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## Race disparities in cardiovascular disease risk factors within socioeconomic status strata

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## ABSTRACT

**Purpose:** Racial differences in socioeconomic status (SES) explain some, but not all, of racial disparities in cardiovascular disease (CVD) risk. To address this, race disparities among higher SES individuals need to be assessed. The purpose of this study was to assess whether racial disparities in CVD risk factors differ by SES levels.

**Methods:** Data from the National Health and Nutritional Examination Survey 2007–2014 were used to calculate racial differences in hypertension, high cholesterol, diabetes, and obesity. Interactions between race and SES were assessed.

**Results:** African Americans had higher odds of hypertension (odds ratio [OR], 1.90; 95% confidence interval [CI], 1.72–2.09), diabetes (OR, 1.66; 95% CI, 1.33–2.07), and obesity (OR, 1.64; 95% CI, 1.46–1.83) than whites. Significant interactions between race and income greater than or equal to \$100,000 were observed for obesity (OR, 1.55; 95% CI, 1.24–1.94) and between race and education (college graduate or more; OR, 1.58; 95% CI, 1.16–2.15). Disparities in diabetes were observed in the highest SES groups, but not among those in the lowest SES groups.

**Conclusions:** Race disparities in some CVD risk factors varied by SES levels. Results suggest that race disparities in obesity are larger among those with income greater than or equal to \$100,000 and who are college graduates. It is possible that African Americans experience fewer health-related benefits of increased income and education levels compared with whites.

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## Introduction

Compared with whites, African Americans exhibit poorer outcomes for cardiovascular disease (CVD) risk factors, such as hypertension, diabetes, and obesity [1]. These disparities are accompanied by higher CVD-related mortality rates among African Americans [1]. Many explanations for racial disparities in health outcomes have been proposed with socioeconomic status (SES) being the most prominent [2–5]. When SES is adjusted for in statistical analyses, however, race differences for several health outcomes are not fully explained [5–7].

Adjusting for SES measures cannot fully elicit the nuanced ways in which SES and race operate to influence health for a few reasons. It

may be due to the disproportionate percentage of lower SES African Americans compared to whites [4]. Moreover, there are racial differences in the benefits of higher SES [7]. Similarly educated African Americans have lower incomes than their white counterparts and live in poorer areas [7]. Therefore, the nonequivalence of SES across race cannot be accounted for by simply adjusting for SES differences.

Studies have sought to examine the importance of additional factors on residual racial disparities such as discrimination [8], stress and coping strategies [9], social support [10,11], depression [12], and socioenvironmental factors [13–18]. Another strategy is to apply a more complex approach to the interrelationships between race, SES, and health. Studies have examined race differences in the SES gradient and found that, for many health outcomes, the SES gradient is weaker among African Americans compared with whites [6,19–23].

Racial health disparities within SES categories can also give a better understanding of interrelationships between race, SES, and health. Disparities are observed at all SES levels, and the magnitude differs across the SES spectrum [24–28]. Previous studies may not

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fully explicate these interrelationships because of broad SES categories and relatively low thresholds to represent high SES. In previous studies, high SES was categorized as more than 12 years of education or incomes greater than 200% of the poverty line. Very little is known about racial health disparities among higher SES groups, for example, among the college educated or among those with incomes greater than \$100,000 [27,29,30].

Comparing similarly educated and affluent African Americans to whites can help better understand the interrelationship between race, SES, and health and determine whether the higher SES benefits are similar among African Americans and whites. The objective of this study is to measure disparities between African Americans and whites in CVD risk factors and assess whether these disparities differ by SES levels. It is hypothesized that race differences in CVD risk factors will exist in higher SES groups.

## Methods

The National Health and Nutrition Examination Survey (NHANES) is an ongoing nationally representative survey of the health, functional, and nutritional statuses of the U.S. population. Each sequential series of this cross-sectional survey sampled the civilian noninstitutionalized population, with an oversample of low-income individuals, participants aged between 12 and 19 years, adults over the age of 60 years, African Americans, and Mexican Americans [31]. This survey used a stratified, multistage probability sampling design where data were collected in two phases. First, information regarding the participant's health history, health behaviors, and risk factors was obtained during a home interview. Then participants were invited to take part in a medical examination where they receive a detailed physical examination [31]. Data from 2007 to 2014 were combined to obtain a sufficient sample of high-SES African Americans and consisted of 12,726 non-Hispanic black (referred to as African American) and non-Hispanic white adults aged 20 years or older who completed the medical examination and did not have a missing value for any analytical variables.

Dichotomous dependent variables included obesity, hypertension, diabetes and high cholesterol. Height and weight were measured in the medical examination. Respondents were considered obese if their body mass index (BMI) was greater than or equal to 30 kg/m<sup>2</sup>. Up to four blood pressure (BP) measurements were conducted. The average of three systolic and diastolic BP measurements was utilized to determine hypertension status. A respondent was considered to have hypertension if systolic BP was greater than or equal to 140 mm Hg, diastolic BP was greater than or equal to 90 mm Hg, or they reported taking medication for hypertension. Three measures of cholesterol were obtained during the examination. Those with total cholesterol of 240 mg/dL or more or who reported currently taking medication for cholesterol were considered to have high cholesterol. Data on glucose levels were collected for respondents who fasted before the examination. Respondents with a fasting glucose of greater than or equal to 126 mg/dL or who reported that they were currently taking insulin or other diabetes medication were considered to have diabetes.

The main independent variable is self-reported race. Respondents were asked whether they were Hispanic or Latino and then asked to which racial group they belong. Non-Hispanic whites and African Americans were included in these analyses.

SES was measured by household income and level of education. Both SES variables were categorized to represent the highest levels of SES measured by the survey. Family income was categorized as follows: \$0–\$34,999; \$35,000–\$74,999; \$75,000–\$99,999; and \$100,000 or more. Educational attainment was categorized as follows: less than a high school graduate, high school graduate or General Education Development/high school equivalency recipient,

some college or associate's degree, and college graduate or more. Analyses also controlled for the following: age, sex, marital status (currently, formerly, or never), insurance status, self-rated health, current smoking, and physical inactivity. Age was measured continuously while others were measured dichotomously or with dummy variables. Insurance status represented whether the respondent had any health insurance. Those who reported fair or poor health were given a value of "1" for the self-rated health variable. Current smoking status represented survey respondents who currently smoke cigarettes every day or some days. Physical inactivity represented survey respondents who do not participate in any moderate or vigorous physical activity.

The mean and proportional differences between race groups for analytical variables were evaluated using Student's *t* for continuous variables and  $\chi^2$  tests for categorical variables. Race differences were assessed with logistic regressions with hypertension, high cholesterol, diabetes, and obesity as dependent variables. The first set of models adjusted for age, sex, marital status, insurance status, self-rated health, smoking status, and physical inactivity. The second set of models additionally adjusted for SES. The interactions of race with income and race with education on the odds of CVD risk factors were assessed using multiplicative interaction terms. Model fit was assessed using Somers' D and Harrell's *c* statistics. If a significant interaction was observed, then logistic regressions were conducted to assess race differences within SES categories. Following the procedure recommended by the National Center for Health Statistics, all analyses used Taylor-linearization procedures for the complex multistage sampling design and a weight variable was created to account for the combining of multiple years of NHANES [31–36]. *P*-values less than or equal to .05 were considered statistically significant, and all *t* tests were two sided. All statistical procedures were performed using STATA statistical software, version 14 (StataCorp LP, College Station, TX) and used "svy commands" to invoke weights.

## Results

Table 1 contains descriptive statistics by race. African Americans were younger, more likely to be female, less likely to be currently married, and more likely to be formerly or never married. African Americans were also less likely to be insured, more likely to be current smokers, and be physically inactive. A greater percentage of whites had incomes greater than or equal to \$100,000 (28.3%) compared with African Americans (10.9%,  $P < .001$ ). Almost one-third of whites (32.8%) were college graduates, whereas about one in six African Americans (16.6%) graduated from college ( $P < .001$ ). More African Americans had hypertension (42.5% vs. 35.0%,  $P < .001$ ), diabetes (13.4% vs. 8.3%,  $P < .001$ ), and were obese (47.3% vs. 34.4%,  $P < .001$ ) compared to whites. Fewer African Americans (32.9%) reported high cholesterol as compared with whites (39.6%,  $P < .001$ ).

In Table 2, the racial differences in the odds of CVD risk factors were assessed controlling for demographics, insurance status, and health behaviors (model 1). African Americans had almost twice the odds of hypertension (odds ratio [OR], 1.94; 95% confidence interval [CI], 1.74–2.15), and 78% and 67% greater odds of diabetes (OR, 1.78; 95% CI, 1.46–2.16) and obesity (OR, 1.67; 95% CI, 1.49–1.87) than whites, respectively. Regression models additionally adjusted for SES in model 2. African Americans, after controlling for income and education, had greater odds of hypertension (OR, 1.90; 95% CI, 1.72–2.09), diabetes (OR, 1.66; 95% CI, 1.33–2.07), and obesity (OR, 1.64; 95% CI, 1.46–1.83) compared with whites. African Americans had lower odds of high cholesterol in both models 1 (OR, 0.81; 95% CI, 0.73–0.89) and 2 (OR, 0.81; 95% CI, 0.74–0.92). Obesity was associated with income greater than or equal to \$100,000 (OR, 0.80;

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