

Original Research Article

FROM BODY MEASUREMENTS TO METABOLIC HEALTH: RELATIONSHIP BETWEEN ANTHROPOMETRIC INDICES, INTRA-ABDOMINAL FAT TISSUE, AND LIPID PROFILE

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Received : 04/08/2026
Received in revised form : 04/09/2026
Accepted : 17/09/2026

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DOI: 10.70034/ijmedph.2026.3.934

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 6065-6070

ABSTRACT

Background: Simple clinical anthropometric indices like BMI, WC, HC, and WHR were used to assess central obesity. Accurate intra-abdominal fat measurement requires MRI, CT, or USG. Raised triglycerides, total cholesterol, LDL and low HDL are risk factors for atherosclerosis.^[3] High LDL is strongly linked to coronary heart disease (CHD), while high HDL is protective. Disturbed lipid profiles commonly occur in cardiovascular disease, with BMI, WC, and HC as key predictors. Abdominal fat distribution, particularly intra-abdominal fat, correlates strongly with altered lipid profiles and cardiovascular risk. Early intervention based on lipid profile can reduce cardiovascular risk. Therefore, this study aims to examine relationships between anthropometric measures, lipid profile, and intra-abdominal fat tissue in healthy subjects. The aim is to study the relationship between anthropometric measurements with lipid profile and intraabdominal fat tissue in healthy subjects.

Materials and Methods: This cross-sectional study was done in 352 Master Health checkup individuals from Trichy SRM Medical College Hospital and Research Centre, Tiruchirappalli, in which 171 were males and 181 were females. Anthropometric measurements, including height, weight, waist circumference, hip circumference, waist-to-hip ratio, and BMI, were recorded. Recording of subcutaneous adipose tissue (SAT) and Visceral adipose tissue (VAT) was done by ultra sonogram. Lipid profiles like total cholesterol, HDL, LDL, VLDL, Serum.Triglyceride was done in the Clinical Bio-Chemistry Laboratory, Chennai Medical College Hospital, Irungalur with COBAS 311 at HITACHI Diagnostics. Statistical analysis was conducted using SPSS -21 Software. Pearson's correlation test assessed the correlation between anthropometric indices, abdominal fat tissue and lipid profile. P-value <0.05 was considered as statistically significant.

Results: In this study BMI positively correlated with SAT, VAT. WC also had positive correlation with visceral adipose tissue (VAT). So VAT is significant.VAT is also known to cause metabolic syndrome, inflammation and CVD. Waist hip ratio also correlates with visceral adipose tissue (VAT) than SAT.

Conclusion: It is concluded that Waist circumference and Waist hip ratio positively correlated with visceral adipose tissue. Body mass index had positive correlation with both SAT and VAT. It can be concluded that Waist circumference, Waist hip ratio, Body mass index are the better parameter in predicting the visceral adipose tissue. There is no significant correlation between lipid parameter and anthropometric measurements.

Keywords: Obesity, Underweight, SAT, VAT, STG, HDL, LDL, VLDL.

INTRODUCTION

Obesity is prevalent globally and it raises the morbidity and mortality of any given population.^[5,6] In the development of metabolic syndrome, atherosclerosis and other cardiovascular disease, central obesity is the significant risk factor.^[7,8]

The deranged lipid profile is one of the risk factor for the incidence of IHD in Indian population.^[3]

The accurate calculation of intra-abdominal fat tissue needs imaging modalities like MRI, CT and USG.^[1,2]

Since these investigations are highly costly and complex for large scale studies and for daily day today clinical set up simple clinical anthropometric indices like BMI, WC, HC, WHR are easily and comfortably used to assess central obesity. The significant step in assessing central obesity is the measurement of fat accumulation.^[1] Raised levels of triglyceride, total cholesterol, LDL and low HDL are the documented risk factors for atherosclerosis.^[3]

In adults, higher risk of CHD is strongly correlated to high LDL while high HDL is usually protective. Frequently observed are the increased levels of LDL, high TC and low levels of HDL in combination with hypertriglyceridemia.^[4]

Disturbed lipid profile is seen in cardiovascular disease. It has been found that the anthropometric predictors for cardiovascular risk are BMI, WC and HC.^[9] The significant implication of abdominal fat and lipid profile measurement is to intervene at the earliest to reduce the cardiovascular disease.

It has been established that there is an associations between overweight and altered lipid profile. Subjects with the higher risk of altered lipid profile could be possibly identified by the fat distribution and the intra-abdominal fat is regarded as the most clinically relevant type of fat in humans.^[10]

Therefore, aim of the present study is to study the relationship between anthropometric measurements with lipid profile and intra-abdominal fat tissue in healthy subjects.

MATERIALS AND METHODS

Study Design: Cross sectional study

Sample size: A total of 352 individuals where included in the study, out of 352, 171 were males and 181 were females.

Place of study: Trichy SRM (previously Chennai Medical college Hospital and research centre) Irungalur, Trichy.

Methodology: Subjects were picked up from Master Health checkup. Subjects in a fasting state,

underwent anthropometric measurements, and lipid profile estimation.

Anthropometric measurements were done at Non-Communicable Diseases Outpatient department, Lipid profile Test was done at Clinical Bio-Chemistry Laboratory, Chennai Medical College Hospital, Irungalur with COBAS 311 from HITACHI Diagnostics.

Institutional Ethics Committee approval was obtained, and written informed consent was taken from all participants before enrolment. Anthropometric measurements like weight, height, waist hip ratio, hip circumference, waist circumference were taken with the individuals in relax, standing erect posture with their arms at their sides and feet together.^[11]

Weight was obtained from electronic weighing machine with light clothing and without shoes. Height was measured using fixed stadiometer. Waist circumference was recorded at the middle of the lowest rib and lateral iliac crest by using a measuring tape. Hip circumference was calculated at the level of trochanter major or at the point of maximum buttocks.^[11] Waist Hip Ratio is the ratio of waist circumference and hip circumference.

Lipid profile was measured in 10 hrs fasting state. 2ml of venous blood was collected in the syringe by vene puncture under strict aseptic precaution. Lipid profiles included total cholesterol, HDL, LDL, VLDL, Serum. Triglycerides.^[12]

Cholesterol estimation done by Cobas 311 with HITACHI diagnostics with enzymatic method. HDL estimation done by Homogenous Assay (Direct HDL-C Assay). LDL estimation done in 2 steps by Ultra centrifugation to remove VLDL leaving behind LDL and HDL as well as IDL and lp(a) and followed by Chemical precipitation of HDL from either the whole serum obtained from the ultracentrifugation. Triglycerides estimation was done by an enzymatic method called Glycerol kinase method.

Ultra sound image analysis was done Using 3.5 MHz probe situated 1 cm above umbilicus. All ultrasound measurements were taken by the same examiner. SAT and VAT measurements were taken using USG.^[1] Subcutaneous Fat Tissue was measured between skin and external surface of rectus abdominis muscle. Visceral Fat Tissue recorded between interior of rectus abdominis muscle and the anterior aortic wall.

The collected data were expressed as mean $\pm$ standard deviation (SD) and analysed using Statistical Package for Social Sciences (SPSS) version 21.

RESULTS

Table 1: Correlation between SAT and VAT with Anthropometric Measurements

SAT (cm) with other Parameters	Mean	S.D	Correlation	Sig.	VAT (cm) with other Parameters	Mean	S.D	Correlation	Sig.
BMI (kg/m ²)	25.511	2.62823	.144	<0.05*	BMI (kg/m ²)	25.5113	2.62823	0.230	<0.05*
SAT	1.4085	0.41674			VAT	4.4901	0.88828		
WC (cm)	74.43	10.955	-0.035	>0.05	WC(cm)	74.43	10.955	0.159	<0.05*
SAT	1.4085	.41674			VAT	4.4901	0.88828		
HC (cm)	91.43	11.800	-0.055	>0.05	HC (cm)	91.43	11.800	-0.001	>0.05
SAT	1.4085	.41674			VAT	4.4901	0.88828		
WHR	.81314	.059707	0.023	>0.05	WHR	0.81314	0.05970	0.338	<0.05*
SAT	1.4085	.41674			VAT	4.4901	0.88828		
WC (cm)	74.43	10.955	-0.035	>0.05	WC (cm)	74.43	10.955	0.159	<0.05*
SAT	1.4085	.41674			VAT	4.4901	0.88828		

*p Value - <0.05 is significant.

[Table 1] shows SAT had statistically significant positive correlation with BMI, but no statistically significant correlation with WC, HC and WHR This Table also shows that VAT had statistically

significant positive correlation with BMI, WC and WHR (p=0.000, p=0.003, p=0.000) respectively, but no statistically significant correlation with HC.

Table 2: Correlation of Total Cholesterol, Serum Triglyceride with Anthropometric Measurements and Abdominal Fat Tissue

TCL(mg/dl) with other Parameters	Mean	S.D	Correlation	Sig.	STG (mg/dl)with other Parameters	Mean	S.D	Correlation	Sig.
BMI (Kg/m ²)	25.5113	2.62823	.053	>0.05	BMI (Kg/m ²)	25.511	2.62823	0.071	>0.05
TCL	177.51	20.334			STG	137.75	12.811		
WC (cm)	74.43	10.955	-0.147	<0.05*	WC(cm)	74.43	10.955	0.040	>0.05
TCL	177.51	20.334			STG	137.75	12.811		
HC (cm)	91.43	11.800	-0.089	>0.05	HC(cm)	91.43	11.800	0.024	>0.05
TCL	177.51	20.334			STG	137.75	12.811		
WHR	.81314	.05970	-0.151	<0.05*	WHR	0.8131	.0597	0.036	>0.05
TCL	177.51	20.334			STG	137.75	12.811		
SAT (cm)	1.4085	.41674	-0.011	>0.05	SAT (cm)	1.4085	.41674	0.115	<0.05*
TCL	177.51	20.334			STG	137.75	12.811		
VAT (cm)	4.4901	.88828	-0.149	<0.05	VAT(cm)	4.4901	.88828	0.077	>0.05
TCL	177.51	20.334			STG	137.75	12.811		

*p Value -< 0.05 is significant.

[Table 2] shows that Serum Triglyceride had statistically significant positive correlation with SAT (p=0.03), but no correlation with BMI, WC, HC, WHR, VAT

This Table also shows that Total Cholesterol had statistically significant negative correlation with WC, WHR, VAT (p=0.006, p=0.004, p=0.005) but no correlation with BMI, HC, SAT.

Table 3: Correlation of HDL & LDL with Anthropometric Measurements and Abdominal Fat Tissue

HDL(mg/dl)with other Parameters	Mean	S.D	Correlation	Sig.	LDL(mg/dl)with other Parameters	Mean	S.D	Correlation	Sig.
BMI (Kg/m ²)	25.511	2.62823	-.185	<0.05*	BMI (Kg/m ²)	25.511	2.6282	-0.020	>0.05
HDL	44.45	7.579			LDL	128.82	9.549		
WC(cm)	74.43	10.955	-0.198	<0.05*	WC(cm)	74.43	10.955	-0.171	<0.05*
HDL	44.45	7.579			LDL	128.82	9.549		
HC(cm)	91.43	11.800	0.115	<0.05*	HC(cm)	91.43	11.800	-0.017	>0.05
HDL	44.45	7.579			LDL	128.82	9.549		
WHR	.81314	0.05970	-0.195	<0.05*	WHR	0.8131	0.0597	-0.338	<0.05*
HDL	44.45	7.579			LDL	128.82	9.549		
SAT (cm)	1.4085	0.41674	-0.071	>0.05	SAT (cm)	1.4085	0.4167	0.016	>0.05
HDL	44.45	7.579			LDL	128.82	9.549		
VAT (cm)	4.4901	0.88828	-0.131	<0.05*	VAT (cm)	4.4901	0.8882	-0.087	>0.05
HDL	44.45	7.579			LDL	128.82	9.549		

*p Value of <0.05 is significant.

[Table 3] shows HDL had statistically significant negative correlation with BMI, WC, WHR, and VAT and had significant positive correlation with HC but no correlation with SAT.

This Table also shows that LDL had statistically significant negative correlation with WC, WHR ($p=0.001$, $p=0.000$) but no correlation with VAT, SAT, HC, BMI.

Table 4: correlation of VLDL with anthropometric measurements and abdominal fat tissue

VLDL(mg/dl) with other Parameters	Mean	S.D	Correlation	Sig.
BMI(Kg/m ²)	25.5113	2.62823	-0.192	<0.05*
VLDL	20.76	7.492		
WC(cm)	74.43	10.955	-0.188	<0.05*
VLDL	20.76	7.492		
HC(cm)	91.43	11.800	0.012	>0.05
VLDL	20.76	7.492		
WHR	0.81314	0.05970	-0.409	<0.05*
VLDL	20.76	7.492		
SAT (cm)	1.4085	0.41674	-0.228	<0.05*
VLDL	20.76	7.492		
VAT (cm)	4.4901	0.88828	-0.431	<0.05*
VLDL	20.76	7.492		

*p value of <0.05 is significant.

[Table 4] shows that VLDL had statistically significant negative correlation with BMI, WC, WH ratio, SAT, VAT ($p=0.000$, $p=0.000$, $p=0.000$, $p=0.00$) but no statistically significant correlation with HC.

DISCUSSION

Central obesity is a major risk factor for metabolic syndrome, atherosclerosis, and cardiovascular disease, so this study investigated whether simple body measurements can better predict abdominal fat tissue and lipid profile in 352 adults. Because intra-abdominal fat and abnormal lipid levels are closely linked to insulin resistance and dyslipidemia, this study used ultrasonography to measure abdominal fat and related these findings with anthropometric indices, which are practical tools in large studies where advanced imaging is not feasible.^[1]

[Table 1] of the present study shows that SAT was positively related to BMI but not to WC, HC, or WHR. This agrees with Zhang et al., who found that SAT was more strongly related to BMI than to WC.^[18] However, Oka et al. reported that SAT was related to both BMI and WC.^[19] These differences may be due to variations in age, sex, ethnicity, study population, and fat distribution. BMI reflects overall body fat, whereas WC and WHR mainly reflect abdominal fat.

VAT was positively related to BMI, WC, and WHR but not to HC. This agrees with Jia et al, who found that BMI, WC, and WHR were associated with visceral fat.^[20] In contrast, Kuk et al, reported a positive relationship between HC and VAT, which became negative after adjusting for WC and age. These differences may be due to differences in the study population and methods used to measure body fat.

[Table 2] showed that triglycerides were positively related to SAT but not to BMI, WC, HC, WHR, or VAT. This agrees with a youth study in which SAT was associated with higher triglyceride levels,

especially after puberty. The association remained significant after adjusting for BMI, WC, and waist-to-height ratio.^[21] However, a study in middle-aged Japanese adults found that both SAT and VAT were initially associated with triglycerides. After adjusting for both fat depots and other body measurements, only VAT remained significantly associated with triglycerides.^[19]

Total cholesterol was negatively related to WC, WHR, and VAT but was not related to BMI, HC, or SAT. Fox et al,^[22] found no significant relationship between total cholesterol and VAT, WC, BMI, or SAT.^[23] This supports the lack of association in our study but not the negative correlations. Other studies have reported that higher VAT and WC are associated with higher total cholesterol, which differs from our findings.^[24] Differences in age, sex, medication use, health status, and lifestyle may explain these results.

[Table 3] showed that HDL cholesterol was negatively associated with BMI, WC, WHR, and VAT. It was positively associated with HC but had no significant relationship with SAT. Sam et al. supported our finding by reporting that higher visceral fat was associated with lower HDL cholesterol.^[25] However, the AWI-Gen study reported different results. It founded that visceral fat was positively associated with triglycerides and that HC was negatively associated with triglycerides. It did not find the same negative associations between HDL and BMI, WC, WHR, or VAT.^[26] These differences may be due to variations in population, sex, lifestyle, and metabolic health.

[Table 3] of the present study also shows that LDL had significant negative correlation. A study by Teslovich et al. provides partial support for your finding because it reported no robust association between genetically determined VAT and LDL cholesterol; although higher VAT showed a directionally consistent association with lower HDL cholesterol.^[27] The, EPIC-Norfolk population-based cohort study opposes your finding. It reported that higher WHR and WC were positively associated

with LDL cholesterol, whereas larger HC was associated with lower LDL cholesterol.^[28]

[Table 4] of the present study shows that VLDL had significant negative correlation with BMI, WC, WH ratio, SAT, VAT but no statistically significant correlation with HC. A study by Miyashita et al. provides partial support for your findings because BMI and SAT were not independently associated with lipoprotein parameters. This is consistent with your result showing no significant correlation between VLDL and some measures of overall or subcutaneous fat.^[29] A study by Nie et al. opposes your findings because VAT was positively associated with large VLDL particle concentration and VLDL particle number. This is contrary to the significant negative correlation between VLDL and VAT observed in your study.^[30]

BMI measures overall body size but cannot show where fat is stored or distinguish fat from muscle. In our study, BMI was positively associated with SAT and VAT and negatively associated with HDL and VLDL, but it was not associated with triglycerides, total cholesterol, or LDL. BMI, WC, and WHR were positively related to VAT, while WC was a useful indicator of visceral fat and WHR reflected central fat distribution. These findings suggest that WC and WHR may be more useful than BMI for identifying abnormal fat distribution and lipid-related cardiovascular risk. In rural India, where advanced body-fat and lipid tests may not be easily available, BMI, WC, and WHR can serve as simple and low-cost screening tools for cardiovascular risk.

CONCLUSION

It is concluded that Waist circumference and Waist hip ratio was positively correlated with visceral adipose tissue (VAT). Body mass index had positive correlation with both subcutaneous adipose tissue (SAT) and visceral adipose tissue (VAT). It can be concluded that Waist circumference, Waist hip ratio, Body mass index are the better parameter in predicting the visceral adipose tissue (VAT). There is no significant correlation between lipid parameter and anthropometric measurements.

Limitations of the Study

Its small sample size, cross-sectional design, and single-institution setting limited this study, which may affect the generalizability of the findings. Only young male participants were included, excluding females and other age groups, healthy diet, and physical activity should be provided.

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