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Perceived Discrimination and Markers of Cardiovascular Risk among Low-Income African American Youth

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Abstract

Objectives—Our study examines the relationship between perceived discrimination and levels of C-reactive Protein and blood pressure in low-income youth ages 10–15 years old.

Methods—Data were collected from 10–15 year old focal children and their mothers. Face-to-face interviews were implemented to collect data on stressors including experiences of everyday discrimination from youth. High sensitivity CRP in dried blood spot samples and diastolic and systolic blood pressure were also collected at the time of the interview.

Results—Perceived discrimination among youth was significantly associated with higher levels of CRP, systolic and diastolic blood pressure. CRP, systolic, and diastolic blood pressure remained significant after controlling for age-adjusted BMI, waist circumference, and other factors.

Conclusion—Discrimination is a salient risk factor for inflammation and cardiovascular health. Early life course inflammation and cardiovascular reactivity are important candidate pathways through which the repeated exposure to discrimination for minority group members contributes to racial and economic health inequities in adulthood.

Keywords

C-reactive protein; discrimination; blood pressure; adolescent; health disparities

Introduction

Discrimination is a key factor contributing to minority health disparities (Williams and Mohammed 2013). Perceptions of discrimination among African Americans are associated with increased coronary artery calcification (Lewis et al. 2006), blood pressure (Sawyer et al. 2012; Clark 2000), carotid intima-media thickness (Troxel et al. 2003), lower birth weight offspring (Mustillo et al. 2004), and oxidative stress (Szanton et al. 2012). While these physiological pathways to poor health have been documented for adults, substantially less is known about the degree to which perceived discrimination is associated with inflammatory and cardiovascular symptoms earlier in life. The central purpose of this study, therefore, is to assess whether perceived discrimination during early adolescence places low-

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income African American youth at cardiovascular risk through systemic inflammation and elevated blood pressure.

Experiencing discrimination early in life may place youth at risk for earlier onset and more severe cardiovascular disease during adulthood, reinforcing durable racial health inequities in the United States (Fuller-Rowell, Williams, Love et al. 2013). To better understand whether the stress of discrimination is associated with adverse health early in the life course, we examined the relationship between discrimination and markers of cardiovascular and immune related inflammation in a sample of low-income, African American youth. We hypothesized that the stress of perceived discrimination is positively associated with systemic inflammation as measured by C-reactive Protein (CRP). Furthermore, because stress triggers increased sympathetic nervous system (SNS) reactivity, we next hypothesized that experiencing or perceiving discrimination is significantly positively related to systolic and diastolic blood pressure among African American youth.

Background

Few studies have examined the physiologic consequences of discrimination and unfair treatment for African American children and adolescents. There is evidence, however, that perceived discrimination among minority adolescents is related to elevated smoking (Guthrie et al. 2002), anger (Wong et al. 2003), alcohol use and abuse (Cheadle and Whitbeck 2011), depressive symptoms, general psychological distress (Sellers et al. 2006), and poorer self-rated health (Priest et al. 2011). Despite the attention given to a broad range of adolescent outcomes, the relationship between discrimination and either systemic inflammation or cardiovascular reactivity in young adolescents remains largely unexplored (Sanders-Phillips et al. 2009).

Although specific links between discrimination, inflammation, and cardiovascular reactivity in early life have not yet been examined, there is growing evidence indicating that these factors play a key role in adult health. For example, there are indications that systemic inflammation in childhood and adolescence play central roles in the progression of atherosclerosis (Groner et al. 2006). Two such potential pathways are through childhood CRP (Reinehr et al. 2006) and blood pressure (Juonala et al. 2005). Assessing the degree to which these CVD risk correlates during early adolescence are associated with the stress of discrimination is essential for understanding the early life course determinants driving inequities in minority health through adulthood.

CRP, an acute phase marker of systemic inflammation, is a protein synthesized in the liver as a downstream response to a rise in other inflammatory factors such as Interleukin-6 elevation (Slopen et al. 2013). CRP is linked to atherosclerosis and other cardiovascular risks in adulthood (Kaptoge et al. 2010). Although the causal order is not fully established (Danesh and Pepys 2009), elevated CRP during childhood predicts adult CRP (Juonala et al. 2006), high blood pressure, and abdominal obesity (Ford et al. 2005; Slopen et al. 2012; Visser 2001). Similarly, elevated childhood blood pressure is positively associated with adult atherosclerosis (Kavey et al. 2003) while elevated systolic blood pressure predicts arterial stiffness (Li et al. 2004). Taken together, these findings suggest that inflammation

and cardiovascular response are likely indicators of early life risk for the onset and progression of cardiovascular disease.

Although links between these risk factors and early discrimination exposure have yet to be fully specified, the stress of chronic exposure to adversity may affect the hypothalamic-pituitary-adrenocortical (HPA) axis, reducing efficient cardiovascular response to stress during childhood and adolescence (Pollitt et al. 2007; Evans and Kim 2007). Such stress exposure activates the SNS, leading to elevated blood pressure and hypertension, increasing the likelihood of CVD onset when chronic (Sowers, Epstein, and Frohlich 2001). In addition to the elevation of blood pressure, stress exposure stimulates the SNS, which contributes to elevation of some inflammation markers such as CRP (e.g. McKewen 1998). There is increasing evidence that an array of social stressors, including those in conjunction with discrimination, are proximate determinants of the disproportionate racial differences in cardiovascular and metabolic health outcomes among racial minorities (Williams and Mohammed 2013).

African Americans are disproportionately represented in the low income population and present higher rates of cardiovascular conditions such as hypertension while also suffering from higher cardiovascular disease mortality relative to other racial/ethnic groups (Nwankwo et al. 2013; Colhoun et al. 1998). Moreover, CRP is on average higher among African American than white adults (Khera et al. 2005). After controlling for other cardiovascular risk factors including BMI, African American women have CRP levels that are on average higher than African American males and Caucasian males and females (Khera et al. 2005). During youth, African American low SES adolescents show more arterial stiffness and intima media thickness relative to Caucasian and higher SES youth (Thurston and Matthews 2009).

Such disparities in African American health point to the need for research examining how early in the life course elevations in inflammatory markers emerge in this population leading to later cardiovascular risk. Adolescence is a particularly important period to examine changing health, as it is a time of social expansion when youth reshape and expand their social networks (e.g., Cheadle and Goosby 2012). Moreover, youth appear to be strongly reactive to social conditions as a result of neurobiological development (Steinberg 2008). Consequently adolescence may be a particularly sensitive time to the pain and frustration of experiencing discrimination (Sebastian et al. 2010). Discriminatory experiences become more common for African American youth during adolescence as they begin to spend more time in public places outside of the home (e.g. stores, schools, restaurants) increasing their exposure to discrimination (Fisher et al. 2000; Goosby and Walsemann 2012).

The goal of our study, therefore, is to examine the relationship between perceptions of discrimination among youth, ages 10–15 years old, and cardiovascular risk measured with high sensitivity CRP and blood pressure. We expect to find that discrimination is positively associated with CRP levels and both diastolic and systolic blood pressure.

Methods

Data for this study come from the Omaha Urban Research on Health Study (OURHealth Study). Low-income African American and Caucasian mothers with a focal child between the ages of 10 and 15 were recruited through health fairs. Data was collected between February and July 2013. The purpose of the study was to examine relationships between stressors, such as economic hardship, discrimination, and the manifestations of stress related illness among low-income mothers and their offspring. Mothers were included based on meeting the following criteria: (a) income at 125% or greater of the federal poverty line adjusting for household size, (b) mother's racial classification as either Black or Caucasian, (c) being born in the U.S., and (d) having a biological child between the ages of 10 and 15 years of age. The final sample included 58 mother/child dyads. For the purpose of this study, we restrict our focus to the relationships between reports of discrimination and health among offspring in the sample.¹

Upon completion of screening, separate face-to-interviews were conducted with mothers and their children. Survey data were collected on features of economic hardship, experiences of major and everyday discrimination, health histories of both mother and child, and psychosocial measures of stress. Prior to or upon completion of face-to-face interviews, up to eight drops of capillary whole blood were collected on filter paper (McDade, Williams, and Snodgrass 2007) for subsequent laboratory analysis for CRP. In addition, blood pressure and anthropometric measures of height, weight, and waist circumference were collected from participants during their session following interviews.

Measures

C-reactive protein was measured using a high sensitivity immunoassay previously validated for use with dried blood spot (DBS) samples (McDade, Burhop, and Dohnal 2004). Samples were dried overnight following collection and then sent to the Laboratory for Human Biology Research at Northwestern University where they were stored at stored at -30°C degrees, prior to analysis. For comparability with serum, estimates were converted to the equivalent serum/plasma value using the Deming regression conversion formula: serum (mg/l) = $1.84 \times \text{DBS (mg/l)}$. One case with a CRP level over 10mg/L after conversion was excluded from the analyses due to indications of acute, active infection (Pearson et al. 2003). The final CRP measure was log transformed to rescale the distribution to account for non-normality. *Systolic* and *diastolic blood pressure* measurements were obtained from participants using the Omron HEM-9070XL digital sphygmomanometer (Omron Healthcare Co, Bannockburn, Illinois). The three blood pressure measurements were taken using the dominant arm over a 15-minute period during data collection while the participants were seated. The three readings for both systolic and diastolic blood pressure were averaged and used in subsequent analyses.

¹Preliminary analyses showed no significant relationship between maternal and child reports of discrimination and maternal discrimination did not attenuate child discrimination-health relationship and was thus dropped from final analyses. Findings available upon request.

The focal independent variable in these analyses is child's *perceived discrimination* measured using a modified version of the Everyday Discrimination scale adapted for adolescents (Forman et al. 1997). The Everyday Discrimination scale appraises chronic, commonplace, and subtler forms of discriminatory experiences without priming respondents to think about race (Williams et al. 1997; Deitch et al. 2003). Although, some literature suggests that discrimination should be ascribed to a particular attribute to be considered discrimination (Major et al. 2002), the Everyday Discrimination scale is strongly associated with institutional and interpersonal racial discrimination (Hughes 2003; Krieger et al. 2005) and is accepted as a valid measure that accounts for discriminatory experiences among people of color (Seaton et al. 2008).

In this study, the questionnaire included thirteen questions regarding the child's experiences with daily discrimination. The question asked "In your day-to-day life how often have any of the following things happened to you?" followed by thirteen items including: you are treated with less courtesy than others, you are treated with less respect than others, you receive poorer service than other people at restaurants or stores, and et cetera. The response options for each question ranged from never, a few times a year, a few times a month, at least once a week, to almost every day. The items were coded with values ranging from 0 for never to 4 for almost every day and summed to create a continuous scale. After factor analysis, three items were dropped (being served poorer at a restaurant or store, people act afraid of you, and being followed around in stores) due to low loadings. The remaining items loaded on a single factor composed of child's daily discrimination, which included ten items ($\alpha = .84$).

Control variables include *age-adjusted BMI*, *waist circumference* in inches, *age* (in years), *gender* (1=female), and *mother's highest education level* (1=high school or less, 2=some college, and 3=college or higher). *Age adjusted and sex-adjusted BMI* was created using the Zanthro package in Stata, which uses standardized methods to calculate age-specific BMI z-scores for children and adolescents using U.S.-specific reference growth charts (Vidmar et al. 2004).

Statistical Analysis

All analyses were conducted using Stata version 13 (StataCorp 2013). Descriptive analyses are reported as means and standard deviations for all variables included in the analyses and reported for each analytic sample in Table 1. In the following bivariate models all measures were standardized for ease of interpretation (standard deviations). Ordinary Least-Squares (OLS) Regression analyses were used to fit the final models of each dependent variable (CRP, diastolic, and systolic blood pressure) on perceived discrimination and all control variables. Final analyses were restricted to African American youth resulting in 9 youth being dropped from the analytic sample (approximately 16%).²

²Preliminary analyses indicate that the 9 Caucasian youth in the sample systematically reported fewer incidences of discrimination and are thus a statistically different population from the African American youth. When whites were included in the analyses, the results remained similar to restricted analyses. Results available upon request.

Results

The descriptive statistics including unstandardized means and standard deviations of the sample are shown in Table 1 for both the full analytic sample and the samples with complete cases for each dependent variable. Characteristics of the full and analytic samples did not differ significantly. Average diastolic and systolic blood pressure readings in the sample were in the normal range of values of approximately 115 mmHg (SD=13.6) and 70 mmHg (SD=11.2) for diastolic blood pressure (normal systolic <120; normal diastolic <80; DHHS 2005). Youth were on average in the normal BMI range (M=24.5, SD= 5.9; normal BMI <24.9). Approximately 79% of youth in the sample were female and the average age of the sample was 12 years. Mothers had, on average, 'some college education'.

Bivariate standardized results in Table 2 and Figure 1 show evidence of significant relationships between discrimination and inflammation and blood pressure. For every standard deviation increase in discrimination reports, there is a .46 standard deviation increase in log transformed CRP. Similarly, a standard deviation increase in discrimination is associated with a .43 standard deviation increase in systolic blood pressure and a .48 standard deviation increase in diastolic blood pressure. Figure 1 pictorially presents the patterns of the reported bivariate relationships.

The multivariate models in Table 3 report results controlling for covariates that may also be associated with the dependent variables of interest. For example, youth BMI and waist circumference are associated with CRP and blood pressure in children and adolescents (Visser et al. 2001). The final models also control for adolescent sex, age, and mother's educational attainment. After accounting for these control variables, the relationships between discrimination and CRP, and between discrimination and systolic and diastolic blood pressure remain statistically significant. For CRP, the inclusion of additional covariates attenuates the discrimination coefficient by approximately 27% (b=.34, SE=.15; $p < .05$), but the relationship remains statistically significant. Similarly, the effect size for systolic blood pressure is reduced by approximately 21% in the fully estimated model (b=.34, SE=.15; $p < .05$). Finally, the relationship between discrimination and diastolic blood pressure remains statistically significant with a negligible change in coefficient magnitude relative to the bivariate models (b=.47, SE=.15; $p < .01$).

Discussion

This study provides support for the hypotheses that perceived discrimination among low-income African American youth is associated with increased systemic inflammation and blood pressure. The study is the first of its kind to demonstrate the harmful nature of discrimination for cardiovascular health risks in African American youth as early as 10 years of age. Focusing on younger populations prior to the onset of confounding predominantly adult conditions (e.g., arthritis, atherosclerosis, undetected illness, etc.) appears to hold promise for understanding the pathways through which stressors such as discrimination alter health trajectories to shape long-term health prospects (Lambert et al. 2004; Sanders-Phillips et al. 2009).

Our results support prior research reporting harmful health consequences of discrimination during childhood and adolescence and pointing to the critical need for systematic examination of these factors at early ages (Sanders-Phillips et al. 2009). There is prospective evidence that African Americans who report discrimination at ages 16–18 have higher allostatic load by age 20 (Brody et al. 2014). Our analysis compliments these prior findings by providing new evidence of the physiological consequences of perceived discrimination for African Americans in an even younger sample. These findings thus point to a potential explanatory pathway through which discrimination negatively influences African American health and illness progression: via the stress related activation of the SNS and the upregulation of immune related inflammation.

Over activation of SNS and inflammation are important pathways that may inform African American adults' disproportionately higher rates of hypertension and cardiovascular disease mortality than other racial groups (Albert et al. 2008), and greater vascular reactivity during resting state (Wyatt et al. 2003). In addition, E-selectin, a set of cell adhesion molecules expressed as part of an inflammatory response to endothelial dysfunction and strongly correlated with elevated CRP, is shown to be positively associated with chronic discrimination in African American men (Friedman et al. 2009; Ross 1999; Pasteri et al. 2000). Moreover, high levels of discrimination are associated with shortened leukocyte telomeres in African American males who report high levels of internalized racial bias in conjunction with discrimination (Chae et al. 2014)—a particularly important factor given the inverse association between telomere length and cardiovascular disease risk (Fitzpatrick et al. 2007). Finally, among both African American men and women chronic discrimination is also linked to elevated levels of the vasoconstrictor endothelin-1 (Cooper et al. 2009). Indeed, in conjunction with our results, these studies further illustrate the need for prospective systematic examinations of the discrimination-health link during childhood and adolescence.

Adolescence is also a critical time to examine the role of discrimination for youth because teens are aware of their social standing during this period. Although there is a growing literature documenting racial discrimination associations with psychological outcomes, less is known about risky or protective psychosocial mechanisms that might offset or exacerbate youth *physiological* stress outcomes. For example, during adolescence relationships between discrimination and higher levels of depressive symptoms, anger (Wong et al. 2003), and psychological distress (Fisher et al. 2000) may be offset by adaptive coping strategies such as positive racial identity (Sellers 2006). Positive racial identity or the degree to which one attaches high importance and meaning attributed to racial classification (Sellers et al. 1998) is shown to moderate the impact of discrimination exposure on autonomic stress response in young adults (Neblett and Roberts 2013). Future studies should also consider the roles of individual personality characteristics including self-esteem (Utsey et al. 2000), rejection sensitivity (London et al. 2007), and negative affectivity that may either mediate or moderate stress reactivity to the discrimination. Incorporating measures of potential protective mechanisms that may offset the harmful physiological consequences of discrimination exposure for progression of cardiovascular disease risk in African American adolescents would be beneficial to future work in this area. This area of exploration may

likely hold clues in helping minority youth deal adaptively with such negative experiences given that racial discrimination remains pervasive and implicit bias against blacks among white Americans is endemic (Schmidt and Nosek 2010).

This study is not without limitations. First, our sample is small and consists largely of female youth. There is, however, little evidence that baseline measures of CRP or blood pressure differ among boys and girls in the age range assessed here after accounting for adiposity and oral contraceptive use (Cook et al. 2000; Lambert, Delvin, Paradis, et al. 2004). However, larger more sex-balanced studies are required to attempt to generalize our results to a larger population. Second, the study is cross-sectional. Prospective, longitudinal data on both discrimination experiences and cardiovascular markers of health are needed. Third, this study specifically targeted woman who were low income and recruited through health fairs. Thus, our sample may include mother/child dyads with worse average health and in need of health care for themselves and/or for their child. Future research employing random selection of more economically diverse samples from known populations needed (Falk et al. 2013). Relatedly, the sample is geographically bound to a large, highly segregated mid-western city. More diverse samples are needed to assess generalizability across places.

Finally, we were unable to distinguish the impact of racial attribution of discrimination with these data. Racial discrimination is thought to be a qualitatively different type of discriminatory experience relative to other types of discrimination, such as gender (Chae et al. 2010). Because adolescence is a tumultuous developmental period where youth become highly cognizant of social ties and relationships, they become more psychologically and physiologically reactive to exclusionary experiences (Cheadle and Goosby 2012). Discriminatory experiences for black youth may in fact be exacerbated and more harmful during this developmental period, but more research is required to understand whether attribution to racial discrimination is as harmful to health as the scalar measurement of non-attributed discrimination.

Despite these limitations, this study moves beyond prior adolescent discrimination research by assessing manifestations of cardiovascular disease risk indicators in early adolescence among disadvantaged youth. These findings support the proposition that discrimination is harmful for cardiovascular disease risk on health early in life, at least for disadvantaged African American female adolescents. Thus, this study provides foundational evidence of the harmful health impacts of discrimination during the early life course and points to a need for ongoing research over longer timelines and with more heterogeneous samples. Assessing the degree to which the physiological consequences of perceived discrimination are exhibited in early life may be essential for understanding racial health inequalities in the U.S., particularly for systemically marginalized groups such as African Americans.

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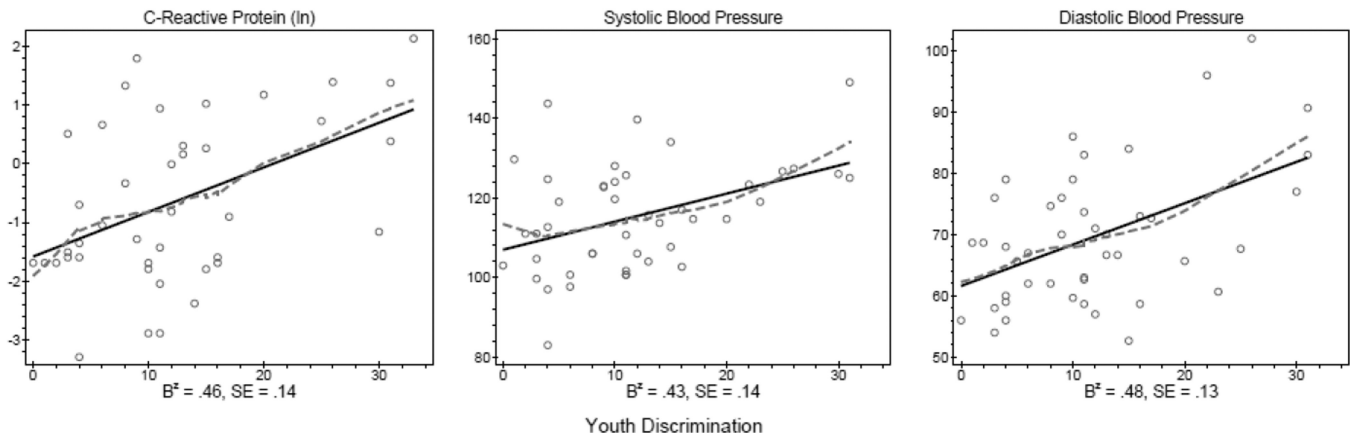


Figure 1.
Bivariate Distribution of CVD Risk Markers Regressed on Youth Discrimination
Note: Standardized coefficients reported.

Table 1

Sample Descriptive Statistics

	Obs	Total Sample					CRP ^a		Systolic BP ^b		Diastolic BP ^c	
		Mean	[SD]	Min	Max	Mean	[SD]	Mean	[SD]	Mean	[SD]	
<i>Dependent Variables</i>												
CRP	42	1.33	[1.83]	0.04	8.52	1.26	[1.84]					
Systolic BP	45	114.90	[13.65]	83.00	149.00			114.84	[13.43]			
Diastolic BP	45	69.47	[11.19]	52.70	102.00					69.24	[11.21]	
<i>Independent Variable</i>												
Daily Discrimination	46	12.33	[8.61]	0.00	33.00	12.18	[8.77]	11.72	[8.28]	11.72	[8.28]	
<i>Controls</i>												
Age-Adjusted BMI	47	24.45	[5.94]	15.00	42.70	24.14	[6.00]	23.95	[5.77]	23.95	[5.77]	
Waist Circumference	47	81.16	[14.79]	61.00	124.00	81.06	[15.41]	80.41	[13.75]	80.41	[13.75]	
Age	47	12.32	[1.64]	10.00	15.00	12.40	[1.60]	12.33	[1.57]	12.33	[1.57]	
Female	47	0.79		0.00	1.00	0.78		0.77		0.77		
Mothers Education	46	2.11	[0.71]	1.00	3.00	2.08	[0.66]	2.09	[0.68]	2.09	[0.68]	

Note: All measures [except Female] are standardized for analyses. Table represents unstandardized values.

Analytic sample sizes:

^a 40;

^b 43;

^c 43

Table 2

Bivariate Regression Analyses of Youth Health Markers on Discrimination

	CRP		Systolic BP		Diastolic BP	
	β	[SE]	β	[SE]	β	[SE]
Daily Discrimination	0.46	** [.14]	0.43	** [.14]	0.48	*** [.13]
Observations	41		44		44	

Note: Standardized OLS coefficients b and standard errors [SE] are shown.

* p .05,

** p .01,

*** p .001

Table 3
Multivariate Regression Analyses of Youth Health Markers on Discrimination

	CRP		Systolic BP		Diastolic BP	
	β	[SE]	β	[SE]	β	[SE]
Daily Discrimination	0.34 *	[.15]	0.34 *	[.15]	0.47 **	[.15]
<i>Controls</i>						
Age-Adjusted BMI	0.28	[.29]	0.11	[.27]	-0.01	[.27]
Waist Circumference	0.24	[.24]	-0.06	[.25]	0.02	[.26]
Age	-0.06	[.18]	0.17	[.16]	-0.03	[.17]
Female	0.20	[.36]	-0.81 *	[.37]	-0.31	[.37]
Mother's Education	-0.10	[.19]	0.23	[.16]	0.18	[.17]
Observations	40		43		43	

Note: Standardized OLS coefficients b and standard errors [SE] are shown.

* p .05,

** p .01