

# Ethnic and Sex Differences in Fatty Liver on Cardiac Computed Tomography: The Multi-Ethnic Study of Atherosclerosis

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## Abstract

**Objective:** To describe ethnic and sex differences in the prevalence and determinants of fatty liver in a multiethnic cohort.

**Patients and Methods:** We studied participants of the Multi-Ethnic Study of Atherosclerosis who underwent baseline noncontrast cardiac computed tomography between July 17, 2000, and August 29, 2002, and had adequate hepatic and splenic imaging for fatty liver determination (n=4088). Fatty liver was defined as a liver/spleen attenuation ratio of less than 1. We compared the prevalence and severity of fatty liver, in 4 ethnicities (white, Asian, African American, and Hispanic), and the factors associated with fatty liver in each ethnicity, stratifying by obesity and metabolic syndrome. Multivariable ordinal logistic regression was used to determine the effect of cardiometabolic risk factors on the prevalence of fatty liver in different ethnicities.

**Results:** The prevalence of fatty liver varied significantly by ethnicity (African American, 11%; white, 15%; Asian, 20%; and Hispanic, 27%;  $P < .001$ ). Although African Americans had the highest prevalence of obesity, a smaller percentage of obese African Americans received a diagnosis of fatty liver than did other ethnicities (African American, 17%; white, 31%; Asian, 37%; and Hispanic 39%;  $P < .001$ ). Hispanics had the highest prevalence of fatty liver, including the obese and metabolic syndrome population. An increase in insulin resistance predicted a 2-fold increased prevalence of fatty liver in all ethnicities after multivariable adjustment.

**Conclusion:** African Americans have a lower prevalence and Hispanics have a higher prevalence of fatty liver than do other ethnicities. There are distinct ethnic variations in the prevalence of fatty liver even in patients with the metabolic syndrome or obesity, suggesting that genetic factors may play a substantial role in the phenotypic expression of fatty liver.

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**N**onalcoholic fatty liver disease (NAFLD) is estimated to affect 20% to 30% of the world population<sup>1</sup> and approximately 1 in 3 adult Americans.<sup>2</sup> An increasing prevalence of NAFLD has been linked to the rising rates of insulin resistance, the metabolic syndrome, and diabetes mellitus.<sup>3,4</sup> This trend portends increased morbidity and mortality because NAFLD has been found to be independently associated with cardiovascular disease events<sup>5,6</sup> and all-cause mortality<sup>7-9</sup> even in younger adults.<sup>10</sup>

Prior research has compared ethnic differences in fatty liver with lipoprotein classes, abdominal fat, and insulin resistance.<sup>11-13</sup>

Although African Americans have a similar burden of obesity, liver fat content and the prevalence of NAFLD may be lower in them than in other ethnicities.<sup>14</sup> In contrast, patients of Hispanic<sup>15</sup> and Asian<sup>16</sup> ethnicities have a higher liver fat content than do white patients. Sex differences in fatty liver have been less well studied; the Dallas Heart Study<sup>1</sup> found that white women had a much lower prevalence of hepatic steatosis than did white men.

New accurate radiological methods for fatty liver estimation have enabled study in larger populations.<sup>17-19</sup> The Multi-Ethnic Study of Atherosclerosis (MESA), a population-based cohort that emphasizes diverse ethnic enrollment, is ideal for



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this study because all participants received cardiac computed tomographic (CT) scans with axial slice acquisition extending inferiorly to the liver and spleen. The objectives of this study were to describe the ethnic- and sex-specific prevalence of CT-measured fatty liver in a secondary analysis of the MESA cohort, and to delineate the factors associated with fatty liver within each ethnic group.

## PATIENTS AND METHODS

### Design Overview

The MESA is a population-based study investigating the prevalence, correlates, and progression of subclinical cardiovascular disease. The study design has been published previously.<sup>20</sup> Briefly, 6814 participants aged 45 to 84 years representing 4 ethnicities (white, Asian, African American, and Hispanic) were recruited from 6 US communities (Forsyth County, North Carolina; Northern Manhattan and Bronx, New York; Baltimore City and Baltimore County, Maryland; St Paul, Minnesota; Chicago, Illinois; Los Angeles County, California) between July 17, 2000, and August 29, 2002. All participants were free of clinical cardiovascular disease at study enrollment. An approximately equal number of men and women were recruited according to prespecified age and ethnicity strata. All participants gave informed consent, and the institutional review board at each site approved the study protocol.

Medical history, anthropometric measurements, laboratory testing, and cardiac CT scans were taken during the first examination. Waist circumference at the umbilicus was measured to the nearest 0.1 cm. Height and weight were measured, and body mass index (BMI) was calculated ( $\text{kg}/\text{m}^2$ ). Diabetes mellitus was defined as a fasting blood glucose level of 126 mg/dL or more [to convert the glucose value to mmol/L, multiply the value by 0.0555] or the use of hypoglycemic medications. Hypertension was defined as a systolic blood pressure of 140 mm Hg or more, a diastolic blood pressure of 90 mm Hg or more, or the use of antihypertensive medications. The metabolic syndrome was defined by the National Cholesterol Education Program Adult Treatment Panel III criteria as 3 or more of the following: waist circumference greater than 102 cm for men and greater than 88 cm for women, triglyceride

level 150 mg/dL or more, high-density lipoprotein (HDL) level less than 40 mg/dL for men and less than 50 mg/dL for women, blood pressure 130/85 mm Hg or more, and a fasting blood glucose level 110 mg/dL or more.<sup>21</sup>

Diet was assessed on the basis of a previously published scale quantifying adherence to a Mediterranean diet,<sup>22</sup> which has been studied in participants of the MESA.<sup>23</sup> Participants were awarded diet scores for consuming more healthy foods (vegetables, legumes, fruits, nuts, cereal or grains, and fish) and fewer detrimental foods (full-fat dairy, meat, poultry, and saturated fat) than the median intake. Participants whose diet scores were above the median value were defined as having a healthy diet.

Data regarding physical activity were obtained from the MESA Typical Week Physical Activity Survey.<sup>24</sup> Participants averaging more than 150 min/wk moderate-intensity physical activity or more than 75 min/wk vigorous physical activity were considered physically active on the basis of the current American Heart Association guidelines.<sup>25</sup>

Participants with a history of heavy alcohol use (>14 drinks/wk for men and >7 drinks/wk for women), cirrhosis, or oral corticosteroid or amiodarone use ( $n=285$ ) were excluded.

### Image Acquisition

Two consecutive nonenhanced cardiac CT scans were performed for coronary artery calcium scoring. Participants were scanned using electron-beam CT at 3 centers (New York, Chicago, and Los Angeles: Imatron C150, General Electric Medical Systems) and using 4-detector row CT at 3 centers (Winston-Salem, North Carolina centers: Lightspeed, General Electric Medical Systems, or Volume Zoom, Siemens).

Electron-beam CT used an exposure time of 100 ms, a peak voltage of 130 kVp, and a tube current of 630 mA. The 2 multidetector row CT scanners operated in the axial scan mode with a gantry rotation speed of 0.5 seconds. The Lightspeed scanner used a tube voltage of 120 kVp and a tube current of 320 mA, acquiring four 2.5-mm sections simultaneously. The Volume Zoom system used a tube voltage of 140 kVp and a tube current of 139 mA, acquiring four 2.5-mm sections per cardiac cycle. Prospective electrocardiographic triggering occurred at 50% and 80% of the RR interval for multidetector row CT and

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