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Relationship between anthropometric indices with visceral adiposity and lipid profile in overweight and obese adults

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Abstract

Background: Obesity and its related conditions have grown into major health problems. The World Health Organization (WHO) describes obesity as an excessive fat accumulation that negatively impact the health,". A commonly used measure to assess the obesity is the body mass index.It does not differentiate between muscle mass and fat accumulation and provides no indication of the body shape. Body shape index and body roundness index are suggested new anthropometrics can be used to assess the shape of the body fatness. Bio-electrical impedance is a non-invasive technique used to assess visceral fat accumulation.

The aim of this study is to find the possible relationship between the different anthropometric indices and lipid profile with the visceral adiposity rating.

Methods: a cross sectional study including a convenient sample of obese adults; males and females were included. Anthropometric indices are measured, fasting blood sample to assess lipid profile and body composition analysis using in-body 270 was done to all the participants.

Results: the mean age and SD of the study sample was 37.56±10.92 years; the mean BMI and SD equal to 39.30±6.63; 37.5% of the study sample were in the morbid obesity category. The mean of total cholesterol, serum triglycerides, high density lipoprotein and low density lipoprotein were (188mg/dl, 130mg/dl, 44mg/dl and 117mg/dl) respectively.

Conclusions: we establish a statistically significant direct correlation between Waist-to-Hip Ratio and serum triglyceride levels, as well as between visceral fat and the Body Roundness Index.

Keywords: Obesity, visceral fat, dyslipidemia

Introduction

Obesity and its related conditions have grown into major health problems, and obesity is currently classified as the fifth most common leading cause of mortality worldwide. The World Health Organization (WHO) describes obesity as an excessive fatty tissue accumulation that may adversely impact the health," additional clarifying that "the central cause of obesity and overweight is a disproportion of energy between the energy intake and energy expenditure. [1, 2]

Most researchers approve that obesity is an "acquired" disease that, greatly depends on lifestyle influences (i.e., personal choices), such as decreased physical activity and continuing overeating, despite its genetic and epigenetic factors. Researchers found that different forms of obesity, including central obesity, are associated to the increased risk of a number of chronic diseases, which consist of cancer, asthma, hypercholesterolemia, diabetes and atherosclerosis diseases. [3, 4]

BMI affords a rapid assessment and useful measure for assessing obesity. The unit of "Body Mass Index" (BMI), which is measured by calculating (weight in kg / height in m^2) is a simple index intended to classify adults into one of three categories: "underweight," "overweight," or "obese." However it is developed in the early 1830s by a Belgian mathematician and sociologist, BMI still widely used as a measure of obesity and obesity rates. For example, the WHO, classifies the adult obesity by means of BMI cutoffs.

BMI classification according to WHO. [5, 6]

BMI categories	BMI range
<18.5	Underweight
18.5 -24.9	Normal
25-29.9	Over-weight
39-34.9	Obese class I
35- 39.9	Obese class II
≥ 40	Morbid obesity

Selected anthropometric measurements are used as a surrogates for visceral or central obesity have been used in medical settings for a long time to identify health risk associated with the obesity. A frequently used, is the body mass index (BMI). However, it does not help us to differentiate between muscle mass and fatty tissue and gives no idea about the body shape. [7] the higher the BMI can be attributed to an the increase in fat mass (FM), fat-free mass (FFM) or both of them, decreasing the benefit of BMI to estimate adiposity. Waist circumference (WC) generally is used as a measurement of abdominal adiposity. Its association with insulin resistance has been reported to be better than that of BMI. [8]

A body shape index (ABSI), body roundness index (BRI), based on standardizing waist circumference (WC), hip circumference (HC) to BMI and height. The benefit of ABSI and BRI is that they associate the data from WC, HC, height and weight. the higher the ABSI or BRI; it means that; the WC is higher than expected for the given height and weight, and is correlated to a more central accumulation of body mass. [9]

Visceral fat in the abdominal area can be assessed by different methods, as for example the bioelectrical impedance analysis (BIA), dual-energy X-ray absorptiometry (DXA), ultrasound and computed tomography scan CT scan), and magnetic resonance imaging (MRI). BIA is a noninvasive method to assess the visceral fat in the abdominal cavity that is easily accessible and avoids exposure to radiation [10].

Body composition assessment based on Bioelectric impedance analysis (BIA) is a non- invasive and a valid tool for quantification of Total body water (TBW), fat and fat-free mass or lean body mass (LBM) in the human body [11]. It also measure the ratio of fat to non-fat (bone, muscle, and other tissue) in body weight and is often used as a crucial reference for evaluating personal health, motor capability, nutritional status, and physical health [12].

Blood lipid profile is a modifiable risk factors for atherosclerosis and coronary heart disease. These are hydrophobic in nature and include cholesterol esters, cholesterol, phospholipids, triglycerides and are transported to the other tissues as lipoproteins. Main classes of lipoproteins include: chylomicrons (CM), low density lipoproteins (LDL) and high density lipoproteins (HDL), named by the site of their assembly and type of lipid and apo-protein they have. It has been found that many serum lipid abnormalities are common in obesity subjects, collectively termed as dyslipidemia, though, these dyslipidemias are sometimes hyperlipidemia where as in the majority of lipids are shifted to the upper limits of range or higher than the range [13].

Abnormalities in lipid metabolism were noted commonly in patients who were obese. Substantial studies indicated that high BMI is directly linked to high total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and triglycerides (TG) and an inverse relationship with high-density lipoprotein cholesterol (HDL-C) [14].

Material and Methods

Study sample and setting: Across sectional study including a convenient sample of obese adults attending the clinical nutrition consultation clinic at Ghazi Al-Hariri hospital in Baghdad. Sixty-four adults were included in the study sample who met the inclusion criteria (7 males and 57 females). Data was collected for 3 months duration from the 1st of May to the 31st of July 2024.

Data collection: data was collected by direct interview with all participants after having a verbal consensus, and including; demographic data as age and gender; Anthropometric indices: weight, height, WC, HC, BMI, body shape index (BSI) and body roundness index (BRI); Blood sampling: HDL, LDL, TG, and TC and finally Body composition analysis using the non-invasive technique by in-body 270 and we include only visceral fat rating**.**

Inclusion criteria

- Healthy adults 18-65 years of age free from chronic disease.
- Males and female were included.

Exclusion criteria

- Pregnant ladies.
- Geriatric clients >65 years of age.
- Those with chronic disease as DM and hypertension.
- Those receiving lipid lowering medications and hypoglycemic drugs.
- Those engaged in strenuous regular exercises (athletes and body builders).
- Those with any limb amputation.
- Patients with genetic or hereditary diseases affecting the motor and nervous system.

Ethical approval

An official letter of permission from the Arab board of medical specializations was obtained. verbal approval was taken from all the members of the study sample.

Anthropometry Measurements

Weight was measured using In-body 270 and rounded to the nearest 0.5 kg. The height of the subjects was measured with stadio-meter to the nearest 0.5 cm. WC was measured using a elastic measuring tape at a level halfway between the lower rib margin and the iliac crest to the nearest 0.5 cm. The other anthropometric indexes were calculated using the following formulas:

WHR = WC/HC

BMI = weight (kg)/ Height (m)^2

BSI = WC (cm) /(BMI$^{2/3}$ * height (cm)$^{1/2}$)

BRI = 364.2 - 365.5 × √[1 - ((WC(cm) / (2π))^2) / (0.5 × height(cm))^2]

These formulas were inserted and calculated using Microsoft Excel 2010

Statistical analysis

Analysis of data was carried out using the available statistical package of IBM SPSS-29 (IBM Statistical Packages for Social Sciences- version 29, Chicago, IL, USA). Data were calculated by using simple measures of percentage, frequency, mean, standard deviation, and range (minimum values -maximum values). Pearson correlation was considered for the correlation between the two quantitative variables with the t-test for testing the significance of correlation. The correlation coefficient value (r) was either positive (direct correlation) or negative (inverse correlation) with value <0.3 represent no correlation, 0.3-<0.5 represent weak correlation, 0.5-<0.7 moderate strength, >0.7 strong correlation [15, 16].

Results

In this cross sectional study; the mean age and SD of the study sample was 37.56±10.92 years that ranging from (20-57) years old; with females making about 89.1% of the study sample. All the participants of the study sample were obese with BMI ≥ 30. the subdivision of BMI categories were distributed almost equally for class I & II obesity and morbid obesity (29.7%, 32.8% and 37.5%) respectively. With a mean BMI and SD equal to 39.30±6.63. the mean and SD of the lipid profile results are shown in table 1.

Table 1: Demographic data, anthropometric and results of lipid profile across the study sample

		No.	%
Age (years)	<30years	20	31.3
	30---39	12	18.8
	40---49	22	34.4
	=>50years	10	15.6
	Mean±SD (Range)	37.56±10.92 (20-57)	
Gender	Male	7	10.9
	Female	57	89.1
BMI (Kg/m2)	Obese I	19	29.7
	Obese II	21	32.8
	Morbid obesity	24	37.5
		Mean±SD (Range)	
Anthropometrics	BMI (Kg/m2)	39.30±6.63 (30.11-55.10)	
	Weight (Kg)	99.48±16.69 (70-139)	
	Height (m)	1.59±0.07 (1.46-1.77)	
	Body shape index	0.071±0.005 (0.061-0.081)	
	Body roundness index	6.760±1.987 (3.496-11.627)	
Lipid profile	Total cholesterol (mg/dL)	188.98±35.36 (130-264)	
	Triglycerides (mg/dL)	130.50±57.25 (58-249)	
	HDL (mg/dL)	44.67±9.06 (27-64)	
	LDL (mg/dL)	117.89±29.23 (71-169)	

75% of those with morbid obesity were older than 40 years old; while 65% of patients with class I &II obesity were younger than 40 years old. This differences was statistically significant with p-value 0f 0.021. Regarding gender differences and its association with the grade of obesity; female patients constitute about 85% of those with obesity class I & II and 95% of those with morbid obesity; with no statistical significance probable because the majority of the study sample were female clients (89.1 %). There was no statistically significant differences in lipid profile categories according to the danger levels with the obesity grading. Visceral fat rating was statistically significant with the obesity grading with p-value of 0.0001. visceral fat rating more than 20 in all patients with morbid obesity; and in 57% of those with class I & II obesity. The previous data are shown in details in table 2.

Table 2: Association of the obesity grading with age group, gender and lipid profile categories

		Obese I&II		Morbid obesity		P value
		No.	%	No.	%	
Age (years)	<30years	16	40.0	4	16.7	0.021*
	30---39	10	25.0	2	8.3	
	40---49	10	25.0	12	50.0	
	=>50years	4	10.0	6	25.0	
	Mean±SD (Range)	35.35±10.64 (20-57)		41.25±10.60 (20-55)		0.035#
Gender	Male	6	15.0	1	4.2	0.179
	Female	34	85.0	23	95.8	
Total cholesterol (mg/dL)	Danger (=>200)	17	42.5	9	37.5	0.693
	Not	23	57.5	15	62.5	
Triglycerides (mg/dL)	Danger (=>150)	14	35.0	8	33.3	0.892
	Not	26	65.0	16	66.7	
HDL (mg/dL)	Danger (<40M; <50F)	11	27.5	12	50.0	0.069
	Not	29	72.5	12	50.0	
LDL (mg/dL)	Danger (=>160)	3	7.5	3	12.5	0.506
	Not	37	92.5	21	87.5	
Visceral fat rating	<20	17	42.5	-	-	0.0001*
	20---24	21	52.5	13	54.2	
	=>25	2	5.0	11	45.8	
*Significant difference between percentages using Pearson Chi-square test (χ^2-test) at 0.05 level.						
#Significant difference between two independent means using Students-t-test at 0.05 level.						

Correlations

We assess the positive and negative correlations of visceral fat rating and WHR with the age, BMI, body shape index, body roundness index and lipid profile including (total cholesterol, triglycerides, high density lipoprotein and low density lipoprotein). Regarding the visceral adiposity; there was no correlation with (age group categories, body shape index and the lipid profile); while there were a moderate direct positive correlation with the BMI level and body roundness index with a statistically significant p-value of 0.0001.

Regarding the WHR; there was no correlation with the BMI categories; also no correlation (either positive or negative) with the TC, HDL and LDL level. There were a moderate direct positive correlation with the age, body roundness index and serum triglycerides level with a statistically significant p-value of (0.001, 0.0001, 0.008) respectively. There were a strong direct positive correlation with the body shape index with a p-value of 0.0001. The previous data are shown in details in table 3

Table 3: Correlation of WHR and visceral fat rating with the other demographic and anthropometric and lipid profile results of the study sample

		WHR	Visceral fat rating
Age (years)	r	0.417**	0.234
	P	0.001	0.063
BMI (Kg/m2)	r	0.118	0.679**
	P	0.351	0.0001
WHR	r	-	0.181
	P	-	0.153
Body shape index	r	0.731**	0.112
	P	0.0001	0.378
Body roundness index	r	0.470**	0.685**
	P	0.0001	0.0001
Total cholesterol (mg/dL)	r	0.297*	0.084
	P	0.017	0.510
Triglycerides (mg/dL)	r	0.327**	0.104
	P	0.008	0.415
HDL (mg/dL)	r	0.038	0.036
	P	0.768	0.780
LDL (mg/dL)	r	0.182	0.054
	P	0.149	0.670
*Correlation is significant at the 0.05. **Correlation is highly significant at the 0.01 level.			

Discussion

Association between visceral fat rating and central adiposity with dyslipidemia has been studied by several studies [17, 18]. visceral fat is usually enclosed around the major organs, such as the liver, pancreas, and the kidneys. It make sure that there is certain space between each of them. Too much visceral fat deposits can lead to inflammation and high blood pressure, which increases the risk of serious health problems [19].

This can be explained by the fact that inflammation induce a variety of alterations in lipid metabolism that may initially dampen inflammation, but if it is chronic; it could contribute to the increased risk of atherosclerosis. The most commonly seen changes are low serum HDL and high triglycerides. The increase in serum triglycerides is due to both an increase in hepatic VLDL production and secretion and a decrease in the clearance of triglyceride rich lipoproteins [20].

Unfortunately; our study fail to find such a positive correlation, this could be attributed to several factors; such as individual Variation in that People's bodies can respond differently to fat distribution, others may have different metabolic regulation, and finally it could be possible in the early Stages in which visceral fat may not always immediately impact triglyceride and cholesterol levels. These levels can become abnormal over time as visceral fat continues to accumulate. This can be identified as metabolically healthy obesity (MHO), which is the term used to designate a subgroup of obese subjects without obvious detrimental consequences of increased weight such as dyslipidemia [21].

In the present study we found a statistically significant direct correlation between WHR and elevated serum triglycerides. These results agreed with a recent study done Manawat *et al* 2020; in which they found that there was positive correlation between dyslipidemia and anthropometric variables (weight, BMI and WHR) in obese adults [22].

We also examine the new anthropometric indices (body shape index and body roundness index). And its relation to visceral fat rating. There was a highly significant direct positive correlation between the visceral fat rating with the body roundness index; in which we incorporate the weight, height, waist circumference and hip circumference in its calculation. BRI range from 1-16, the higher the number, the more circular your body shape is. BRI was developed to predict both body fat and the percentage of visceral adipose tissue using WC in relation to height, which allows estimation of the shape of the human body figure as an ellipse or oval. BRI can improve the predictive power of body fat and visceral adipose tissue thus better reflecting health status as a function of the body [23]. Also a recent meta-analysis and a systematic review done at 2020 conclude that BRI is a good indicator of visceral adiposity as a characteristic of metabolic syndrome [24].

Unfortunately; in the present study; we did not found such a direct correlation between ABSI and visceral adiposity. This can be attributed to Variability in Fat Distribution either visceral or simply abdominal sub cutaneous fat and may be due to population differences account for differences in body composition.

There was a statistically significant direct positive correlation between WHR as a measurement of central obesity and serum triglycerides. The fact that high WHR is one of the known measurement for central obesity as fatty tissue accumulation; This fact can be explained by the accumulation of adipose tissue and the release of free fatty acids, which are easily directed to the liver for a higher production of TG [25].

Conclusion and recommendations

The current study has established a direct correlation between Waist-to-Hip Ratio (WHR) and serum triglyceride levels, as well as between visceral fat and the Body Roundness Index (BRI). This relationship highlights WHR and BRI as a useful indicators of metabolic disturbances and potential cardiovascular risk. BRI can effectively reflect the amount of visceral fat. We recommend Incorporate WHR and BRI in Health Assessments. Clinicians should consider individual variations in body fat distribution and metabolic profiles when developing personalized health strategies. further researches are needed to explore the mechanisms underlying the correlations observed in our study.

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