Comparison of Epicardial and Pericardial Fat Thickness Assessed by Echocardiography in African American and non-Hispanic White Men: A Pilot Study

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Objectives: Compared to non-Hispanic Whites, African American men have less intra-abdominal visceral adipose tissue (VAT) relative to total fat mass despite having a higher risk of obesity-related diseases. This study explores whether this racial pattern of VAT distribution extends to the intrathoracic VAT.

Methods: We used two-dimensional transthoracic echocardiography to measure pericardial and maximum and minimum epicardial fat thickness anterior to the right ventricle in 50 African American and 106 non-Hispanic White men, aged 40–75 years, consecutively referred for echocardiography for standard clinical indications. Age, coronary risk factors, height, and weight were recorded, and body mass index (BMI) was calculated. The two groups were compared with respect to pericardial and maximum, minimum, and average epicardial fat thicknesses.

Results: Among non-Hispanic Whites, pericardial and minimum epicardial fat measured at the mid-right ventricular wall were higher by 37% and 69%, respectively, than among African Americans (5.2±3.1 mm vs 3.8±3.1 mm, $P<.011$; 2.2±1.6 mm vs 1.3±1.2 mm, $P<.001$). Maximum epicardial fat along the distal right ventricular wall was 19% greater in non-Hispanic Whites, but this difference was not statistically significant (4.3±2.6 mm vs 3.6±2.0 mm, $P=.133$). The average epicardial fat measured at two sites was 26% greater in non-Hispanic Whites (2.9±2.0 mm vs 2.3±1.3 mm, $P=.019$).

Conclusions: Among men referred for echocardiography, non-Hispanic Whites have more epicardial and pericardial fat than do African Americans. Echocardiography may be a useful research tool for investigating VAT distribution and its relationship to cardiovascular risk. (*Ethn Dis*. 2008;18:311–316)

Key Words: African Americans, Visceral Adipose Tissue, Epicardial Fat, Pericardial Fat, Echocardiography

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Introduction

Increased intra-abdominal visceral adipose tissue (VAT) is recognized as an emerging risk factor that predicts type 2 diabetes mellitus and cardiovascular disease more strongly than does total body fat.[1–2] VAT is also found in the thoracic cavity, primarily in the epicardial and pericardial fat subcompartments. Although less well studied than intra-abdominal VAT,[3] intrathoracic VAT measured by magnetic resonance imaging (MRI) or computed tomography (CT) is associated with intra-abdominal VAT,[4–6] hypertension,[5,6] insulin resistance,[5] high triglycerides,[6] and coronary artery disease in Asians.[6] These observations suggest that intrathoracic VAT may also be a marker of cardiometabolic risk. The thickness of the epicardial adipose tissue subcompartment can be measured easily and conveniently by transthoracic echocardiography and correlates with MRI-determined epicardial fat and intra-abdominal VAT,[7] several cardiometabolic risk factors,[8,9] and growth hormone deficiency.[10]

Age, sex, and degree of obesity are associated with the distribution of VAT. Several studies have shown that race also affects the distribution of VAT.[11–14] Paradoxically, compared to non-Hispanic Whites, African American men have less intra-abdominal VAT relative to their total fat mass despite having a higher risk of obesity-related diseases.[11–14] Whether the racial pattern of VAT accumulation observed in the abdomen also occurs in the thorax is unknown but may be of importance, given the increased susceptibility of African Americans to obesity-related disease and the observed association of epicardial fat with coronary artery disease and cardiac dimensions.[6,15] Furthermore, because of its proximity to the right ventricle and absence of a fascial boundary, epicardial fat may directly affect the coronary arteries and myocardium through paracrine actions of locally secreted adipocytokines and other bioactive molecules and contribute disproportionately to the development of cardiovascular disease.[16] Absence or even reversal of the racial pattern of intra-abdominal VAT in the epicardial fat might partially explain the ethnic discrepancy in cardiovascular mortality and intra-abdominal VAT. Alternatively, if the racial distribution of intra-abdominal VAT is also observed in the thorax, this finding would further support the paradox. Therefore, we used transthoracic echocardiography to compare epicardial and pericardial fat thickness in middle-aged and elderly African American and non-Hispanic White men.

Methods

Patients

This is a cross-sectional analysis of consecutive male patients referred to our university-affiliated echocardiography laboratory for standard clinical indica-

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tions from July through December 2004. Patients with previous heart surgery, left chest irradiation, pericardial effusion, or corticosteroid use were excluded. From this database, we identified 118 self-reported non-Hispanic White and 53 self-reported African American men, aged 40–75 years. Of these, 12 non-Hispanic White and 3 African American men were excluded because their echocardiographic images were inadequate for measuring epicardial and pericardial fat thickness. Thus, the final sample size for the present analyses consists of 50 African American and 106 non-Hispanic White men.

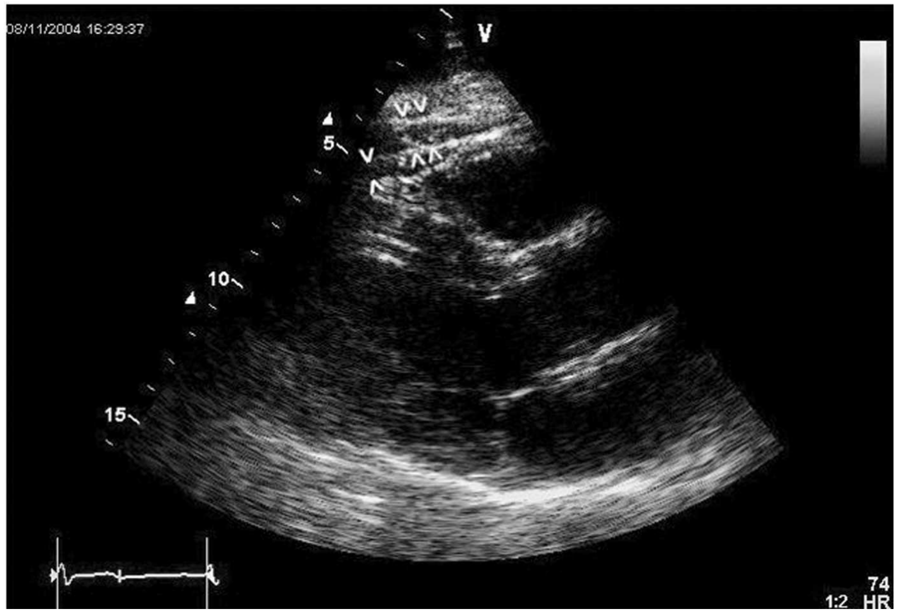

Fig 1. Echocardiogram in the parasternal long-axis view of a 56-year-old non-Hispanic White male with large amounts of epicardial (7.2 mm) and pericardial fat (8.1 mm). Single arrowhead = epicardial fat; double arrowhead = pericardial fat

Demographic and Anthropometric Data

Permission to review the patients' electronic medical records and echocardiograms was obtained from the human subjects institutional review board. Indications for echocardiography were obtained from the request forms filled out by the ordering physicians. Those indications included chronic coronary artery disease, chest pain, heart failure, arrhythmias, valve disease or murmur, monitoring ventricular function in patients receiving chemotherapy, abnormal electrocardiogram, and preoperative cardiac risk assessment. Indications occurring in two or fewer subjects were classified as other. Age, height, and weight were recorded from questionnaires completed by the patients at time of echocardiography. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Coronary risk factor status, including hypertension, dyslipidemia, and diabetes mellitus, was determined from physician office visits and laboratory data found in the electronic records within the six-month time frame before the reviewed echocardiogram. Hypertension was defined as a systolic blood pressure >140 mm Hg or a diastolic blood pressure >90 mm Hg or the use of antihypertensive medication. Dyslipidemia was defined as use of lipid-lowering agents or low-density lipoprotein cholesterol >160 mg/dL, high-density lipoprotein cholesterol <35 mg/dL, or triglycerides >200 mg/dL. Diabetes mellitus was defined as fasting blood glucose >126 mg/dL or the use of glucose-lowering medication.

Echocardiographic Methods

Complete transthoracic two-dimensional echocardiograms with harmonic imaging were performed by using commercially available equipment (Vivid 7, GE Vingmed, Milwaukee, Wisc), and images were digitized. To avoid inter-reader variability, a single investigator (HJW), blinded to clinical data, retrospectively reviewed the echocardiograms (Echopac 6, GE Vingmed). All measurements were made from two cardiac cycles in the parasternal long-axis view and averaged. In the parasternal long-axis view, epicardial fat is immediately anterior to the right ventricle, and its thickness is measured between the visceral and parietal pericardium.[7–9,15] Pericardial fat is anterior to the epicardial fat and the parietal pericardium in this view.[3] In most patients the epicardial and pericardial fat were hypoechoic relative to the myocardium but more echo-dense than blood. Because it is compressed during diastole, epicardial fat was measured in late systole. Also, because epicardial fat is not evenly distributed along the curved right ventricular free wall in this view, we measured minimum epicardial fat thickness (usually in the vicinity of the mid-right ventricular free wall) and maximum thickness (usually between the mid- and distal-right ventricular free wall) and calculated their average as a more global measure of epicardial fat thickness.

Table 1. Age and anthropometric and clinical characteristics of African American (*n*=50) and non-Hispanic White men (*n*=106) referred to a university clinic for echocardiography, July–December 2004

Variable	African Americans	Non-Hispanic Whites	*P* Value
Age (years), mean ± SD	58±9	60±9	.082
BMI (kg/m^2), mean ± SD	29±5	29±5	.899
Weight (lbs), mean ± SD	205±42	206±40	.859
Hypertension, *n* (%)	36 (72)	53 (50)	.009
Diabetes mellitus, *n* (%)	13 (26)	17 (16)	.140
Dyslipidemia, *n* (%)	27 (54)	73 (69)	.070

SD = standard deviation, BMI = body mass index.

Pericardial fat, which has a more symmetric distribution along the parietal pericardium and does not significantly change in size during the cardiac cycle, was measured at the mid-level of the right ventricle. In many patients pericardial fat has a slight basal to apical movement related to cardiac and parietal pericardial motion, which facilitates its recognition and measurement and distinguishes it from other thoracic structures. All measurements of epicardial and pericardial fat thickness were made perpendicular to the right ventricular free wall. Figure 1 shows how pericardial (double arrowheads) and maximum epicardial fat thickness (single arrowheads) were measured from the parasternal long axis view of a non-Hispanic White patient with large amounts of both epicardial and pericardial fat. The echocardiograms of 36 patients were randomly selected and blindly reviewed on two separate occasions (by HJW) to determine the coefficient of variation. The coefficients of variation for the measurements of pericardial and minimum and maximum epicardial fat thickness were 11%, 12%, and 13%, respectively.

Statistical Analysis

Continuous variables are reported as means plus or minus standard deviations and categorical variables as frequencies and proportions. Statistical comparisons between African Americans and non-Hispanic Whites were performed by using either two-sided unpaired *t* tests or χ^2 test, as appropriate, for continuous variables or proportions. Relationships among age, anthropometric characteristics, and epicardial and pericardial fat thickness were analyzed by using Spearman correlation analyses. All *P* values reported are two sided. A *P* value $<.05$ was considered significant. All analyses were performed with NCSS for Windows (NCSS, Kayesville, Utah).

RESULTS

African American and non-Hispanic White men did not differ significantly with respect to age, weight, or BMI (Table 1). Prevalence of coronary risk factors was high in both groups, but the proportion of those with hypertension was significantly lower in non-Hispanic Whites than in African Americans. Non-Hispanic Whites were also more likely to have dyslipidemia and less likely to have diabetes than African Americans, but the differences did not reach statistical significance. Although non-Hispanic Whites were more commonly referred for coronary artery disease and African Americans more commonly for heart failure, the reasons for referral did not significantly differ between the two groups (Table 2).

Ranges of measurements for African Americans and non-Hispanic Whites,

Table 2. Indications for echocardiography in African American (*n*=50) and non-Hispanic White men (*n*=106) referred to a university echocardiography clinic, July–December 2004

Indication	African Americans *n* (%)	Non-Hispanic Whites *n* (%)	*P* Value
Coronary artery disease	5 (10)	23 (21)	.098
Chest pain	14 (28)	24 (23)	.467
Heart failure	6 (12)	5 (5)	.097
Valve disorder	4 (8)	11 (10)	.638
Preoperative evaluation	7 (14)	18 (17)	.709
Arrhythmia	5 (10)	15 (14)	.469
Abnormal electrocardiogram	4 (8)	4 (4)	.264
Monitoring cardiotoxic chemotherapy	3 (6)	4 (4)	.531
Other	2 (4)	5 (5)	.840

In this study of middle-aged and elderly men referred for echocardiography, non-Hispanic White men had larger pericardial and epicardial fat thickness measured by echocardiography than did African American men of similar age, weight, and BMI.

respectively, were .0–3.8 mm and .0–8.3 mm for minimum epicardial fat thickness, .0–7.5 mm and .0–18.7 mm for maximum epicardial fat thickness, .0–5.4 mm and .0–6.8 mm for average epicardial fat thickness measured at two sites, and .0–11.9 mm and .0–16.5 mm for pericardial fat thickness. Among non-Hispanic Whites, minimum epicardial fat thickness measured at the mid-right ventricular wall was 69% higher than among African Americans ($P<.001$, Table 3). Maximum epicardial fat thickness along the distal right ventricular free wall was 19% higher in non-Hispanic Whites than in African Americans, but this difference was not significant($P=.133$). The average of the epicardial fat thickness measured at two sites was 26% higher in non-Hispanic Whites($P=.019$). Among non-Hispanic Whites, pericardial fat thickness was 37% higher than among African Americans($P=.011$).

The Spearman rank order correlation coefficient for pericardial and maximum epicardial fat thickness was moderate but significant ($r=.27$, $P=.001$). The Spearman correlation coefficients between age and pericardial and minimum, maximum, and averaged epicardial fat thickness were $r=.26$, $P=.002$; $r=.27$, $P=.001$; $r=.25$, $P=.004$; and $r=.26$, $P=.002$, respectively. BMI did not significantly correlate with pericardial or any measures of epicardial fat.

DISCUSSION

In this study of middle-aged and elderly men referred for echocardiography, non-Hispanic White men had larger pericardial and epicardial fat thickness measured by echocardiography than did African American men of similar age, weight, and BMI. Pericardial and epicardial fat thickness correlated significantly but moderately with each other and with age.

Although there have been no previous investigations of the relationship between intrathoracic fat and racial ancestry with which to compare our results, several studies of the racial patterns of intra-abdominal VAT have been reported. In three studies that used CT, non-Hispanic White men had 31%–47% larger cross-sectional area of intra-abdominal VAT than did African American men.[11–13] Similarly, in a study that used MRI, non-Hispanic White men had 31% more intra-abdominal VAT volume than did African American men.[14] Our results are consistent with these studies and suggest that racial patterns of VAT distribution in the abdomen extend to the thorax. The mechanisms of these racial differences in VAT accumulation are unknown. However, our findings, along with those regarding intra-abdominal VAT, are paradoxical given the increased risk of developing obesity-related cardiac and metabolic disorders among African American men despite having less intra-abdominal and intrathoracic VAT.[12,17] A proposed explanation for this paradox is that the interrelationships of visceral adiposity, insulin resistance, dyslipidemia, and cardiovascular disease differ according to racial origin.[11–12,17–23] Visceral adiposity may be more strongly associated with insulin resistance in non-Hispanic Whites, while other risk factors such as subcutaneous adipose tissue may contribute to the development of insulin resistance, diabetes, and cardiovascular disease in African Americans.[12,17,21]Also, unlike other ethnic groups, up to 33% of African American men with diabetes have an insulin-sensitive form of the disorder that may develop and contribute to cardiovascular disease independently of visceral adiposity.[24]

Table 3. Epicardial and pericardial fat thickness in African-American (*n*=50) and non-Hispanic white men (*n*=106) referred to a university clinic for echocardiography, July–December 2004

Variable	African Americans Mean ± SD	Non-Hispanic Whites Mean ± SD	*P* Value
Minimum epicardial fat thickness, mm	1.3±1.2	2.2±1.6	.001
Maximum epicardial fat thickness, mm	3.6±2.0	4.3±2.6	.130
Average epicardial fat thickness at two sites, mm	2.3±1.3	2.9±2.0	.019
Pericardial fat thickness, mm	3.8±3.1	5.2±3.1	.011

SD = standard deviation.

Epicardial fat thickness assessed by echocardiography has recently been advanced as a practical method for evaluating visceral adiposity and cardiometabolic risk.[7–9] Compared with MRI and CT, echocardiographic assessment of epicardial fat has advantages and disadvantages. Echocardiography is more readily available and less expensive than either MRI or CT. Unlike CT, echocardiography does not use ionizing radiation. Therefore, echocardiography may be more practical for longitudinal population studies of intrathoracic VAT and ultimately for clinical applications. However, echocardiography only samples a tomographic slice of the epicardial and pericardial fat and may not reflect the total volume. Nevertheless, epicardial fat thickness measured by echocardiography correlates highly with MRI-determined epicardial fat and intra-abdominal VAT.[8] Furthermore, studies of epicardial fat thickness measured by echocardiography have observed the expected relationships of epicardial fat with insulin resistance[7] and other cardiovascular risk factors.[8]

Limitations

Our study has several limitations and should be considered hypothesis-generating. The echocardiograms were reviewed retrospectively. Images were, therefore, obtained without necessarily optimizing heart orientation, focal zone, depth, and gain for measurement of pericardial and epicardial fat, which could affect the accuracy of our measurements. The relatively large coefficients of variation may be related to this limitation and may also reflect a learning curve for performing these new measurements. Another potential source of variability is the fact that studies were performed by three different sonographers. Our subjects were from a clinical population with more cardiovascular disease and risk factors than expected in a population-based cohort. Our findings may therefore be not generalizable to other populations. Although only the difference in prevalence of hypertension reached statistical significance, we observed differences in the frequency of risk factors and indications for performing echocardiography between the non-Hispanic Whites and African Americans studied, which may have affected our results. We used BMI as our measure of total adiposity to ensure that degree of obesity of the two patient groups was similar. Some studies have suggested that BMI may not predict total adiposity equally in non-Hispanic White and African American men.[25] However, a more recent report from the Heritage Family Study showed no race effect on the relationship between BMI and adiposity in men.[26]

Conclusions

Despite these and other possible limitations, our findings suggest that among middle-aged and elderly patients referred for echocardiography, non-Hispanic White men have more epicardial and pericardial fat than do African American men. We propose that larger cohort studies using MRI or CT, including an analysis of the ongoing Multiethnic Study of Atherosclerosis (MESA), are warranted to confirm this conclusion. The observation that echocardiography, a widely available and inexpensive technique, can identify racial differences in intrathoracic VAT accumulation may facilitate using racial comparisons to better understand the factors that contribute to fat distribution and its effect on cardiovascular risk.

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AUTHOR CONTRIBUTIONS

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