International Journal of Biomedical Research

ISSN: 0976-9633 (Online)
Journal DOI:10.7439/ijbr
CODEN:IJBRFA

Research Article

Correlation between body fat components and coronary heart disease risk scores

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Abstract

Introduction: Though body fat is well known risk factor for coronary heart disease, it is not known whether components of body fat can be considered equivalent to coronary heart disease prediction scores in predicting future risk of coronary heart disease.

Aim: To test correlation between coronary heart disease risk scores and components of body fat.

Material and methods: The study subjects were evaluated clinically. Anthropometric data were obtained. Serum fasting lipid profile was tested. Body fat and components were tested by Omron karada scan. Framingham score, PROCAM score and Vascular age were calculated. Correlation between coronary heart disease risk scores with subcutaneous tissue fat, visceral fat, total body fat, WHR and BMI was tested by Pearsons correlation.

Results and Data Analysis: Our study included 103 patients. 44.7% study subjects were diabetic. 35% of the male patients were smokers. Framingham Risk score was significantly higher in males (*p* value 0.0000). BMI, Total body fat percentage, tissue fat and visceral fat levels were not found to correlate with coronary heart disease risk scores. Regression analysis showed visceral fat as the strongest correlate of each of the coronary heart disease risk scores, and WHR was the next most significant independent predictor of these outcomes.

Conclusion: WHR, visceral fat are best correlates of coronary heart disease risk scores and can be considered as surrogates of coronary heart disease risk prediction scores in clinical practice.

Keywords: Waist hip raio, Framingham score, Visceral fat

1. Introduction

Cardiovascular diseases are one of the very important causes of death all over the world. There are several factors known to be strongly associated with coronary heart disease. Body fat is one such factor. Among the components of body fat, visceral adiposity has been proposed to correlate more with coronary heart disease risk. Visceral fat and WHR are linked to the development of glucose intolerance in many populations, including Asian Indians [1-5]. But whether body fat can identify future coronary heart disease by itself is not known. There are well studied and proven scoring systems to identify future risk of coronary heart disease events in an individual like Framingham score, PROCAM score and Vascular age. Our study is an effort to find out if quantity of body fat, the anthropometric parameters indicating body fat and its components-visceral and tissue fat can be considered as a predictor of future coronary heart disease events similar to Framingham risk score, PROCAM score and Vascular age.

2. Material and Methods

Study was conducted after getting clearance from our college- Karnataka Institute of Medical Sciences ethics committee. After taking written and informed consent, study subjects were evaluated by clinical examination first and by fat measurement, blood tests later. Our study included 103 patients who were willing to be part of study.

2.1 Inclusion criteria: Adult patients willing for clinical evaluation, to undergo tests for body fat measurement and blood test for lipid profile estimation.

2.2 Anthropometric measurements: Using a measuring tape, with the subject standing, the waist circumference was measured as the narrowest circumference between the lower costal margin and the iliac crest. The hip circumference was the maximum circumference at the level of the greater trochanter of femur. Waist Hip Ratio (WHR) was then calculated.

2.3 Body fat measurement: Body fat was measured by bio-impedence method by Omron karada scan HBF 361. The study subjects were asked to hold the body fat measuring instrument in standing position with arms extended. Total body fat, subcutaneous fat, visceral fat as measured by the instrument were noted. This method has been proven to correlate well with body fat analyzed by DEXA[6] .

2.4 Lipid profile test: Serum lipid profile of the study subjects was tested in the morning after overnight fast for 12 hours at least.

2.5 Calculation of coronary heart disease risk scores: Framingham score, PROCAM score and Vascular age were calculated using software after entering relevant data of history, anthropometric data, blood sugar levels and serum lipid profile values.

2.6 Statistical analysis: The data were analyzed using the software SPSS. Mean and standard deviation for each continuous variable was calculated separately for males and females. The correlation between the Framingham risk scores, PROCAM scores, Vascular age with anthropometric data and components of serum lipid was tested by Carl Pearson's correlation coefficient method. The influence of anthropometric data and components of serum lipid on Framingham risk scores, PROCAM scores, Vascular age was tested by the multivariate regression analysis.

3. Results and Data Analysis

Our study included 103 patients. The distribution of the cardiac risk factors, results of laboratory investigations and the anthropometric data are summarized in table1.

Table 1: Baseline characteristics of the patients.

	MALES (n=71)	FEMALES (n=32)	TOTAL (n=103)
AGE	54.09±10.64	52.53±12.59	53.61±11.24
DIABETES	37.5%	47.9%	44.7%
Smoking	35.2%	0%	24.3%
SBP	141.23±21.72	142.75±22.14	141.70±21.75
DBP	82.67±11.67	85.87±11.89	83.66±11.77
Weight	72.40±9.66	65.06±10.35	70.12±10.40
Height	165.12±5.60	155.71±7.01	162.20±7.46
T.Chol	179.43±43.20	176.09±46.13	178.39±43.93
LDL	114.29±32.72	113.71±36.93	114.11±33.90
HDL	39.09±6.62	51.21±43.09	42.86±25.02
TGL	162.52±68.25	147.62±71.80	157.89±69.36
BMI	26.49±3.63	27.21±5.05	26.71±4.12
WHR	0.963±0.05	0.86±0.09	0.93±0.08

SBP-Systolic blood pressure, DBP-Diastolic blood pressure, Tchol-total cholesterol, TGL-Triglycerides, BMI-body mass index, WHR-waist hip ratio

A high percentage of patients in our study were suffering from Diabetes mellitus (44.7% overall). 35% of the male patients were smokers. Mean systolic blood pressure was in hypertensive range (141.70 mmHg ± SD 21.75) among the whole study group as well as males and females. But diastolic blood pressure (83.66mmHg ± SD11.77mmHg) in our whole study group as well as separately in males and females was within normal limits. Mean BMI of our whole study group was 26.71± 4.12 suggestive of slight overweight. The same was observed in males and females separately also. Mean values of Total cholesterol (178.39±43.93), HDL (42.86±25.02), LDL (114.11±33.90) were within normal limits, but triglyceride levels were slightly higher (157.89±69.36). There was no significant gender difference in Vascular age (*p* value 0.13) and PROCAM scores (*p* value 0.97), but Framingham Risk score was significantly higher in males (*p* value 0.0000) [table 2].

Table 2: Comparison of male and female with different variables

Variable	Sex	n	Mean	SD	t-value	P-value
Vascular age	Male	71	73.66	10.15	1.5138	0.1332
	Female	32	69.81	15.24		
PROCAM score	Male	71	9.11	7.46	-0.0252	0.9799
	Female	32	9.16	9.45		
Framingham score	Male	71	15.01	11.55	5.9501	0.0000*
	Female	32	2.66	2.97		

*p<0.05

In order to negate the influence of anti-hypertensive and hypo-lipidemic medications on results, the results were re-analyzed by dividing the patients into two groups, one receiving anti-hypertensive and hypo-lipidemic treatment and the other not receiving treatment. But the Vascular age, PROCAM score and Framingham Risk score were not significantly different between these two groups [table 3].

Table 3: Comparison of with and without treatment with different variables

Variable	Treatment	n	Mean	SD	t-value	P-value
Vascular age	Without Rx	75	74.09	10.31	1.1264	0.2633
	With Rx	28	70.10	12.17		
PROCAM	Without Rx	75	8.68	7.82	-0.3413	0.7338
	With Rx	28	9.60	9.44		
Framingham score	Without Rx	75	10.19	10.30	-1.0675	0.2888
	With Rx	28	14.00	12.87		

Rx- treatment

Body mass index (BMI), Total body fat percentage, tissue fat and visceral fat levels were not found to correlate with Vascular age [table 4], PROCAM score [table 5] and Framingham Risk scores [table 6]. But Waist Hip Ratio (WHR) was found to significantly correlate with Framingham Risk scores [table 6].

Table 4: Correlation coefficient between waist-hip ratio, visceral fat, tissue fat, total fat% and BMI with vascular age by Karl Pearson's correlation coefficient method

Variables	Vascular age with		
	r-value	t-value	p-value
Waist-hip ratio	0.0534	0.5371	0.5924
Visceral fat	0.1522	1.5479	0.1248
Tissue fat	0.0007	0.0067	0.9946
Total Fat%	-0.0785	-0.7911	0.4308
BMI	-0.0010	-0.0101	0.9919

Table 5: Correlation coefficient between waist-hip ratio, visceral fat, tissue fat, total fat% and BMI with PROCAM by Karl Pearson's correlation coefficient method

Variables	PROCAM with		
	r-value	t-value	p-value
Waist-hip ratio	-0.0520	-0.5232	0.6020
Visceral fat	0.1073	1.0842	0.2808
Tissue fat	-0.0150	-0.1505	0.8807
Total Fat%	-0.0387	-0.3891	0.6980
BMI	-0.0355	-0.3573	0.7216

*p<0.05

Table 6: Correlation coefficient between waist-hip ratio, visceral fat, tissue fat, total fat% and BMI with Framingham score by Karl Pearson's correlation coefficient method

Variables	Framingham score		
	r-value	t-value	p-value
Waist-hip ratio	0.2579	2.6828	0.0085*
Visceral fat	0.0041	0.0412	0.9673
Tissue fat	-0.1021	-1.0318	0.3046
Total Fat%	-0.1323	-1.3418	0.1827
Body Mass Index	-0.0262	-0.2629	0.7931

*p<0.05

The set of independent predictors for each of the dependent variables was determined through stepwise regression analyses. In these multivariate models, visceral fat remained the strongest correlate of each of the coronary heart disease risk scores, and WHR was the next most significant independent predictor of these outcomes.

Table 7: Multiple linear regression analysis of Vascular age by BMI, total body fat, tissue fat, Visceral fat and WHR.

Variable	Coefficient	Std Error	F-test	P-Value
Body Mass Index	-0.151	0.763	0.0392	0.843396
Total Fat	-0.096	0.295	0.1069	0.744460
Subcut. tissue fat	-0.463	0.559	0.6876	0.409022
Visceral Fat	1.159	0.574	4.0824	0.046119
Waist Hip Ratio	7.592	21.582	0.1237	0.725789
CONSTANT	72.216	14.847	23.6602	0.000004

Correlation Coefficient: r^2=0..05

Table 8: Multiple linear regression analysis of PROCAM score by BMI, total body fat, tissue fat, Visceral fat and WHR.

Variable	Coefficient	Std Error	F-test	P-Value
Body Mass Index	-0.127	0.518	0.0604	0.806395
Total Fat	0.038	0.200	0.0370	0.847873
Subcut. tissue fat	-0.274	0.379	0.5214	0.472020
Visceral Fat	0.716	0.389	3.3884	0.048744
Waist Hip Ratio	-7.080	14.640	0.2339	0.629753
CONSTANT	17.340	10.071	2.9645	0.088329

Correlation Coefficient: r^2=0.04

Table 9: Multiple linear regression analysis of Framingham Risk Score by Body Mass Index, total body fat, tissue fat, Visceral fat and Waist Hip Ratio.

Variable	Coefficient	Std Error	F-test	P-Value
Body Mass Index	-0.621	0.676	0.8434	0.360727
Total Fat	-0.019	0.261	0.0055	0.940866
Subcut. tissue fat	-0.550	0.495	1.2361	0.269003
Visceral Fat	0.321	0.508	0.4002	0.528478
Waist Hip Ratio	67.700	19.118	12.5400	0.000617
CONSTANT	-23.415	13.152	3.1697	0.078179

Correlation Coefficient: r^2=0.16

4. Discussion

Body fat is one of the very well proven risk factors for coronary heart disease. Body mass index (BMI), waist circumference (WC) are the anthropometric measures commonly employed to quantify overall adiposity. However, as more and more research has been carried out in this field, it is becoming obvious that regional fat depots may be playing a greater role than overall adiposity with regards to coronary heart disease etiology.[7-9] This has been stressed by several studies which have highlighted pericardial fat and abdominal visceral adipose tissue (VAT) as unique, pathogenic fat depots.[10-16] However, the results have not been consistent and in study by Amir A. Mahabadi et al. [17] none of these fat depots are independently associated with CVD after further adjustment for traditional risk factors. Our study is an effort to understand the concept of varying influence of different fat tissues on coronary heart diseases. We tested this by quantifying total body fat, visceral fat, tissue fat and correlating them with known scoring systems of identifying future risk of coronary heart disease events- Framingham Risk Score, PROCAM score and Vascular age. Our study, as per our knowledge, is the first to test correlation between components of body fat and coronary heart disease risk scores.

Framingham risk score is used to predict the 10 year risk of developing coronary heart disease in people without history of cardiovascular disease. [18] It has been developed based on data from a sample of the Framingham Heart and Offspring studies. This scoring system considers sex, age, total cholesterol, HDL cholesterol, systolic blood pressure, and smoking.

PROCAM score is also a risk score to predict risk of coronary heart events in individuals with no coronary heart disease and is derived from the European PROCAM study, performed in Germany.

"Heart Age" or "Vascular Age" is a newer concept to convey expression of age-appropriate cardiovascular risk based on the output of Framingham Risk Scores and shown to promote more accurate risk perception in users. [19] It is a simple method for communicating risk to general population.

Earlier, fat, in general, was considered to be always associated with increased coronary heart disease risk. But as more and more research has been carried out, this concept has been proven to be only partly correct. The location of fat is an important derterminant of its coronary heart disease risk potential. In the abdomen, visceral fat appears to confer greater disease risk than adipose tissue in the subcutaneous location.[20, 21,22] Coronary heart disease risk is also influenced by the location of fat within the thigh.[23, 24] Fat in other fat depots (i.e., stored within muscle, around muscle fibers) is related to insulin resistance in obese persons, but there appears to be no such correlation with subcutaneous thigh fat. [25] Although the mechanisms responsible for the differing effects of central and peripheral adiposity on coronary heart disease risk remain to be determined, the total adiposity probably does not adequately indicate the extent of coronary heart disease risk in individuals. Hence, usefulness of BMI, which is only an indicator of total adiposity only, in assessing coronary heart disease risk is therefore questionable. The same factor has been reflected in our study also and we did not find BMI and total body fat to be significantly correlating with coronary heart disease risk prediction scores. But, Waist Hip Ratio, which is a marker of visceral adiposity, and visceral fat itself were found to correlate significantly with coronary heart disease risk prediction scores. On the other hand, tissue fat was not found to correlate with coronary heart disease risk scores. The scientific reason why truncal adiposity increases risk for coronary heart diseases and lower-extremity adiposity decreases risk for coronary heart diseases has been based on heterogeneity of adipose tissue metabolism in different locations. It is clear from the data available from in vitro studies that adipocytes located in visceral abdominal regions are more sensitive to lipolytic stimuli and resistant to suppression of lipolysis by insulin than fat cells from gluteal-femoral subcutaneous regions; [26, 27] Daily systemic flux of free fatty acids, per unit of fat mass, has been shown to be higher in subjects with a predominant abdominal adiposity than in those with fat predominant in lower body, due both to a higher sensitivity to the activation of lipolysis and to an reduced suppression of lipolysis in abdominal fat cells. And also, abdominal fat may impact hepatic free fatty acid flux directly due to its location close to the portal circulation and, hence, increase TG synthesis and decrease hepatic insulin clearance. [21, 28]

Thus from our study, we recommend considering WHR and visceral fat to be equivalent to coronary heart disease risk prediction scores. In clinical practice, apart from stressing only on measures aimed at weight reduction, measures to reduce abdominal adiposity may be more fruitful in coronary heart disease risk reduction. Instead of calculating coronary heart disease risk scores, which are not very easy to calculate in clinical practice, WHR and visceral fat can be used as easy to use, scientifically sound tools to convey future coronary heart disease risk events to the general population.

5. Conclusion

-WHR, visceral fat are best correlates of coronary heart disease risk scores.

-BMI, total body fat, tissue fat do not correlate with coronary heart disease risk scores.

-WHR, visceral fat can be considered as surrogates of coronary heart disease risk prediction scores in clinical practice.

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