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Research Article

Body Mass, Total Body Fat and Visceral Fat Percentage Predict Insulin Resistance Better Than Waist Circumference and Body Mass Index in Healthy Young Male Adult in Indonesia

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Abstract

The incidence of obesity which leads to insulin resistance (IR) and metabolic disorder increases in developing countries including Indonesia. Male adult has higher risk to have abdominal obesity than female which is associated with cardiometabolic disorders. Several anthropometric measurements have been proposed to predict IR. The aim of this study was to investigate whether body mass, body mass index (BMI), waist circumference (WC), body fat percentage (BF) or visceral fat percentage (VF) could become a better predictor of IR in healthy young male adult. Total of 140 healthy young male adults ranging from 18-25 years were recruited in the study. Insulin resistance was measured by calculating Homeostatic Model Assessment for Insulin Resistance (HOMA-IR). Subjects with HOMA-IR value $\geq$75th percentile with cut off 3.75 were defined as IR. Anthropometric measurements included body weight, BMI, WC were performed whereas BF and VC were measured by bioelectrical impedance analysis (BIA). IR had significant strong correlation with body weight, BMI, WC, BF and VF. The area under curve of body mass, BF, VF were greater than WC and BMI. Anthropometric measurements correlated strongly with IR but body weight, BF, VF have stronger correlation than WC and BMI in healthy young male adult.

Keywords: insulin resistance, body weight, body fat, visceral fat, waist circumference, body mass index

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1. Introduction

Obesity is defined as excess or abnormal fat mass [1]. It is estimated worldwide that overweight people reach 1.2 billion population and 300 million of them are obesity [2]. Prevalence of obesity in Indonesia was increased in this past 20 years and the prevalence in adult male was also increased [3]. Obesity is associated with several metabolic disorders including insulin resistance (IR) and diabetes mellitus (DM). Obesity induces the development of IR through several mechanisms [4,5]. IR is a predisposition of development DM and metabolic syndrome [6,7].

The gold standard for measuring insulin resistance is quantification method using hyperinsulinemic normal blood glucosa clamp but the procedure is quite difficult, inconvenient, expensive, and time consuming to be performed. A development called homeostasis model assessment of IR (HOMA-IR) is commonly used as an alternative method to evaluate insulin resistance which is more convenient, simple, fast, and effective in cost [8,9].

Obesity has strong correlation with development of IR eventhough the causes of IR are multifactorial. Obesity can be measured by several anthropometric properties such as body weight (BW), body mass index (BMI), waist circumference (WC) and recently obesity indices commonly measured by body fat percentage (BF) and visceral fat percentage (VF) performed by bioelectrical impedance analysis. WC is commonly used as the criteria of abdominal obesity as the evidence that fat distribution in visceral region is correlated well with IR [10].

The aim of this study was to evaluate the association between 5 common obesity indices including BW, BMI, WC, BF, VF with IR and to stratify their diagnostic value for prediting IR in healthy young male adult population.

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2. Material And Methods

2.1 Study Sample

This was a cross sectional study performed during the period of July 2017 to February 2018. All voluntary participants were the 1st to the 6th grade male medical students of Hasanuddin University, Makassar, Indonesia who agred to join the study and gave written informed consent. Total of 140 subjects were recruited to join the study. All subjects performed overnight fasting for at least 8 hours and fasting blood was collected. Anthropometric measurements were also obtained from participants. All study samples were Asian ethnicity with mostly Indonesian ethnic. We excluded paticipants who used medication including oral hypoglicemic agents, lipid reducing drugs and corticosteroids. This study was approved by Komite Etik Penelitian Kesehatan (Health Research Ethical Committee) of Medical Faculty, Hasanuddin University, Makassar, Indonesia and complied with the Declaration of Helsinki.

2.2 Anthropometric and Laboratory Measurements

Anthropometric measurements were performed by a single examiner. BW and height were measured, BMI was calculated as weight (kg) devided by height squared (m^2). WC was measured at midway level between iliac crist and lower border of 12th rib. BF and VF percentages were measured by using Tanita (Tokyo, Japan) bioelectrical impedance analysis (BIA). Blood samples were collected after at least 8 hour overnight fasting periode. Fasting glucose was measured using Abx Pentra 400 (Horiba, USA) while insulin was measured by using Elecsys 2010 (Roche, Indianapolis, IN, USA).

2.3 Definition of IR

Insulin resistance was calculated by using the homeostatis model asessment of insulin resistance (HOMA-IR) index= (Insulin [µIU/mL] x Fasting Blood Glucose [mg/dL]/ 405.

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HOMA-IR value ≥75 percentile was used as cut-off to define IR. In our study, the cut-off value for IR was 3.75. All HOMA-IR values below the cuf-off were defined as insulin sensitive/non IR.

2.4 Statistical Analysis

Normality of data distribution was tested by using Kolmogorov-Smirnov test. All normally distributed data were expressed as mean±standard deviation (SD) while non normally distributed were expressed as median (minumum-maximum). BF and fasting plasma glucose were normally distributed while age, BW, height, BMI, WC, insulin, and HOMA-IR were not normally distributed. Correlation of HOMA-IR and all variables were analyzed with Spearman Correlation Test. Receiver operating characteristic (ROC) curves were generated for BW, BMI, WC, BF and VF as predictors of IR. The area under the ROC curve (AUC) and the optimal cut-off points for IR prediction of BW, BMI, WC, BF and VF were determined by the largest sum of sensitivity and specificity. All statistical analysis were performed by using the Statistical Package for the Social Sciences, Version 21.0 (SPSS Inc, Chicago, IL, USA). Statistical significance was defined as $p<0.05$.

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RESULTS

The characteristics of subjects are shown in Table 1. There is no significant difference of age between IR and non IR Groups. BW, BMI, WC, BF, and VF are significantly higher in IR group compared with non IR. FPG does not differ significantly between both groups but insulin and HOMA-IR are significantly higher in IR group.

Tabel 1. Characteristics of Total, IR and non IR Groups

Variable	Total (n=140)	Non-IR (n=105)	IR (n=35)	*P*
Age, year	21(18-25)	21(18-25)	21(18-24)	0.15#
BW, kg	66.45(44.4-136.10)	64.2(44.4-136.10)	85.7(56-129.40)	0.00#
BMI, kg/m^2	23.77(13.14-49.9)	22.82(16.31-49.99)	27.90(13.14-49.31)	0.00#
WC, cm	85(66-136)	83(66-136)	99(71-135)	0.00#
BF, %	21.18±7.31	19.46±6.66	26.33±6.78	0.00*
VF, %	7(1-23)	6(1-23)	11(1-23)	0.00#
FPG, mg/d:	97.49±8.56	96.86±8.11	99.38±9.64	0.131*
Insulin, µIU/mL	11(3.52-46.82)	9.21(3.52-15.75)	21.16(14.17-46.82)	0.00#
HOMA-IR	2.66(0.68-14.22)	2.2(0.68-3.74)	5.11(3.75-14.22)	0.00#

Data are expressed mean±standar deviation for normally distributed variables and median (minimum-maximum) for non normally distributed variables. Subjects are devided into 2 groups, IR negative and IR positive based on HOMA-IR ≥75 percentile value (cut-off 3.75). IR = Insulin Resistance, BW = body weight, BMI = body mass index, WC = waist circumference, BF = body fat percentage, VF = visceral fat percentage
*T Test
#Mann Whitney Test

BW, BMI, WC, BF, VF show significant correlation with HOMA-IR (Table 2).

Table 2. Correlation of IR with Several Indices of Obesity

Variables	Correlation Coefficient*	*P*
BW	0.480	0.00
BMI	0.390	0.00
WC	0.456	0.00
BF	0.438	0.00
VF	0.438	0.00

IR = Insulin Resistance, BW = body weight, BMI = body mass index, WC = waist circumference, BF = body fat percentage, VF = visceral fat percentage
*Spearman Correlation Test

ROC curve shows AUC of BW, BMI, WC, BF, and VF have strong prediction of IR with BW, BF, and VF have better prediction value than WC and BMI (Figure 1). BF has the

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highest sensitivity by using cut-off 22.05 whereas VF has the highest specificity by using cut-off 8.5 (Table 3).

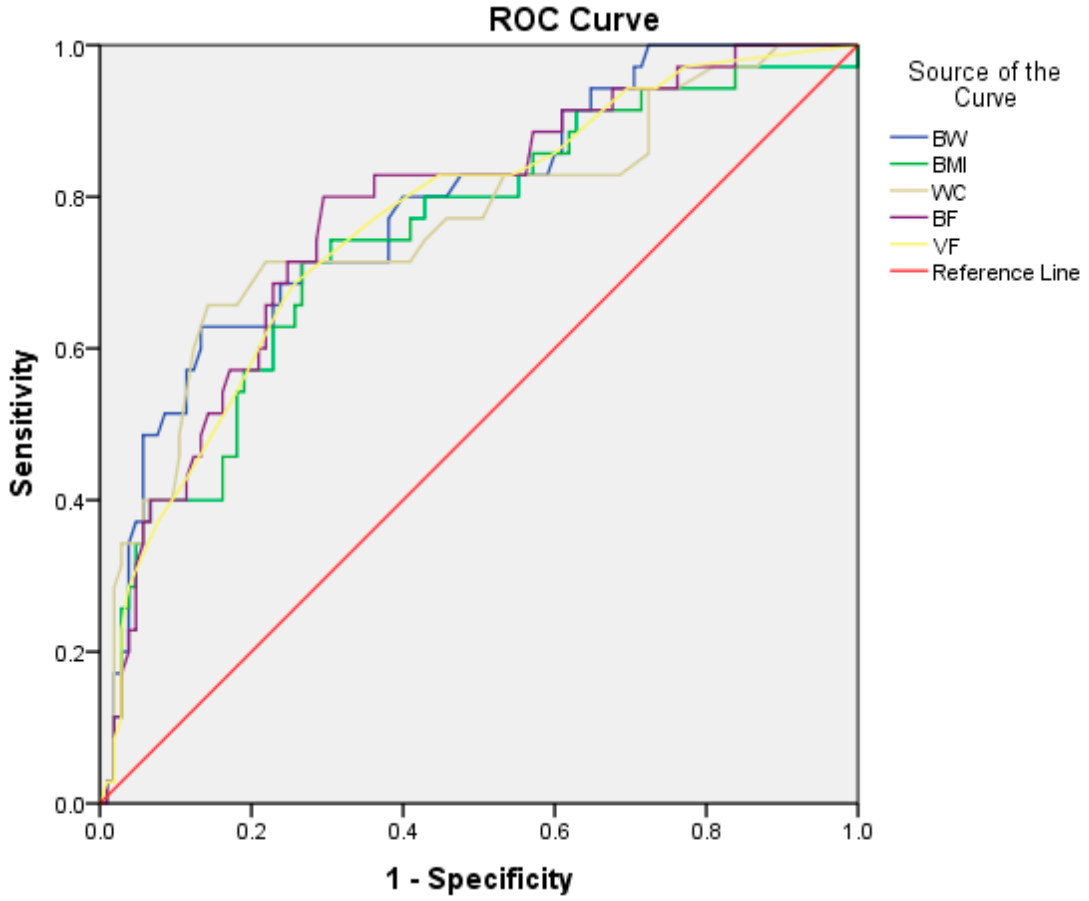

Figure 1. ROC Curve for BW, BMI, WC, BF, and VF as predictors of IR. IR = Insulin Resistance, BW = body weight, BMI = body mass index, WC = waist circumference, BF = body fat percentage, VF = visceral fat percentage, ROC = receiver operating characteristic curve.

Table 3. The AUC, Sensitivity, and Specificity by the Most Optimal Cut-Off Point of Different Obesity Indices in Predicting IR

Variables	AUC (95% CI)	Sensitivity	Specivicity	Cut-off Point
BW	0.788 (0.701-0.876)	0.714	0.733	70.2
BMI	0.747 (0.651-0.844)	0.714	0.733	24.93
WC	0.765 (0.666-0.864)	0.714	0.781	91.5
BF	0.779 (0.691-0.868)	0.743	0.714	22.05
VF	0.766 (0.675-0.858)	0.686	0.743	8.5

AUC = area under the ROC curve, IR = Insulin Resistance, BW = body weight, BMI = body mass index, WC = waist circumference, BF = body fat percentage, VF = visceral fat percentage

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Logistic regression shows every 1 point increase of BW, BMI, WC, BF, and VF increases 1.065, 1.144, 1.076, 1.155, 1.227 occurance of IR respectively (Table 4)

Table 4. Logistic Regression Analysis For Determining IR

Variables	P	OR	95% CI	
			Lower	Upper
BW	0.00	1.065	1.037	1.095
BMI	0.00	1.144	1.065	1.228
WC	0.00	1.076	1.041	1.112
BF	0.00	1.155	1.082	1.233
VF	0.00	1.227	1.116	1.349

IR = Insulin Resistance, BW = body weight, BMI = body mass index, WC = waist circumference, BF = body fat percentage, VF = visceral fat percentage

DISCUSSION

In this study of healthy young male adults Indonesian subjects, the cut-off value of HOMA-IR was 3.75, higher than proposed by earlier Caucasian study with cut-off 2.29, middle age, elderly Taiwanese with cut-off 2.30, and Iranian with cut off 2.6 [11-13]. This difference might be due to difference of ethicity, gender, and age group. The results of our study show that 5 obesity indices –BW, BMI, WC, BF, and VF- all have significant correlation with IR. Further analysis revealed that the AUC of BW, BF and VF were larger than WC and BMI. Interesting finding in our study was BW found to have stronger correlation with IR and had the largest AUC area compared with other obesity indices, with best cut-off 70.20 kg in our population, for BW was rarely used as obesity index. We proposed BW cut-off point 70.20 as a simple IR predictor for young male adult in our population. We could not explain exactly the causality and pathomechanism why BW and IR had the best predictor value, further researches are needed to confirm it. We found the cut-off values of BMI and WC were 24.93 kg/m^2 and 91.5 cm respectively, which nearly meet the criteria of obesity classified by World Health Organization for Asia population (BMI = 25 kg/m^2) and criteria for abdominal obesity (WC = 90 cm). From this result, we suggest that young male adult who meet the cut-off point for obesity index mentioned above should be screened for risk of IR and further the cardiometabolic

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disorders to prevent the development of diseases. In our study, BF and VF had slightly larger AUC than WC and BMI. The possible explaination might be the BF and VF in male adult had better value in reflecting adipose tissue which was one of main cause of IR while WC and BMI did not exactly mirror fat content.

WC and BMI have been used as traditional obesity index for assessing IR. Bluher [14] reported that BMI and WC were best predictors of cardiometabolic comorbidities in obese pubertal adolescents. Ling [15] reported that BMI and WC were simple predictors of fasting insulin and insulin resistance in overweight and obese adolescents. WC was strongly associated with glucose and lipid disturbance in obese subjects [16]. BMI had strong association with HOMA-IR in adolescents [17]. In this past few years, several obesity index assessed with BIA method including BF and VF were evaluated. Fernandes [18] found that BIA method was good in identifying excess visceral and subcutaneus fat. Fat mass measured by BIA method had good association with fat mass evaluated from Dual Energy X Ray Absorptiometry (DXA) [19]. Study from Korean high school students showed that BF was associated with HOMA-IR in male students [20].

Our result and other previous results showed that predictions of IR might be influenced by ethicity, gender and age. Our study is one of a few study concerning young male adult in South East Asia especially in Indonesia to study the association of 5 obesity indices with IR. Our study revealed that BW, BMI, WC, BF, and VF had significant association with IR, but BW, BF, and VF had slightly better predictor value than WC and BMI.

Our study had several limitations. First, this was a cross-sectional study, therefore, causal relationship of obesity indices and IR could not be determined and explained. Second, the number of study subjects was limited and relatively small, recruited from single population.

In conclusion, we demonstrated that BW, BMI, WC, BF, and VF had significant correlation with IR but BW, BF and VF had better predictor value.

Author Contribution: Liong Boy Kurniawan conceived the idea for the paper, researched literature, researched data, wrote and edited the manuscript. All other authors contributed in developed the concept, discussion, wrote and edited the manuscript.

Conflicts of Interest: The authors declare no conflict of interest. This study is a part of corresponding author on going Dissertation project.

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