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VISCERAL ADIPOSITY INDEX AND LIPID ACCUMULATION PRODUCT – LESS INVASIVE INDICES FOR ADIPOSITY AMONG ADULT WOMEN

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Abstract:

The purpose of this study was to access the fat accumulation by less invasive methods. The prevalence of obesity was found out among 346 adult women between the age group of 18-30 years, anthropometric screening was performed using standard procedures. To a subsample, biochemical estimations and indicators was calculated and evaluated. The results show that as BMI increases there was a significant increase in VAI and LAP levels. An interesting finding of the study was that higher fat accumulation was seen for normal BMI individuals. Thus, VAI and LAP can be used as adiposity indicators as they are less invasive and cost effective. Further studies are required to validate the indices.

Index Terms: *Adiposity, Adult Women, LAP, Obesity and VAI.*

I. INTRODUCTION

Obesity is associated with increased health risks and pain that can impair physical health status and impose limitations on daily activities. Reduced physical health as well as stigmatization and discrimination associated with obesity can contribute to impaired mental well-being (Katz et al., 2000). Obesity represents a major public health problem in developed countries (Rippe et al., 1998). Obesity is also an independent risk factor for a variety of chronic diseases such as diabetes, hypertension, and coronary heart disease, thus associated with high levels of possibly avoidable health care costs (Quesenberry et al., 1998). Body fat tissue is traditionally distributed into two main compartments with different metabolic characteristics like subcutaneous adipose tissue (SAT) and visceral adipose tissue (VAT). While both of these tissue types are important, particular attention has been directed to visceral adiposity owing to its association with various medical pathologies (Shuster et al., 2012).

Abdominal obesity, which is characterized as increased adipose tissue surrounding the intra-abdominal organs, is also referred to as visceral or central obesity. Visceral obesity itself is an independent component of metabolic syndrome and the magnitude of obesity directly relates to the prognosis of this condition (Mathieu, 2008). Abdominal obesity and the consequent Insulin resistance are said be important contributing factors for diabetes and dyslipidemia (Hamdy et al., 2006). Several studies have shown higher risk of diabetes in association with abdominal obesity (Boyko et al., 2000)

India can be categorized as overweight or obese, which is an alarming figure for a developing country (Mishra et al., 2009). Asian Indians, have a higher risk for obesity related complications at a lower level of BMI their Caucasian counterparts owing to higher visceral fat (Anjana et al., 2004). Indian phenotype is uniquely predisposed to develop diabetes and represents the population with increased abdominal adiposity (especially visceral adiposity) predisposing them to higher CMR compared to

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Caucasians at the same levels of BMI (Joshi, 2012). The Body Mass Index (BMI) of 23 to 24.9kg/mt2 for overweight and >25kg/mt2 for obesity (Mishra et al., 2009). Early identification and treatment of individuals with MetS could reduce risk of developing relevant diseases. Visceral adiposity index (VAI) and lipid accumulation product (LAP) are two novel indexes used for identifying MetS. The objective of the study is to associate and access VAI and LAP among the selected age group.

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 HDL cholesterol (HDL)), and indicative of fat distribution and function. The VAI has shown a strong positive correlation with peripheral glucose utilization during euglycemic hyperinsulinemic clamp and seems to be independently associated with cardio- and cerebrovascular events (Amato et al., 2010). LAP combines waist measurements and fasting triglyceride (TG) levels, reflectingboth the anatomic and physiological changes associated with lipidoveraccumulation (Xia et al., 2012)

II. METHODOLOGY

A. Participants:

A total of 346 adult women were recruited in the study by purposive sampling method. Initially the prevalence of obesity was screened. A sub sample of 61 adult women (12 normal, 9 were overweight and 40 were obese) was selected depending upon the inclusion and exclusion criteria. Willingness to participate and women of prescribed age group were included. Differently abled women, with known diabetes, hypertension and psychological problem and morbid obese women were excluded from the study. Due Ethical clearance was procured from Institutional Human Ethics Committee. The study was approved by Institutional Human Ethics Committee, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu.

B. Anthropometry Measurements:

Basic information like socio-economic status was noted. Anthropometric measurements like Height (cm), Weight (kg), Waist Circumference (WC) (cm), Hip Circumference (HC) (cm) were measured using standard procedures. From these measurements Body Mass Index (BMI), Waist-Hip Ratio (WHR) and Waist-Height Ratio (WHtR) was calculated by following formulas.

BMI = weight (kg)/height $(m)^2$

WHR = waist circumference (cm) / hip circumference (cm)

WHtR = waist circumference (cm) / height (cm)

The adult women were divided into four quartiles depending upon their BMI.

C. Biochemical Estimations:

Overnight fasting blood samples were collected. To a sub sample of 100 adult women, the biochemical parameters like blood pressure and lipid profile was done. Biochemical estimations like triglycerides, high density lipoprotein and low-density lipoprotein were analyzed using CHOD POD, enzyme selective protection method and homogenous enzymatic colorimetric assay methods respectively.

D. Obesity Indicators:

Indices like Visceral Adiposity Index (VAI) and Lipid Accumulation Product (LAP) was calculated.VAI and LAP are gender-specific, based on simple anthropometric and functional parameters by using standard formulas by below given formulas.

1) Visceral Adiposity Index (VAI):

Visceral Adiposity Index is an empirical mathematical model, gender-specific, based on simple anthropometric (BMI & WC), functional parameters like triglycerides (TG) and HDL cholesterol (HDL) (Amato et al., 2010).

$$VAI = \frac{WC}{39.58(1.84 \times BMI)} \times \frac{TG}{0.81} \times \frac{1.52}{HDL}$$

were, WC - waist circumference (cm); TG - triglycerides (mmol); HDL - high-density lipoprotein (mmol); BMI - body mass index[13].

2) Lipid Accumulation Product (LAP):

The Lipid Accumulation Product, which is based on a combination of WC and the fasting concentration of triglyceride (TG), has been proposed as an alternative measure of excessive fat accumulation.

$$LAP = (WC - 58) \times (TG)$$

were, WC - waist circumference (cm); TG - triglycerides (mmol) (Kahn, 2005).

E. Statistical Analysis:

All the statistics analysis was done in SPSS 16v. The results are expressed in mean ± SD. Data analysis was carried out using t-test with $p<0.05$ being significant (95% confidence interval. Correlation analysis was performed using Pearson correlation test. Linear Regression curve was used to analyze the R value and R squared value.

III. RESULTS AND DISCUSSION

A. Prevalence of Obesity among Adult Women (N=346):

The lower BMI cut-off values was proposed by International Obesity Task Force for defining overweight and obesity among Asian population (WHO, 2000). Body Mass Index by Asian standards was used to find the prevalence of obesity. The Fig. 1 shows that among 346 adult women, 27% were obese and 20% were underweight. Overweight and obesity in middle-income countries are trickling down, from wealthier women to the rest of the population thus requires population level approaches (Popkin et al., 2013; Colchero et al., 2017).

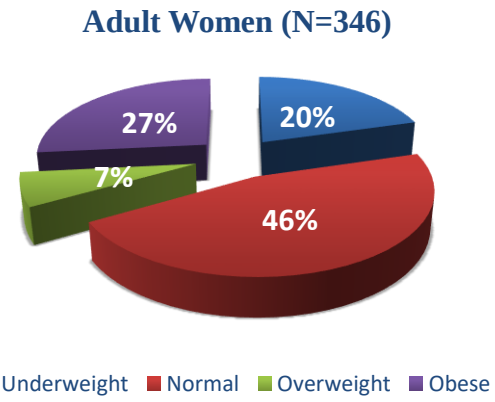

Fig-1. Body Mass Index among 346 adult women

B. Demographic and Anthropometric Measurements among Adult Women:

The study enrolled 346 adult women and the demographic and anthropometric measurements were divided depending upon the BMI as shown in Table 1. The demographic details showed that all the adult women were literate**.** Among the adult women, 150 were married, 201 were students, 54 were employed and 91 were house wives**.**

The income level of adult women resulted that, majority (55%) were in middle income group. In socio demographic factors sex, residence, type of family, socioeconomic status was identified as significant risk factors (Mehta et al., 2020). The anthropometric measurements showed a significant difference ($p < 0.05$) among the variables except height. Waist circumference (WC) and the waist to hip ratio (WHtR), are proposed to assess the visceral fat (Alshamiri et al., 2020).

Table 1: Anthropometric Measurements of Adult Women (N=346)

Variables	Under Weight (n=71)	Normal (n=160)	Over weight (n=23)	Obese (n=92)
Age*	21.41±0.50	20.96±1.59	22.91±3.41	23.13±3.47
Height (cm)	157.51±5.68	157.50±7.57	156.74±7.55	155.13±6.12
Weight(kg)*	44.39±12.58	52.37±6.56	59.60±6.05	68.56±8.08
Waist circumference (cm)*	61.17±3.37	69.16±5.12	77.61±5.4	85.63±7.77
Hip circumference (cm)*	82.35±4.05	88.67±11.03	93.00±4.47	101.19±14.20
BMI*	17.03±1.03	22.16±14.55	24.02±0.44	28.34±3.03
WHR*	0.73±0.05	1.11±1.49	0.82±0.08	0.94±0.75
WHtR*	0.39±0.03	0.46±0.31	0.50±0.04	0.55±0.75

*** (p <0.05)**

C. Biochemical Estimations among Selected Adult Women (n=100):

The below table shows the statistical difference between non-obese and obese with respect to biochemical parameters. There was a statistical difference seen among total cholesterol, triglycerides, HDL and LDL cholesterol between the two groups. In a study conducted by Mazloom et al., 2009 concluded that obese women demonstrated significantly higher serum concentrations of TG, and cholesterol compared with non-obese participant.

Table 2: Biochemical Parameters among Selected Adult Women (n=100)

Variables	Normal Range (mg/dl) *	Non-Obese (n=50)	Obese (n=50)	p value
Total Cholesterol (mg/dl)	<200	156.33±29.34	171.75±27.66	0.0081*
Triglycerides (mg/dl)	<150	83.40±41.31	108.04±47.13	0.0065*
HDL (mg/dl)	<60	47.30±12.30	42.52±9.36	0.0311*
LDL (mg/dl)	<100	97.80±26.20	114.36±21.70	0.0009*

*** (p <0.05)**

D. Obesity Indicators among Selected Adult Women (n= 100):

The Visceral Adiposity Index (VAI) and Lipid Accumulation Product (LAP) was calculated separately among selected obese and non-obese adult women. The result showed that there was extreme statistical difference seen on VAI and LAP between the groups (Table 3).

It was observed, the VAI of obese was higher (2.20±1.23) compared to non-obese (1.52±0.95) (Fig. 2a). A study conducted among type II diabetics women showed a higher VAI value of 2.64±1.56 than men (1.87±0.94) (Amato et al., 2014) A study concluded that VAI can be replaced by specialized imaging procedures having an advantage of minimal economic burden and radiation hazard. However, it is a requisite to identify the age and sex specific cutoff points in the general population for early diagnosis and disease prevention for persons at risk for metabolic disorders, diabetes and CVD (Pathak et al., 2016).

The LAP values of obese (37.80±21.26) was twice higher compared to non-obese (13.51±8.67) (Fig. 2b). The LAP value of non-diabetic women was 23.99 (13.09–40.12) which was lower than the obese women in the study (Xia et al., 2012). Ray et al., 2018 in a study concluded that among the Indian population, lipid accumulation product index is a better predictor of MetS compared to Body Mass Index and Waist Circumference. He also suggested that LAP must be included in laboratory reports as rapid, precise and inexpensive indicator.

Table 3: VAI and LAP among Selected Adult Women (n=100)

Variables	Non-Obese (n=50)	Obese (n=50)	P value
VAI	1.52±0.95	2.20±1.23	0.0026*
LAP	13.51±8.67	37.80±21.26	0.0001*

*** (p <0.05)**

E. Correlation Analysis among Selected Adult Women:

Pearson Correlation analysis was done and a positive significant correlation seen between age, LAP, BMI, WHT and WHtR. BMI, WC, waist-to-hip ratio and waist-to-height ratio showed a positive correlation with LAP. In comparison with another study, VAI and LAP was found to be positively correlated with other indices among lean women with PCOS (Ilhan et al., 2018)

F. Regression Analysis among Selected Adult Women:

The regression analysis was done between BMI and LAP which showed a positive correlation, by linear curve and it was found that the R Square value was 0.143 and the adjusted R Square was 0.120.

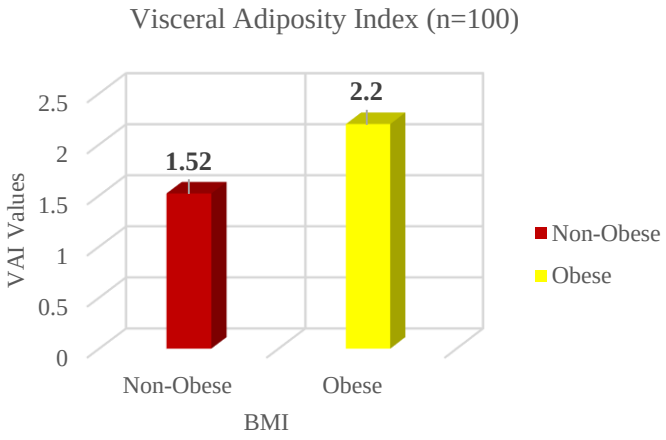

Fig- 2a: VAI among Selected Adult Women (n=100)

IV. CONCLUSION:

Abdominal obesity is dangerous compared to weight gained on other parts of the body. The importance of measuring the fat accumulation is essential for prevention of lifestyle diseases. The study shows that the adiposity indicators like VAI and LAP perform well and correlates with BMI, WHT and WHtR. VAI and LAP are less invasive, cost effective and can be used as an effective indicator to prevent diabetes, Mets and cardio vascular diseases. Early identification and treatment of individuals with abdominal adiposity can reduce the risk of diabetes.

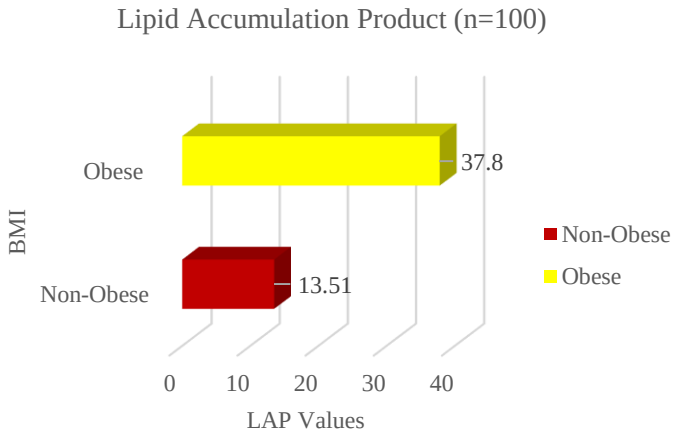

Fig- 2b: LAP among Selected Adult Women (n=100)

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