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A Study on the Role of Visceral Adiposity Index in Correlation with Glycaemic Status of Diabetic Individuals

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Abstract
Introduction: *Diabetes has become a worldwide public health problem seriously threatening human health. It is reported that individuals with high visceral adiposity are associated with increased risks of Insulin resistance and metabolic disorders and are more likely to suffer from diabetes. This study was done on the role and comparative predictive ability of visceral adiposity index in predicting the glycaemic control in diabetic individuals*
Methodology: *A total of 108 Diabetic patients were studied. Visceral adiposity index (VAI) was calculated using Waist circumference (WC), Body mass index (BMI), Fasting lipid profile (FLP). Fasting blood sugar (FBS), Post prandial blood sugar (PPBS), HaemoglobinA1C(HBA1C) were measured and association of VAI with the parameters and comparative predictive ability of VAI was studied*
Results: *Among the 108 patients (male=43, female= 65), area under the curve in Receiver operating characteristic curve (ROC) analysis demonstrated that VAI had a good predictability to identify the glycaemic status as FBS have 70%, while for HbA1c it is about 68% and it was superior to other anthropometric parameters like BMI and WC*
Conclusion: *Visceral adiposity index is a good and superior predictor of glycaemic status in diabetic individuals. It can be used as an easy to calculate handy tool in assessing the adiposity status as well as the glycaemic status of the diabetic individuals*
Keywords: *Visceral adiposity index, Insulin resistance, Diabetes.*

Introduction

Excess fat may lead to insulin resistance (IR) and abnormal glucose metabolism. Obesity is closely related to high blood glucose. Adipose tissue is a main source of reactive oxygen species, which may contribute to the development of obesity-associated IR and cause type 2 diabetes as a consequence. However, obese people may vary in their body fat distribution and disease risk, and regional adipose tissue distribution was found as a key role in explaining the relationship between adiposity and glycometabolism.[1]

For measuring the volume of visceral fat, magnetic resonance imaging (MRI) and computed tomography (CT) has been recognized as the gold standard for quantitative detection, however, these two methods are inconvenient and expensive and are obviously not suitable for large-scale epidemiological studies.[1]

The Visceral Adiposity Index (VAI) is an empirical-mathematical model, gender-specific, based on simple anthropometric (BMI and WC) and functional parameters (Triglycerides (TG) and High density lipoprotein (HDL)) and indicative of fat distribution and function. It is an empirical-mathematical model that does not originate from theoretical assumptions, but from observation in a healthy normal/overweight population of a linear relationship between BMI and Cardiovascular events, from which a linear equation has been extrapolated.[2]

Aims and Objectives

1) To study the role of visceral adiposity index in predicting the glycaemic control in diabetic individuals.
2) To study the predictive ability of visceral adiposity index to identify the glycaemic status of diabetic individuals as compared to other anthropometric measures (Body mass index, Waist circumference)

Materials and Methods

Study Area and Design

This study was conducted at Sri Manakula Vinayagar Medical College and Hospital for a period of six months. The design employed was a hospital based cross sectional study.

Study Participants

The sample size was calculated to be 108 by using Open Epi, Version3, open-source calculator. All patients with Type-2 Diabetes mellitus above 18 years of age were included in the study. Patients below age of 18 years and with impaired liver function, on drugs like steroids were excluded from the study

Sampling Procedure

All patients attending Department of General Medicine at Sri Manakula Vinayagar Medical College Hospital and Research Centre satisfying the inclusion criteria and exclusion criteria were enrolled in the study after getting proper informed and written consent from the participants. Fasting blood sugar, Post prandial blood sugar, Haemoglobin A1C, Fasting lipid profile (FLP) levels, WC, BMI of all the diabetic patients included in the study were measured and VAI was calculated according to the formula

$$\text{Men VAI} : \left[\frac{WC\ (cm)}{\{39.68+(1.88x\text{BMI}(\frac{kg}{m2}))\}}\right] \text{x} \left[\frac{\text{TG(mmol/l)}}{1.03}\right] \text{x} \left[\frac{1.31}{HDL\text{(mmol/l)}}\right]$$

$$\text{Women VAI} : \left[\frac{WC\ (cm)}{\{36.58+(1.89x\text{BMI}(\frac{kg}{m2}))\}}\right] \text{x} \left[\frac{\text{TG(mmol/l)}}{0.81}\right] \text{x} \left[\frac{1.52}{\text{HDL(mmol/l)}}\right]$$

Later association between VAI and FBS, PPBS and HBA1C of the patients was studied and also the predictive ability of VAI was compared with that of BMI and WC of glycaemic status in these individuals. Ethical consideration: The study protocol was approved by the SMVMCH-Institutional Ethics Committee (No. EC/63/2021). Voluntariness, privacy and confidentiality was maintained throughout the study.

Statistical Analysis: Data was entered in Microsoft Excel and analysed using SPSS (Version 24.0, developed by IBM Corp, Armonk, New York) software. Categorical data was represented in the form of frequency and percentages. Continuous data was represented in the form of mean and SD or Median with IQR (Inter – quartile range). Chi-square test used as a test of significant for the categorical variables. p value <0.05 was considered to be statistically

significant.ROC curve to assess the sensitivity of the test and obtained through SPSS software, p value<0.05 was considered to be statistically significant.MS Excel was used to obtain the graphs.

Results

Table 1: Demographical and Epidemiological characteristics (N=108): Out of 108 patients, 43 were male, 65 were female. Systemic hypertension, Renal disorder, Coronary artery disease were the most common co-morbidities associated with study group. Majority of the study participants were Obese.

Variables	Male n (%)	Female n (%)	OR; *p* value; 95% CI
Age (in years)			
< 50	17 (39.5)	24 (36.9)	1
≥ 51	26 (60.5)	41 (63.1)	1.117; 0.784; 0.506 – 2.466
Mean ± SD	55.19 ± 11.27	53.77 ± 10.84	0.514[a]
Systemic hypertension			
Normotensive	24 (55.8)	44 (67.7)	1
Hypertensive	19 (44.2)	21 (32.3)	1.659; 0.211; 0.749 – 3.674
Liver disorder			
No disorder	43 (100.0)	65 (100.0)	-
Renal disorder			
Absent	33 (76.7)	61 (93.8)	**1**
Present	10 (23.3)	4 (6.2)	**4.621; 0.01; 1.345 – 15.881***
Coronary artery disease			
Absent	41 (95.3)	61 (93.8)	1
Present	2 (4.7)	4 (6.2)	0.744; 0.739; 0.130 – 4.251
BMI (kg/m^2)			
Underweight (<18.5)	1 (2.3)	2 (3.1)	0.472; 0.610; 0.014 – 6.952
Normal weight (18.6 – 22.9)	12 (27.9)	11 (16.9)	1
Overweight (23 – 24.9)	9 (20.9)	6 (9.2)	1.364; 0.655; 0.357 – 5.402
Obesity (> 25)	21 (48.8)	46 (70.8)	0.422; 0.084; 0.156 – 1.126
Mean ± SD	24.81 ± 3.79	27.09 ± 4.24	**0.005**[a]
Waist circumference (cm)			
Normal	20 (46.5)	10 (15.4)	1
Abnormal	23 (53.5)	55 (84.6)	**<0.001; 0.083 – 0.519***
Mean ± SD	90.44 ± 10.67	89.43 ± 10.21	0.622[a]

**p* value < 0.05 is statistically significant; [a]Independent t-test; Pearson's chi-square test

Table 2: Risk factors present among the study participants (N = 108)

Other risk factors (Multiple options)	n (%)
No risk factors	80 (74.1)
Nervous system (CVA, Seizures, parkinsonism)	12 (11.1)
Dyslipidaemia	5 (4.6)
Thyroid	4 (3.7)
Cardiovascular disorder	3 (2.8)
DCM	3 (2.8)
Psoriasis	1 (0.9)
Tuberculosis	1 (0.9)

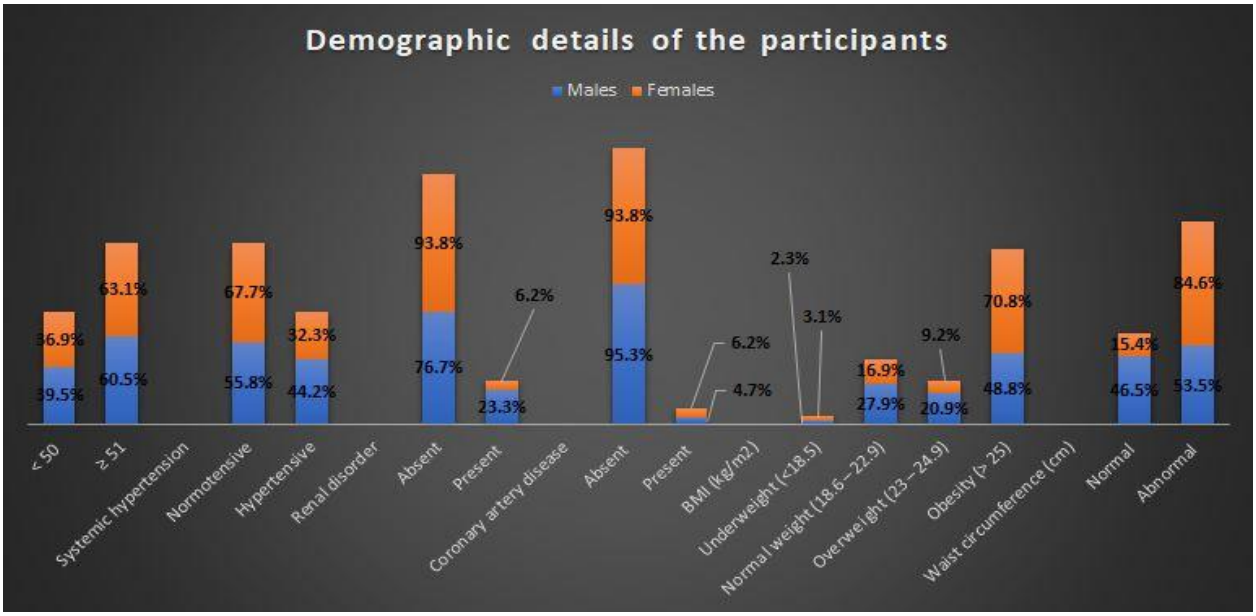
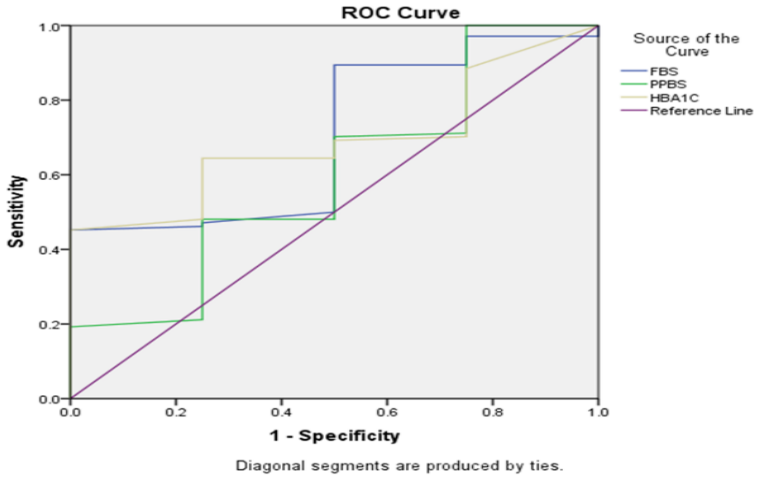


Table 3: Association of visceral adiposity index with glycaemic status:
Receiver operating characteristic curve (ROC curve)
The area under the curve in ROC analysis demonstrated that VAI had a good predictability to identify the glycaemic status as FBS have 70%, while for HbA1c it is about 68%.

VAI



Area Under the Curve

Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
FBS	.702	.121	.172	.466	.938
PPBS	.597	.150	.510	.304	.891
HBA1C	.688	.093	.204	.505	.870

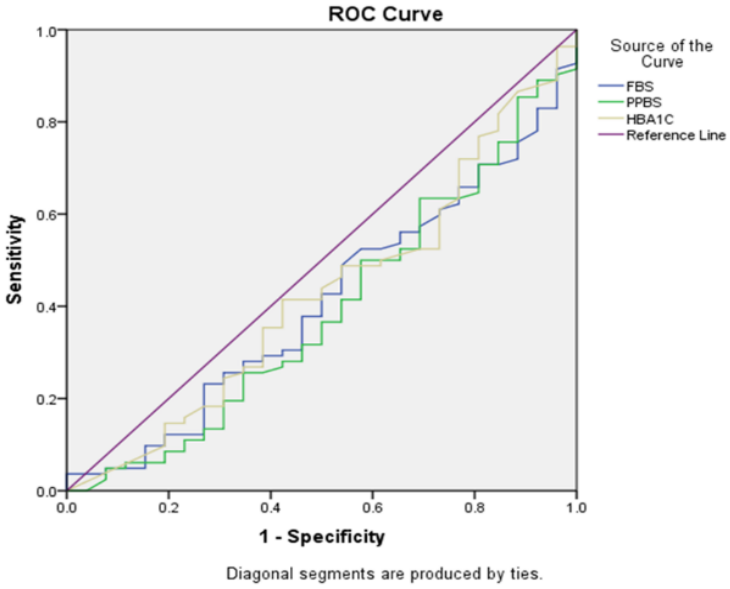
The test result variable(s): FBS, PPBS, HBA1C has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

The area under the curve in ROC analysis demonstrated that Body mass index had predictability to identify glycaemic status as HBA1C have 42 %, while for FBS it is about 40%.

BMI



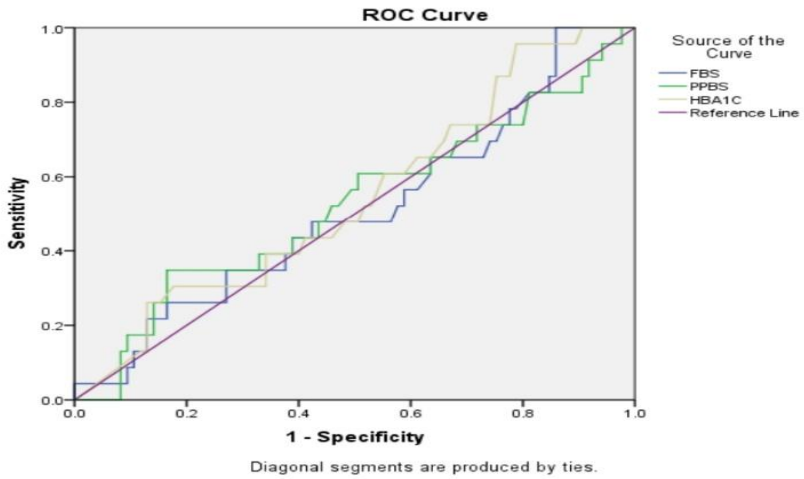
Area Under the Curve

Test Result Variable(s)	Area
BMI	.761
TG	.946
WC	.656
CHOL	.639
HDL	.260

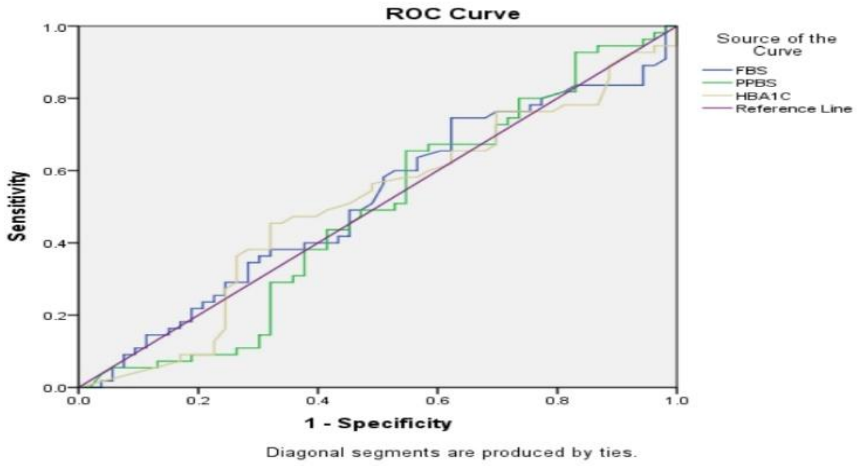
The test result variable(s): BMI, TG, WC, CHOL, HDL has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

The area under the curve in ROC analysis demonstrated that WC had predictability to identify the glycaemic status as FBS have 50%,51%, PPBS have 52%,48%, HBA1C have 54 %,50 % in males and females respectively

For males



For females



Discussion

In the present study we evaluated the association of Visceral adiposity index with FBS, PPBS, HBA1C and the predictive ability of visceral adiposity index to identify the state of glycaemic control as compared to WC, BMI was also studied.VAI calculated showed strongest strength correlation with Triglycerides at 0.001 level (r=0.892; p<0.001) and Cholesterol at 0.001 level (r=0.321; p<0.001)

Area under the ROC curve demonstrated that VAI had a good predictability to identify the state of glycaemic control as FBS have 70 %, while for HBA1C it is about 68 %. The results are in comparison to 67 % prediction of poor glycaemic status reported in Ekhlas Khalid Hameed et al. study[3] and 71 % prediction of diabetes reported in Aysha Alkhalaqi et al. study[4]

The area under the curve in ROC analysis demonstrated that VAI had good predictability for parameters like TG (0.946), BMI (0.761),WC (0.656),Cholesterol (0.639)

In comparison, area under the ROC curve analysis demonstrated that Visceral adiposity index had a good predictive ability to identify the state of glycaemic control than BMI and WC. The multiple components of VAI have a stronger association with induced inflammation and adipocytokine production which may explain the higher predictive power of VAI for glycaemic status than BMI and WC[4]

So higher visceral obesity indicates poor glycaemic status in diabetic individuals

Conclusion

Visceral adiposity index is a good predictor of glycaemic status in diabetic individuals and is a superior predictor of glycaemic status when compared with conventional parameters like Body mass index and waist circumference

It can be used as an easy to calculate handy tool in assessing the adiposity status as well as the glycaemic status of the diabetic individuals

More Indian studies are needed to validate its usage for assessing the metabolic risk in individuals

Limitations

The study sample is less and study is done in single hospital setting. This study does not contain any comparative group. Complications of diabetes mellitus were not included in the study.

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