AMJ
ISSN: 0005-2523

ISSN: 0005-2523
Volume 63, Issue 02, February, 2023

Correlation Between Visceral Adiposity Index and Homeostatic Model Assessment of Insulin Resistance Value in The Non-Diabetic Young Adult Population

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Keywords:
Visceral adiposity index, insulin resistance, HOMA-IR, non-diabetic.

ABSTRACT

The visceral adiposity index (VAI), which is linked to the risk of insulin resistance (IR), cerebrovascular illness, and metabolic syndrome, assesses the amount of damage to visceral adipose tissue. One of the most extensively used methods for determining IR is homeostatic insulin resistance (HOMA-IR). The goal of this study was to determine whether or not the VAI score correlates with HOMA-IR in a group of young adults without diabetes. This is a cross-sectional research was done at Hasanuddin University Makassar from January to March 2021,. Anthropometric measurements were taken. Each person had testing for their lipid profiles, fasting blood glucose, and fasting insulin. Values for the VAI and HOMA-IR were calculated. As statistical tests, the Person Correlation Test, and Chi-square were utilized. As the results, 31.10±3.01 years was the average age. The Receiver Operating Characteristic (ROC) curve study revealed that the VAI cut-off value for HOMA-IR prediction in males was 2.37, while that in females was 2.25. VAI has a positive relationship with HOMA-IR in both men and women ($p<0.001$). The male group with a VAI value of greater than 2.37 had a 41.6 times greater potential of having an IR compared to the male group with a VAI value of less than 2.37. Female with a VAI value greater than 2.25 are 24.9 times more likely to have an IR than female with a VAI value less than 2.25. In conclusion, VAI has a significant correlation with HOMA-IR in the non-diabetic young adult population.

1. Introduction

The insulin resistance syndrome, which encompasses hyperinsulinemia, hypertension, hyperlipidemia, type 2 diabetes melitus (T2DM), and an elevated risk of cardiovascular disease, is a complicated disorder that obesity contributes to [1]. Excess adiposity, particularly visceral adiposity, is linked to IR. Fat tissue accumulation is assessed using a variety of anthropometric measurements [2]. The body mass index (BMI) was used to calculate peripheral obesity, but it does not represent body composition and cannot separate

lean mass from fat mass [3]. More practical measures, such as waist circumference (WC) or waist-to-hip ratio (WHR), were used to assess visceral obesity [3], [4]. Elevated visceral fat generates additional free fatty acids than subcutaneous fat, raising the risk of IR [2].

The visceral adiposity index (VAI), a gender-specific indicator of visceral adiposity, was developed by [5]. VAI is a mathematical formulation with anthropometric data factors as well as metabolic factors. Anthropometric factors consist of body mass index (BMI) and waist circumference (WC), while metabolic factors consist of fasting triglycerides (TG) and high-density lipoprotein cholesterol (HDL-C) VAI is an efficient biomarker that can assess visceral adipose tissue dysfunction. Elevated VAI is connected to a higher risk of cerebrovascular disease and is a part of the metabolic syndrome [6], [7]. CT scanning can be replaced with VAI as a marker of visceral adiposity because it has been shown to be an excellent measure of visceral obesity [2].

VAI was found to be closely linked in research with IR of the general WC population [8]. The IR is involved in the pathogenesis of the metabolic syndrome, T2DM, dyslipidemia, polycystic ovarian syndrome, and heart disease [7- 9]. IR is becoming more common, not just in adults but also in teenagers. For diagnosing IR, the hyperinsulinemic-euglycemic clamp (HEC) was the gold standard, but it was invasive, complicated, and expensive. The homeostatic model evaluation of insulin resistance is one of the most generally accepted ways for measuring insulin resistance in research settings (HOMA-IR) [8], [10], [11].

There are many studies that have found that VAI has a relationship with HOMA-IR. Likewise, in the study of [12], who found IR had a relationship with VAI in obese subjects, [13] findings also showed that in participants with normal WC, VAI and HOMA-IR had a significant association. Meanwhile, according to Susano et al., compared to WC or BMI, VAI has a more significant relationship with HOMA-IR [13], [14].

The authors are interested in conducting this research because there has been no research regarding the relationship between VAI and the incidence of IR based on HOMA-IR in non-diabetic young adult populations in Makassar, Indonesia.

2. MATERIALS AND METHODS

2.1 Research Design and Research Subjects

We used cross-sectional method at Hasanuddin University, Makassar, Indonesia from January to March 2021. Internal medicine students at Hasanuddin University Makassar participated in the study. Inclusion criteria were male and female subjects between 25 and 40 years old with no history of diabetes or anti-dyslipidemia drug consumption, and who were willing to sign an informed consent to participate in this research

2.2 Data Collection

Consecutive sampling was used to select research subjects. Each young, non-diabetic adult who met the study requirements was assessed for BMI, WC, TG, HDL-C, fasting blood glucose (FBG), fasting insulin, and the HOMA-IR value. The BMI was calculated as weight (kg)/height $(m)^2$. FBG (mg/dl) x fasting insulin (µU/L)/405 was used to calculate the HOMA-IR. The subjects were classified as IR if HOMA-IR was in tertile 3. The formula was used to determine the VAI value:

ISSN: 0005-2523
Volume 63, Issue 02, February, 2023

$$\text{VAI(male)} = \frac{\text{WC (cm)}}{(39.68 + (1.88\text{xBMI})} \text{x} \frac{\text{TG (mmol/L)}}{1.03} \text{x} \frac{1.31}{\text{HDL} - \text{C (mmol/L)}}$$

$$\text{VAI(female)} = \frac{\text{WC (cm)}}{(36.58 + (1.89\text{xBMI})} \text{x} \frac{\text{TG (mmol/L)}}{0.81} \text{x} \frac{1.52}{\text{HDL} - \text{C (mmol/L)}}$$

2.3 Data Analysis

For subject characteristics, a univariate test was used, followed by a bivariate test utilizing the chi-square test, Pearson's correlation, and ROC curve analysis. If the p-value was < 0.05, the statistical test findings were judged significant.

2.4 Ethical Clearance

The Health Research Ethics Commission of Hasanuddin University, Medical Faculty, accepted this study protocol in compliance with the ethical recommendations, with permission letter number: 843/UN4.6.4.5.31/PP36/2020.

3. FINDINGS

In this study, 98 young adults without diabetes were included (50% males). Table I lists the fundamental traits of the research participants. Research subjects had an average BMI of 26.44±4.64, WC 92.06±11.84, TG 100.48±57.76, HDL-C 53.50±12.88, FBG 88.17±7.21, fasting insulin 9.63±6.44, VAI 3.35±2.37, and HOMA-IR 2.614±1.14.

Table I. Subject Characteristics

Variable	Minimal	Maximal	Males (n=49) Mean ± SD	Females (n=49) Mean ± SD	Total (n=98) Mean ± SD
Age (year)	25	39	31.24 ± 2.89	30.96 ± 3.14	31.10 ± 3.01
BMI (kg/m^2)	18.7	49.2	27.70 ± 3.59	25.18 ± 5.23	26.44 ± 4.64
WC (cm)	63	130	97.76 ± 10.03	86.36 ± 10.78	92.06 ± 11.84
TG (mg/dL)	29	326	116.12 ± 67.19	84.84 ± 41.57	100.48 ± 57.76
HDL-C (mg/dL)	27	94	47.80 ± 9.67	59.2 ± 13.23	53.50 ± 12.88
FBG (mg/dL)	72	117	88.02 + 7.56	88.33 ± 6.92	88.17 ± 7.21
Fasting Insulin u(IU/mL)	3.0	48.2	11.17 ± 8.29	8.09 ± 3.20	9.63 ± 6.44
VAI	0.72	11.84	3.66 ± 2.73	3.04 ± 1.92	3.35 ± 2.37
HOMA-IR	61	11.89	2.49 ± 2.07	1.79 ± 0.82	2.14 ± 1.61

Because there was no cut-off in assessing IR, the cut-off value for HOMA-IR is based on tertile, and the cut-off value for VAI is based on ROC curve analysis. Subjects were classified as IR if their HOMA-IR was in tertile 3 with a value of 2.03. Figure 1 depicts the male ROC curve analysis results. The AUC value was 0.880 (p<0.001), indicating that the VAI value with a cut-off value of 2.37 was very sensitive in predicting the HOMA IR value. On the other hand, the ROC curve analysis's findings in females were shown in Figure 2. The AUC value was 0.855 (p<0.001), indicating that the VAI value with a cut-off value of 2.25 predicts the HOMA IR value very well.

Table II. The Correlation Between VAI and HOMA-IR Value in Non-Diabetic Young Adult Subjects

Variable	Statistic	HOMA IR
VAI	R	0,424
	P	0,000*
	N	98

*Pearson's correlation analysis.

Pearson's correlation analysis found a very substantial correlation between VAI and HOMA-IR in both males and females ($p<0.001$) (Table II). Males with a VAI score higher than 2.37 had a 41.6 times increased chance of developing IR than men with a VAI value lower than 2.37, according to the odds ratio (OR). Additionally, IR risk was 24.9 times higher in females with a VAI value above 2.25 compared to those with a VAI value below 2.25. Additionally, we discovered there is a significant connection between the VAI score and the presence of IR in both males and females (Table III).

Table III. Insulin Resistance Incidence Risk Based on Gender

	Cut-off VAI		Insulin Resistance		Total	Odds Ratio (OR)
			IR	Non-IR		
Male	≥ 2,37	n	17	9	26	
		%	65,4%	34,6%	100,0%	41,6
	< 2,37	n	1	22	23	(4,79 – 360,61)
		%	4,3%	95,7%	100,0%	
Female	≥ 2,25	n	13	12	25	
		%	52,0%	48,0%	100,0%	24,9
	< 2,25	n	1	23	24	(2,90 – 213,99)
		%	4,2%	95,8%	100,0%	

Chi-Square test (p-value 0.000)

4. DISCUSSION

The study's eligibility requirements were satisfied by 98 young adults who did not have diabetes. The malfunction of visceral adipose tissue was evaluated using the visceral adiposity index (VAI), which was associated with IR. VAI was discovered to be a reliable indicator of central obesity by [15]. The VAI cut-off value varies in each study. The VAI cut-off to detect metabolic syndrome was categorized by age in the study by [5] on a Caucasian population, and it was found to be 2.52 in people aged 30 and 2.23 in persons aged 30-42. According to [8], the VAI cut-off for detecting visceral adipose dysfunction was 1.9. Meanwhile, [16] reported that the VAI cutoff in the Iranian population was 4.1 in males and 4.3 in females. [17] found in Palembang (Indonesia) that the VAI cutoff for predicting IR that would develop into diabetes was 4.74 in males and 6.83 in females. The VAI was a valuable tool for assessing the cardiometabolic risk associated with visceral obesity in both research and clinical practice [18], [19]. In Indonesia, the cut-off value for VAI has not been established. As a result, in our study, the VAI cut-off was determined using ROC curve analysis. In males, the VAI cut-off was 2.37. On the other hand, females showed that the VAI cut-off was 2.25. The AUC of VAI in both males and females was 0.880 and 0.855, suggesting that VAI has a good ability to detect adipose tissue dysfunction. [19] confirmed this finding, reporting that the VAI was a significant indicator for assessing adipose tissue dysfunction and insulin sensitivity. Furthermore, the VAI value was shown to be closely associated with cardiometabolic risk as it increased.

The HOMA-IR was a simple and practical model to evaluate IR using fasting blood glucose and fasting insulin levels. HOMA-IR is more correlated with visceral fat mass than subcutaneous fat, according to [20], and visceral fat accumulation has a significant impact on how IR develops. The HOMA-IR cut-off differs between males and females based on race, ethnicity, age, and fat distribution variances [21]. The HOMA-IR cut-off in Spain's young adult population at the 90th percentile was 3.15 [22]. [23] discovered that the HOMA-IR cut-off value in the Indian young adult population was 3.0, whereas [24] found that the cut-off value in the United States was 2.1. [13] found a cut-off value of 2.09 in the Chinese population. Because the HOMA-IR cut-off in Indonesia has not been determined, patients in this study were classified as having IR

ISSN: 0005-2523
Volume 63, Issue 02, February, 2023

if their HOMA-IR was in tertile 3 with a value of 2.03. [2] discovered a strong relationship between adipose tissue depots and IR as measured by HOMA-IR in a meta-analysis.

Our investigation revealed a substantial positive relationship between the VAI and HOMA-IR, with higher VAI values resulting in higher HOMA-IR values in both groups (female and male) ($p<0.001$). This assertion is supported by [13] from China, who showed that VAI was an independent predictor of high HOMA-IR in both groups (female and male). This study propose that the accumulation of visceral adipose tissue may have an important influence in populations without central obesity. Substantial relationship between VAI and HOMA-IR is also indicated by [6], [14], [24], [25]. Following the visceral fat mass, total fat mass, BMI, and WC all showed a strong correlation with HOMA-IR [10], [26].

Based on their HOMA-IR value, subjects were categorized into IR and non-IR groups in our study. As a result of the reduced role of insulin in metabolically active tissues and organs such as skeletal muscle, the liver, and adipose tissue, insulin resistance develops [28]. In fat-induced IR, ectopic fat deposition occurs in visceral fat and insulin-sensitive organs, including the muscle and the liver, as a result of inadequate accumulation of lipids in adipose tissue under the skin (subcutaneous). These tissues will eventually develop lipotoxicity, which will change insulin signaling and worsen glucose tolerance throughout the body [9]. [28] found an association between increased VAI values and IR. This notion is supported by the study's findings, which showed that in both males and females, the mean VAI value among the IR group was considerably greater than among the non-IR group. Furthermore, a study in obese people by [29], [12] found that the degree of IR evaluated by HOMA-IR showed a strong positive correlation with VAI.

The OR value indicated that male individuals with a VAI value >2.37 were 41.6 times more likely to develop IR than male subjects with a VAI value <2.37. Furthermore, IR was 24.9 times more likely to occur in female individuals with a VAI value >2.25 compared to female subjects with a VAI value <2.25. We also found a significant association between the VAI value and the occurrence of IR in both males and females. In line with previous research, [30] discovered that the higher the VAI value, the higher the risk of developing diabetes mellitus in both males and females. In addition, the increase in visceral adipose tissue assessed by the VAI will lead to an increased risk of developing IR and metabolic syndrome [24].

5. CONCLUSION

In the group of young adults without diabetes, the VAI and HOMA-IR showed a strong correlation.

ACKNOWLEDGMENTS

We are very grateful to Hasanuddin University, Hasanuddin University Hospital, and Dr. Wahidin Sudirohusodo for the facilities and assistance that have assisted in this research.

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