Jackson Heart Study

Discrimination and Hypertension Risk Among African Americans in the Jackson Heart Study

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Abstract—African Americans have a higher risk of hypertension compared with other racial or ethnic groups in the United States. One possible explanation for this disparity is discrimination. Few studies have examined the association between discrimination and incidence of hypertension. We examined whether everyday discrimination, lifetime discrimination, and stress from discrimination were associated with incident hypertension and whether these associations differed by gender, age, discrimination attribution, and coping responses to discrimination among African Americans in the Jackson Heart Study. Discrimination was self-reported by 1845 African Americans aged 21 to 85 years without hypertension at baseline (2000–2004). Participants completed 2 follow-up study visits from 2005 to 2008 and 2009 to 2013. We used Cox proportional hazards regression to estimate associations of discrimination with incident hypertension. Overall, 52% (n=954) of the participants developed hypertension over the follow-up period. After adjustment for age, gender, socioeconomic status and hypertension risk factors, medium versus low levels of lifetime discrimination (hazard ratio, 1.49 [95% CI, 1.18–1.89]), and high versus low levels of lifetime discrimination (hazard ratio, 1.34 [95% CI, 1.07– 1.68) were associated with a higher incidence of hypertension. No statistically significant interactions with gender, age, attribution, or coping were present. Higher stress from lifetime discrimination was associated with higher hypertension risk after adjustment for demographics (hazard ratio for high versus low, 1.19 [95% CI, 1.01–1.40]), but the association was attenuated after adjustment for hypertension risk factors (hazard ratio, 1.14 [95% CI, 0.97-1.35]). Lifetime discrimination may increase the risk of hypertension in African Americans. (Hypertension. 2020;76:715-723. DOI: 10.1161/HYPERTENSIONAHA.119.14492.) • Data Supplement

Key Words: African American ■ coping ■ discrimination ■ hypertension ■ Jackson Heart Study

There are well-documented racial disparities in hypertension morbidity and mortality, with African Americans faring worse than other racial and ethnic groups in the United States. Although several risk factors (eg, smoking, alcohol use, obesity, physical activity) have been associated with hypertension, they do not appear to fully explain racial differences, suggesting that other risk factors may contribute. 3-5

Discrimination is a chronic stressor that has been posited to contribute to adverse health outcomes, including hypertension.^{4,6-12} Discrimination may directly impact hypertension via the stress pathway, activating the sympathetic nervous system and hypothalamic-pituitary-adrenal axis.^{6,8,10,13} Discrimination may also lead to the development of hypertension through unhealthy behaviors, such as unhealthy eating or sedentary lifestyles, that may serve as a coping mechanism for the stress arising from discrimination.^{14,15}

Research on discrimination and blood pressure/hypertension^{8,9,11,16} has consisted mostly of cross-sectional studies. One large study of African American women found no associations of discrimination with incident hypertension.¹⁷ A second study

of white, African American, Hispanic, Chinese, and Japanese women found that everyday discrimination was associated with larger increases in diastolic and systolic blood pressure over time but was not associated with incident hypertension. ¹⁸ Additional longitudinal studies in large population-based samples are needed to determine whether discrimination is a contributor to hypertension in African Americans.

Discrimination comprises both discrete life events and daily hassles, but few studies have examined the roles of both aspects of discrimination in a large African American sample. ¹⁹ Furthermore, the health impact of discrimination may vary according to the individual's gender and age. ^{9,20} The double minority status of women who are also racial minorities, may result in stronger effects of discrimination in African American women than in African American men. ^{21–24} There is evidence supporting differential effects of discrimination by age, with one study showing an association of lifetime discrimination with higher blood pressure in older, but not younger age groups. ²⁵

Discrimination may also have differential impacts on hypertension based on the reason for discrimination

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(henceforth referred to as discrimination attribution)²² and coping strategies.²⁶ It has been suggested that discrimination attributed to racial factors may be a more intense form of discrimination affecting African Americans.²⁷ In addition, discrimination-specific coping responses have been posited to reduce the effects of discrimination.²⁸

The Jackson Heart Study (JHS), provides an opportunity to investigate the longitudinal associations of multiple measures of discrimination with hypertension incidence among a large population-based sample of African Americans.

Methods

The JHS data and materials can be requested from the JHS Committee at https://www.jacksonheartstudy.org/Research/Study-Data/Data-Access

The JHS is a prospective cohort study of cardiovascular disease among noninstitutionalized African Americans residing in the tri-county areas of Jackson Mississippi (Hinds, Madison, Rankin). Participants (21–95 years of age) were recruited from the Atherosclerosis Risk in Communities (ARIC) study (31% of the sample); a commercially available list (Accudata Integrated Marketing) of households (17%); a community random sample of volunteers (30%); and the adult family members of Atherosclerosis Risk in Communities (ARIC) study participants or volunteer participants (22%). Additional details are described elsewhere. ²⁹⁻³¹

Information on demographics, risk factors, medication use, behaviors, anthropometry, and psychosocial factors was obtained via in-home interviews, self-administered questionnaires, and inclinic examinations. Participants were enrolled (N=5306) during baseline, henceforth referred to as visit 1 (2000–2004). Follow-up data were collected at visit 2 (2005–2008, 79.2% of visit 1 participants retained) and visit 3 (2009–2013, 90.8% of visit 2 participants retained). The study protocol was approved by the institutional review boards of the University of Mississippi Medical Center, Jackson State University, and Tougaloo College. Participants provided written informed consent. Page 10 (2009–2013)

Two measures of discrimination were obtained at visit 1, everyday discrimination, and lifetime discrimination. The Everyday Discrimination Scale (Cronbach's α =0.88)³² captured how often participants experienced recurrent episodes of unfair treatment in 9 domains (Table S1 in the Data Supplement).³³ Everyday discrimination was assessed using the mean of the response scores (ranging from 1 to 7). Everyday discrimination was categorized into tertiles to determine whether threshold effects were present.

The Lifetime Discrimination Scale (Cronbach's α =0.78)³² captured the lifetime occurrence (yes/no) of unfair treatment across 9 domains (Table S1). Lifetime discrimination was assessed using the count of the domains (ranging from 0 to 9) for which unfair treatment was reported. ^{21,24} Due to the skewed distribution of the values, lifetime discrimination was divided into three categories (low: no discrimination, medium: values from 1 to 3, high: values \geq 3). Evidence suggests that stress may play a key role in the health outcomes arising from discrimination.^{7,10} Therefore, perceived stressfulness of lifetime discrimination³² was assessed among respondents who reported at least one experience of lifetime discrimination (very stressful versus moderately or not stressful; Table S1).

Participants were also asked to answer two separate questions indicating the main reason (ie, age, gender, race, height, weight, other) for reported experiences of everyday discrimination and lifetime discrimination (Table S1).

Participants who reported experiencing everyday discrimination were asked to identify the strategy that they most commonly used to cope with discrimination from a list of 12 strategies (Table S1). The responses were used to assign each participant to one of three coping styles: active coping (speak up, try to change, work harder to prove them wrong, or pray); passive coping (accept it, ignore it, keep it to yourself, avoid it, or forget it); and external/other coping (blame yourself, get violent or other; Table S1). Participants who reported lifetime discrimination were asked to identify which

of the 12 coping strategies they used. We created an average score (continuous) based on the number of coping strategies used by each participant within each coping style. Analyses of coping with everyday and lifetime discrimination were limited to passive and active coping styles because of the small number of reports of the external coping style.

Participants were defined as having hypertension if they were taking antihypertensive medication or had a systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg at follow-up visits 2 or 3. Blood pressure measurements were obtained from trained staff using a Hawksley random-zero sphygmomanometer (Hawksley & Sons Ltd, Lansing, Sussex, United Kingdom) at visit 1 and visit 2 and a semiautomatic oscillometric device (Omron HEM-907XL, Omron Healthcare, Inc, Lake Forest, Il) at visit 3 administered on the right arm of participants after 5 minutes of sitting in an upright position with their legs uncrossed and feet flat on the floor. Two blood pressure measurements were obtained 1 minute apart and the average of the 2 measurements was calculated for each study visit. The blood pressure measurements obtained using the random-zero sphygmomanometer were calibrated to the semi-automatic oscillometric device. 34,35 The use of antihypertensive medication was self-reported by participants.

Age (continuous), gender, and socioeconomic status (captured by level of education, income, and occupation) were included as potential confounders.⁷ Educational attainment was based on visit 1 self-report of years of schooling completed: (1) less than high school diploma; (2) high school graduate/general equivalency diploma; and (3) vocational school, trade school or college graduate. Income based on family income, family size and poverty level was categorized as: (1) poor (< poverty level); (2) lower-middle (1−1.5× the poverty level); (3) upper-middle (>1.5−<3.5× the poverty level); (4) affluent (≥3.5× the poverty level); and (5) unknown. Occupation was coded as (1) managerial/professional; (2) service; (3) sales; (4) construction; (5) production; and (6) other (farming, fishing, forestry, military, sick, unemployed, retired, other).

Hypertension risk factors were included as potential mediators or confounders. Visit 1 measures included body mass index (continuous, weight in kilograms divided by height in meters squared); cigarette smoking (current, former, never); alcohol consumption (≤7 drinks/wk, >7 drinks/wk); dietary intake (score based on intake of fruits and vegetables: ≥4.5 cups/day, fish: >3.5 ounces, twice/wk, sodium: <1500 mg/day, sugary beverages: <450 kcal/wk, and whole grains: ≥3 servings/day; categorized as poor: 0-1 component and intermediate/ideal: 2–5 components)³⁶; and physical activity (<150 minutes of moderate physical activity and <75 minutes of vigorous physical activity, ≥150 minutes of moderate physical activity and ≥75 minutes of vigorous physical activity. Separate tests for interaction by gender, age (continuous and dichotomized: <median age and ≥median age), discrimination attribution and coping responses were performed.

The distribution of covariates at visit 1 was examined within categories of hypertension development and discrimination. The proportion of participants who developed hypertension and the age-adjusted rates of hypertension were calculated. Participants who did not develop hypertension were censored at their last visit. The adjusted hazard ratios (HR) and 95% CI for the associations between discrimination (at visit 1) and incident hypertension (at visit 2 or visit 3) were calculated using Cox proportional hazards regression.

The first model was adjusted for age, gender, and socioeconomic status. Hypertension risk factors were added in a second model. Interaction terms were also included in the fully adjusted models to assess effect modification by gender, age, discrimination attribution, and coping responses. Analyses of discrimination attribution and coping responses were restricted to those who reported any everyday discrimination or any lifetime discrimination. Analyses were performed using Statistical Analysis Software (SAS version 9.4; SAS Institute, Inc, Cary NC).

Table 1. Distribution of Visit 1 Characteristics of JHS Participants by Incident Hypertension Status

	Total n=1845	Did Not Develop Hypertension n=891	Developed Hypertension n=954		
	% or Mean±SD	% or Mean±SD	% or Mean±SD	P Value*	
Age	49.2±12.0	46.4±11.9	51.9±11.4	<0.0001	
Gender				0.22	
Women	61.1	59.7	62.5		
Education				0.0002	
<high diploma<="" school="" td=""><td>11.6</td><td>9.1</td><td>14.0</td><td></td></high>	11.6	9.1	14.0		
High school diploma/GED	15.9	14.1	17.5		
Vocational school/trade school/college	72.5	76.8	68.5		
Income				0.04	
Poor	10.6	11.8	9.4		
Lower-middle	16.8	14.9	18.6		
Upper-middle	27.2	27.1	27.3		
Affluent	30.8	32.8	29.0		
Missing	14.6	13.4	15.7		
Occupation				0.04	
Managerial/professional	42.2	43.2	41.2		
Service	18.7	16.6	20.8		
Sales	19.2	21.4	17.2		
Construction	6.3	6.6	6.0		
Production	12.7	11.3	13.9		
Other	0.9	0.9	0.9		
Body mass index, kg/m ²	30.7±7.2	29.8± 6.7	31.5±7.4	< 0.0001	
Smoking status				0.001	
Current	12.9	10.3	15.4		
Former	13.8	12.7	14.8		
Never	73.3	77.0	69.8		
Alcohol consumption				0.55	
≤7 drinks/wk	92.9	93.3	92.6		
>7 drinks/wk	7.1	6.7	7.4		
Diet				0.59	
0-1 component	66.6	66.0	67.2		
2–5 components	33.4	34.0	32.8		
Physical activity				0.0004	
Moderate <150 and vigorous <75 min	77.2	73.6	80.5		
Moderate ≥150 and vigorous ≥75 min	22.8	26.4	19.5		
Everyday discrimination [†]				0.47	
Low: 1.00–1.56	33.1	32.5	33.7		
Medium: 1.66–2.44	33.9	33.2	34.6		
High: 2.55–6.89	33.0	34.3	31.7		
Everyday discrimination attribution [‡]				0.19	
Age	9.9	9.0	10.8		
Gender	8.3	8.6	8.0		

(Continued)

Table 1. Continued

	Total n=1845	Did Not Develop Hypertension n=891	Developed Hypertension n=954				
	% or Mean±SD	% or Mean±SD	% or Mean±SD	P Value*			
Race	49.7	51.3	48.3				
Height or weight	3.7	2.7	4.6				
Other reason	28.4	28.4 28.4 28.3					
Coping with everyday discrimination§							
Active	67.8	69.2	66.5				
Passive	32.2	32.2 30.8 33.5					
Lifetime discrimination							
Low: 0.00-0.00	12.0	13.6	10.5				
Medium: 1.00-2.00	29.1	27.7	30.4				
High: 3.00-9.00	58.9 58.7 59.1		59.1				
Stress from lifetime discrimination ¹							
Very stressful	20.5	17.5	23.2				
Moderately stressful	58.1	58.1 61.4 55.2					
Not stressful	21.4	21.1	21.6				
Lifetime discrimination attribution [‡]				0.57			
Age	5.5	5.6	5.4				
Gender	6.4	6.4 5.6					
Race	62.7	63.8	61.6				
Height or weight	1.5	1.2	1.8				
Other reason	23.9	23.8	24.0				
Coping with lifetime discrimination§							
Active	0.66±0.31	0.66±0.32	0.66±0.31	0.99			
Passive	0.38±0.32	0.38±0.31	0.39±0.32	0.41			

GED indicates general equivalency diploma; and JHS, Jackson Heart Study.

"Stress from lifetime discrimination was restricted to participants who reported at least one instance of lifetime discrimination (total: n=1617; no hypertension: n=765; yes hypertension: n=852. Among the 1624 who reported at least one instance of lifetime discrimination, 7 were missing stress from lifetime discrimination).

*Discrimination attribution was restricted to those who reported everyday discrimination (total: n=1606; no hypertension: n=780; yes hypertension: n=826) or lifetime discrimination (total: n=1612; no hypertension: n=766; yes hypertension: n=846).

[§]Coping with everyday discrimination was restricted to participants who reported at least one instance of everyday discrimination and reported active or passive coping (total: n=1570; no hypertension: n=761; yes hypertension: n=809). Coping with lifetime discrimination was restricted to those who reported lifetime discrimination and reported active or passive coping (total active: n=1620; no hypertension: n=769; yes hypertension: n=851; total passive: n=1611; no hypertension: n=766; yes hypertension: n=845).

Results

Among the 5306 participants enrolled at visit 1, 2998 were excluded from the analyses because they were missing blood pressure measurements (n=2) or had prevalent hypertension (n=2996) at visit 1. Participants excluded for having hypertension at visit 1 reported higher levels of discrimination than participants without hypertension at visit 1. Among the remaining 2308 participants without hypertension at visit 1, participants who did not attend both follow-up visits 2 and 3 (n=321) and participants who were missing one or more of the discrimination measures or covariates (n=142) were

also excluded. This left a total of 1845 JHS participants available for analyses.

Over the follow-up period, 954 (52%) participants developed hypertension. Compared with participants who did not develop hypertension, those who developed hypertension were older, less likely to be college-educated, had a higher body mass index, were more likely to be current or former smokers, and engaged in less physical activity (Table 1). Participants reporting high everyday discrimination were more likely than those reporting low everyday discrimination to be younger, men, more educated, and have an unhealthy

 $^{^*}P$ values based on χ^2 and t tests.

[†]Median (25th and 75th percentiles): 2.00 (1.44 and 2.78).

Median (25th and 75th percentiles): 3.00 (2.00 and 5.00).

Table 2. Distribution of Visit 1 Characteristics of JHS Participants by Categories of Discrimination

	Everyday Discrimination*			Lifetime Discrimination [†]			Stress From Lifetime Discrimination‡	
	Low n=611	Medium n=626	High n=608	Low n=221	Medium n=537	High n=1087	Not Stressful/ Moderately Stressful n=1285	Very Stressful n=332
	% or Mean±SD	% or Mean±SD	% or Mean±SD	% or Mean±SD	% or Mean±SD	% or Mean±SD	% or Mean±SD	% or Mean±SD
Age	51.8±12.9	49.2±11.7	46.6±10.6	51.3±14.1	48.8±12.8	49.0±11.0	48.6±11.7	50.3±11.4
Gender	,						,	
Women	64.7	61.3	57.4	62.0	67.2	58.0	58.8	68.6
Education	'							1
≤High school diploma	35.0	22.0	25.7	48.9	33.2	20.4	23.3	30.1
Income	'						'	
Poor	12.0	7.7	12.2	17.2	10.8	9.1	8.2	15.4
Occupation								
Construction	18.7	17.4	21.7	10.4	5.4	5.9	6.1	4.5
Body mass index, kg/m²	30.3±6.6	30.6±7.2	31.2± 7.6	30.4±7.4	30.5±6.9	30.8±7.2	30.5±6.9	31.4±7.8
Smoking status								J.
Current	11.0	12.5	15.5	12.2	12.3	13.4	12.4	15.4
Alcohol consumption	n	ı	ı	ı				I
>7 drinks/wk	5.9	6.6	8.9	5.4	6.5	7.7	6.9	8.7
Diet								
0-1 component	64.3	67.9	67.6	66.1	67.8	66.2	66.0	69.0
Physical activity		,						
Moderate <150 and vigorous <75 min	79.7	75.2	76.6	79.2	80.5	75.2	76.0	81.3

GED indicates general equivalency diploma; and JHS, Jackson Heart Study.

Everyday discrimination is the mean of 9 items with scored responses from 1 to 7: low: 1.00-1.56; medium: 1.66-2.44; high: 2.55-6.89.

*Stress from lifetime discrimination was restricted to participants who reported at least one instance of lifetime discrimination (total: n=1617; no hypertension: n=765; yes hypertension: n=852. Among the 1624 who reported at least one instance of lifetime discrimination, 7 were missing stress from lifetime discrimination).

lifestyle profile (Table 2). Similar patterns were observed comparing participants who reported high versus low lifetime discrimination. Participants who reported more stress from lifetime discrimination were more likely to be older, and to engage in unhealthy behaviors than those reporting less stress from lifetime discrimination (Table 2). Everyday discrimination was moderately correlated with lifetime discrimination (Spearman correlation coefficient r_s =0.40, P<0.0001). Stress from lifetime discrimination was weakly correlated with everyday and lifetime discrimination (r_s =0.07, P=0.003 and r_s =0.09, P=0.0003, respectively).

There were no consistent dose-response trends in the association of everyday discrimination with age-adjusted incident hypertension for men or women. However, in both men and women, those reporting one or more domains for lifetime discrimination had higher age-adjusted incidence rates of hypertension than those reporting no lifetime discrimination. Higher stress from lifetime discrimination was associated

with higher age-adjusted incidence of hypertension for both men and women (Table 3).

Everyday discrimination was not associated with incident hypertension after adjustment for age, gender, and socioeconomic status (Table 4, model 1) or after additional adjustment for hypertension risk factors (Table 4, model 2). Lifetime discrimination was associated with incident hypertension (medium versus low: HR, 1.49 [95% CI, 1.18–1.89] and high versus low: HR, 1.34 [95% CI, 1.07–1.68]; Table 4, model 2). However, gender-stratified analyses (Table 4) showed that the associations were present in women, but not in men, although the test for interaction was not statistically significant (*P*=0.19).

Higher stress from lifetime discrimination was associated with higher risk of hypertension (HR for high versus low, 1.19 [95% CI, 1.01–1.40]) after adjustment for age, gender, and socioeconomic status (Table 4, model 1). The associations with stress from discrimination were weakened and no longer statistically significant (HR, 1.14 [95% CI, 0.97–1.35]) after

[†]Lifetime discrimination is the count of 9 items: low: 0.00-0.00; medium: 1.00-2.00; high: 3.00-9.00.

Table 3. Proportions and Age-Adjusted Rates of Hypertension Among JHS Participants by Categories of Discrimination

	Women				Men			
	N of Incident Hypertension Cases	Proportion Developing Hypertension	Total Person- Years of Follow-Up	Hypertension Rate per 100 Person-Years (95% CI)	N of Incident Hypertension Cases	Proportion Developing Hypertension	Total Person- Years of Follow-Up	Hypertension Rate per 100 Person-Years (95% CI)
Everyday discrimination		,						
Low: 1.00-1.56	214	0.54	2574	7.7 (6.8–8.6)	108	0.50	1440	6.8 (5.7–8.1)
Medium: 1.66-2.44	217	0.56	2587	8.3 (7.4–9.2)	113	0.47	1662	6.5 (5.5–7.7)
High: 2.55-6.89	165	0.47	2439	7.1 (6.2–8.1)	137	0.53	1781	8.0 (7.0–9.2)
Lifetime discrimination								,
Low: 0.00-0.00	61	0.44	915	5.6 (4.3-7.2)	39	0.46	572	6.6 (5.0-8.6)
Medium: 1.00-2.00	202	0.56	2402	8.2 (7.3–9.2)	88	0.50	1202	7.1 (6.0–8.5)
High: 3.00-9.00	333	0.53	4284	7.7 (7.0–8.4)	231	0.50	3110	7.3 (6.6–8.2)
Stress from lifetime discrimi	nation							,
Not stressful/moderately stressful	394	0.52	5125	7.6 (7.0–8.3)	260	0.49	3622	7.1 (6.4–7.9)
Very stressful	140	0.61	1533	8.9 (7.8–10.2)	58	0.57	668	8.0 (6.5–10.0)

JHS indicates Jackson Heart Study.

adjustment for hypertension risk factors (Table 4, model 2). There was also no interaction with gender (P=0.98).

There were no statistically significant (P<0.05) interactions with age (continuous: everyday, P=0.40; lifetime, P=0.11; stress, P=0.84 and dichotomized: everyday, P=0.89; lifetime, P=0.09; stress, P=0.87), discrimination attribution (everyday, P=0.26; lifetime, P=0.75; stress, P=0.64), or coping (everyday, active versus passive: P=0.41; lifetime, active: P=0.31, passive: P=0.91; stress, active: P=0.44, passive: P=0.13; Table 4).

Discussion

Discrimination has been hypothesized to contribute to racial disparities in hypertension, but previous studies focusing on discrimination and hypertension have been mostly cross-sectional, used limited discrimination measures, and often included small samples. 9,11,16 We used data from a large population-based sample with detailed measures of discrimination and objectively assessed hypertension to examine the relationship between discrimination (everyday, lifetime, stress from lifetime discrimination) and incident hypertension, as well as heterogeneity in this association by gender, age, discrimination attribution, and coping style.

In the current study, there was an association of incident hypertension with lifetime discrimination, but not with everyday discrimination. Participants who reported high and medium versus low lifetime discrimination had a higher risk of hypertension. This association persisted after adjustment for hypertension risk factors. Higher stress resulting from lifetime discrimination was also associated with incident hypertension, although the association was attenuated and no longer significant after adjustment for hypertension risk factors. In gender-stratified analyses, point estimates suggested that the association of incident hypertension with lifetime discrimination was stronger in women than in men and the association was only statistically significant in

women. However, there was no statistically significant effect modification by gender. There was also no effect modification by age, discrimination attribution, or coping style.

Reviews of studies of the association of discrimination with blood pressure or hypertension^{4,8–12,16,37–40} have reported mixed findings from mostly cross-sectional studies. Previous cross-sectional analyses of JHS data did not find an association between everyday discrimination and prevalent hypertension, but greater lifetime discrimination was associated with higher prevalence of hypertension.⁷ Our analyses extended these findings to a longitudinal setting and demonstrated that lifetime discrimination was also associated with incident hypertension. Like prior work,⁷ point estimates suggested that associations were stronger in women than in men. However, tests for interaction with gender were not statistically significant.

Only 2 longitudinal studies have examined discrimination (everyday and lifetime) and incident hypertension. Moody et al¹⁸ found that everyday discrimination did not predict incident hypertension risk among a sample of white, African American, Latino, and Asian middle-aged women. Cozier et al¹⁷ found no association between discrimination (everyday, lifetime) and incident hypertension in a large sample of African American women, although they found limited evidence of associations between everyday discrimination and incident hypertension among women born outside of the United States.

A major advantage of our study over Cozier et al¹⁷ is the use of objectively assessed hypertension. In contrast to the study by Moody et al,¹⁸ we included a large sample of African American men and women and investigated a measure of lifetime discrimination. The everyday discrimination scale captures minor day-to-day occurrences of discrimination, which may be more likely to affect short-term changes in blood pressure. Detecting these effects may require ambulatory blood pressure monitoring. In contrast, the lifetime discrimination scale captures major occurrences of lifetime exposure to discrimination that may better

Model 1* HR (95% CI) Model 2[†] HR (95% CI) **Overall** Women Men Overall Women Men Everyday discrimination Low: 1.00-1.56 (ref) 1.00 1.00 1.00 1.00 1.00 1.00 Medium: 1.66-2.44 1.09 (0.93-1.28) 1.16 (0.95-1.41) 1.00 (0.76-1.31) 1.08 (0.92-1.26) 1.06 (0.85-1.32) 1.10 (0.80-1.53) High: 2.55-6.89 1.07 (0.90-1.26) 0.96 (0.77-1.18) 1.27 (0.98-1.66) 1.02 (0.86-1.20) 0.85 (0.67-1.08) 1.31 (0.95-1.81) Lifetime discrimination Low: 0.00-0.00 (ref) 1.00 1.00 1.00 1.00 1.00 1.00 Medium: 1.00-2.00 1.47 (1.16-1.85) 1.67 (1.24-2.25) 1.19 (0.81-1.76) 1.49 (1.18-1.89) 1.73 (1.29-2.34) 1.10 (0.74-1.63) High: 3.00-9.00 1.38 (1.10-1.72) 1.51 (1.13-2.02) 1.20 (0.84-1.72) 1.34 (1.07-1.68) 1.47 (1.10-1.96) 1.09 (0.76-1.56) Stress from lifetime discrimination Not stressful/moderately 1.00 1.00 1.00 1.00 1.00 1.00 stressful (ref)

1.13 (0.84-1.53)

1.14 (0.97-1.35)

1.21 (0.99-1.47)

Table 4. HRs of Incident Hypertension by Categories of Discrimination Among JHS Participants

1.19 (1.01-1.40) BMI indicates body mass index; HR, hazard ratio; and JHS, Jackson Heart Study.

*Model 1: Adjusted for age, gender, education, income, and occupation.

Very stressful

†Model 2: Adjusted for model 1 + BMI, smoking, alcohol, diet, and physical activity.

capture long-term cumulative exposures, and hence may be more likely to have detectable effects on a chronic outcome like incident hypertension.41

Consistent with other studies, we did not find that discrimination attribution modified the association of discrimination with hypertension.^{7,42} Some cross-sectional studies suggest that active coping strategies (vis-a-vis passive coping) mitigate the impact of discrimination on high blood pressure, 21,24 whereas, other cross-sectional studies have found that active coping exacerbates the association. 43,44 Coping style (passive or active) did not moderate the association between discrimination and incidence of hypertension in our study. Additional studies that examine the role of coping are warranted.

Our study included African Americans residing in Mississippi, which may limit the generalizability to other locations. It is possible that the participants who were included in the study represent a selected sample of persons who had survived to middle or old age without developing hypertension. If this group is less likely to develop hypertension for other reasons, they could be less vulnerable to the hypertensive effects of discrimination. Given likely exposures to discrimination over the life course, it is possible that discrimination had an impact on the development of hypertension for those who already had hypertension at visit 1 and were excluded from these analyses. These factors could have resulted in an underestimate of the true association of discrimination with incident hypertension in our analyses.

Our study relied solely on self-reported data on discrimination. Discrimination was also measured at a single time point, which limits the ability to capture changes in discrimination experiences. Our analyses used hypertension incidence as the outcome, but it is possible that ambulatory blood pressure measurements may be better suited to detect any effects of discrimination on blood pressure.8

Consistent with the weathering hypothesis,⁴⁵ the association between greater lifetime discrimination and increased risk of hypertension may reflect the impact of cumulative exposure to stressors over the life course and the physiological reactions to stress that contribute to poor health outcomes. However, the unique effects of stress from lifetime discrimination cannot be determined since additional stressors were not controlled for in the analyses. Thus, confounding by other stressors remains a possibility. Moreover, some of the hypertension risk factors that we controlled for (such as health behaviors and body mass index) could themselves be the result of discrimination.

1.16 (0.95-1.42)

1.18 (0.88-1.60)

Perspectives

Our results suggest that discrimination is a chronic stressor that may increase the risk of hypertension. Future studies should measure discrimination at different time points to capture the impact that dynamic changes in unfair treatment may have on hypertension risk, and measure additional moderators, such as racial residential segregation and social support, to better understand how psychosocial resources may mitigate and modify the impact of discrimination on hypertension. Finally, additional studies with African Americans in other regions of the United States are warranted to confirm the findings in this study. Findings from this study have important implications for future research on health disparities and are important to the design of interventions and policies aimed at reducing the negative health effects of discrimination.

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Disclosures

None.

References

- Hertz RP, Unger AN, Cornell JA, Saunders E. Racial disparities in hypertension prevalence, awareness, and management. *Arch Intern Med*. 2005;165:2098–2104. doi: 10.1001/archinte.165.18.2098
- Carnethon MR, Pu J, Howard G, Albert MA, Anderson CAM, Bertoni AG, Mujahid MS, Palaniappan L, Taylor HA Jr, Willis M, et al; American Heart Association Council on Epidemiology and Prevention; Council on Cardiovascular Disease in the Young; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; Council on Functional Genomics and Translational Biology; and Stroke Council. Cardiovascular health in African Americans: a scientific statement from the American Heart Association. Circulation. 2017;136:e393–e423. doi: 10.1161/CIR.000000000000000534
- Balfour PC, Rodriguez CJ, Ferdinand KC. The role of hypertension in race-ethnic disparities in cardiovascular disease. Curr Cardiovasc Risk Rep. 2015;9:18. doi: 10.1007/s12170-015-0446-5
- Williams DR, Neighbors H. Racism, discrimination and hypertension: evidence and needed research. Ethn Dis. 2001;11:800–816.
- Hicken MT, Lee H, Morenoff J, House JS, Williams DR. Racial/ethnic disparities in hypertension prevalence: reconsidering the role of chronic stress. *Am J Public Health*. 2014;104:117–123. doi: 10.2105/AJPH.2013.301395
- Clark R, Anderson NB, Clark VR, Williams DR. Racism as a stressor for African Americans. A biopsychosocial model. *Am Psychol*. 1999;54:805– 816. doi: 10.1037//0003-066x.54.10.805
- Sims M, Diez-Roux AV, Dudley A, Gebreab S, Wyatt SB, Bruce MA, James SA, Robinson JC, Williams DR, Taylor HA. Perceived discrimination and hypertension among African Americans in the Jackson Heart Study. Am J Public Health. 2012;102 Suppl 2:S258–S265. doi: 10.2105/AJPH.2011.300523
- Brondolo E, Love EE, Pencille M, Schoenthaler A, Ogedegbe G. Racism and hypertension: a review of the empirical evidence and implications for clinical practice. *Am J Hypertens*. 2011;24:518–529. doi: 10.1038/ajh.2011.9
- Dolezsar CM, McGrath JJ, Herzig AJM, Miller SB. Perceived racial discrimination and hypertension: a comprehensive systematic review. *Health Psychol*. 2014;33:20–34. doi: 10.1037/a0033718
- Williams DR, Mohammed SA. Discrimination and racial disparities in health: evidence and needed research. *J Behav Med*. 2009;32:20–47. doi: 10.1007/s10865-008-9185-0
- Paradies Y, Ben J, Denson N, Elias A, Priest N, Pieterse A, Gupta A, Kelaher M, Gee G. Racism as a determinant of health: a systematic review and meta-analysis. *PLoS One*. 2015;10:e0138511. doi: 10.1371/journal.pone.0138511
- Lewis TT, Williams DR, Tamene M, Clark CR. Self-reported experiences of discrimination and cardiovascular disease. *Curr Cardiovasc Risk Rep.* 2014;8:365. doi: 10.1007/s12170-013-0365-2
- Harrell JP, Hall S, Taliaferro J. Physiological responses to racism and discrimination: an assessment of the evidence. Am J Public Health. 2003;93:243–248. doi: 10.2105/ajph.93.2.243
- Jackson JS, Knight KM, Rafferty JA. Race and unhealthy behaviors: chronic stress, the HPA axis, and physical and mental health disparities over the life course. Am J Public Health. 2010;100:933–939. doi: 10.2105/AJPH.2008.143446
- Sims M, Diez-Roux AV, Gebreab SY, Brenner A, Dubbert P, Wyatt S, Bruce M, Hickson D, Payne T, Taylor H. Perceived discrimination is associated with health behaviours among African-Americans in the Jackson Heart Study. J Epidemiol Community Health. 2016;70:187–194. doi: 10.1136/jech-2015-206390

- Cuffee YL, Hargraves JL, Allison J. Exploring the association between reported discrimination and hypertension among African Americans: a systematic review. Ethn Dis. 2012;22:422–431.
- Cozier Y, Palmer JR, Horton NJ, Fredman L, Wise LA, Rosenberg L. Racial discrimination and the incidence of hypertension in US black women. *Ann Epidemiol*. 2006;16:681–687. doi: 10.1016/j.annepidem.2005.11.008
- Moody DLB, Chang YF, Pantesco EJ, Darden TM, Lewis TT, Brown C, Bromberger JT, Matthews KA. Everyday discrimination prospectively predicts blood pressure across 10 years in racially/ethnically diverse midlife women: study of women's health across the nation. *Ann Behav Med*. 2019;53:608–620. doi: 10.1093/abm/kay069
- Gee GC, Walsemann KM, Brondolo E. A life course perspective on how racism may be related to health inequities. Am J Public Health. 2012;102:967–974. doi: 10.2105/AJPH.2012.300666
- Brondolo E, Gallo LC, Myers HF. Race, racism and health: disparities, mechanisms, and interventions. *J Behav Med*. 2009;32:1–8. doi: 10.1007/s10865-008-9190-3
- Krieger N, Sidney S. Racial discrimination and blood pressure: the CARDIA Study of young black and white adults. Am J Public Health. 1996;86:1370–1378. doi: 10.2105/ajph.86.10.1370
- Roberts CB, Vines AI, Kaufman JS, James SA. Cross-sectional association between perceived discrimination and hypertension in African-American men and women: the Pitt County Study. Am J Epidemiol. 2008;167:624–632. doi: 10.1093/aje/kwm334
- Lewis TT, Van Dyke ME. Discrimination and the health of African Americans: the potential importance of intersectionalities. *Curr Dir Psychol Sci.* 2018;27:176–182. doi: 10.1177/0963721418770442
- Krieger N. Racial and gender discrimination: risk factors for high blood pressure? Soc Sci Med. 1990;30:1273–1281. doi: 10.1016/0277-9536(90)90307-e
- Beatty Moody DL, Waldstein SR, Tobin JN, Cassells A, Schwartz JC, Brondolo E. Lifetime racial/ethnic discrimination and ambulatory blood pressure: the moderating effect of age. *Health Psychol*. 2016;35:333–342. doi: 10.1037/hea0000270
- Pascoe EA, Smart Richman L. Perceived discrimination and health: a metaanalytic review. *Psychol Bull.* 2009;135:531–554. doi: 10.1037/a0016059
- Lewis TT, Cogburn CD, Williams DR. Self-reported experiences of discrimination and health: scientific advances, ongoing controversies, and emerging issues. *Annu Rev Clin Psychol*. 2015;11:407–440. doi: 10.1146/annurev-clinpsy-032814-112728
- Brondolo E, Ver Halen NB, Pencille M, Beatty D, Contrada RJ. Coping with racism: a selective review of the literature and a theoretical and methodological critique. *J Behav Med*. 2009;32:64–88. doi: 10.1007/ s10865-008-9193-0
- Fuqua SR, Wyatt SB, Andrew ME, Sarpong DF, Henderson FR, Cunningham MF, Taylor HA Jr. Recruiting African-American research participation in the Jackson Heart Study: methods, response rates, and sample description. *Ethn Dis.* 2005;15(4 Suppl 6):S6–S29.
- Payne TJ, Wyatt SB, Mosley TH, Dubbert PM, Guiterrez-Mohammed ML, Calvin RL, Taylor HA Jr, Williams DR. Sociocultural methods in the Jackson Heart Study: conceptual and descriptive overview. *Ethn Dis*. 2005;15(4 Suppl 6):S6–S48.
- Taylor HA Jr, Wilson JG, Jones DW, Sarpong DF, Srinivasan A, Garrison RJ, Nelson C, Wyatt SB. Toward resolution of cardiovascular health disparities in African Americans: design and methods of the Jackson Heart Study. *Ethn Dis*. 2005;15(4 Suppl 6):S6–S17.
- Sims M, Wyatt SB, Gutierrez ML, Taylor HA, Williams DR. Development and psychometric testing of a multidimensional instrument of perceived discrimination among African Americans in the Jackson Heart Study. Ethn Dis. 2009;19:56–64.
- Williams DR, Yan Yu, Jackson JS, Anderson NB. Racial differences in physical and mental health: socio-economic status, stress and discrimination. *J Health Psychol.* 1997;2:335–351. doi: 10.1177/135910539700200305
- Abdalla M, Booth JN 3rd, Seals SR, Spruill TM, Viera AJ, Diaz KM, Sims M, Muntner P, Shimbo D. Masked hypertension and incident clinic hypertension among blacks in the Jackson Heart Study. *Hypertension*. 2016;68:220–226. doi: 10.1161/HYPERTENSIONAHA.115.06904
- Seals SR, Colantonio LD, Tingle JV, Shimbo D, Correa A, Griswold ME, Muntner P. Calibration of blood pressure measurements in the Jackson Heart Study. *Blood Press Monit*. 2019;24:130–136. doi: 10.1097/MBP.00000000000000379
- 36. Lloyd-Jones DM, Hong Y, Labarthe D, Mozaffarian D, Appel LJ, Van Horn L, Greenlund K, Daniels S, Nichol G, Tomaselli GF, et al; American Heart Association Strategic Planning Task Force and Statistics Committee. Defining and setting national goals for cardiovascular health

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- promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. *Circulation*. 2010;121:586–613. doi: 10.1161/CIRCULATIONAHA.109.192703
- Brondolo E, Rieppi R, Kelly KP, Gerin W. Perceived racism and blood pressure: a review of the literature and conceptual and methodological critique. Ann Behav Med. 2003;25:55–65. doi: 10.1207/S15324796ABM2501_08
- Paradies Y. A systematic review of empirical research on self-reported racism and health. *Int J Epidemiol*. 2006;35:888–901. doi: 10.1093/ije/dyl056
- Williams DR, Neighbors HW, Jackson JS. Racial/ethnic discrimination and health: findings from community studies. Am J Public Health. 2003;93:200–208. doi: 10.2105/ajph.93.2.200
- Couto PF, Goto JB, Bastos JL. Blood pressure and interpersonal discrimination: systematic review of epidemiologic studies. *Arq Bras Cardiol*. 2012;99:956–963. doi: 10.1590/s0066-782x2012005000090
- 41. Geronimus AT, Hicken M, Keene D, Bound J. "Weathering" and age patterns of allostatic load scores among blacks and whites

- in the United States. Am J Public Health. 2006;96:826-833. doi: 10.2105/AJPH.2004.060749
- Williams DR, John DA, Oyserman D, Sonnega J, Mohammed SA, Jackson JS. Research on discrimination and health: an exploratory study of unresolved conceptual and measurement issues. *Am J Public Health*. 2012;102:975–978. doi: 10.2105/AJPH.2012.300702
- James SA, LaCroix AZ, Kleinbaum DG, Strogatz DS. John Henryism and blood pressure differences among black men. II. The role of occupational stressors. J Behav Med. 1984;7:259–275. doi: 10.1007/BF00845359
- 44. Michaels EK, Reeves AN, Thomas MD, Price MM, Hasson RE, Chae DH, Allen AM. Everyday racial discrimination and hypertension among midlife African American women: disentangling the role of active coping dispositions versus active coping behaviors. *Int J Environ Res.* 2019;16:4759. doi: 10.3390/ijerph16234759
- Forde AT, Crookes DM, Suglia SF, Demmer RT. The weathering hypothesis as an explanation for racial disparities in health: a systematic review. *Ann Epidemiol.* 2019;33:1–18.e3. doi: 10.1016/j.annepidem.2019.02.011

Novelty and Significance

Forde et al

What is New?

One of the first large community-based longitudinal studies to demonstrate a link between greater exposure to discrimination over the life course and incidence of hypertension among African Americans.

What is Relevant?

Discrimination may contribute to disparities in hypertension.

Summary

Lifetime discrimination was associated with a higher risk of incident hypertension. Discrimination may be an important stressor experienced by African Americans and may contribute to higher risk of hypertension in this population.