Original Article

The Significance of Different Obesity Parameters in Obese Participants with Insulin Resistance

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Abstract

Background: Studies found a link between visceral obesity and insulin resistance (IR). Numerous attempts made to discover a link between fat lipotoxicity and IR by measuring waist circumference (WC) or body mass index (BMI). This study investigates the relationship between body adiposity index [BAI], a body shape index [ABSI], BMI, waist-to-hip ratio [WHR], TGI-WC = Triglyceride glucose index-× WC, and TGI-BMI = Triglyceride glucose index-BMI. Homeostatic model assessment of IR (HOMA-IR) is utilized to examine the significance of those indices in the target population with obesity-linked IR in Iraq. **Objective:** The aim is to identify the most relevant obesity index by examining the relationship between multiple obesity indices and IR in obese healthy individuals. **Design and Methods:** 100 obese and nonobese patients' height, weight, and hip circumference were taken. Triglycerides (TGs), glycated hemoglobin (HbA1c), serum insulin, and fasting plasma glucose were obtained to calculate HOMA-IR, TGI-WC, and TGI-BMI. **Results:** Healthy adults 18–50 years were divided (obese and not-obese), clinical features were averaged, and standard errors of the mean calculated. Results for the first obese group were blood pressure [BP] = 114 ± 2/75 ± 9, HbA1c=5.76 ± 0.09, TG = 175.26 ± 3.66, fasting blood glucose [FBG] = 111.84 ± 1.57, WC = 106.62 ± 1.68, BMI = 32.02 ± 0.69, while those for the second group were BP = 111 ± 8/70 ± 6, HbA1c = 4.41 ± 0.06, TG = 96.36 ± 2.02, FBG = 82.40 ± 1.48, WC = 83.76 ± 0.85, and BMI = 22.84 ± 0.22. The relationships between obesity indices were analyzed with HOMA-IR being judged to be IR when it acquired a score value of ≥ 2. The Pearson's correlation coefficient® used to represent was WHR: $r = 0.58$, $P = 0.0001$, ABSI: $r = 0.44$, $P = 0.04$, BAI: $r = 0.50$, $P = 0.02$, TGI-WC: $r = 0.89$, $P = 0.0001$, and TGI-BMI: $r = 0.74$, $P = 0.74$. **Conclusion:** All of the obesity and lipid-related indices investigated were positively correlated with IR. The use of TGI-WC is recommended since it is straightforward to calculate using accessible laboratory tests; it showed the highest (Pearson's) coefficient ($r = 0.89$; $P = 0.0001$).

Keywords: Homeostatic model assessment of insulin resistance, insulin resistance, obesity parameter

Introduction

Obesity is a condition marked by excessive body fat buildup that is brought on by an imbalance between food intake and energy utilization. The prevalence of overweight and obesity is rising annually around the world.[1] Moreover, it is a significant health risk factor and obesity-related morbidity and consequences incur significant costs for those who are affected, their families, health-care systems, and society as a whole.[2]

Obesity is now recognized as a key element of the metabolic syndrome (insulin resistance [IR] syndrome.[3] Particularly, visceral obesity has a significant impact on the emergence of IR.[4] Both of them (obesity and IR) are well-known risk factors for hypertension, type 2 diabetes, and cardiovascular disease.[5-7] The American Medical Association, the largest medical association in the US, has released a statement referring to obesity as a disease in and of itself.[8]

In light of that, the estimation of visceral obesity based on waist circumference (WC) has been controversial. Several WC cut-offs for various ethnic groups have been accepted by the International Diabetes Federation (IDF).[9] Furthermore, numerous studies have examined the nature of the connection between WC and IR or hyperinsulinemia.[10,11]

Access this article online

Quick Response Code:

Website: http://www.mmjonweb.org

DOI: 10.4103/mj.mj_19_23

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Submitted: 13-Mar-2023 **Revised:** 20-Apr-2023 **Accepted:** 21-Apr-2023 **Published:** 07-Aug-2023

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How to cite this article: Ali BH, Hussein II, Almaliky AK. The significance of different obesity parameters in obese participants with insulin resistance. Mustansiriya Med J 2023;22:128-31.

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There are two types of obesity: central and global; accordingly, body mass index (BMI), WC, and waist-to-hip ratio (WHR) are traditional obesity indicators that are useful for screening obesity. BMI is generally accepted as a reliable criterion for evaluating global obesity. Central obesity is measured using the WC and WHR variables. The body adiposity index (BAI) and a body shape index (ABSI) are two recent examples of novel indices that have been proposed to measure central obesity. The BAI is a measurement of body fat based on height and hip circumference and was suggested by Bergman[12] as a novel marker for obesity among African–Americans and Mexican–Americans.

While WC, rather than height, weight, or BMI, is the basis of the new obesity measurement index, ABSI, developed by Krakauer and Krakauer.[13] Findings showed that ABSIs predictive power was superior to that of WC and BMI.

Previous studies have examined the relationships between IR and common obesity indicators such as BMI, WC, and WHR.[14,15]

Fatty tissues dysfunction and altered lipid metabolic processes unquestionably play a crucial role among the potential causes of obesity-induced metabolic derangements.[16] Obese people frequently have raised plasma-free fatty acids[17] as a result of probable increased food intake, accelerated lipolysis from adipocytes, and several pathways connecting excess fatty acids and triglycerides (TGs) with IR.[18]

In light of this, various studies were motivated to investigate TG-related markers that combined obesity indices for IR, such as triglyceride glucose index × BMI (TGI-BMI) and triglyceride glucose index × WC (TGI-WC), and they reported on the effectiveness of these markers.[19,20]

Knowing that homeostatic model assessment of IR [HOMA-IR] has been widely utilized in clinical practice and the academic community to estimate IR as a biochemical metric,[21,22] but as this test considered expensive and not available routinely, trials had been made to explore different parameters which may replace it in both clinical and research fields.

Studying the obesity indices that are closely related to insulin function is crucial for the prediction, early intervention, and delay of the deterioration of IR into diabetes and other related metabolic diseases. Taking that into account, this study was designed to discover which is more significant between these indices when compared with HOMA-IR to assess IR in obese adults.

Study Design

One hundred males and females, both obese and nonobese, were enrolled in the study, as shown in Figure 1. The following qualifications for inclusion applied: (1) the obese had to fulfill the following: BMI ≥30 kg/m^2 or WC ≥94 cm in men or ≥80 cm in women according to the WHO and International Diabetic Federation (IDF),[23] (2) not diabetic, (3) apparently healthy, and (4) IR evaluation by HOMA-IR. Cardiovascular disease, acute or chronic inflammation, malignant tumors, the use of antidiabetic or antihypertensive drugs, and smoking or drinking habits are exclusion criteria.

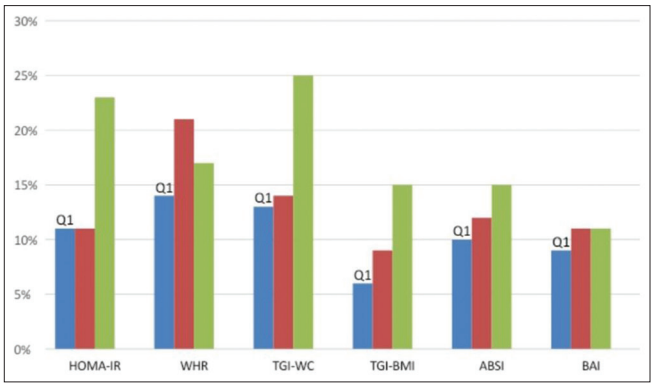

Figure 1: Sample quartiles for HOMA-IR and obesity indices according to Q1 = 25th, Q2 = 50th, and Q3 = 75th percentile in order relation with obesity percentage. HOMA-IR: Homeostatic model assessment of insulin resistance

All participants underwent a thorough medical history check and general examination in which mercury sphygmomanometer was used to take blood pressure (BP) readings. Standard methods were used to take anthropometric measurements. Height (cm) was obtained, and WC (cm) was measured using a tape measure at the point midway between the umbilicus and the rim of the iliac crest, along with weight (kg) through digital balance. BMI, WHR, BAI, and ABSI were roughly calculated using the formulas below:

BMI = Weight (kg)/height^2 (m^2).

BAI = {hip circumference (HC [cm])/height (m)}−18.[24]

ABSI = WC/(BMI$^{2/3}$ × height$^{1/2}$).[25]

WHR = WC/HC.[24]

Each participant's blood was drawn following an overnight fast, and the samples were used to obtain their blood sugar, glycated hemoglobin (HbA1c), TG level, and serum insulin levels. HOMA-IR is calculated as fasting insulin mIU/L × fasting glucose mg/dl over 405, where the threshold is above two.

Lipid-related indices were calculated using the following formulas:

TGI-BMI = {ln [Fasting triglyceride (mg/dl) × Fasting glucose (mg/dl)]/2} × BMI (kg/m^2).[20]

TGI-WC = {ln [Fasting triglyceride (mg/dl) × Fasting glucose (mg/dl)]/2} × WC (cm).[20]

Results

The clinical characteristics and measurements of the 100 participants (52% female, 48% male) were compared based

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on whether or not they were obese according to inclusion criteria, and the results data (average ± standard deviation) of each parameter are shown in Table 1.

Participants in the first group had higher age, BMI, WC, and BP. Furthermore, fasting glucose, HbA1C, and TG levels were all elevated.

A significant difference between the 2 groups was observed in values of HOMA-IR, ABSI, BAI, WHR, TGI-WC, and TGI-BMI. Therefore, the relation of each index in obese participants with HOMA-IR needs to be determined using the statistic value of Pearson's correlation coefficient® and presenting the results in Table 2.

Furthermore, HOMA-IR and other indices were compared in relation with obesity percentage using quartiles (Q1 = 25th percentile, Q2 = 50th percentile, Q3 = 75th percentile) and demonstrating in Figure 1.

Table 1: The clinical characteristics of hundred people (obese and nonobese) at Al-Yarmouk teaching hospital from October 2022 to January 2023

Variable	Obese	Nonobese	*P*
Age	40.80±1.39	34.80±1.57	0.0053**
BP (SD) mmHg	114±2/75±9	111±8/70±6	0.003**
HbA1c	5.67±0.09	4.41±0.06	0.0001**
FBG (mg/dL)	111.84±1.57	82.40±1.48	0.0001**
TG (mg/dL)	175.26±3.66	96.36±2.02	0.0001**
WC (cm)	106.62±1.68	83.76±0.85	0.0001**
BMI (kg/m^2)	32.02±0.69	22.84±0.22	0.0001**
HOMA-IR	2.38±0.04	1.230±0.03	0.0001**
WHR	0.97±0.01	0.82±0.08	0.0011**
TGI-WC	526±63	375±56	0.0001**
TGI-BMI	158.2±26.2	95.4±8.4	0.0001**
ABSI	0.82±0.09	0.69±0.05	0.0012**
BAI	29%±7%	25%±2%	0.0001**

***P*≥0.001 means highly significant. The values expressed by (average±SE). BP: Blood pressure, TG: Triglyceride, HbA1c: Glycated hemoglobin, WC: Waist circumference, BMI: Body mass index, WHR: Waist-to-hip ratio, TGI-WC: TG glucose index-WC, BMI: Body mass index, ABSI: A body shape index, BAI: Body adiposity index, SE: Standard error, FBG: Fasting blood glucose, HOMA-IR: Homeostatic model assessment of insulin resistance, TGI-BMI: TG glucose index-BMI, SD: Standard deviation

Table 2: Correlations between obesity indices and homeostatic model assessment of insulin resistance in all obese participants

Parameters	Correlation coefficient-*r* with HOMA-IR	*P*
TGI-WC	0.89	0.0001**
TGI-BMI	0.74	0.0001**
WHR	0.58	0.0001**
ABSI	0.44	0.06*
BAI	0.50	0.02*

**P*≤0.5 means significant, ***P*≤0.01 means HS. WC: Waist circumference, BMI: Body mass index, TGI-WC: Triglyceride glucose index-WC, TGI-BMI: Triglyceride glucose index-BMI, WHR: Waist-to-hip ratio, ABSI: A body shape index, BAI: Body adiposity index, HS: Highly significance, HOMA-IR: Homeostatic model assessment of insulin resistance

Discussion

Obesity has long been associated with IR. Many studies have investigated the link between WC and IR.[10,11]

New methods, such as WHR, BAI, and ABSI, have been proposed to compensate for the shortcomings of older methods in relation to IR, obesity, and metabolic syndrome.[24-26]

Therefore, the present study was carried out to assess the comparative abilities of new indices in predicting IR in obese apparently healthy adults.

In china, a study published on April 22, 2018, by Liu *et al*.[27] conclude that among obese patients with IR, the WHR is the most relevant obesity index when compared to BAI, BMI, and ABSI. Another study conducted in 2017 on nondiabetic Chinese women with normal body weight concluded that WHR is independently associated with IR but not compared with any other new indices.[28] In light of the mentioned investigations, the results of the current study reveal that WHR is more strongly associated with obesity and IR than BAI and ABSI, with an association coefficient of 0.58 and a *P* = 0.0001 [Table 2].

Fat accumulation, particularly in connection to visceral adiposity and ectopic lipid deposition in extra-adipose tissues and its link with IR, suggests the use of a number of additional lipid-related markers. TGs and older indices have frequently been combined in recent years. Researchers are interested in the relationship between the TG-BMI and TG-WC.[29,30]

According to a study from 2022 by Cho *et al*.,[30] the TGI-WC index was more accurate than the HOMA-IR for identifying nonalcoholic fatty liver disease in healthy persons in Korea.

Comparing the findings of this study to those of previous studies, the present study's results indicate that all parameters can be used to predict obesity with IR. Figure 1 shows the relative ascending of obesity percentages with Q1, Q2, Q3 with twice time more participants in Q3 than Q1, especially for HOMA-IR and TGI-WC more than other parameters' quartiles, in other word, around 75% of participants with high obesity percentage related to HOMA-IR and TGI-WC.

However, among all obesity indices, TGI-WC with *r* = 0.89, *P* = 0.0001 is the most relevant to HOMA-IR, followed by TGI-BMI, WHR, ABSI, and BAI as shown in Table 2. The study findings agree with researches that WC has predictive power for IR-associated obesity; multiplying it by TG (TGI-WC) increases its power to be equal to HOMA-IR and may be superior.

Conclusion

All of the obesity and lipid-related indices investigated were positively correlated with IR. WC-related triglyceride

index (TGI-WC) showed the highest bivariate (Pearson's) coefficient ($r = 0.89$; $P = 0.0001$).

Recommendation

This study recommends using TGI-WC to estimate obesity-related IR in apparently healthy adults in clinical practice and epidemiologic surveys because the required values can be obtained from simple anthropometric measurements and routine laboratory tests. In addition, we recommend to increase sample size of obese people and investigate lipid-related indices like TGI-WC for obtaining a cut point in predicting IR-associated obesity and may be to relate it with prediabetes, type 2 diabetes, and cardiovascular diseases.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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