

RESULTS

Baseline characteristic

The total number of subjects in this study was 214 participants, with 85 patients diagnosed with MetS and 129 subjects non MetS as controls. Baseline characteristics between MetS and control subjects were significantly different in BMI, total cholesterol, HDL-C-Chol, WC, BP (p<0.05), but not significantly different between age, sex and FPG (TABLE 1).

TABLE 1. Baseline characteristics of MetS and control subject

Characteristic	MetS (n=85)	Non-MetS (n=129)	p
Aged (year)	45.31 (22.06-66.02)	44.91 (20.46-68.21)	0.988*
Sex (n)			
• Female	47	75	0.681**
• Male	38	54	
Total cholesterol (mg/dL)	185.00 ± 39.25	161.34 ± 30.89	<0.001***
HDL-C-Chol (mg/dL)	184.10 (88.10-380.20)	161.50(74.90-250.20)	<0.001*
FPG (mg/dL)	71.20(44.05-227.60)	72.00(41.90-224.90)	0.061*
Systolic BP (mmHg)	130.00(100.00-190.00)	115.00(90-175)	<0.001*
Diastolic BP (mmHg)	85.00(60.00-145.00)	75.00(60.00-110.00)	<0.001*
BMI (kg/m2)	29.20(18.8-42.2)	24.50(17.50-294.00)	<0.001*
WC (cm)	96.24 ± 10.86	84.02 ± 9.63	<0.001***

*non-parametric test; **Chi-square test; ***independent t-test.

TABLE 2 shows that in the MetS group the prevalence of obesity with a BMI cut-off value>27 was 75.3% and the prevalence of the total cholesterol/HDL-C ratio >5 was 55.3%. Obesity independently increased the risk of MetS by 7.30 times greater than non-obesity and the ratio of cholesterol total/HDL-C>5 independently increased the risk of MetS 7.16 times greater than the groups with a ratio of cholesterol total/HDL-C<5. Based on the results of logistic regression analysis, obesity increased the risk of MetS by 6.93 and the ratio of total cholesterol/HDL-C>5 by 6.73.

TABLE 2. Odds ratio of IMT and metabolic measurement of Mets Subjects

Anthropometry	Prevalence	p [Crude OR (95%CI)]	p (Adjusted OR)
Obesity (IMT>27)	75.3%	<0.001* 7.30 (3.92-13.59)	<0.001** 6.91 (3.5-13.64)
Total cholesterol/HDL-C ratio>5	55.3%	<0.001* 7.16 (3.75-13.69)	<0.001** 6.73 (3.28-13.83)

*Chi-square, **logistic regression

TABLE 3 shows that the prevalence of subjects with visceral fat>10% was 75.3% and independently increased the risk of MetS by 5.32 times. Logistic regression analysis showed that visceral fat increased the risk of MetS by 5.65 and total cholesterol/HDL-C ratio of>5 by 4.12 times.

TABLE 3. Odds ratio of visceral fat and metabolic measurement of MetS subjects

Anthropometry	Prevalence	p [Crude OR (95%CI)]	p (Adjusted OR)
Percentage of visceral fat (>10%)	75.3%	<0.001* 5.32 (2.89-9.78)	<0.001** 5.65 (2.86-11.16)
Total cholesterol/HDL-C ratio >5	55.3%	<0.001* 7.16 (3.75-13.69)	<0.001** 4.12 (2.15-7.90)

*Chi-square;**logistic regression

TABLE 4 shows the prevalence of central obesity was 92.94 % and independently increased the risk of MetS by 13.37 times greater than non-central-obesity. Based on the results of logistic regression analysis, central obesity increased the risk of MetS by 17.62 times along with the ratio of total cholesterol/ HDL-C>5 by 9.54.

TABLE 5 reports the prevalence of WHtR was 97.64% and independently increased the risk of MetS by 20.75 times. Based on logistic regression analysis, WHtR increased the risk of MetS by 16.59 times and the ratio of total cholesterol/ HDL-C >5 by 6.05 times.

TABLE 4. Odds ratio of WC and metabolic measurements of MetS subject

Anthropometry	Prevalence (%)	p [Crude OR (95%CI)]	p (Adjusted OR)
Central obesity (WC >80 cm in female; WC > 90 cm in male)	92.94	<0.001[*] 13.37 (5.44-32.85)	<0.001[**] 17.62 (6.39-48.62)
Total cholesterol total/HDL-C ratio >5	55.3	<0.001[*] 7.16 (3.75-13.69)	<0.001[**] 9.54 (4.26-21.36)

[*]Chi-square;[**]logistic regression

TABLE 5. Odds ratio of WHtR and metabolic measurements of MetS subjects

Anthropometry	Prevalence (%)	p [Crude OR (95%CI)]	p (Adjusted OR)
WHtR	97.64	<0.001[*] 20.75 (4.87-88.41)	<0.001[**] 16.59 (3.77-73.12)
Total cholesterol/HDL-C ratio > 5	55.3	<0.001[*] 7.16 (3.75-13.69)	<0.001[**] 6.05 (3.03-12.04)

*Chi-square; [**]logistic regression

DISCUSSION

In this study, the prevalence and determinants of anthropometry and metabolic measurements of MetS according NCEP ATP III criteria in subjects of Javanese ethnicity in Yogyakarta Special Region have been investigated. The obesity and central obesity based on WC and WHtR increased the risk of MetS but WHtR more than WC. This is different from the research conducted by Zhao *et al.*[9] in a Chinese population, that identified high blood pressure was the most common MetS component when using the modified ATP III criteria. There is a positive relationship between MetS and obesity parameters including BMI and the amount of fat under the skin (sum of skin-folds). It was reported that BMI, an index of general obesity, was positively correlated with systolic and diastolic blood pressure. That study showed that overweight subjects have increased risk of developing MetS 5.54 times higher than patients with normal BMI. Obese people are at risk of developing MetS 7.44 times higher than normal patients. It was reported that obesity, both general and central, is a major determinant of hypertension in the general population.[3] The higher BMI value does not always describe the high adipocyte mass value, because body weight does not differentiate between fat mass and tissue mass other than fat. Epidemiological studies also proved that the ability of BMI as a determinant to predict cardiometabolic risk is lower than WC and WHtR.[4] Although BMI is being routinely measured at all ages because of its prognostic significance, it is not an accurate measure of adiposity.

BMI is in fact not able to differentiate fat- and fat-free tissues, and does not take into account body fat distribution, which may be more important than total adiposity as a risk factor for cardiometabolic disease.[11]

Logistic regression analysis showed a strong association between BMI and total cholesterol/HDL-C ratio with MetS. One study reported that patients with total cholesterol/HDL-C ratio >5 are at risk of developing MetS 8.8 times greater than those with ratio of total cholesterol/ HDL-C<5.[3] Our study is consistent with that result and our research reports that subjects with total cholesterol/HDL-C ratio >5 are at risk of developing MetS 7.16 times greater than those with the ratio of total cholesterol/HDL-C<5. The same was reported in Korean adolescents indicating that the distributions of thetriglyceride to HDL-C ratio and total cholesterol to HDL-C ratioare useful markers of MetS with high predictive value.[12] Another research reported that the TG/HDL-C-C ratio is a better marker than the LDL-C/HDL-C ratio and the TC/ HDL-C ratio for identifying MetS in an Iranian population and could be used in clinical practice.[13] The difference in results found may be due to differences in the criteria used in determining metabolic syndrome. Additionally, elevated TC / HDL-C may improve lipid profile to some extent through lifestyle changes, i.e. diet and physical activity.[14]

A recent meta-analysis in the Indonesian population reported that WC is the best anthropometric parameter for detecting MetS in adolescents because the value of area under curve (AUC) are higher than BMI and WHtR.[15] Waist to height ratio is simple index to good proxy for central obesity and has substantial practical advantages. Therefore, WHtR represents a rapid and effective global indicator for health risks of obesity, and its use could simplify the international public health message.[16]

A similar results in Iran by Gharipour *et al.*[17] indicated that WC is best obesity indicator for distinguishing MetS among Iranian elderly men. These results are different from our study, that found patients with high WHtR have a higher prevalence and increases risk of Mets by 20.75 times. Generally, WHtR values in Asian populations have better performance to describe cardiometabolic risk than WC, because WC cannot reflect the effect of height on cardiometabolic risk even though it represents abdominal fat mass. Likewise, the percentage of abdominal visceral fat is more associated with insulin resistance.[17]

Some research reported that WHtR is better than WC and BMI at predicting adiposity in children and adolescents. It can be a useful surrogate of body adiposity when the effect of age and gender is taken into account and when direct measures of subcutaneous fat (that is, skinfolds thickness) are not available,[11] Another study in a Chinese population reported that AUC cut-off values showed that the association of WHtR and WC was higher than that for BMI for all risk conditions for both sexes, except for hypertension in men. The AUC values for WC showed a higher association with hypertension and MetS for women than men. Compared with BMI, measures of central obesity, particularly WHtR, show a better association with obesity related cardiovascular diseases.[18] Moreover, WHtR are not only effective as indicators of abdominal obesity, but also more effective parameters predicting risk factors for cardiovascular diseases. A study showed that WHtR is of great value for screening populations at high risk for abdominal obesity and cardiovascular diseases and predicting the risk for cardiovascular diseases.[19]

Some limitations in this study are the small sample size and cross-sectional design. The study results need to be confirmed by long-term prospective studies with larger samples.

CONCLUSION

In conclusion, WHtR is a better marker of risk factor for MetS independently. However in combination with WC and total cholesterol/HDL-C ratio, they are better for identifying MetS in the Javanese population.

ACKNOWLEDGMENTS

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