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Socioeconomic status discrimination and C-reactive protein in African-American and White adults

Running Head: SES discrimination and C-reactive protein

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Highlights

Manuscript Title: Socioeconomic status discrimination and C-reactive protein in African-American and White adults

- Psychosocial stress in the form of discrimination has been linked to important health outcomes.
- Most studies have focused on racial discrimination or overall mistreatment.
- We examined the associations between socioeconomic status (SES) discrimination and C-reactive protein (CRP) by race and education.
- SES discrimination was associated with elevated CRP independent of racial and gender discrimination among higher educated African-Americans only.
- Associations were not observed among lower educated African-Americans and higher or lower educated Whites.

Socioeconomic status discrimination and C-reactive protein in African-American and White adults

Objectives: We examined the association between socioeconomic status (SES) discrimination and C-reactive protein (CRP) in a biracial cohort of middle-aged adults using an intersectionality framework.

Methods: Participants were 401 African-American and White adults from a population-based cohort in the Southeastern United States. SES discrimination was self-reported with a modified Experiences of

Discrimination Scale, and CRP levels were assayed from blood samples. Linear regression analyses were used to examine the associations among SES discrimination, race, education, and CRP after controlling for age, gender, racial and gender discrimination, financial and general stress, body mass index, smoking, sleep quality, and depressive symptoms. Intersectional effects were tested using race×SES discrimination, education×SES discrimination and race×education×SES discrimination interactions.

Results: Adjusting for sociodemographics, racial discrimination, gender discrimination, and all relevant two-way interaction terms, we observed a significant race×education×SES discrimination interaction ($p=0.019$). In adjusted models stratified by race and education, SES discrimination was associated with elevated CRP among higher educated African-Americans ($\beta=0.29$, $p=0.018$), but not lower educated African-Americans ($\beta= -0.13$, $p=0.32$); or lower educated ($\beta= -0.02$, $p=0.92$) or higher educated ($\beta= -0.01$, $p=0.90$) Whites.

Conclusions: Findings support the relevance of SES discrimination as an important discriminatory stressor for inflammation specifically among higher educated African-Americans.

Keywords: African-Americans; Social discrimination; C-reactive protein; Inflammation

Acronyms: META-HEALTH= Morehouse & Emory Team-up to Eliminate Cardiovascular Health Disparities; CRP= C-reactive protein; SES= socioeconomic status; BMI= body mass index; BDI-II= Beck Depression Inventory-II; PSQI= Pittsburgh Sleep Quality Index

1. Introduction

Research examining the impact of discrimination as a psychosocial stressor on health has grown considerably over the past decade (Lewis et al., 2015). Across studies, reports of discrimination have been associated with a number of important health outcomes, such as coronary artery calcification (Lewis et al., 2006), obesity (Hunte, 2011; Lewis et al., 2011), hypertension (Dolezsar et al., 2014), breast cancer (Taylor et al., 2007), depression (Schulz et al., 2006), sleep (Slopen et al., 2015), and asthma (Coogan et al., 2014). However, this literature has primarily focused on racial discrimination or overall mistreatment (Lewis et al., 2015), with some attention given to discrimination based on weight (Sutin et al., 2014).

Discrimination based on social class, or socioeconomic status (SES) discrimination, has been less widely studied; although it is known that membership in higher, versus lower, social classes affords individuals access to opportunities and resources that may positively impact health (Adler and Newman, 2002). SES discrimination can be conceptualized as the unfair treatment of an individual or group because of their perceived or actual social standing (e.g., based on occupation, income, education, etc.). SES discrimination may be particularly relevant for health in today's society given the well-established association between SES-related factors and health (Adler and Stewart, 2010) and the increasing divides along lines of education, income and wealth in the U.S. (Congressional Budget Office, 2011). In a recent study of 425 African-American and White adults (Van Dyke et al., 2016) from the Morehouse & Emory Team-up to Eliminate Cardiovascular Health Disparities (META-HEALTH) cohort, an association between self-reported SES discrimination and poor sleep was observed among African-Americans, but not Whites. This association was independent of financial stress and other forms of discrimination. Additional exploratory analyses revealed that SES discrimination was particularly harmful for sleep among higher educated African-Americans, but not lower educated African-Americans or lower or higher educated Whites. These results suggest that SES discrimination may be a particularly relevant psychosocial stressor for health among higher educated African-Americans.

Findings from this study are consistent with an "intersectional" theoretical framework (Crenshaw, 1991), which argues that individuals holding intersecting racial and socioeconomic identities have unique

life experiences of both "oppression" and "opportunity" that can impact their health over the life-course (Jackson and Williams, 2006). For example, while higher educated African-Americans are considered socially advantaged in terms of economic position, they still occupy a disadvantaged status of being a racial minority. Thus, their education-related opportunities and life experiences cannot be considered independent of their racial status; and vice-versa, their life experiences and opportunities related to their race cannot be considered independent of their educational status.

The current study was designed to build upon previous research (Van Dyke et al., 2016) by examining the independent association between SES discrimination and C-reactive protein (CRP) in middle-aged African-American and White adults from the META-HEALTH cohort using an intersectionality framework. CRP is a marker of inflammation that has been linked to an increased risk of cardiovascular events (Cushman et al., 2009; Ridker et al., 2000; Rutter et al., 2004). Across studies, African-Americans and lower SES individuals have elevated levels of CRP compared to Whites and their higher SES counterparts; however, the socioeconomic gradient observed in CRP levels for Whites has not been consistently observed in African-Americans (Fuller-Rowell et al., 2015; Gruenewald et al., 2009).

Self-reports of generic forms of discrimination have been associated with elevated levels of CRP in at least one prior study of African-American adults (Lewis et al., 2010). Findings for the association between racial/ethnic discrimination in particular and CRP have been fairly mixed, with some studies observing associations between racial/ethnic discrimination and CRP among African-Americans and Whites (Beatty et al., 2014; Cunningham et al., 2012), and others not (Albert et al., 2008). Moreover, in two prior studies examining associations between discrimination and inflammatory markers in general, generic reports of discrimination were associated with other markers of inflammation, such as Il-6, but not CRP (Kershaw et al., 2016; Stepanikova et al., 2017). However, none of these studies focused on discrimination on the basis of SES. Further, while some of these studies examined whether associations between discrimination and inflammation differed by race (Beatty et al, 2014; Albert et al, 2008; Kershaw et al 2016), none examined the additional role of SES in these associations, despite the known relevance of SES to health outcomes. Thus, it is currently unknown whether: 1) self-reports of discrimination based

on SES are associated with CRP levels; 2) whether any observed associations are independent of other forms of discrimination, and 3) whether the association varies across groups holding intersecting racial and socioeconomic identities.

Based on previous research, we hypothesized that self-reports of SES discrimination would be associated with elevated CRP levels independent of racial and gender discrimination, particularly among higher educated African-Americans. Across studies, higher educated African-Americans typically report more discrimination (both racial and general) than their lower educated counterparts (Albert et al., 2008; Bobo and Suh, 2000; Borrell et al., 2006; Gee, 2002); see Brondolo, et al (Brondolo et al., 2009) for an exception. Additionally, some studies have found that discrimination (both racial and general) is associated with less favorable health outcomes among higher, compared to lower, SES African-Americans (Carliner et al., 2016; Fuller-Rowell et al., 2012; Jackson et al., 1995). Finally, given the other stressful exposures likely experienced by individuals holding intersecting racial and socioeconomic social identities, we also examined whether the association between self-reports of SES discrimination and CRP was independent of other discriminatory stressors, such as racial and gender discrimination, as well as general perceived stress and financial stress.

2. Material and Methods

2.1 Participants

Participants were 469 non-Hispanic African-American and White males and females ages 30-65 from four Metropolitan Atlanta, GA counties. Participants were recruited for the Morehouse & Emory Team-up to Eliminate Cardiovascular Health Disparities (META-HEALTH) Study, a two-stage cross-sectional study conducted from March 2006 to October 2009, focused on the cultural, psychosocial, and biological factors of cardiovascular health in adults. The first stage of the META-HEALTH study included 3,391 individuals who were randomly sampled and contacted using random digit dialing methodology to complete phone questionnaire interviews. Within each county, the selection of participants was stratified by median income to ensure adequate representation of individuals from

varying levels of SES. Of those in the first stage of the study, 469 participated in the second stage of the study, which included an extended questionnaire interview, a clinical exam, and a blood draw. For analyses, a total of 68 participants of those 469 were excluded due to missing information on reports of SES discrimination and/or level of CRP. There were no significant differences in the distribution of study variables between participants excluded from analyses due to missing information on reports of SES discrimination and/or level of CRP (n=68) and participants included in analyses (n=401) (p's>0.05); however, there were marginal differences in scores on the Pittsburgh Sleep Quality Index, with included participants reporting more sleep problems than excluded participants (p=.08). Our final analytic sample was 68.2% female, 54.1% college-educated, and included a total of 401 participants-- 207 African-Americans and 194 Whites. During analyses, an additional 41 participants were excluded due to missing data on covariates. All participants provided written informed consent, and this study was approved by the Emory and Morehouse institutional review boards.

2.2 Reports of Discrimination

The Experiences of Discrimination Scale was used to measure reports of SES discrimination. The Experiences of Discrimination scale has demonstrated high levels of validity and reliability and has been widely used in both African-American and White populations (Krieger et al., 2005). A modified version of the scale developed by the original authors was utilized to measure SES discrimination (Krieger and Sidney, 1997). Participants were asked if they had ever "been prevented from doing something" or "been hassled or made to feel inferior" because of their "socioeconomic position or social class," in a number of different settings including: at school, getting a job, at work, getting medical care, from the police or in the courts on the street or in a public setting. These questions were repeated for racial, and then gender discrimination, respectively. Since most participants in our sample reported discrimination in no or only one setting, discrimination scores were highly skewed. Therefore, a dichotomous ever/never variable was used for each type of discrimination (Hunte and Williams, 2009).

2.3 C - Reactive Protein

Venous blood samples were collected in sodium heparin tubes from participants who were instructed to fast 12 hours prior to the clinical exam during the second stage of the study. CRP was assayed by immunonephelometry (Siemens/Dade Behring) using plasma frozen at -70^{o} C (Morris et al., 2011).

2.4 Demographics

Self-reported age, race (non-Hispanic African-American, non-Hispanic White), education, and gender were collected in the first stage of the study. We chose to use education as the primary measure of SES because it remains relatively constant throughout adulthood and is less likely compared to other measures of SES, such as income and wealth, to have a large amount of missing responses. Finally, and most importantly, prior studies have consistently documented differences in reports of discrimination by educational attainment among African-Americans across a range of cohorts (Albert et al., 2008; Bobo and Suh, 2000; Borrell et al., 2006; Gee, 2002). Participants were asked to indicate the highest level of education they completed (no school, elementary, some high school, some college or technical school, or college graduate). Educational attainment was dichotomized as higher educated (college graduate) or lower educated (no school, elementary, some high school, some college or technical school).

2.5 Covariates

Covariates were selected based on previous literature identifying them as potential correlates of discrimination and/or CRP (Lewis et al., 2010; O'Connor et al., 2009) and included body mass index (BMI), sleep quality, depressive symptoms, perceived stress, financial stress, and smoking status. BMI was measured during the clinical exam, and was calculated using measured height and weight (BMI= weight (kg)/ height (m^2). Depressive symptoms were measured with the Beck Depression Inventory-II (BDI-II) (Beck et al., 1961) , a 21-item questionnaire assessing depressive symptoms in the past two weeks. Questions from the BDI-II were summed to create a composite BDI-II score with a potential range of 0-63. The Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989), a 19-item questionnaire that measures aspects of sleep over the preceding month, was used to assess subjective sleep quality.

Questions from the PSQI were summed to create a composite score ranging from 0-21, with higher scores indicating more sleep complaints and lower quality sleep.

Perceived stress was measured using the Perceived Stress Scale, a reliable and valid 14-item scale assessing general feelings of stress (Cohen et al., 1983), with composite scores ranging from 0 to 56. Financial stress was assessed with three questions examining stress related to paying for (1) medical care, (2) food, or (3) bills. For each respective scenario, those reporting financial stress once in a while, fairly often, or very often were given a score of 1, and scores were summed across the three scenarios to create an ordinal measure ranging from 0-3. Smoking status was categorized as "never," "former," or "current." "Former" smokers reported having smoked at least 100 cigarettes in their entire life, though they reported not currently smoking cigarettes.

2.6 Statistical Analysis

Study variables were characterized by race and educational status using descriptive and correlation analyses. Linear regression analyses were used to examine associations among race, education, self-reports of SES discrimination and C-reactive protein. In order to examine intersectional effects, we formally tested for race × SES discrimination, education × SES discrimination and race × education × SES discrimination interactions in non-stratified linear models containing race, education, and all relevant two-way interactions. We observed a significant three-way race × education × SES discrimination interaction in the non-stratified models, and thus ran additional, linear regression models stratified by race and education. For non-stratified models and models stratified by race and education, we adjusted for age, gender (Step 1), reports of racial and gender discrimination (Step 2), BMI, smoking status, perceived stress, financial stress (Step 3), and subjective sleep quality and depressive symptoms (Step 4). Since levels of CRP were right-skewed in our sample, they were log-transformed in regression analyses. No multicollinearity was observed. All analyses were conducted using SAS software version 9.4 (SAS® Institute, Inc., Cary, NC, USA). An alpha level of 0.05 was used for analyses.

3. Results

3.1 Participant Characteristics

Descriptive statistics of the analytic sample are presented in Table 1. Among higher educated participants, African-Americans were younger (p=0.009) and more likely to report both SES and racial discrimination (p<0.01) than their White counterparts. Among lower educated participants, African-Americans were more likely than Whites to report financial stress (p<0.001), SES discrimination (p=0.047), and racial discrimination (p=0.004). Among higher educated participants, there were racial differences in health status variables, such that among higher educated participants, African-Americans had higher levels of CRP (p=0.001), BMI (p<0.001), and subjective sleep quality (p=0.021) than their White counterparts. There were no racial differences in health status variables among lower educated participants.

In correlation analyses (Supplementary tables 1-4), racial and gender discrimination were moderately correlated with SES discrimination in all four race by education categories (r= 0.21-0.50; all p-values <0.05). SES discrimination was correlated with CRP levels in higher educated African-Americans only (r=0.33, p=0.0028).

3.2. Primary Analyses

In a linear regression model adjusted for sociodemographics, racial discrimination, gender discrimination, and all relevant two-way interaction terms, there was a significant race × education × SES discrimination interaction (p=0.019). After additional adjustment for BMI, smoking status, perceived stress, financial stress, subjective sleep quality, and depressive symptoms, this interaction remained significant (p=0.049). The interaction is depicted using estimated marginal means from fully adjusted linear regression models in Figure 1. Because CRP was initially log-transformed, values were back-transformed using geometric means. As shown in Figure 1, the association between SES discrimination and CRP was strongest among higher educated African-Americans, relative to higher educated whites and lower educated participants from both racial groups. However, there was a slight inverse association between SES discrimination and CRP among lower educated African-Americans, although it was not significant (Table 2).

As shown in Table 2, in linear models stratified by race and education and adjusted for age and gender, SES discrimination was significantly associated with CRP among higher educated African-Americans (β=0.31, p=0.004, R^2=0.12). Reports of SES discrimination remained associated with elevated CRP levels among higher educated African-Americans after further adjustment for racial and gender discrimination (β=0.36, p=0.005, R^2=0.13), BMI, smoking status, financial and perceived stress (β=0.32, p=0.008), and sleep quality and depressive symptoms (β=0.29, p=0.018, R^2=0.39) (Table 2).

No association between reports of SES discrimination and CRP was found among higher educated Whites in minimally or fully-adjusted models (β=0.05, p=0.50, R^2=0.05; β= -0.01, p=0.90, R^2=0.19), or among lower educated Whites in minimally or fully-adjusted models (β=0.21, p=0.12, R^2=0.05; β=-0.02, p=0.92, R^2=0.42) or among lower educated African-Americans in minimally or fully-adjusted models (β= -0.10, p=0.35, R^2=0.05; β= -0.13, p=0.32, R^2=0.21) (Table 2).

Among covariates in fully-adjusted models (Table 3), BMI was significantly associated with elevated CRP among all participants ($p \leq 0.01$). For higher educated African-Americans, perceived stress (β=0.02, p=0.04) and sleep quality (β=0.04, p=0.04) were associated higher levels of CRP, and higher depressive symptoms (β=-0.03, p=0.04) were associated with lower levels of CRP. For higher educated Whites, older age was associated with higher CRP (β=0.01, p=0.04). Racial discrimination was not significantly associated with CRP in fully-adjusted models for any race by education group ($p>0.05$).

3.3 Exploratory Analyses

We calculated adjusted mean differences in CRP levels between groups to further explore differences by reports of SES discrimination across race and education. Because of the small numbers within race by education by reports of SES discrimination groups (i.e. lower educated Whites) these analyses were exploratory in nature. Significant differences were observed between higher educated African-Americans reporting SES discrimination and all other groups (e.g. lower educated African-Americans reporting SES discrimination; higher educated whites reporting SES discrimination, etc.; all p-values<.05) except lower educated whites reporting SES discrimination (p=.17) and lower educated

African-Americans not reporting SES discrimination (p=.52). Differences between higher educated African-Americans reporting SES discrimination and lower educated whites not reporting SES discrimination were marginally significant (p=.07).

Additional exploratory analyses were conducted to examine the association between racial discrimination and CRP without SES discrimination in the model in order to more directly compare our results to prior research, which has primarily focused on this relationship. In fully-adjusted models without SES discrimination, racial discrimination was not significantly associated with CRP among higher educated African-Americans (p=0.13), higher educated Whites (p=0.62), lower educated African-Americans (p=0.76), or lower educated Whites (p=0.48).

4. Discussion

In this population-based cohort of African-American and White Adults, reports of SES discrimination were associated with elevated CRP levels, but only among higher educated African-Americans. Findings among higher educated African-Americans remained significant after adjusting for demographics, other forms of discrimination, financial and general stress, depressive symptoms, and cardiovascular risk factors, including BMI and smoking which are important potential mediators between psychosocial exposures and levels of CRP (O'Connor et al., 2009; Taylor et al., 2006). These findings are consistent with a recent study from this same cohort (Van Dyke et al., 2016) which suggested that reports of SES discrimination were particularly relevant for sleep among college-educated African-Americans, and with a growing body of research that has documented the reduced benefit of SES on health outcomes among African-Americans compared to Whites (Fuller-Rowell et al., 2015; Lewis et al., 2005). Indeed, in our cohort, predicted values of CRP were highest in college-educated African-Americans reporting SES discrimination compared to all other groups – including African-Americans without a college degree. This suggests that SES discrimination may be one factor that diminishes, or actually outweighs, the potential protective effect of a college education on CRP for African-Americans. The fact that we observed significant associations among higher educated African-Americans but not lower educated

African-Americans or Whites illustrates the utility of an intersectional framework for examining these relationships; however, the underlying explanation for these associations is less clear.

Although much of the research on discrimination and health among African-Americans has focused on race-related exposures, the current findings suggest that SES discrimination may be a particularly salient stressor for higher educated African-Americans. In our sample, 38% of African-Americans attained a college degree compared to 71% of Whites. Although trends have improved over time, the attainment of a college degree is less likely and some have argued, more difficult for African-Americans in comparison to Whites in the U.S. (Williams and Mohammed, 2013). This may be due in part to known racial differences in high school completion rates (Heckman and Lafontaine, 2010) and educational access (Frankenberg, 2013) and quality (McDaniel et al., 2011). Therefore, African-Americans who have completed a college education may find this aspect of their social identity particularly valuable. Thus, when confronted with SES discrimination, college-educated African-Americans may feel that this valued and important social identity, along with the access to benefits and opportunities (i.e., upward mobility) that come along with that identity, is being threatened (Cose, 1993; Jackson et al., 2006). Research on status loss suggests that the idea of possibly losing status can incite physiological responses, such as elevated systolic blood pressure and pulse pressure (Scheepers et al., 2009), especially among higher status groups. Although we are unaware of any studies on status loss and inflammation per se, it is possible that SES discrimination represents a form of status threat for college-educated African-Americans that might increase stress-related inflammation.

SES discrimination may be particularly relevant for college-educated African-Americans if they work or socialize in settings where their levels of income and wealth do not match those of their White counterparts. There are known differences in the economic return on a college education for African-Americans as compared to Whites (Emmons and Noeth, 2015). Studies have found that higher education does not provide the same dividends in income and wealth for African-Americans as it does for Whites. For example, in 2013, among four-year college graduates, median family income and net worth was 1.8 and 11 times higher, respectively for Whites compared to African-Americans (Emmons and Noeth, 2015).

For college-educated African-Americans, this could lead to an inability to maintain social norms or to "keep up with the Joneses," which could result in SES discrimination, as well as social exclusion. A study in a Chicago community among African-American youth found that striving to maintain the cultural norms of material success was associated with higher blood pressure, but only among those without the economic means to do so (Sweet, 2010). It is possible that for many college-educated African-Americans, living life in a relatively lower economic position while in a higher SES environment could lead to social experiences, including SES discrimination, that are uniquely stressful and result in elevated inflammation.

It is noteworthy that we did not observe an association between reports of racism and CRP among higher or lower educated African-Americans in this cohort. Other studies have also observed null results when examining the effects of racism on health outcomes among African-Americans (Albert et al., 2008), although some positive associations have been found (Cunningham et al., 2012; Goosby et al., 2015). But our results are consistent with those from a 2015 meta-analysis, which found that racism and health associations were consistently weaker in studies of African-Americans, compared to other racial/ethnic groups (Paradies et al, 2015). Some have argued that reports of racism may not fully capture the range of discriminatory stressors that individuals occupying "intersectional" racial and socioeconomic identities are exposed to (Lewis et al., 2015).

It is also possible that college-educated African-Americans misattribute certain discriminatory experiences to SES discrimination when they may be due to race (Levin et al., 2002). There is a strong link between race and class in the United States (Williams and Mohammed, 2013); thus, college-educated African-Americans may be more likely to be perceived as lower SES than their White counterparts (Cose, 1993). Using nationally representative data on 12,686 men and women over a 19-year period, Saperstein and Penner (2013) found that interviewers were more likely to classify a previously identified White person as African-American than a previously identified African-American person as White if that individual had experienced a decrease in social standing (i.e., "becoming unemployed, impoverished, or living in the inner city)." Consequently, for interviewers, African-American race was automatically linked to indices of low SES. Nonetheless, despite the possibility of misattributions, in our cohort reports of

SES discrimination were significantly associated with CRP among college-educated African-Americans, while reports of racial discrimination were not. This suggests that SES discrimination may be an important form of discriminatory stress to consider independent of its possible link to racial discrimination. Additional research in this area is needed.

The fact that our observed associations were not explained by behavioral factors such as BMI, smoking, or sleep suggests that more direct physiological pathways may play a role. There is limited research exploring the mechanistic pathways through which discrimination influences CRP levels (Berger and Sarnyai, 2015; Williams and Mohammed, 2009). However, some pathways in which psychosocial stressors, such as discrimination, may be linked to CRP have been suggested. For one, discriminatory stress has been linked to dysregulation of the autonomic nervous system in the form of decreased heart rate variability (Kemp et al., 2016). Studies have also found associations between reports of discrimination and cortisol dysregulation (Adam et al., 2015; Zeiders et al., 2014). Reports of discrimination have also been associated with depressive symptoms (Schulz et al., 2006), as well as visceral fat (Lewis et al., 2011). All of these factors have been linked with inflammation (Lampert et al., 2008; Miller et al., 2009; O'Connor et al., 2009). Social status-related stressors may also be linked to inflammation through neurobiological pathways related to stress response (Berger and Sarnyai, 2014). More research is needed to further examine pathways through which discriminatory stressors, such as SES discrimination, might influence levels of CRP, and if the physiological mechanisms that influence CRP differ by type of discrimination.

There are limitations that should be considered in the interpretation of our study findings. To begin with, while educational attainment has been a strong correlate of reports of discrimination in prior studies, we recognize there are limitations to using a single indictor (e.g., education) as a proxy for SES. In future studies, it may be important to consider additional indicators of SES to represent intersectional socioeconomic identities. Additionally, although our primary exposure, reports of SES discrimination, was measured with one of the most widely used methodologies for assessing discrimination, it was self-reported and is subject to limitations inherent in self-reported measures (Lewis et al., 2015). Similarly,

while a dichotomization of "ever/never" for experiences of discrimination has been used in prior research (Hunte and Williams, 2009), this may lead to a limited ability to examine the relationship between the severity of discrimination and health. Further, because the current analysis primarily focused on SES and race, we did not examine the association between SES discrimination and CRP by gender, although prior research has documented differential associations between other forms of discrimination and CRP by gender (Cunningham et al., 2012; Kershaw, et al., 2016). It is also important to note that the cross-sectional design of our study limits the ability to infer a causal relationship between reports of SES discrimination and CRP. Finally, results from our study should be replicated in a larger and more geographically and racially diverse cohort. It is possible that certain intersectional socioeconomic and racial identities (e.g. college-educated and African-American) may have more or less salience in the US South relative to the Northeast, Midwest or West Coast. Moreover, our sample included a relatively small number of lower educated Whites. A recent study (Case and Deaton, 2015) suggests non-Hispanic Whites with less education have seen the most marked increases in all-cause mortality among middle-aged non-Hispanic men and women in the U.S. between 1999-2013. Thus, socioeconomic-related factors may be particularly important to consider for health in this group.

Despite these limitations, this study has several strengths. To our knowledge, this is the first study to examine the association between reports of SES discrimination, and CRP. Our cohort is unique, in that it is population-based, and includes African-Americans and Whites with both high and lower levels of education living in a defined geographic area. We also control for a range of potential confounders- including other stressors- that might explain our associations. Although replication is needed, our findings expand upon the intersectionality literature by providing evidence of the importance of examining psychosocial stressors, specifically discriminatory stressors, using an intersectionality framework. Our findings also expand upon the current discrimination and CRP literature by incorporating an understudied form of discriminatory stress, SES discrimination, as a factor independently associated with elevated levels of CRP.

5. Conclusions

Discriminatory stress related to SES may be an important psychosocial risk factor for elevated CRP among higher educated African-Americans. In this cohort of non-Hispanic African-American and White men and women, reports of SES discrimination were associated with elevated levels of CRP independent of other forms of discriminatory stress among higher educated African-Americans, but not lower educated African-Americans, or higher or lower educated Whites. Future studies are needed to replicate these findings and to consider the relationship between SES discrimination and other important health outcomes. Moreover, findings from this study underscore the need for future studies to consider relationships between discriminatory stress and health using an intersectionality framework.

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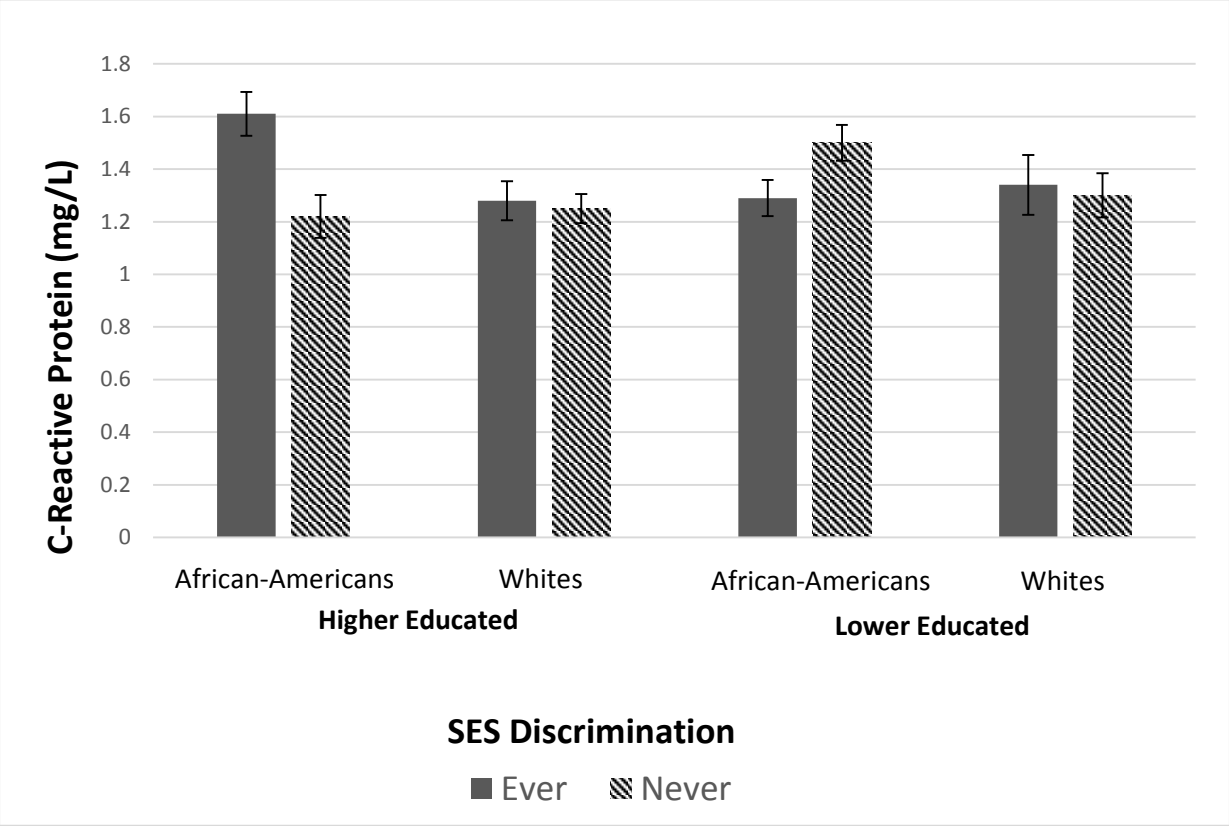
Association between Socioeconomic Status Discrimination and C-reactive Protein by Education and Race in the META-HEALTH Study (N=360)



Note. META-HEALTH=Morehouse & Emory Team up to Eliminate Cardiovascular Health Disparities. SES=Socioeconomic Status. Values are estimated marginal means from linear regression models adjusted for age, gender, racial and gender discrimination, body mass index, smoking, financial and perceived stress, sleep quality, and depressive symptoms.

Table 1. Selected Demographic and Psychosocial Characteristics of African-American and White Adults (*N*=401) by Education and Race in the META-HEALTH Study

	African-Americans	Whites	*p*[a]
Higher Educated	**(n=79)**	**(n=138)**	
Age	47.8 (9.1)	51.3 (9.3)	0.009
Female, %	74.7	68.1	0.32
Experiences of discrimination, %			
Socioeconomic	50.6	31.9	0.006
Racial	76.9	39.9	<0.001
Gender	64.1	57.3	0.32
C-reactive protein (geometric mean) (mg/L)	1.60 (0.77)	1.28 (0.57)	0.001
Depressive symptoms	6.8 (6.6)	7.4 (7.9)	0.57
Body Mass Index (kg/m^2)[b]	31.4 (6.7)	27.8 (5.9)	<0.001
Smoking Status, %			0.18
Current	11.5	8.7	
Former	16.7	27.5	
Perceived stress	19.1 (6.5)	20.2 (7.9)	0.31
Financial stress	1.0 (1.0)	0.8 (1.1)	0.30
Subjective sleep quality	6.2 (3.6)	5.1 (3.1)	0.021
Lower Educated	**(n=128)**	**(n=56)**	
Age	50.2 (9.6)	52.7 (9.5)	0.099
Female, %	66.4	66.1	0.96
Experiences of discrimination, %			
Socioeconomic	51.6	35.7	0.047
Racial	68.8	46.4	0.004
Gender	51.6	55.4	0.64
C-reactive protein (geometric mean) (mg/L)	1.74 (1.01)	1.50 (0.72)	0.10
Depressive symptoms	9.1 (8.4)	8.5 (7.7)	0.63
Body Mass Index (kg/m^2)[b]	31.3 (8.1)	30.3 (7.6)	0.40
Smoking Status, %			0.11
Current	25.8	21.4	
Former	24.2	39.3	
Perceived stress	22.0 (8.4)	21.8 (7.6)	0.88
Financial stress	1.8 (1.2)	1.0 (1.2)	<0.001
Subjective sleep quality	6.7 (4.0)	5.7 (3.1)	0.11

Abbreviations: META-HEALTH=Morehouse & Emory Team up to Eliminate Cardiovascular Health Disparities; SD=Standard deviation.

Values are presented as Mean (SD) or percent.

[a]p values refer to T-Tests and Chi-square tests for differences by race within education group.

[b]BMI= weight (in kg)/height (in m^2).

Table 2. Linear Regression Models Examining Association between SES Discrimination and C-reactive Protein by Education and Race among African-American and White Adults in the META-HEALTH Study

	Higher Educated		***Lower Educated***	
	African–Americans	**Whites**	**African-Americans**	**Whites**
	Beta (*SE*)	Beta (*SE*)	Beta (*SE*)	Beta (*SE*)
Model 0				
SES Discrimination Crude	0.32 (0.10) *p*=0.003	0.07 (0.08) *p*=0.38	-0.10 (0.10) *p*=0.32	0.21 (0.13) *p*=0.11
Model 1				
SES Discrimination Adjusted for age and gender	0.31 (0.11) *p*=0.004	0.05 (0.08) *p*=0.50	-0.10 (0.11) *p*=0.35	0.21 (0.13) *p*=0.12
Model 2				
SES Discrimination Adjusted for model 1 covariates+ racial and gender discrimination	0.36 (0.12) *p*=0.005	0.05 (0.08) *p*=0.58	-0.13 (0.12) *p*=0.28	0.18 (0.16) *p*=0.25
Model 3				
SES Discrimination Adjusted for model 2 covariates+ body mass index, smoking, financial and perceived stress	0.32 (0.12) *p*=0.008	-0.02 (0.08) *p*=0.81	-0.19 (0.12) *p*=0.13	-0.05 (0.15) *p*=0.76
Model 4				
SES Discrimination Adjusted for model 3 covariates+ sleep quality and depressive symptoms	0.29 (0.12) *p*=0.018	-0.01 (0.09) *p*=0.90	-0.13 (0.13) *p*=0.32	-0.02 (0.17) *p*=0.92

Abbreviations: CRP= C-reactive Protein; SE=Standard Error; META-HEALTH=Morehouse & Emory Team up to Eliminate Cardiovascular Health Disparities; SES=Socioeconomic status.

Ns for Higher Educated African-Americans: Model 0-1: 79; Model 2: 77; Model 3: 76; Model 4: 70
Ns for Higher Educated Whites: Model 0-1: 138; Model 2: 138; Model 3: 134; Model 4: 129
Ns for Lower Educated African-Americans: Model 0-1: 128; Model 2: 128; Model 3: 122; Model 4: 109
Ns for Lower Educated Whites: Model 0-1: 56; Model 2: 56; Model 3: 56; Model 4: 52

Table 3. Fully-Adjusted Linear Regression Models Examining Association between SES Discrimination and C-reactive Protein by Education and Race among African-American and White Adults in the META-HEALTH Study (N=360)

	Higher Educated		***Lower Educated***	
	African–Americans	**Whites**	**African-Americans**	**Whites**
	Beta (*SE*)	Beta (*SE*)	Beta (*SE*)	Beta (*SE*)
SES Discrimination	0.29 (0.12)*	-0.01 (0.09)	-0.13 (0.13)	-0.02 (0.17)
Age	-0.01 (0.01)	0.01 (0.01)*	-0.01 (0.01)	0.01 (0.01)
Gender	0.16 (0.12)	0.03 (0.09)	0.18 (0.12)	-0.03 (0.15)
Racial Discrimination	0.13 (0.15)	0.04 (0.09)	0.09 (0.14)	-0.09 (0.15)
Gender Discrimination	-0.19 (0.13)	-0.04 (0.09)	-0.02 (0.13)	0.27 (0.16)
Body Mass Index	0.02 (0.01)**	0.02 (0.01)*	0.02 (0.01)**	0.03 (0.01)**
Smoking (Ref=Never)				
Current	0.29 (0.16)	0.27 (0.14)	0.14 (0.14)	0.31 (0.20)
Former	-0.07 (0.16)	0.04 (0.09)	0.02 (0.14)	-0.04 (0.14)
Financial Stress	-0.06 (0.06)	0.02 (0.04)	0.04 (0.05)	0.05 (0.07)
Perceived Stress	0.02 (0.01)*	-0.01 (0.01)	0.01 (0.01)	-0.01 (0.01)
Sleep Quality	0.04 (0.02)*	0.01 (0.01)	-0.02 (0.02)	-0.04 (0.02)
Depressive Symptoms	-0.03 (0.01)*	0.01 (0.01)	-0.01 (0.01)	0.01 (0.01)

Abbreviations: CRP= C-reactive Protein; SE=Standard Error; META-HEALTH=Morehouse & Emory Team up to Eliminate Cardiovascular Health Disparities; SES=Socioeconomic status.

$p<0.05$*
$p<0.01$**