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Candace D. Speight Date

Racial Discrimination and Cardiovascular Disease Risk in African American and White Adults and the Role of Race and Socioeconomic Status

By

Candace D. Speight

Master of Public Health

Epidemiology

_____

Tené T. Lewis, PhD

Committee Chair

Racial Discrimination and Cardiovascular Disease Risk in African American and White Adults and the Role of Race and Socioeconomic Status

By

Candace D. Speight

B.S.

Furman University

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Thesis Committee Chair: Tené T. Lewis, PhD

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Abstract

Racial Discrimination and Cardiovascular Disease Risk in African American and White Adults and the Role of Race and Socioeconomic Status

By Candace D. Speight

Recently, there has been increased interest in studying racial discrimination as a predictor of cardiovascular health. African Americans report more racial discrimination than Whites and are overrepresented among those with cardiovascular disease (CVD). Additionally, among African Americans, those with high socioeconomic status (SES) report the most racial discrimination; thus discrimination may impact CVD health differently, depending on SES level. This study examined the association between Experiences of Discrimination and two indicators of CVD risk --C-reactive protein (CRP) and sleep quality. It further examined whether the association between racial discrimination and CVD risk was stronger for African Americans compared to Whites and whether the effect of racial discrimination differed by education level among African Americans. Data came from META-Health, a two-stage cross-sectional random-digit dialing study of African American and White adults (n=3391). A subset (n=458) attended a clinic visit for further interview and clinical assessment. Linear regression analyses were used to evaluate the relationship between racial discrimination and both CRP and sleep quality after adjusting for demographic factors, additional risk factors and depression. Racial discrimination was a not a significant predictor of CRP levels ($p > 0.05$) and there was no race by racial discrimination interaction ($p > 0.05$). There was also no education by racial discrimination interaction among African Americans ($p > 0.05$). Racial discrimination was a significant predictor of decreased sleep quality (reference: 0 experiences; 1-2 experiences: $\beta = 1.09$, $p = 0.004$; 3+ experiences: $\beta = 0.88$, $p = 0.02$) although the effect was similar for both races ($p = 0.36$). Among African Americans with a high school education or less, those who reported 1-2 experiences of racial discrimination had significantly lower sleep quality ($\beta = 4.32$, $p = 0.02$) compared to those who reported no racial discrimination. However, this relationship was attenuated by depression in the final model ($\beta = 2.48$, $p = 0.13$). In conclusion, although racial discrimination was not significantly associated with CRP levels, it was significantly associated with poor sleep quality in both African Americans and Whites. In African Americans, this effect seemed to hold only for low SES African Americans.

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BACKGROUND

As of 2013, 88% of African Americans reported that racial discrimination against African Americans still exists in the United States (1). Racism is a problem reported by millions of Americans and in recent years there has been a greater emphasis on studying the health effects of exposure to racial discrimination (2-5). African Americans report more racial discrimination than Whites and when it is studied as stressor, racial discrimination has been implicated as a factor in the health disparities existing in many diseases (6, 7). Racial discrimination can be viewed as a long term stressor that causes increased reactivity, including increased cortisol levels, blood pressure, and heart rate, which can negatively impact health (8, 9). This increased reactivity in the face of discrimination has been linked to the development of stress disorders like hypertension and other cardiovascular diseases (10).

Previously, racial discrimination research focused largely on hypertension in African Americans. For example, in a study of 356 African Americans in the Metro Atlanta Heart Disease study, stress from perceived racism was associated with an increased odds of hypertensive status (11). Similarly, in a study of 245 African American and Latino adults, researchers found that reports of perceived racism were positively associated with ambulatory blood pressure levels (ABP) (12). Reviews and recent meta-analyses have found that racial discrimination is significantly associated with hypertensive status and ABP; however findings are strongest for ABP (13, 14).

Other, less-studied CVD risk factors may also be important. Recent studies have found associations between discrimination and CVD risk factors such as lipid levels, oxidative stress (15, 16). C-reactive protein (CRP), a marker of inflammation, is

positively correlated with poor cardiovascular health including hypertension and coronary heart disease (17-19). African Americans have demonstrated consistently higher levels of CRP when compared to Whites (21, 21). Studies have also found associations between CRP and other psychological factors such as depression and stress (22, 23).

Sleep and sleep quality have been linked to a number of health outcomes including mortality and heart disease (24). Short sleep and sleep disorders have been associated with increased risk for hypertension, diabetes, obesity, stroke, heart attack, depression, and death (25-27). African Americans also report greater sleep difficulty than Whites (28-30).

Racial discrimination has been proposed as a possible factor explaining health disparities in sleep and CRP (31, 32). The present study examines racial discrimination in relation to both CRP and sleep quality (an overall, subjective rating of sleep) and whether the effect of racial discrimination differs between African Americans and Whites.

Racial Discrimination and CRP

Few studies have examined the association between discrimination and CRP levels and findings have been mixed. Lewis et al. found a positive dose-response relationship between greater discrimination as measured by the Everyday Discrimination Scale (EDS) and CRP levels in a sample of 296 older adult African Americans (33). Another study also using the EDS looked at discrimination in relation to changes in CRP over time in a multi-ethnic sample of 2,490 Hispanic, Chinese, Japanese, African American, and White women (34). While there was no main effect of discrimination,

there was an interaction effect between discrimination and body mass index (BMI) on CRP levels for the full sample. Discrimination was a statistically significant predictor of CRP in non-obese women in all races. While both studies found a significant association between discrimination and CRP, because the EDS does not ask about racism directly, racial discrimination could be secondary to other forms of discrimination like gender and age. Research has found that scales that inquire about unfair treatment without attribution to race result in much higher self-reports for both Whites and African Americans, and less racial variation compared to measures that ask specifically about attribution to race (35).

Studies using measures that specifically ask about racism, have observed slightly different results than those using the EDS. In a 2008 study examining CRP in African Americans, Whites and Hispanics, Albert et al. assessed racial discrimination by asking "have you ever been discriminated against due to your race/ethnic background (36)". Racial discrimination was not significantly associated with CRP in either race. The Coronary Artery Development in Young Adults (CARDIA) study used the Experiences of Discrimination Scale (EOD) to assess racial discrimination experienced in Years 7 and 15 in relation to CRP levels in Year 20 in sample of 3,336 African American and White adults (37). Findings differed by race and gender. There was an association between racial discrimination and CRP in initial models for African American women who reported 1-2 experiences of discrimination compared to those who reported none, but the association was attenuated when BMI in the final model. There was no significant association between the EOD and CRP levels in White and African American men in final models but there was a positive association between racial discrimination and CRP

levels found in White women reporting 3 or more experiences of discrimination. Researchers did note between group differences but did not formally test for an interaction between race and discrimination. Further, because the CARDIA study relied on reports of lifetime exposure to racism that occurred 5-13 years prior to the assessment of CRP; they may have had a less accurate assessment of the exposure (racial discrimination), which may have decreased their likelihood of observing a significant association.

Racial Discrimination and Sleep

Sleep has been studied in relation to general discrimination in both African Americans and Whites. Racial discrimination is a stressor and chronic stress is often associated with poor sleep (38). Also, those who experience discrimination also report greater depressive symptoms, which are often linked to sleep difficulties (39, 40). In a study of 217 African-American and White men and women by Beatty et al., researchers found significant associations between everyday discrimination measured by the EDS and poor sleep duration and sleep efficiency (measured by actigraphy and PSG), and subjective sleep quality (measured by the Pittsburgh Sleep Quality Index (PSQI) (41). Lewis et al. evaluated the EDS in 368 African-American, White, and Chinese women in relation to both objective sleep outcomes measured by PSG and subjective sleep quality measured by the PSQI (42). There was a positive association between discrimination and sleep difficulties and wake after sleep onset, and the effect was the same for all races. In a sample of African American and White older adults, Slopen & Williams found that when answers to the EDS were attributed to race, they were a significantly associated with self- reported greater sleep difficulty and shorter sleep duration (43). Similarly,

when responses to the Major Experiences of Discrimination were attributed to race/ethnic differences, there was an inverse relationship with sleep duration. While these studies have found significant associations between the EDS and sleep quality in both African Americans and Whites, it is important to also consider studies that measure racism specifically.

Socioeconomic Status and Racial Discrimination in African Americans

SES can determine the level of exposure to racism in African Americans. Williams noted racism and racial discrimination have often led to residential discrimination, which disproportionately affects low SES African Americans (44). Consequently, many lower SES African Americans live and work in places with a higher concentration of African Americans. Conversely, higher SES African-Americans live and work in places with higher concentrations of Whites, which could increase their exposure to racial discrimination.

Empirical research supports these arguments. In a study of 1249 African American and White women, researchers found that African American women who lived in disadvantage neighborhoods and had low education levels reported more racial discrimination (45). Findings from CARDIA found that African Americans who had a higher education, higher income, and lived in a more advantaged neighborhood were more likely to report higher levels of racial discrimination assessed by the EOD (46).

Some studies have found that SES is not protective against health for African Americans and racial discrimination has been cited as a potential explanation (28, 29). For example, in one study, Jackson et al. looked at the prevalence of short sleep among different occupations and industries in 41,088 African Americans and Whites, using the

National Health Interview Survey (28). They found that African Americans had a higher prevalence of short sleep than Whites in most industries and the disparity was highest in higher SES jobs. Another study which surveyed 9,553 African Americans, Whites, Hispanics and other race groups found that African Americans above the poverty level had a significantly greater odds of poor sleep than African Americans below the poverty level (29).

To our knowledge, only the CARDIA study has examined education as an effect modifier in the relationship between racial discrimination and CRP in African American adults (37). The researchers did not find an interaction between education and racial discrimination. However, reports of racial discrimination were assessed 5-13 years prior to the assessment of CRP and may not have fully captured all relevant exposures, which may have made it more difficult to observe significant associations.

Similarly, only one study has examined the interaction between SES and racism on sleep quality and daytime fatigue (47). Grandner and colleagues focused on racism in healthcare settings only and used employment status as their proxy for SES. They created four employment categories: employed, unemployed, unable to work and other (retired, student or homemaker). They did not find effect modification by employment status, but employment status may not fully capture SES. Further, the measure of racism only captured one domain (racism in healthcare settings), thus research with a more comprehensive assessment of racism is needed.

The goal of this study is to further examine the link between racial discrimination and CVD health and determine whether racial discrimination has a stronger impact on CVD health for African Americans compared to Whites, and for high-SES African

Americans compared to low-SES African Americans. We used META-Health, a population-based sample of middle-aged Africa Americans and Whites from the Atlanta Metropolitan area. While many prior studies found that the association between racial discrimination and CVD risk was similar among African Americans and Whites, few used validated measures that directly and specifically measured interpersonal racial discrimination. It is hypothesized that there will be a positive association between racial discrimination and CRP as well as sleep quality in both African Americans and Whites, and that this association will be stronger for African Americans. Secondly, it is hypothesized that within African Americans, those with higher SES will demonstrate a stronger relationship between racial discrimination and CVD risk compared to those of lower SES.

Racial Discrimination and Cardiovascular Disease Risk in African American and White Adults and the Role of Race and Socioeconomic Status

Candace D. Speight, Tené T. Lewis

ABSTRACT

Recently, there has been increased interest in studying racial discrimination as a predictor of cardiovascular health. African Americans report more racial discrimination than Whites and are overrepresented among those with cardiovascular disease (CVD). Additionally, among African Americans, those with high socioeconomic status (SES) report the most racial discrimination; thus discrimination may impact CVD health differently, depending on SES level. This study examined the association between Experiences of Discrimination and two indicators of CVD risk --C-reactive protein (CRP) and sleep quality. It further examined whether the association between racial discrimination and CVD risk was stronger for African Americans compared to Whites and whether the effect of racial discrimination differed by education level among African Americans. Data came from META-Health, a two-stage cross-sectional random-digit dialing study of African American and White adults (n=3391). A subset (n=458) attended a clinic visit for further interview and clinical assessment. Linear regression analyses were used to evaluate the relationship between racial discrimination and both CRP and sleep quality after adjusting for demographic factors, additional risk factors and depression. Racial discrimination was a not a significant predictor of CRP levels ($p > 0.05$) and there was no race by racial discrimination interaction ($p > 0.05$). There was also no education by racial discrimination interaction among African Americans ($p > 0.05$). Racial discrimination was a significant predictor of decreased sleep quality (reference: 0 experiences; 1-2 experiences: $\beta = 1.09$, $p = 0.004$; 3+ experiences: $\beta = 0.88$, $p = 0.02$) although the effect was similar for both races ($p = 0.36$). Among African Americans with a high school education or less, those who reported 1-2 experiences of racial discrimination had significantly lower sleep quality ($\beta = 4.32$, $p = 0.02$) compared to those who reported no racial discrimination. However, this relationship was attenuated by depression in the final model ($\beta = 2.48$, $p = 0.13$). In conclusion, although racial discrimination was not significantly associated with CRP levels, it was significantly associated with poor sleep quality in both African Americans and Whites. In African Americans, this effect seemed to hold only for low SES African Americans.

A survey in 2013 revealed that 88% of African Americans report experiencing racial discrimination (1). Racial discrimination is viewed as a stressor that increases reactivity, resulting in increased blood pressure and heart rate, which can ultimately lead to poor cardiovascular health (8, 9). African Americans are disproportionately burdened by cardiovascular disease (CVD) thus researchers have studied racial discrimination as a potential explanation for health disparities (44). Early work focused primarily on hypertension but recent work has broadened to more novel CVD risk factors including oxidative stress and lipid levels (15, 16). This study will examine whether racial discrimination is a predictor of C-reactive protein (CRP) and sleep quality, both risk factors for CVD.

CRP, a maker of inflammation and poor cardiovascular health, is a predictor of hypertension and coronary heart disease (17-19). African Americans consistently report higher levels of CRP than Whites (20, 21). Few observational studies have examined the association between discrimination and CRP and results have been inconsistent. Some have found no association between discrimination and CRP while others have found statistically significant associations in specific samples such as White women, non-obese women and African American older adults (36, 37, 41, 42). However, only one of these studies explicitly assessed racial discrimination using a validated measure; thus there is a need for additional research on racism and CRP in particular. The current study will examine racial discrimination in a sample of African American and White adults.

Sleep quality is also an important factor affecting health and is a predictor of mortality and heart disease (24). African Americans report diminished sleep quality in comparison to Whites, including shorter sleep and more difficulty falling and staying

asleep (28-30). Several observational studies have examined the association between sleep quality and overall discrimination as well as racial discrimination and all have found significant associations in both African Americans and Whites (41-43, 47). These studies used different methods of capturing discrimination including single dichotomous questions asking about racial discrimination, as well as scales that inquired about general discrimination. However, none of these studies used a validated scale that measured individual racism specifically.

Researchers have found that among African Americans, socioeconomic status (SES) determines exposure to racism. African Americans with higher SES report more experiences of racism (45, 46). Consequently, it is possible that there is an interaction between SES and racial discrimination for CVD risk. However, few studies have assessed the effects of racism by education interaction on CRP and sleep quality.

This study will examine the relationship between racial discrimination and both CRP and sleep quality in middle aged African Americans and Whites from the META-Health cohort. In order to address gaps in the literature, this study will use a validated scale that specifically asks about racial discrimination. It is proposed that racial discrimination will be significantly and positively associated with CRP and sleep difficulties in both races but the relationship will be stronger in African Americans. Additionally, among African Americans, it is hypothesized that the effect of racial discrimination will differ by SES level, with high SES African Americans demonstrating a stronger relationship between racial discrimination and CVD risk.

METHODS

Participants

Participants were from The Morehouse and Emory Team up to Eliminate Health Disparities (META-Health) Study, a two-stage random digit-dialing cross sectional study of African American and Whites living in the Atlanta Metropolitan area, ages 30-65. A total of 3,391 phone interviews were conducted between 2005 and 2010. All participants were invited to either the Emory or Morehouse campuses to complete the second stage which consisted of an extended interview and physical measurements. Of the total, 753 completed the second stage. Pregnant women were excluded as well as those with acute illnesses or a history of myocardial infarction or stroke. This study was approved by the Emory University and Morehouse School of Medicine Institutional Review boards and all participants gave informed consent.

Measure of Racial Discrimination

Racial Discrimination was measured using the Experiences of Discrimination Scale a 9 –item validated scale. The 7-item version of the EOD was employed in this study, with each item referring to a domain where racial discrimination occurred (48, 49). Participants responded to the following question: 'Have you ever experienced discrimination, been prevented from doing something, or been hassled or made to feel inferior in any of the following situations because of your race?' It was applied to the following domains: 'at school,' 'getting a job,' 'at work,' 'getting medical care,' 'getting housing,' 'from the police or in the courts,' and 'on the street or in a public setting.' Subjects then answered 'yes' or 'no' to each question and the 'yes's' were summed to create a global score. The Cronbach alpha coefficient was 0.902. These responses were

combined to form categorical variable with 3 levels, 0, 1-2, and 3 plus experiences of discrimination based on the domains.

Covariates

Covariates were chosen based on their known associations with CVD risk. Age, sex and race were based on self-report. Education was measured according to the highest level of education completed and was developed into a categorical variable with three levels: High school or less, some college and college graduate or more. Diagnosis of diabetes and current hypertension medication use were also based on self-repot. Smoking was also self-reported and was assessed as either current smoking or never/former smoking (no cigarettes in the past 30 days). BMI was calculated by dividing weight in kilograms by height in meters (kg/m^2) and was used for analysis as a continuous variable. Framingham Risk Score (FRS), which measures the 10-year risk of having a heart attack from 0-100%, was calculated based on age, gender, total cholesterol, HDL cholesterol, systolic blood pressure, current smoking and current use of hypertension medication. FRS was treated continuously in analyses.

Depression was measured using the Beck Depression Inventory II (BDI-II), a validated self-administered scale that assesses depressive symptoms experienced by the subject in the past two weeks (50). Of the 753 people who participated in the second-stage interview, only 591 completed the BDI-II. The scale consists of 21 statements about various symptoms whose severity is rated on a 0-3 scale. The scores were then summed with higher scores indicating greater depressive symptom severity. This variable was treated as a continuous variable with 0-13 indicating minimal symptoms, 14-19 mild severity, 20-28 moderate severity, and 29-63 severe symptoms. If more than

two questions were missing, the variable was set to missing. If one to two questions were missing, the mean of the answered questions were imputed into the missing values. A variable using a slightly modified version of the BDI-II was created for the multivariate analysis for sleep. Because one of the items is a questions about sleep, this item was removed and the total score summed without it. The scores for the modified version ranged from 0-60.

Measurement of C-reactive Protein

Participants were asked to fast for 12 hours before attending their study visit. Venous blood was collected in sodium heparin tubes and was the plasma was stored at -70 C for further analysis. High sensitivity C-reactive protein was measured using immunonephelometry (Siemens/Dade Behring). Participants were excluded if they were missing this value or if the value was greater than 10.

Measurement of Sleep Quality

Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI) a 19-item self-administered scale (51). The 19 items are broken down into 7 components that measured the frequency of sleep problems. The PSQI is scored on a scale of 0-21 and measures sleep difficulties experienced in the previous one month. Higher scores indicate poorer sleep quality.

Statistical Analysis

All data analyses were performed using SAS 9.3 (Cary, NC). Descriptive statistics were calculated using the total study population. Two-sample t-tests were used to evaluate race differences for continuous variables and Chi-square test of associations were used to evaluate race difference for categorical variables.

In order to examine the relationship between racial discrimination and CVD outcomes, multivariable linear regression models were developed adjusting for appropriate covariates. For CRP and hypothesis 1, the initial model included racial discrimination and demographic characteristics, age, race, and sex and education level. The second model added an interaction term of race x discrimination to determine whether the effect of discrimination on CRP differed for African Americans compared to Whites. Model 3 included the demographic factors adding clinical variables such as FRS, diagnosis of diabetes and BMI. Age and gender were not independently entered into Model 3 because they were incorporated into the FRS. Model 4 added depression as measured by the BDI-II.

For hypothesis 2 for CRP, which examined the relationship between racial discrimination in African Americans with a special emphasis on the role of education, a similar method was utilized. Model 1 controlled for demographic factors such as age, sex and education. Model 2 added an interaction term, discrimination x education, in order to evaluate whether the effect of discrimination on CRP is different for different levels of education. Model 3 included the demographic factors and added clinical characteristics such as FRS, diagnosis of diabetes, and BMI – again removing age and gender. Model 4 included education, clinical factors, and the measure of depression BDI-II.

The same sequence was repeated in order to examine the relationship between racial discrimination and sleep quality. For the PSQI and hypothesis 1, the initial model included racial discrimination and demographic characteristics such as age, race, and sex and education level. The second model included an interaction term of race x discrimination to examine if there is a difference of the effect of racial discrimination by

race. Model 3 included demographic factors and added clinical variables such as BMI, smoking, and the use of hypertension medication. Model 4 added the modified version of the BDI-II, which omits the question about sleep difficulties.

For hypothesis 2 for the PSQI, which examined the relationship between racial discrimination in African Americans with a special emphasis on the role of education, a similar method was utilized. Model 1 controlled for demographic factors, age, sex and education. Model 2 added the interaction term, discrimination x education, in order to evaluate whether the effect of discrimination is difference on different levels of education. Model 3 included demographic factors and added clinical characteristics such as BMI, smoking, and the use of hypertension medication. Model 4 added the modified depression measure, BDI-II.

RESULTS

Subject Characteristics

Demographic and clinical characteristics of the 468 subjects are presented in Table 1 by race. All normal continuous variables are presented as mean (SD), skewed variables are presented as median (IQR) and categorical variables are presented as n (%). CRP was log-transformed for future analyses but is first presented in its original form. Although BMI and FRS are presented as categorical variables, they are used as continuous variables for multivariate analyses. The average age was 50.54 (9.57) and 68% of the sample was female. African Americans tended to be younger ($p=0.02$) and had less formal education ($p < 0.01$). African Americans also reported greater diagnoses of diabetes (13% v. 4%, $p < 0.01$), greater hypertension medication use (69% v. 39%, $p < 0.01$), and reported more current smoking (48% v. 27%, $p = 0.02$). African

Americans had greater BMI (mean BMI 30 v. 27, $p < 0.01$), compared to whites. African Americans and whites did not differ on FRS risk ($p = 0.74$) or on depression assessed by the BDI-II and the modified BDI-II omitting the sleep item ($p = 0.28$ and $p = 0.57$, respectively). African Americans reported more racial discrimination ($p < 0.01$) than whites. African Americans had higher levels of CRP (2.37 v. 1.61, $p < 0.01$) than whites. African Americans reported greater levels of sleep difficulty measured by the PSQI (6.42 v. 5.44, $p < 0.01$) compared to whites.

Association between Racial Discrimination, and CRP

Model 1 examined the relationship between racial discrimination and CRP adjusting for demographic characteristics, age, race and education (Table 2). Racial discrimination was not a significant predictor of CRP levels (reference = 0 reports; 1-2 reports $p = 0.18$; 3+ reports $p = 0.21$) Models 2 and 3 which adjusted for clinical characteristics and depression, respectively, did not alter these results (reference = 0 reports; 1-2 reports $p = 0.84$; 3+ reports $p = 0.66$ and reference = 0 reports; 1-2 reports $p = 0.71$; 3+ reports $p = 0.61$). The race x discrimination interaction term was also non-significant (reference = white, 0 reports; for African Americans 1-2 reports $p = 0.70$; for African Americans, 3+ reports $p = 0.36$).

Interaction between Racial Discrimination and Education in African Americans

Hypothesis 2 evaluates whether the effect of racial discrimination differs by education, among African Americans alone (Table 3). There was no statistically significant interaction between racial discrimination and education ($p = 0.98$).

Association between Racial Discrimination and Sleep

Racial discrimination was a significant predictor of sleep quality for the total sample (Table 4). Compared to reporting no discrimination, reporting 1-2 and 3+ experiences of discrimination were significant predictors of sleep quality ($\beta = 1.38$, $p < 0.01$ and $\beta = 1.17$, $p = 0.01$, respectively) after adjusting for demographics. The race x discrimination interaction term, was not significant (reference = White, 0 reports; African Americans 1-2 reports $p = 0.33$; African Americans, 3+ reports $p = 0.97$), indicating that the effect of discrimination on CRP was the same for both races. Reporting racial discrimination remains a significant predictor of sleep quality after adding clinical factors (1-2 reports, $\beta = 1.37$, $p < 0.01$; 3+ reports $\beta = 1.19$, $p = 0.01$). Model 4 adds depression and the effect of racial discrimination remains significant (1-2 repots $\beta = 1.09$, $p < 0.01$; 3+ reports $\beta = 0.88$, $p = 0.02$).

Interaction between Racial Discrimination and Education in African Americans

Hypothesis 2 examines whether racial discrimination differs of different levels of education among African Americans only. Although the interaction was not significant ($p = 0.17$), there was a difference in the effect of discrimination for those who reported 1-2 experiences of discrimination compared to those who reported no racial discrimination (Table 5). Compared to those with completed a high school education or less, those with a college graduate education or more, 1-2 reports of discrimination was significant ($\beta = -3.96$, $p < 0.05$). For those who completed some college compared to those with a high school education or less, 1-2 reports of discrimination was also significant ($\beta = -5.04$, $p = 0.02$).

Subgroup Analysis of African Americans

In order to further analyze the interaction between education level and racial discrimination, we stratified on education level (Table 6). Because the sample had many sparse strata, only trends were observed. For those with a high school education or less, reporting 1-2 reports of racial discrimination was significant when controlling for demographic factors ($\beta = 4.11$, $p = 0.01$). When clinical factors are entered into Model 2 the effect remained significant ($\beta = 4.38$, $p = 0.02$). After depression was added to Model 3, the effect was attenuated ($p = 0.13$)

DISCUSSION

This study sought to investigate whether there was an association between racial discrimination and risk factors for CVD --CRP and sleep quality—in a sample of middle-aged African American and White adults. The study also examined whether the effect of racial discrimination on CVD risk differed by race, and among African Americans, whether the effect of discrimination on CVD risk differed by education level. Findings differed by outcome. Racial discrimination was not significantly associated with CRP levels for African Americans or Whites. Among African Americans, the effect of racial discrimination on CRP did not differ by education level. However, racial discrimination was significantly associated with sleep quality and the effect was similar for African Americans and Whites.

The lack of association between racial discrimination and CRP in both African Americans and Whites could be attributed to how discrimination was measured. Many of the studies that have found a significant relationship between discrimination and CRP used the EDS, which does not specifically inquire about racism (33, 34). It also focuses

on everyday, chronic experiences, rather than 1-2 major events over the course of a lifetime. Similar to our findings, other studies that measured interpersonal racial discrimination specifically using a lifetime assessment of major events also did not observe significant associations with CRP (36, 37).

Racial discrimination was a significant predictor of sleep quality after controlling for demographics, clinical factors and depression. The effect was the same for both African Americans and Whites, however. Among African Americans, those with higher SES did not exhibit a stronger association between racial discrimination and sleep quality. Those reporting 1-2 experiences of discrimination had higher levels sleep difficulty compared to those reporting zero experiences of racial discrimination.

The sleep results were consistent with prior studies that show a significant association between racial discrimination and sleep quality in African Americans and Whites (41-43, 47). These studies also did not find significant racial differences in the association. This could be due to an overemphasis on measures of discrimination that focus on interpersonal exposure to racism alone. Exposure to structural racism may produce different results. One study examined structural racism in the form of political participation, employment and job status, educational attainment and judicial treatment as predictors of myocardial infarction in African Americans and Whites (52). African Americans living in high-structural racism states had an increased odds of myocardial infarction compared to those living in low-structural racism states. For whites, however, living in a high-structural racism state had no effect or was protective of myocardial infarction compared to those living in a low-structural racism state. Perhaps measuring different forms of racial discrimination could produce different results.

Although there was no significant interaction between racial discrimination and sleep present, there was a significant association in those with a less than high school or less education who reported 1-2 reports of discrimination compared to those who did not report discrimination. This sample of African Americans had a high proportion of individuals who attended or completed college (over 70%). Once the remaining data were stratified by EOD, the numbers were greatly diminished so there may not be enough power to detect a strong association. 1-2 reports being significant as opposed to 3+ reports being significant is consistent with other studies using the EOD (37, 50).

Limitations, Strengths and Future Directions

There are limitations to this study which may have affected findings. First, due to the cross-sectional nature of this study causality cannot be inferred. Also, since the participants in this sample came from one city, the results may not be generalizable to other areas in the USA. Although the initial sample has enough power of analyses, stratifying the results on several levels including race, education and reports of discrimination may have resulted in reduced power for our estimates. Additionally, the use of self-report measures may have biased our study. We used the PSQI, a validated self-report measure of sleep instead of objective measures like actigraphy or PSG. Also, while the EOD is a validated and reliable measure, it does not capture structural racism and is subject to individual perception and discloser (50).

Despite these limitations, there are strengths to be noted as well. This study is among the first to examine the interactive effects of racial discrimination and education on both CRP levels and sleep quality in middle age adults. It utilized a population-based

sample and included validated measures of racial discrimination, subjective sleep and laboratory measures of CRP.

Future studies should continue to explore how racial discrimination impacts both African Americans and Whites and use both chronic measures of interpersonal racial discrimination as well as structural measures of racial discrimination. For sleep, studies should examine the role of SES, especially among African Americans, to determine whether it interacts with racial discrimination in different cohorts. For CRP, future research should re-evaluate the role of racial discrimination to determine whether it has an effect on changes in CRP over time in order to expand beyond cross-sectional studies. Until racial discrimination is no longer reported as a major stressor for African Americans, hopefully this and other research studies will lead to interventions to help society achieve optimal health in the face of this chronic stressor.

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Table 1. Demographic and Clinical Characteristics by Race

	Total (n=458)	African Americans (n=238)	Whites (n=210)	p-value*
Age, mean (STD)	50.54 (9.57)	49.56 (9.58)	51.6 (9.46)	0.02
Female, n (%)	310 (67.69)	166 (69.75)	144 (65.45)	0.32
Education Level				<.001
High school or less, n (%)	89 (19.52)	71 (29.83)	18 (8.26)	
Some college, n (%)	120 (26.32)	75 (31.51)	45 (20.64)	
College graduate or more, n (%)	247 (54.17)	92 (38.66)	155 (71.1)	
Experience of Discrimination				<.001
0 experiences, n (%)	190 (41.48)	63 (26.47)	127 (57.73)	
1-2 experiences, n (%)	115 (25.11)	46 (19.33)	69 (31.36)	
3+ experiences, n (%)	153 (33.41)	129 (54.2)	24 (10.91)	
Diagnosis of Diabetes, n (%)	40 (8.73)	31 (13.03)	9 (4.09)	<0.01
Hypertension medication use, n (%)	108 (23.89)	69 (29.36)	39 (17.97)	<0.01
Current smoking, n (%)	75 (16.41)	48 (20.25)	27 (12.27)	0.02
BMI (kg/m^2), median (IQR)	28.31 (24.72-33.71)	30.13 (26.0-36.36)	26.98 (23.79-31.32)	<.001
BMI (kg/m^2)				<.001
Normal, n (%)	122 (26.64)	44 (18.49)	78 (35.45)	
Overweight, n (%)	148 (32.31)	72 (30.25)	76 (34.55)	
Obese, n (%)	188 (41.05)	122 (51.26)	66 (30.0)	

FRS, median (IQR)[a]	4.0 (2.0-8.0)	4.0 (2.0-8.0)	4.0 (2.0-8.0)	0.69
FRS				0.73
Low, n (%)	349 (84.5)	182 (85.85)	167 (83.08)	
Intermediate, n (%)	57 (13.8)	25 (11.79)	32 (15.92)	
High, n (%)	7 (1.69)	5 (2.36)	2 (1.0)	
BDI-II, median (IQR)[b]	6.0 (2.0-12.0)	6.0 (2.0-13.0)	5.5 (2.0-11.0)	0.28
Modified BDI, median (IQR)[c]	5.0(1.0-9.0)	5.0(1.0-10.0)	5.0(1.5-9.0)	0.57
CRP (mg/L), median (IQR)[d]	1.94 (0.85-4.48)	2.37 (0.93-6.49)	1.61 (0.78-3.49)	<.001
PSQI, mean, (STD)[e]	5.93 (3.32)	6.42 (3.47)	5.44 (3.10)	<0.01

Note. STD= standard deviation; BMI= body mass index; IQR= Interquartile range; FRS= Framingham Risk Score; BDI-II =Beck Depression Inventory II; CRP= C-Reactive Protein; PSQI= Pittsburgh Sleep Quality Index;

[a]Data on FRS available for n = 413

[b]Data on BDI-II available for n = 431

[c]Data on Modified BDI-II available for n = 382; Modified BDI was used for sleep analysis only and is the BDI-II minus a question about sleep.

[d]Data on CRP available for n = 410

[e]Data on PSQI available for n = 406

*Comparisons between blacks and whites were made using two sample t-tests or X^2 tests.

Table 2. Linear Regression Models Examining the Association Between Racial Discrimination and LogCRP

	Model 1 (n=384)[a*]		Model 2 (n=384)[b*]		Model 3 (n=353)[c*]		Model 4 (n=333)[d*]	
Variable	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Experiences of Discrimination								
0 experiences	reference		reference		reference		reference	
1-2 experiences	0.08 (0.06)	0.18	0.09 (0.07)	0.21	-0.01 (0.06)	0.84	-0.02 (0.06)	0.71
3+ experiences	0.08 (0.06)	0.21	0.15 (0.11)	0.15	0.03 (0.06)	0.66	0.03 (0.06)	0.61
Race								
White	reference		reference		reference		reference	
African American	0.09 (0.05)	0.10	0.14 (0.08)	0.09	0.04 (0.05)	0.46	0.03 (0.05)	0.54
EOD*Race								
0 experiences x White			reference					
1-2 experiences x AA			- 0.05 (0.12)	0.70				
3+ experiences x AA			- 0.12 (0.13)	0.36				

Note. EOD = Experiences of Discrimination; AA = African American;

[a] Model 1 includes age, sex, education and race

[b] Model 2 includes Model 1 variables plus the interaction term, discrimination x race

[c] Model 3 includes Model 1 variables plus FRS, history of diabetes and BMI

[d] Model 4 includes Model 3 variables plus depression

* Model is significant

Table 3. Linear Regression Models Examining the Association Between Racial Discrimination and LogCRP in African American

	Model 1 (n=194)[a]		Model 2 (n=194)[b]		Model 3(n=177)[c*]		Model 4 (n=164)[d*]	
Variable	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p value
Experiences of Discrimination								
0 experiences	reference		reference		reference		reference	
1-2 experiences	0.06 (0.10)	0.52	-0.01 (0.18)	0.94	0.00 (0.10)	0.99	0.01 (0.10)	0.86
3+ experiences	0.06 (0.08)	0.51	0.06 (0.15)	0.67	-0.00 (008)	0.97	0.03 (0.09)	0.71
Education								
High school or less	reference		reference		reference		reference	
Some college	- 0.03 (0.09)	0.72	- 0.08 (0.18)	0.65	-0.07 (0.09)	0.43	-0.08 (0.10)	0.42
College or more	0.02 (0.09)	0.86	0.01 (0.15)	0.95	-0.03 (0.09)	0.75	-0.05 (0.09)	0.63
EOD*Education								
0 experiences x High school or less			reference					
1-2 experiences x Some college			0.13 (0.27)	0.64				
1-2 experiences x College or more			010 (0.24)	0.67				
3+ experiences x Some college			0.04 (0.23)	0.85				
3+ experiences x College or more			- 0.03 (0.20)	0.90				

Note. EOD = Experiences of Discrimination;

[a] Model 1 includes age, sex, education and race

[b] Model 2 includes Model 1 variables plus the interaction term, discrimination x education

[c] Model 3 includes Model 1 variables plus FRS, history of diabetes and BMI

[d] Model 4 includes Model 3 variables plus depression

* Model is significant

Table 4. Linear Regression Models Examining the Association Between Racial Discrimination and Sleep Quality

	Model 1 (n=404)[a*]		Model 2 (n=404)[b*]		Model 3 (n=399)[c*]		Model 4 (n=375)[d*]	
Variable	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Experiences of Discrimination								
0 reports	reference		reference		reference		reference	
1-2 reports	1.38 (0.42)	<0.01	1.69 (0.52)	<0.01	1.37 (0.41)	<0.01	1.09 (0.37)	<0.01
3+ reports	1.17 (0.42)	0.01	1.07 (0.74)	0.15	1.19 (0.42)	0.01	0.88 (0.38)	0.02
Race								
White	reference		reference		reference		reference	
African American	0.36 (0.39)	0.36	0.63 (0.57)	0.27	0.24 (0.39)	0.54	0.55 (0.35)	0.12
EOD*Race								
0 experiences x White			reference					
1-2 experiences x AA			- 0.86 (0.87)	0.33				
3+ experiences x AA			- 0.04 (0.93)	0.97				

Note. EOD = Experiences of Discrimination; AA = African American

[a] Model 1 includes age, sex, education and race

[b] Model 2 includes Model 1 variables plus the interaction term, discrimination x race

c Model 3 includes Model 1 variables plus current smoking, BMI, hypertension medicine

[d] Model 4 includes Model 3 variables plus depression

*Model is significant

Table 5. Linear Regression Models Examining the Association Between Racial Discrimination and Sleep Quality in African Americans

	Model 1 (n=203)[a]		Model 2 (n=203)[b]		Model 3 (n=200)[c]		Model 4 (n=186)[d*]	
Variable	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Experiences of Discrimination								
0 reports	reference		reference		reference		reference	
1-2 reports	0.86 (0.76)	0.26	4.18 (1.56)	0.01	0.81 (0.76)	0.29	0.81 (0.52)	0.42
3+ reports	1.08 (0.60)	0.07	1.77 (0.97)	0.07	1.10 (0.60)	0.07	0.54 (0.67)	0.12
Education								
High school or less	reference		reference		reference		reference	
Some college	- 1.04 (0.67)	0.12	0.65 (1.22)	0.60	- 1.01 (0.67)	0.13	-0.38 (0.59)	0.53
College or more	- 1.10 (0.63)	0.08	- 0.17 (1.10)	0.88	- 0.99 (0.64)	0.12	-0.44 (0.57)	0.44
EOD*Education								
0 experiences x High school or less			reference					
1-2 experiences x Some college			- 5.04 (2.05)	0.02				
1-2 experiences x College or more			- 3.96 (1.97)	<0.05				
3+ experiences x Some college			- 1.8 (1.51)	0.23				
3+ experiences x College or more			- 0.96 (1.39)	0.49				

Note. EOD = Experiences of Discrimination;

[a] Model 1 includes age, sex, education and race

[b] Model 2 includes Model 1 variables plus the interaction term, discrimination x education

c Model 3 includes Model 1 variables plus current smoking, BMI, hypertension medicine

[d] Model 4 includes Model 3 variables plus depression

*Model is significant

Table 6. Linear Regression Models Examining the Association Between Racial Discrimination and Sleep Quality in African Americans with High School or Less Education

	Model 1 (n=58)[a]		Model 2 (n=56)[b]		Model 3 (n=49)[c*]	
Variable	Estimate	p-value	Estimate	p-value	Estimate	p-value
Experience of Discrimination						
0 reports	reference		reference		reference	
1-2 reports	4.11 (1.68)	0.02	4.32 (1.78)	0.02	2.48 (1.60)	0.13
3+ reports	1.68 (1.09)	0.13	1.63 (1.13)	0.15	1.86 (0.98)	0.06

[a] Model 1 includes for age, sex, and education

[b] Model 2 includes Model 1 variables plus current smoking, BMI, hypertension medicine

[c] Model 3 includes Model 2 variables plus depression

*The model is significant

SUMMARY, IMPLICATIONS AND FUTURE DIRECTIONS

The purpose of this study was to investigate the relationship between racial discrimination and CVD risk, namely CRP and sleep quality. We wanted to see whether the association between racial discrimination and CVD risk differed by race in African Americans and Whites, and among African Americans, if the association between racial discrimination and CVD risk differed by SES. Racial discrimination was not statistically significantly associated with CRP in either race. Also, among African Americans the association between racial discrimination and CRP did not differ by socioeconomic status. Racial Discrimination was significantly negatively associated with sleep quality but the association was the same among African Americans and Whites. Among African Americans, the association between racial discrimination and did not differ based on SES, however, within the low SES group, reporting more discrimination did result in statistically significantly higher CRP. This was attenuated by depression in later models.

There are several implications for this study. Like previous studies, racial discrimination was significantly associated with poor health in Whites as well as African Americans (41-43, 47). Whites report less racial discrimination than African Americans but self-reported racial discrimination is just as impactful on health as racial discrimination is for African Americans (6). Because this study is cross-sectional, causality cannot be inferred, but the association does warrant further research.

There are many future directions for research on racial discrimination and CVD risk. Studies that have found significant associations with general and racial discrimination and CRP and sleep have used measurements like the EDS which inquire about more general, chronic forms of discrimination (33, 34, 41-43). Future studies

should use measures that specifically inquire about racial discrimination as well as the chronicity of occurrence. Also, this study and many other studies only make use of self-reported interpersonal forms of discrimination. Using structural measures of racial discrimination like incarceration rates and educational attainment may more accurately measure racial discrimination which may also reveal race differences in the association between racial discrimination and CVD risk (52).

Future studies may want to alter the way CVD outcomes are measured. This study looked at single measure of CRP and other studies assessed either single measures of CRP multiple measures of CRP from each participant. Both methods have found significant associations. A study in 2012 found that SES was predictive of changes of CRP levels so future studies may want examine whether racial discrimination predicts changes over time instead of just CRP levels (53). Other studies have found that gender and BMI have more to do with predicting CRP levels so racial discrimination may have a more significant association with changes in CRP than levels of CRP (37, 41). Additionally, this study used self-reported sleep; future studies may want to use standardized sleep measures like PSG and actigraphy.

This study did not find an interaction between SES and discrimination among African Americans on CRP or sleep quality. Other studies have identified how coping mechanisms and ethnic identity mitigate the influence of racial discrimination on health (16, 39). These factors were not present in these data but they also may mitigate the effects of racial discrimination and should be included as mediators of the racial discrimination and CVD health in future research.

The aim of this study was to further investigate the relationship between racial discrimination and CVD risk. Racial discrimination is still an issue in the US and its effect on health, namely CVD risk, clearly warrants future research. Future studies should focus correct measurement of racial discrimination and its interplay with social factors like SES.

Figure 1. PSQI Scores by Education Level in African Americans