Original Article

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Lipid Indices vs Anthropometric Indices in Metabolic Syndrome and Type 2 Diabetes Mellitus

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ABSTRACT

Background: Diabetes mellitus is a metabolic disease known by chronic hyperglycemia which results from defective insulin action and secretion. Metabolic Syndrome consists of a constellation of metabolic abnormalities that confer increased risk of diabetes mellitus. The aim of our study is to find out whether non-invasive, clinically measurable surrogates could be useful in identifying body fat distribution and help predict metabolic syndrome and diabetes risk and to compare the performance of anthropometric indices with lipid indices in identifying metabolic syndrome and diabetes.

Methods: 50 individuals with metabolic syndrome ,50 individuals with type 2 diabetes mellitus and 50 controls were selected by purposive sampling technique. For cases and controls history was taken, physical examination was done .Fasting blood sugar, Serum High density lipoprotein and Serum Triglyceride levels were estimated. Body mass index, a body shape index, visceral adiposity index, lipid accumulation factor was calculated.

Results: The mean values visceral adiposity index, lipid accumulation factor were significantly increased ($p<0.001$) in cases compared to controls.

Conclusion: Our study concluded that lipid indices visceral adiposity index, lipid accumulation factor is better than anthropometric indices like body mass index, a body shape index in predicting metabolic syndrome and type 2 diabetes mellitus. Anthropometric indices when used should be correlated with metabolic variables and clinical symptoms.

Keywords: *Metabolic Syndrome, Diabetes Mellitus, Body Mass Index, Body Shape Index, Visceral Adiposity Index, Lipid Accumulation Factor*

Introduction

Diabetes mellitus is a metabolic disease known by chronic hyperglycemia which results from defective insulin action and secretion. World Health Organization projects that number of diabetics will exceed 350 million by 2030. Metabolic syndrome (MetS) consists of a constellation of metabolic abnormalities that confer increased risk of diabetes mellitus. The major features of the metabolic syndrome include central obesity, hypertriglyceridemia, low HDL (high density lipoprotein) cholesterol, hyperglycemia and hypertension [1].

Body Mass Index (BMI) is one of the largely used screening tool in identification of metabolic syndrome. BMI fails to distinguish between body fat and muscle mass and thus has its drawbacks in predicting metabolic syndrome [2]. MRI and CT are now considered the gold standard for the quantitative evaluation of visceral adipose tissue and subcutaneous adipose tissue [3].

VAI (Visceral Adiposity index) estimates visceral fat distribution and it is a useful determinant of the phenotype change and substituted the necessity to take high-cost imaging studies, thereby making the prediction much more practical in daily clinical practice and populations studies for the assessment of cardio metabolic risk associated with visceral obesity [4]. In addition, VAI showed a correlation with known adipocytokines and cardio metabolic risk serum markers [5-6].

A body shape index (ABSI), based on normalizing waist circumference (WC) to BMI and height. The advantage of ABSI is that it combines information from WC, height and weight. A high ABSI indicates that WC is higher than expected for a given height and weight, and corresponds to a more central concentration of body mass [7].

Lipid accumulation factor (LAP) combines waist measurements and fasting triglyceride (TG) levels, reflecting both the anatomic and physiological changes associated with lipid over accumulation. LAP was closely associated with cardiovascular diseases (CVD), diabetes and metabolic syndrome and outperformed BMI for identifying these diseases [8].

The aim of our study is to find out whether non-invasive, clinically measurable surrogates could be useful in identifying body fat distribution and help predict metabolic syndrome and diabetes risk. We also want to examine the associations of anthropometric and lipid indices with metabolic syndrome and diabetes risk, and to compare the performance of anthropometric indices with lipid indices in identifying metabolic syndrome and diabetes.

Materials and Methods

Study design- The present study was conducted in the department of Biochemistry, Father Muller's medical college after obtaining clearance from institutional ethics committee. The study group consisted of 150 individuals selected by purposive sampling technique who had come to hospital for health check-up during a time period of two years. Informed written consent was obtained from all individual participants included in the study. This was a case-control study with a sample size of 150 patients.

Selection of subjects- 50 individuals with metabolic syndrome (all patients who fulfil criteria for metabolic syndrome, according to National cholesterol education program (NCEP): ATP III 2001 for metabolic syndrome [9]), 50 individuals with type 2 diabetes mellitus and 50 controls (age above 40 years, 38 males and 12 females and not a diabetic or patient with metabolic syndrome).

Exclusion criteria- Smokers, alcoholics, patients with history of liver and renal impairment were excluded from the study.

Sample and data collection- For the selected patient's history was taken, physical examination was done. FBS, Serum HDL and Serum Triglyceride levels were estimated. FBS was estimated using GOD-POD method. Triglycerides were estimated by enzymatic colour test GPO-PAP method. HDL was estimated by immune-inhibition enzymatic colour test. All estimations were done on Olympus AU 400 autoanalyzer.

BMI was calculated as weight (kg) divided by square of the height (m^2). VAI score was calculated as described using the following sex-specific equations, WC is expressed in cm, TG is expressed in mmol/L and HDL levels expressed in mmol/L [10]: Men: [WC/39.68+(1.88*BMI)]*(Triglycerides/1.03) *(1.31/HDL-C), Women: [WC/36.58+(1.89*BMI)]*(Triglycerides/0.81)*(1.52/ HDL-C).

ABSI was calculated as WC(m)/($BMI^{2/3}$ * height$(m)^{1/2}$), expressed in $m^{11/6} kg^{-2/3}$ [11] . LAP was calculated using WC (cm) and TG level (mmol /L) using the following formula for men and women respectively [12] LAP = (WC- 65) * TG for men LAP = (WC-58) * TG for women

Statistical analysis- The data was analysed by ANOVA for multiple group comparisons and Pearson's correlation coefficient for relationship between variables. Statistical analyses were performed with the help of SPSS software. For all statistical analyses the *p* value was considered to be significant when $p < 0.05$.

Results

There was a statistically significant difference between VAI ($F_{(2,147)} = 12.294$, p = .000) and LAP ($F_{(2,147)} = 11.338$, p = .001) on each group (Control, Diabetic, Metabolic syndrome) using statistical test ANOVA.

Table 1: Correlation of diastolic blood pressure DBP), systolic blood pressure (SBP, Fasting blood sugar (FBS), High Density Lipoprotein (HDL), Triglyceride (TG), waist circumference (WC) with visceral Adiposity Index (VAI), A Body Shape Index (ABSI) and Lipid Accumulation factor (LAP) in controls, diabetics and metabolic syndrome.

		VAI		ABSI		LAP	
		r value	p value	r value	p value	r value	P value
Control	Diastolic BP	-.097	.504	-.200	.164	-.062	.668
	Systolic BP	-.079	.588	-.200	.163	-.047	.744
	FBS	-.217	.131	-.240	.093	-.172	.231
	HDL	.080	.579	.016	.914	-.032	.823
	TG	.850	.000**	.759**	.000	.490	.000**
	Waist circumference	.110	.447	.105	.467	.027	.853
Diabetic	Diastolic BP	.067	.643	.165	.252	.367	.009**
	Systolic BP	.367	.009**	.252	.078	.439	.001**
	FBS	.127	.380	.173	.230	.176	.222
	HDL	-.460	.001**	.113	.433	-.135	.349
	TG	.797	.000**	-.267	.061	.926	.000**
	Waist circumference	.071	.623	.277	.052	.453	.001**

		VAI		ABSI		LAP	
		r value	p value	r value	p value	r value	P value
Metabolic syndrome	Diastolic BP	.091	.531	.162	.261	.141	.328
	Systolic BP	.030	.838	.294	.038*	.134	.352
	FBS	-.171	.234	-.239	.095	-.110	.445
	HDL	-.369	.008**	.168	.243	-.193	.180
	TG	.948	.000**	-.172	.233	.948	.000**
	Waist circumference	.285	.045*	.519	.000**	.431	.002**

*** Correlation is significant at the 0.01 level (2-tailed).* * Correlation is significant at the 0.05 level (2-tailed).*

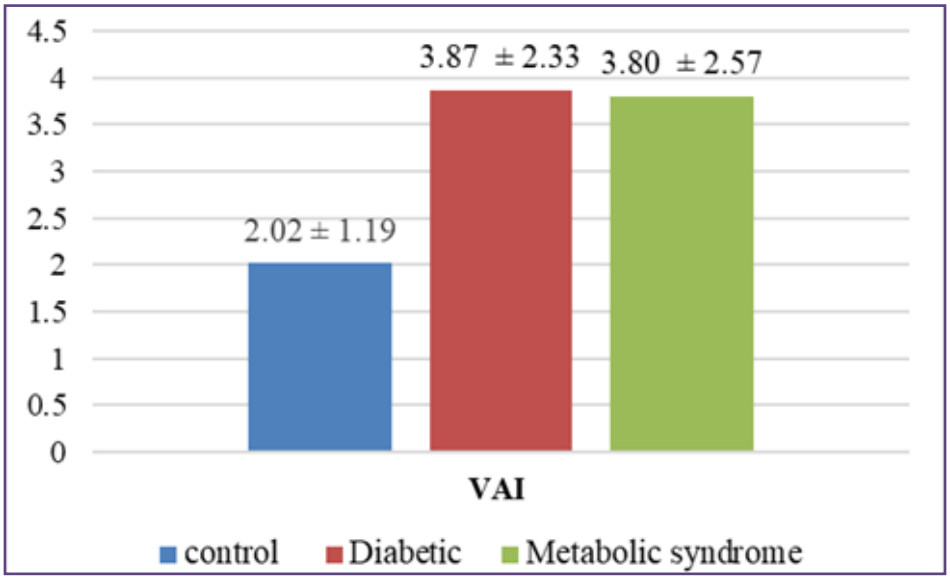

Fig. 1: Comparison of visceral adiposity index between control, diabetic and metabolic syndrome using ANOVA (F (2,147) =12.294, p < 0.001).

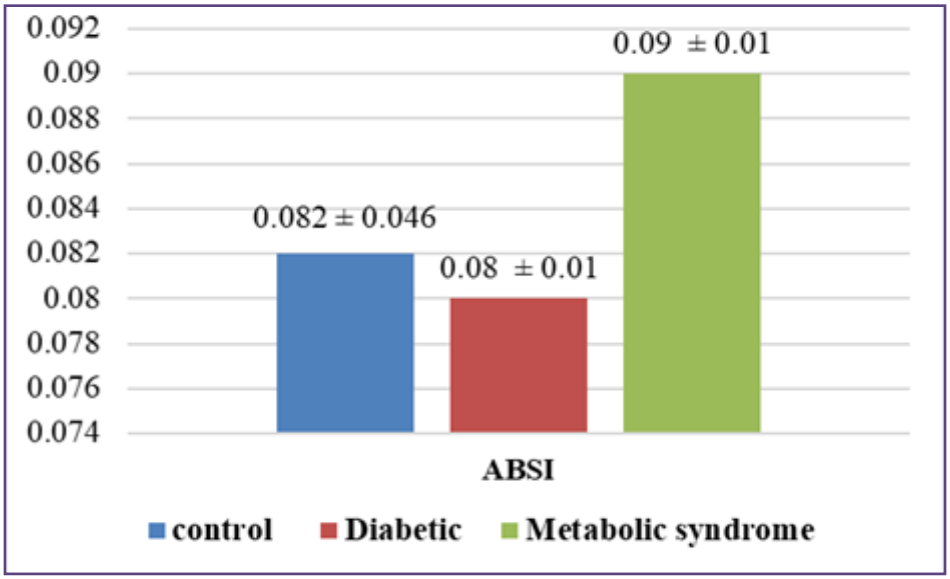

Fig. 2: Comparison of a body shape index between control, diabetic and metabolic syndrome (p value= 0.082) using ANOVA.

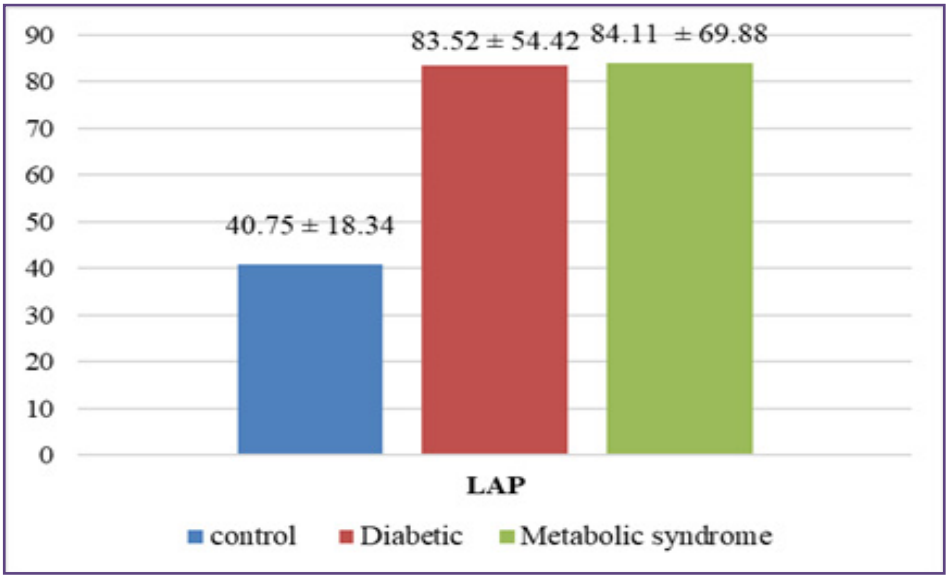

Fig. 3: Comparison of lipid accumulation factor between control, diabetic and metabolic syndrome using ANOVA (F (2,147) = 11.338, p = 0.001).

Discussion

Cardiometabolic risk (CMR) denotes a cluster of metabolic abnormalities predictive of cardiovascular diseases (CVD), which is 3–4 times identifiable among individuals with Type-2 Diabetes Mellitus (T2DM) [13].Therefore it is important to use reliable markers that readily identify patients at risk of CVDs . This study analysed comparative usefulness of VAI, ABSI and LAP in identifying individuals at risk of CVDs.

VAI was found to be significantly increased in patients with metabolic syndrome and type 2 diabetes. A major risk factor for diabetes is visceral obesity [14]. VAI is suggested as a surrogate of visceral adipose and it includes both anthropometric and metabolic variables. VAI provides information regarding visceral adipose tissue and insulin resistance [15]. Visceral obesity which has been proposed as a marker of adiposity dysfunction and ectopic fat deposition is more metabolically deleterious than general obesity or subcutaneous fat and it leads to lipotoxicity and insulin resistance [16]. A prospective cohort study conducted in China showed that the VAI is a better surrogate index than single anthropometric indices [17] . Even though VAI cannot be considered as a diagnostic tool for cardiovascular events, as it includes physical and metabolic parameters, it will reflect other risk factors like altered production of adipocytokines, increase in lipolytic activity and plasma-free fatty acids. In patients with visceral obesity a state of relative hypoleptinemia can be observed in patients when compared with generalized obesity. Leptin resistance when associated visceral fat dysfunction, leads to pancreatic lipotoxicity followed by beta-cell apoptosis and diabetes onset, muscle insulin resistance, liver insulin resistance [18].

ABSI was not found be statistically significant in patients with metabolic syndrome and diabetes mellitus. However ABSI was positively correlated with systolic BP and waist circumference in patients with metabolic syndrome. Our study was in accordance with prospective cohort study done Fujita et al who also concluded that ABSI was an inferior discriminator when compared to other anthropometric and lipid indices [19]. Sikandar Hayat Khan et al reported that ABSI is not a useful indicator in predicting metabolic syndrome and type 2 diabetes [20]. But our study was contradictory to a study done by which found ABSI levels to be statistically significant in patients with type 2 diabetes. They found that ABSI when used along with BMI is a better predicator of type 2 diabetes [21].

LAP is an indicator that measure WC and estimate TG. LAP was found to be significantly increased in patients with metabolic syndrome and diabetes mellitus compared to controls in our study. LAP was found to be positively correlated with diastolic BP, systolic BP, triglycerides and WC in patients with type 2 diabetes mellitus and with triglycerides and waist circumference in patients with metabolic syndrome. Studies done by Khan [22] and Xiang et al [23] found that LAP is better biomarker than BMI for predicting metabolic syndrome and cardiovascular disorders. BMI reflects only excess weight when compared with LAP. Individuals with different metabolic risk profile may have a similar BMI [24]. WC cannot distinguish between subcutaneous and visceral adipose tissue. So, an

increased WC cannot indicate high-risk visceral fat [8].A work done by Henry reported that LAP is a better indicator than BMI and is far superior in identifying diabetes mellitus[25].Studies done by Evan et al concluded that LAP is a useful biomarker for identifying individuals at risk of cardiovascular disorders among T2DM patients[26]. In a study done by Cheng Y et al showed that metabolic syndrome increases risk of cardiovascular disease, and the LAP could be used to recognize the metabolic syndrome even in people without fatty liver disease [27]. Chiang and Koo concluded that LAP was found to be an accurate tool for predicting the risk of metabolic syndrome in Taiwanese people and will help in a primary care centre to decide on which patients require further evaluation [28].

Limitations of our study include a small sample size and we have included only a few lipid and anthropometric indices.

Conclusion

Our study concluded that lipid indices LAP, VAI are better than anthropometric indices like BMI, WC and ABSI in predicting metabolic syndrome and type 2 diabetes. Anthropometric indices when used should be correlated with metabolic variables and clinical symptoms.

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Competing Interests

None declared

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