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The Relationship Between Epicardial Adipose Tissue and Visceral Adiposity Indexes in Individuals Without Established Atherosclerotic Cardiovascular Disease and Diabetes Mellitus

ABSTRACT

Objective: Visceral adipose tissue performs an important role in the development of atherosclerotic cardiovascular disease. Expressing its close association with epicardial adipose tissue simplifies the understanding of visceral adipose tissue in terms of atherosclerotic cardiovascular disease risk and facilitates the implementation of necessary lifestyle changes. In this study, we aimed to explore the relationship between epicardial adipose tissue and visceral adipose tissue proxies such as visceral fat rating, visceral adiposity index, and lipid accumulation product index as well as anthropometrics and lipid profile.

Methods: This cross-sectional study involved 244 participants (131 female, 113 males), aged 18-83 years without established atherosclerotic cardiovascular disease and diabetes mellitus. Epicardial adipose tissue was measured by transthoracic echocardiography. Visceral fat rating, total body fat percentage, and mass were assessed by a bioimpedance analyzer. Mathematical formulas calculated the visceral adiposity index and lipid accumulation product index. Demographic, clinical, and biochemical information of the participants was provided from the hospital's data system. Homeostasis model assessment of insulin resistance -insulin resistance was calculated using fasting insulin and glucose.

Results: Epicardial adipose tissue was significantly correlated with the visceral fat rating, visceral adiposity index, lipid accumulation product index, age, body weight, body mass index, waist circumference, waist-to-height ratio, waist-to-hip ratio, total body fat percentage and mass, systolic blood pressure, diastolic blood pressure, fasting glucose, hemoglobin A1c, insulin, homeostasis model assessment of insulin resistance, total cholesterol, low-density lipoprotein cholesterol, triglyceride, high-density lipoprotein cholesterol, and cigarette smoking. Multivariate regression analyses revealed that age ($\beta = 0.036$, $P = .001$), visceral fat rating ($\beta = 0.221$, $P < .001$), systolic blood pressure ($\beta = 0.033$, $P < .001$), diastolic blood pressure ($\beta = -0.048$, $P < .001$), and cigarette smoking ($\beta = 0.042$, $P < .001$) were independent variables related to epicardial adipose tissue.

Conclusion: Epicardial adipose tissue is associated with cardiovascular disease risk factors and indices of visceral adiposity in people without established atherosclerotic cardiovascular disease and diabetes mellitus.

Keywords: Epicardial adipose tissue, lipid accumulation product index, obesity, visceral adiposity index, visceral fat rating

Introduction

Obesity is a significant health problem with a rapidly increasing global prevalence, The prevalence of obesity in the adult Turkish population has exceeded the critically high rate of 30%.[1] Obesity contributes strongly to cardiovascular risk factors, including lipid disorders, diabetes mellitus (DM), hypertension (HT), and sleep disorders.[2] The fat accumulating around the internal organs is defined as visceral adipose tissue (VAT) and seems to play a key role in the development of cardiometabolic disorders, especially in the cardiovascular system.[3] Hence, evaluation of VAT might be worthy for risk stratification of the cardiometabolic disorders in the absence of high-risk conditions such as DM and atherosclerotic cardiovascular disease (ASCVD). However, it is difficult to exactly characterize the VAT. Furthermore, the standard techniques evaluating VAT such as magnetic resonance imaging (MRI) and computed tomography (CT) are high-cost, time-consuming, and require exposure to ionizing radiation, thus they are not applicable methods in routine clinical practice.[4]

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Visceral fat rating (VFR) is easily measured by a bioimpedance analyzer (BIA) and is a reliable marker of the VAT.[5] Anthropometric measurements such as body mass index (BMI) and waist-to-hip ratio are the most used but are frequently imprecise.[3-5] The visceral adiposity index (VAI) and lipid accumulation product index (LAPI) are also used in the prediction of VAT. However, they are simple mathematical formula–based methods using limited anthropometric [(waist circumference (WC) and BMI)] and biochemical parameters [(triglyceride and high-density lipoprotein cholesterol (TG and HDL-C)].[6,7]

Epicardial adipose tissue (EAT) is a valid and metabolically active VAT and has been proposed as the best proxy for VAT.[3,4] Under physiological conditions, EAT protects the myocardium and coronary arteries. However, in conditions such as obesity and insulin resistance, EAT may shift toward a proinflammatory phenotype and becomes a cardiovascular risk indicator.[4]

Understanding the true markers of visceral adiposity such as EAT and investigating its relationship to the rest of VAT indexes could be an important tool to increase the knowledge of cardiometabolic disorders. Few studies have assessed limited VAT data,[3,4] and no study has yet investigated EAT in accordance with the detailed body fat composition, VAT indexes, anthropometrics, and markers of subclinical atherosclerosis in otherwise normal individuals. In the present work, we analyzed the relationship of EAT with the VFR, VAI, and LAPI, as well as anthropometrics and lipid profiles.

Materials and Methods

This cross-sectional study included 244 (females: 131, males: 113, aged: 18-83 years) Turkish individuals without established ASCVD and DM who was admitted to our hospital check-up clinics. The study was performed between January 2021 and March 2022. Those who agreed to participate in this study and those over the age of 18 were included in the study. Subjects diagnosed with overt infection, pregnancy, DM, ASCVD, heart failure, and subjects taking lipid-lowering drugs were excluded from the study. As exclusion criteria DM was defined as having a fasting plasma glucose value of ≥126 mg/dL, hemoglobin A1c (HbA1C) value of ≥6.5, and already being on oral antidiabetic drugs or insulin therapy. Atherosclerotic cardiovascular disease was defined as established coronary heart disease, cerebrovascular, and peripheral arterial disease. Demographic, clinical, and laboratory parameters were obtained from the hospital's data system. This study has been approved by T.C. İSTİNYE University clinical research ethic committee (2017-KAEK-120) (No: 3/2022.K-42, Date: 20.05.2022). Authors will share data if required. Written consent was obtained from all subjects.

Epicardial Adipose Tissue Assessment

All participants underwent a 2D transthoracic echocardiographic (TTE) assessment using a 1 to 55 MHz S4-2 broadband transducer (iE33, Philips Healthcare, Inc, Andover, Mass, USA). Transthoracic echocardiographic (TTE) was performed while participants were lying in the left lateral decubitus position and measurements were averaged over five sequential heartbeats. All standard 2D TTE images taken from the parasternal long axis, short and apical 4-chamber view triggered to the QRS complex were recorded on videotapes. Epicardial adipose tissue thickness was measured perpendicular to the free wall of the right ventricle in the end-diastolic phase. Echocardiograms were read by 2 skilled cardiologists who were blinded to the subjects' anthropometric characteristics. There was an excellent interobserver and intra-observer agreement on EAT measurement; the intraclass correlation coefficients (ICC) were 0.952 (95% CI; 0.938-0.963 and 0.982 (95%CI; 0.976-0.986), respectively, suggesting an excellent reproducibility of this measure.

Biochemical Analysis

Fasting plasma insulin and glucose (mg/dL), HbA1C (%), total cholesterol (TC), HDL-C(mg/dL), low-density lipoprotein cholesterol (LDL-C) (mg/dL), TG (mg/dL), neutrophil to lymphocyte ratio (NLR), red cell distribution width (RDW), and C-reactive protein (CRP) had been obtained to be included in the analysis. Low-density lipoprotein cholesterol was measured directly by a colorimetric method, and other blood chemistry analyses were done using standard methods. Homeostasis model assessment of insulin resistance (HOMA-IR) was calculated using the HOMA-IR formula of fasting insulin (uIU/mL) × fasting glucose (mg/dL)/405.[8]

Body Composition Measurement

The BIA measurement was performed at room temperature at a standing position with an empty bladder. The subjects were dressed but without shoes and socks. The total body fat weight and percentage (%) (kg) and VFR values were measured with a (TANITA MC-780MA) body composition analyzer. The TANITA analyzer records a range of VFR from 1 to 59. According to the manufacturer's recommendation, level 1 to 12 points to a normal level of visceral fat whereas a level 13 to 59 points to increased visceral fat.

Visceral Adiposity Index and Lipid Accumulation Product Index Calculation

The VAI and LAPI were calculated through the following formulas:

VAI[6]: VAI (women): [WC/(36.58 + 1.89 × BMI)] × [TG (mmol/L)/0.81) × (1.52/HDL-C (mmol/L)]

VAI (Mmen): [WC/(39.68 + 1.88 × BMI)] × [TG (mmol/L)/1.03) × (1.31/HDL-C (mmol/L)]

LAPI[7]: LAP (women): ([WC (cm) - 58] × TG (mmol/L))

LAP (men): ([WC (cm) - 65] × TG (mmol/L))

Data Analysis: Statistical Package for Social Sciences version 17 (SPSS Inc., Chicago, Ill, USA) software was used to perform the statistical analysis. Two-tailed $P < .05$ points out the statistical significance. A histogram with a bell curve and one-sample Kolmogorov–Smirnov test were used in assessing the distribution of the variables. Quantitative data were described as the mean and standard deviation (SD) for normally distributed data and the median and interquartile range (IQR) for data which was not normally distributed. Categorical variables were stated as percentages and frequencies. Differences regarding demographic, anthropometric, biochemical, VAI, LAPI, EAT, and BIA data between groups were analyzed by Mann–Whitney *U* test, independent-samples *t*-test, and Chi-square tests. We

MAIN POINTS

- Epicardial adipose tissue is associated with CVD risk factors.
- Epicardial adipose tissue, like other visceral adiposity indices, increases with increasing body mass index in type 2 diabetic patients without cardiovascular disease.
- The visceral fat rating can predict epicardial adipose tissue.

performed Spearman's correlation analysis between EAT and VFR, VAI, LAPI, and clinical parameters. In addition, multivariate linear regression analyses were performed to determine independent risk factors for EAT, respectively. To assess intra-observer and inter-observer agreement on EAT measurement, we used the intraclass correlation coefficient. The primary endpoint of this work was to reveal the relationship between EAT and the VFR, VAI, and LAPI. As the study mainly concerns obesity, it was considered in the sampling. The sample size (n) was determined as;

$n = Z^2\, p\,(1-p)/d^2\; n = (1.96)^2 \times 0.32\,(0.68)/(0.06)^2\; n = 233$

where p shows the prevalence of obesity which is reported as 32% in the literature,[1] d, represents precision (6%), and Z represents confidence level statistic, which matches 1.96 for a 95% CI. Based on this information, the present analysis required at least 233 participants.

Results

The demographic and anthropometric characteristics, EAT, VAI, and LAPI values are shown in Table 1. Gender state, insulin, total-C, LDL-C, NLR, RDW, and cigarette smoking (packet/year) were not different in individuals with BMI ≥30 and BMI <30. Age, body weight, WC, waist-to-hip ratio, waist-to-height ratio, VAT, total body fat mass and percentage, EAT, VAI, LAPI, SBP, diastolic blood pressure (DBP), fasting glucose (FG), HbA1C, HOMA-IR, TG, and CRP were significantly increased in the BMI ≥30 groups than BMI <30 group.

Age, body weight, BMI, WC, waist-to-height ratio, waist-to-hip ratio, VFR, total body fat percentage and mass, VAI, LAPI, SBP, DBP, FG, HbA1C, insulin, HOMA-IR, total C, LDL-C, TG, and cigarette smoking (pocket/year) have a significant positive correlation with the EAT. In contrast, there was a significant negative correlation between HDL and EAT. No correlation between height, NLR, RDW, and CRP to the EAT was found, as shown in Table 3.

Multivariate regression analysis confirmed that age ($P < .001$), VFR ($P < .001$), SBP ($P < .001$), DBP ($P < .001$), and cigarette smoking (pocket/year) ($P < .001$) were the strongest independent variables related to EAT. However, gender, BMI, LAPI, VAI, waist-to-hep circumference ratio, HbA1C, and HOMA-IR have not had a positive impact on the model.

Table 1. Comparison of the Study Population Characteristics by Body Mass Index

Variables	Entire Study Population n = 244	BMI ≥ 30 n = 70	BMI < 30 n = 174	*P*
Gender: Female/male	131/113	42/28 (%60/%40)	89/85 (%51.1/%48.9)	.210
Age (years)	44.55 ± 12.06	48.11 ± 12.11	43.11 ± 11.77	<.003
Body weight (kg)	79.05 ± 16.38	94.1 ± 14.56	73 ± 12.8	<.001
Height (cm)	168.39 ± 10.20	166.24 ± 9.93	169.25 ± 10.2	.037
Body mass index (kg/m^2)	27.82 ± 4.96	33.96 ± 3.61	25.35 ± 2.82	<.001
Waist circumference (cm)	94.20 ± 12.62	106.76 ± 9.03	89.15 ± 10.1	<.001
Waist-to-height ratio	0.56 ± 0.08	0.64 ± 0.06	0.53 ± 0.06	<.001
Waist-to-hip ratio	0.94 (0.14)	0.98 ± 0.04	0.89 ± 0.08	<.001
Visceral fat rating	8.05 ± 4.01	11.91 ± 3.71	6.49 ± 2.93	<.001
Total body fat (%)	28.06 ± 7.96	34.62 ± 5.93	25.43 ± 7.11	<.001
Total body fat mass (kg)	22.44 ± 8.79	32.51 ± 7.44	18.39 ± 5.38	<.001
EAT (mm)	3.34 ± 1.82	4.18 ± 1.79	3 ± 1.72	<.001
Visceral adiposity index	0.77 (1.04)	2.19 (1.24)	1 (0.59)	<.001
LAPI	41.06 (45.39)	84.14 (72.69)	32.29 (32.48)	<.001
SBP (mmHg)	123.86 ± 15.07	130.11 ± 16.99	121.34 ± 13.48	<.001
DBP (mmHg)	77.38 ± 10.37	81.11 ± 11.01	75.87 ± 9.73	<.001
Fasting glucose (mg/dL)	95.28 ± 9.32	97.49 ± 9.71	94.39 ± 9.04	.019
Hemoglobin-A1c	5.65 ± 0.42	5.82 ± 0.6	5.59 ± 0.38	<.001
Insulin	12.40 (8,20)	13.23 (9.55)	12.22 (8.33)	.058
HOMA-IR	2.90 (1.98)	3.08 (2.18)	2.88 (1.92)	.048
Total cholesterol (mg/dL)	207.57 ± 38.97	210.66 ± 40.71	210.66 ± 38.3	.434
HDL cholesterol (mg/dL)	55.69 ± 14.74	50.69 ± 13.76	57.71 ± 14.67	.001
LDL cholesterol (mg/dL)	132.99 ± 32.10	136.39 ± 31.89	131.62 ± 32.18	.295
Triglycerides (mg/dL)	113 (91)	162.5 (117.75)	104 (74.25)	<.001
NLR	1.84 ± 0.77	1.9 ± 0.8	1.81 ± 0.76	.402
Red cell distribution width	13.33 ± 1.12	13.5 ± 1.11	13.26 ± 1.12	.138
C-reactive protein	1.8 (2.11)	2 (3.33)	1.7 (1.02)	.001
Cigarette (packet/year)	0 (5)	0 (3.93)	0 (7.5)	.141

Continuous variables with normal distribution are expressed as mean ± standard deviation. Variables without normal distribution are expressed as a median (interquartile range).

DBP, diastolic blood pressure; EAT, epicardial adipose tissue; HDL-cholesterol, high-density liquid cholesterol; HOMA-IR, homeostasis model assessment of insulin resistance; LAPI, lipid accumulation product index; LDL-cholesterol, low-density lipoprotein cholesterol; NLR, neutrophil-to-lympho cyte ratio; SBP, systolic blood pressure.

*P-value <.05 is statistically significant.

Table 2. Basic Characteristics of the Study Population

	Entire Study Population n = 244	Male n = 113	Female n = 131	*P*
Age (years)	44.55 ± 12.06	43.02 ± 12.21	45.87 ± 11.81	.065
Body weight (kg)	79.05 ± 16.38	86.93 ± 14.86	72.24 ± 14.52	<.001*
Height (cm)	168.39 ± 10.20	176.02 ± 8.13	161.86 ± 6.82	<.001*
Body mass index (kg/m^2)	27.82 ± 4.96	28.09 ± 4.50	27.60 ± 5.33	.449
Waist circumference (cm)	94.20 ± 12.62	97.71 ± 10.90	91.18 ± 13.25	<.001*
Waist-to-height ratio	0.56 ± 0.08	0.56 ± 0.07	0.56 ± 0.09	.392
Waist-to-hip ratio	0.94 (0.14)	0.95 (0.08)	0.90 (0.19)	<.001*
Visceral fat rating	8.05 ± 4.01	9.58 ± 4.04	6.73 ± 3.49	<.001*
Total body fat (%)	28.06 ± 7.96	23.16 ± 6.46	32.29 ± 6.61	<.001*
Total body fat mass (kg)	22.44 ± 8.79	20.74 ± 8.66	23.91 ± 8.68	.005*
EAT (mm)	3.34 ± 1.82	3.63 ± 1.89	3.09 ± 1.73	.020*
Visceral adiposity index	0.77 (1.04)	1.21 (1.31)	0.48 (0.57)	<.001*
LAP-index	41.06 (45.39)	46.06 (47.26)	35.76 (44.52)	.044*
SBP (mmHg)	123.86 ± 15.07	125.68 ± 13.98	122.29 ± 15.84	.080
DBP (mmHg)	77.38 ± 10.37	78.21 ± 11.08	76.66 ± 9.70	.243

Continuous variables with normal distribution are expressed as mean ± standard deviation. Variables without normal distribution are expressed as a median (interquartile range).
DBP, diastolic blood pressure; EAT, epicardial adipose tissue; LAPI, lipid accumulation product index; SBP, systolic blood pressure.
**P*-value < .05 is statistically significant.

Table 3. Correlation of Epicardial Adipose Tissue with Variables in All Participants

Variable	Spearman's rho	*P*	Variable	Spearman's rho	*P*
Age (years)	0.483	<.001*	Diastolic blood pressure	0.151	.018*
Body weight (kg)	0.378	<.001*	Fasting glucose	0.252	<.001*
Height (cm)	0.054	0.401	Hemoglobin-A1c	0.195	.002*
BMI (kg/m^2)	0.424	<.001*	Insulin	0.211	.001
WC (cm)	0.430	<.001*	HOMA-IR	0.252	<.001
Waist-to-height ratio	0.420	<.001*	Total-C (mg/dL)	0.134	.036*
Waist-to-hip circumference ratio	0.393	<.001*	HDL-C (mg/dL)	-0.198	.002*
Visceral fat rating	0.561	<.001*	LDL-C (mg/dL)	0.166	.009*
Total body fat (%)	0.215	.001*	Triglyceride (mg/dL)	0.268	<.001*
Total body fat mass (kg)	0.368	<.001*	NLR	0.087	.177
Visceral adiposity index	0.325	<.001*	RDW	0.067	.300
LAP-index	0.369	<.001*	C-reactive protein	0.095	.140
Systolic blood pressure	0.374	<.001*	Cigarette (pocket/year)	0.185	.004*

BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; HOMA-IR, homeostasis model assessment of insulin resistance; LAPI, lipid accumulation product index; LDL-C, low-density lipoprotein cholesterol; NLR, neutrophil-to-lymphocyte ratio; RDW, red cell distribution width; total C, total cholesterol; WC, waist circumference.
**P*-value < .05 is statistically significant.

Discussion

Observations of the present study demonstrated that EAT is related to the VAI, LAPI, anthropometrics, and biochemical parameters. In fact, EAT was found to have a good correlation with age, body weight, BMI, WC, waist-to-height ratio, waist-to-hip ratio, VFR, total body fat (%) and mass, VAI, LAPI, SBP, DBP, fasting glucose, HbA1C, insulin, HOMA-IR, total-C, LDL-C, TG, cigarette smoking (pocket/year), and HDL-C. Moreover, EAT was more correlated (spearman's rho: 0.561, r^2: 0.333, $P < .001$) with VFR (Figure 1) in comparison to the rest of the variables in the present study. In addition, different from VAI and LAPI, the VFR was among the independent variables related to the EAT.

Obesity develops as a result of disrupted energy homeostasis, causing excessive fat accumulation and is traditionally defined as BMI >30 kg/m^2. Body fat differs among individuals of similar height and body weight and age groups. Moreover, the heterogeneity of fat composition and its distribution can be more important for the occurrence of cardiometabolic diseases.[9] Epicardial adipose tissue is a true VAT that surrounds the heart and has been proposed as the best proxy for VAT.[3,4] Inflammatory factors and lipid metabolites secreted by EAT cause ASCVD, cardiac remodeling, and consequently heart failure.[4] However, the prognostic capacity of VAT to a large extent and especially of EAT has not yet been fully established and its clinical relevance has so far been limited.

Previous studies suggested that increased VAT has been correlated with increased incidence of T2DM, atherogenic dyslipidemia, and hypertension (HT).[10-12] However, it is very hard to assess and characterize the VAT accurately. In this sense, easily measured and trustworthy indicators of visceral adiposity such as EAT have been suggested

Table 4. Independent Variables Related to Epicardial Adipose Tissue

	Un-stand Coeff.		Stand. Coeff.		
	Beta	**Std. error**	**Beta**	***t***	***P***
Model-1; r^2-adjusted:0.454 *P* < .001*					
Constant	−0.684	20.126		-0.322	.748
Age	0.036	0.010	0.235	3.500	.001
Gender	0.130	0.257	0.036	0.504	.615
Body mass index	−0.038	0.039	−0.103	−0.971	.333
Visceral fat rating	0.221	0.051	0.488	4.381	0<.001
Systolic blood pressure	0.033	0.009	0.271	3.623	0 < .001
Diastolic blood pressure	−0.048	0.012	−0.276	−3.911	0 < .001
Cigarette (pocket/year)	0.042	0.011	0.188	3.887	0 < .001
Lipid accumulation product index	0.001	0.004	0.026	0.173	.863
Visceral adiposity index	−0.005	0.130	−0.005	−0.036	.971
Waist-to-hip circumference ratio	1.009	1.853	0.044	0.544	.587
Hemoglobin-A1c	0.002	0.248	0.001	0.009	.993
HOMA-IR	0.059	0.053	0.062	1.122	.263

*P-value < .05 is statistically significant.
HOMA-IR, homeostasis model assessment of insulin resistance.

for a more accurate comprehension of the cardiometabolic risk associated with variation in fat distribution.[3] Numbers of factors including but not limited to age, gender, ethnicity, sex and growth hormones, inflammation, insulin resistance, and immobility seems to be predisposing determinant for the aggregation of plenty of epicardial fat.[3,13,14] The findings of our study showed that EAT is more strongly correlated with the VFR (rho:0.561, $P < .001$) in comparison to the total body fat mass, BMI, WC, waist--to-Hip ratio, lipid profile, CRP, RDW, and NLR. It was also demonstrated that almost all cardiometabolic parameters increased with increasing BMI.

Anthropometric measures are simple predictors of cardiovascular disease and have been reported to be higher in men than in women.[5] Moreover, Demirbaş et al[15] have investigated the importance of VAIs in predicting cardiometabolic risk factors and found WC, visceral fat, VAI, and LAPI to be significantly higher in the male group than in the female group. Furthermore, Maimaituxun et al[16] found that EAT is a determinant of coronary artery disease in men in comparison to women. In this context, except for EAT, our findings were analogous to the work published by Demirbaş et al[15] In addition, in our data, EAT did not be significantly explained by gender state.

Increasing age is one of the determining factors of the amount of EAT. In addition to WC and myocardial hypertrophy, age has been described as one of the major dependent variables correlated with EAT.[17] Interestingly, EAT depots have been reported to be more strongly correlated with age than WC or BMI.[18] Our observations complement the recently cited studies, particularly the study performed by Guglielmini et al.[18]

Iacobellis et al[3] and Ibrahim[19] have reported that increased visceral fat and EAT are associated with a proatherogenic modification of the lipid profile with a decrease in HDL-C and an increase in LDL-C metabolites. Furthermore, EAT thickness in patients with metabolic syndrome demonstrated a linear positive correlation with carotid intima-media thickness.[20] We observed a lipid profile in our sample consistent with the aforementioned reports.[3,19] The association of EAT with atherogenic hyperlipidemia could indicate high-risk individuals prone to atherosclerosis. Multiple reports have stated that EAT is increasing in patients with T2D[4,21] and has been significantly correlated with HbA1C and FG.[21] Moreover, Iacobellis et al[3] and Demir et al[22] similar to our findings have reported a significant correlation between FG and EAT in non-diabetic subjects. The relationship of EAT with FG and HbA1C proposes that EAT should be considered to play a role in the pathogenesis of insulin resistance and so DM. However, in contrast to the previously mentioned literature,[4,21] HbA1C did not contribute significantly to our suggested regression model.

Increased EAT is correlated with low-grade chronic inflammation, as it secretes proinflammatory mediators.[4,22] In this context, several papers have recently reported a significant relationship between sample hematological inflammatory parameters and EAT in a patient with newly diagnosed HT and metabolic syndrome.[4,22,23] In contrast to just mentioned reports, we did not find a significant association between sample inflammatory biomarkers such as NLR, RDW, and CRP. This contrast can be attributed to the fact that our sample did not consist of high-risk patient populations. Cigarette smoking is a traditional cardiovascular risk factor[1,2] and has been linked to EAT.[24] Similar to the recent citation, our findings suggest that cigarette smoking is an independent predictor of EAT.

Insulin resistance is one of the most important parameters of metabolic syndrome and is clearly linked to the formation of atherosclerosis and inflammation.[4,25] Recently, a study found VAI to be firmly correlated to visceral fat distribution and insulin resistance in subjects with normal WC.[26] Knowles et al[27] reported findings from their study evaluating a total of 1518 patients which found that VAI was one of the best predictors of metabolic syndrome components such as WC, BMI, waist-to-hip ratio, waist-to-height ratio, and visceral adiposity. Similarly, Demirbaş et al and Baloglu et al also found that VAI was independently related to the cardiometabolic risk.[15,28] Moreover, Baloglu et al[28] demonstrated that VAI was found to be the independent predictor of EAT ($b = 0.296$, $P < .001$) in a Turkish sample of T2DM patients. In compliance with the results previously described, in the present study, we demonstrated that VAI was positively correlated

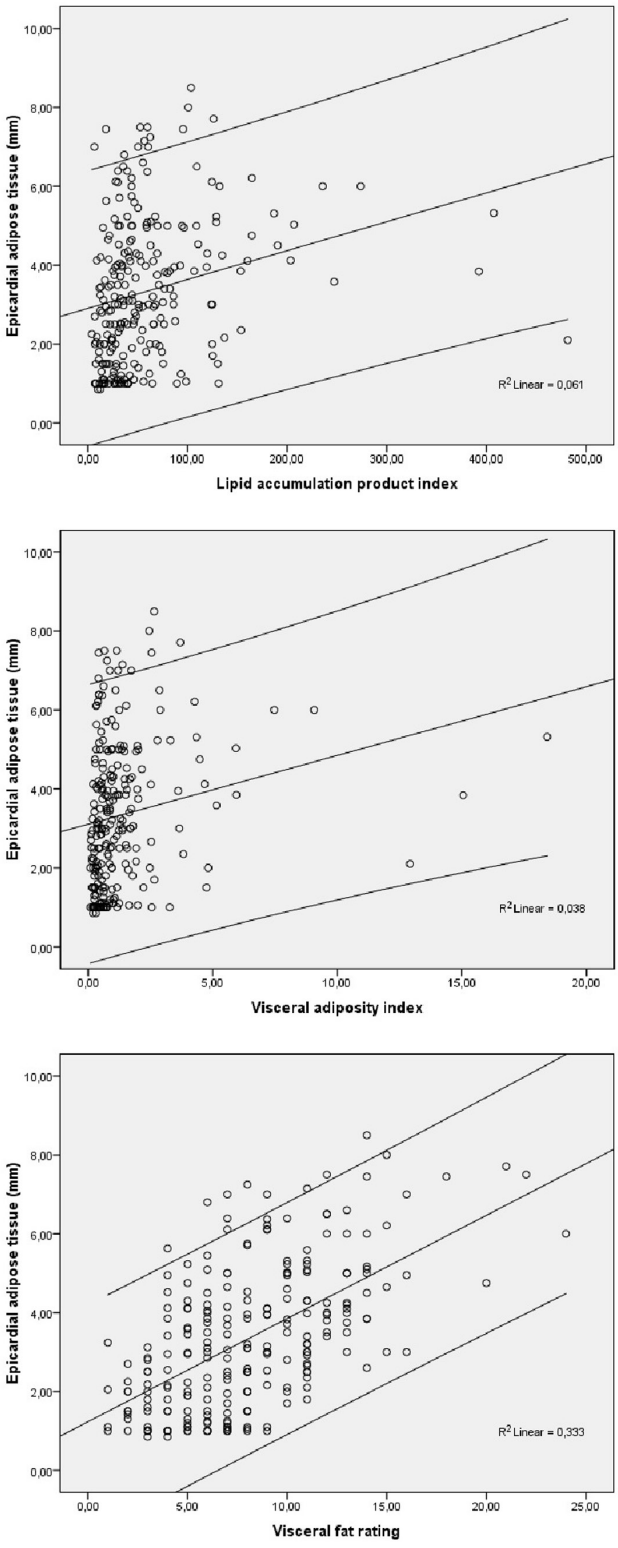

Figure 1. Correlation of the epicardial adipose tissue with lipid accumulation product index, visceral adiposity index, and visceral fat rating.

with EAT (rho: 0.325, $P < .001$), insulin (rho: 0.211, $P < .00$), and HOMA-IR (rho: 0.252, $P < .001$) but were not among the explanatory variables of our suggested model describing EAT. Instead, VFR independently explains EAT in our data.

Similarly, Demirbaş et al reported a good correlation (r: 0.610, $P < .000$) between the LAPI and VFR, but they did not find the LAPI to significantly affect their multivariate regression model which explains cardiometabolic risk.[15] Moreover, the LAPI was also suggested to prognosticate the incidence of CVD compared better to BMI.[29] According to the LAPI, the present study demonstrated a powerful positive correlation between VFR and LAPI (rho : 0.669, $P < .001$) and BMI (rho : 0.785, $P < .001$). However, in a similar manner to the VAI, the LAPI also did not explain our suggested model which describes EAT. While the exact reasons for the difference in reported association continue to be conjectural, it is plausible that ethnic differences, differences in population characteristics,[19] sample size, and variables adjusted in the models studied may be responsible.[15,28]

This is the first study evaluating the relationship between EAT and a detailed obesity profile. The sample size is large enough to reflect the obesity characteristics of the population. Furthermore, metabolic variables were also estimated in this study, which concentrated on correlating anthropometric, BIA, and imaging markers of adiposity. In addition, the participants were not subject to a high-cost, time-consuming, and ionizing method. However, this study has a few limitations that should be taken into account. First, this is a cross-sectional analysis that cannot explain causality. Second, the participants of the current study were obtained from the outpatient clinic of a private hospital which may cause bias. Third, only the Turkish ethnic group was selected for the sample of the study which limits the generalization of our results. Furthermore, MRI and CT, the gold standard modalities for the determination of EAT and VAT, were not used in the present study.

Conclusion

Epicardial adipose tissue is associated with CVD risk factors and indices of VAT in people without established ASCVD and DM. These results may help persons, even without severe cardiovascular disorders to be informed of their risk condition and encourage them to a healthy lifestyle.

Ethics Committee Approval: This study has been approved by T.C. İSTİNYE University clinical research ethic committee (2017-KAEK-120) (Date: 20.05.2022, Approval No: 3/2022.K-42).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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