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RESEARCH ARTICLE

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Multiple forms of perceived job discrimination and hypertension risk among employed women: Findings from the Sister Study

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Abstract

Background: Hypertension has been linked to socially patterned stressors, including discrimination. Few studies have quantified the risk of hypertension associated with exposure to perceived job discrimination.

Methods: We used prospective cohort data from the Sister Study (enrollment from 2003–2009) to estimate self-reported incident hypertension associated with perceived job discrimination based on race, gender, age, sexual orientation, or health status. Job discrimination in the prior 5 years was assessed in 2008–2012, and incident doctor-diagnosed hypertension was ascertained in previously hypertension-free participants.

Results: Among the 16,770 eligible participants aged 37–78 years at the start of follow-up, 10.5% reported job discrimination in the past 5 years, and 19.2% (n = 3226) reported incident hypertension during a median follow-up of 9.7 years (interquartile range 8.2–11.0 years). Self-reported poor health or inclusion in minoritized groups based on race/ethnicity or sexual orientation were more frequent among those reporting job discrimination. In a Cox proportional hazards model adjusting for covariates, report of at least one type of job discrimination (compared to none) was

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associated with a 14% (hazard ratio = 1.14 [95% confidence: 1.02–1.27]) higher hypertension risk. Results from sensitivity analyses reinforced the findings.

Conclusions: Results suggest that interventions addressing job discrimination could have workplace equity and health benefits.

KEYWORDS

hypertension, job discrimination, prospective cohort, workers

1 | INTRODUCTION

Hypertension is a leading risk factor for cardiovascular disease in the United States, affecting over 120 million Americans.[1,2] Annual healthcare costs associated with hypertension from 2003 to 2014 were estimated at $131 billion.[3] Risk factors for hypertension are numerous; to date, prevention strategies have largely focused on modifiable factors such as smoking, diet, and physical activity, although many other factors have been identified, including exposures in fetal and early childhood development, air pollution, noise, and stress.[4,5] The characterization of such risks and the magnitude of their impacts can identify additional pathways for prevention and control of hypertension and addressing related health disparities observed in socially vulnerable and minoritized populations. Perceived discrimination is one such risk linked with many adverse health outcomes, including hypertension.[6–12]

The workplace is a common place for individuals to face discrimination, and studies have shown links between discrimination in the workplace and negative mental health outcomes.[13] For instance, a study in the United States linked perceived work discrimination to depressive symptoms and functional limitations, and a study in Danish workers found a higher risk of depressive disorder onset among those perceiving workplace discrimination.[13,14] However, evidence for physical health outcomes is sparse. Three cross-sectional studies in the United States produced mixed and inconsistent findings for associations of workplace discrimination with hypertension.[15–17] An analysis of data from the Metro Atlanta Heart Disease Study among African Americans found that perceived stress following racism at work was associated with elevated odds of hypertension, and discrimination at work perpetrated by other African Americans was associated with higher systolic blood pressure. However, the study was cross-sectional, and the study population consisted of participants who had all experienced racism or discrimination.[16] In the United for Health Study in the Boston area and the National Health Retirement Study, workplace abuse and discrimination were not associated with hypertension or higher systolic blood pressure.[15,17] A recent longitudinal study using data from the Midlife in the United States study found that workers reporting high levels of workplace discrimination had a higher hazard of hypertension than those reporting lower levels of discrimination.[18] To the best of our knowledge, these studies represent the body of literature on job discrimination and hypertension in the United States.

Measures of job discrimination across these studies varied. Some studies asked about forms of job discrimination tied to identity (e.g., race or sex).[16,17] Others used more general measures that included questions about supervisors or coworkers using ethnic, racial, or sexual slurs but did not assess whether participants perceived discrimination based on dimensions of their identity.[18] Job discrimination can be based on a range of identities (for instance, race, sex, age, health status, and sexual orientation), and evidence is limited on how each type of discrimination may contribute to hypertension risk among individuals facing them.

We aimed to address the limitations of previous studies, using data from the Sister Study, a large national cohort of US women. We hypothesized that job discrimination is associated with an increased risk of hypertension. We estimated associations of job discrimination based on race, gender, sexual orientation, age, and health status with incident hypertension in women workers using prospective cohort data. Additionally, we tested whether sociodemographic factors, such as race/ethnicity, age, educational attainment, and annual household income, modified these associations.

2 | MATERIALS AND METHODS

2.1 | Study population

The Sister Study is a prospective cohort study of US women, aged 35–74 years upon enrollment, who had a sister diagnosed with breast cancer but who had not developed breast cancer themselves.[19] Enrollment occurred from 2003 to 2009, with an initial sample size of 50,884 women. Recruitment efforts included multiple outreach methods and ensured the inclusion of groups often underrepresented in epidemiological studies. After a telephone interview for baseline data collection, participants provided follow-up data through short annual health updates, and detailed follow-up surveys every 2–3 years. We used data release version 10.1, including follow-up data collected through October 12, 2020. The study was approved by the institutional review board of the National Institute of Environmental Health Sciences, and written informed consent was provided by each participant.

Job discrimination was assessed during the first follow-up survey, which served as the initial time point for follow-up for our analysis. We excluded participants from analysis if they did not have a job at the time of the baseline survey (18,020), did not complete any of the survey modules at the first follow-up (2758), or never had a job more than 10 h per week (6662; Figure 1). We additionally excluded participants who had hypertension before the baseline survey (6767), incident

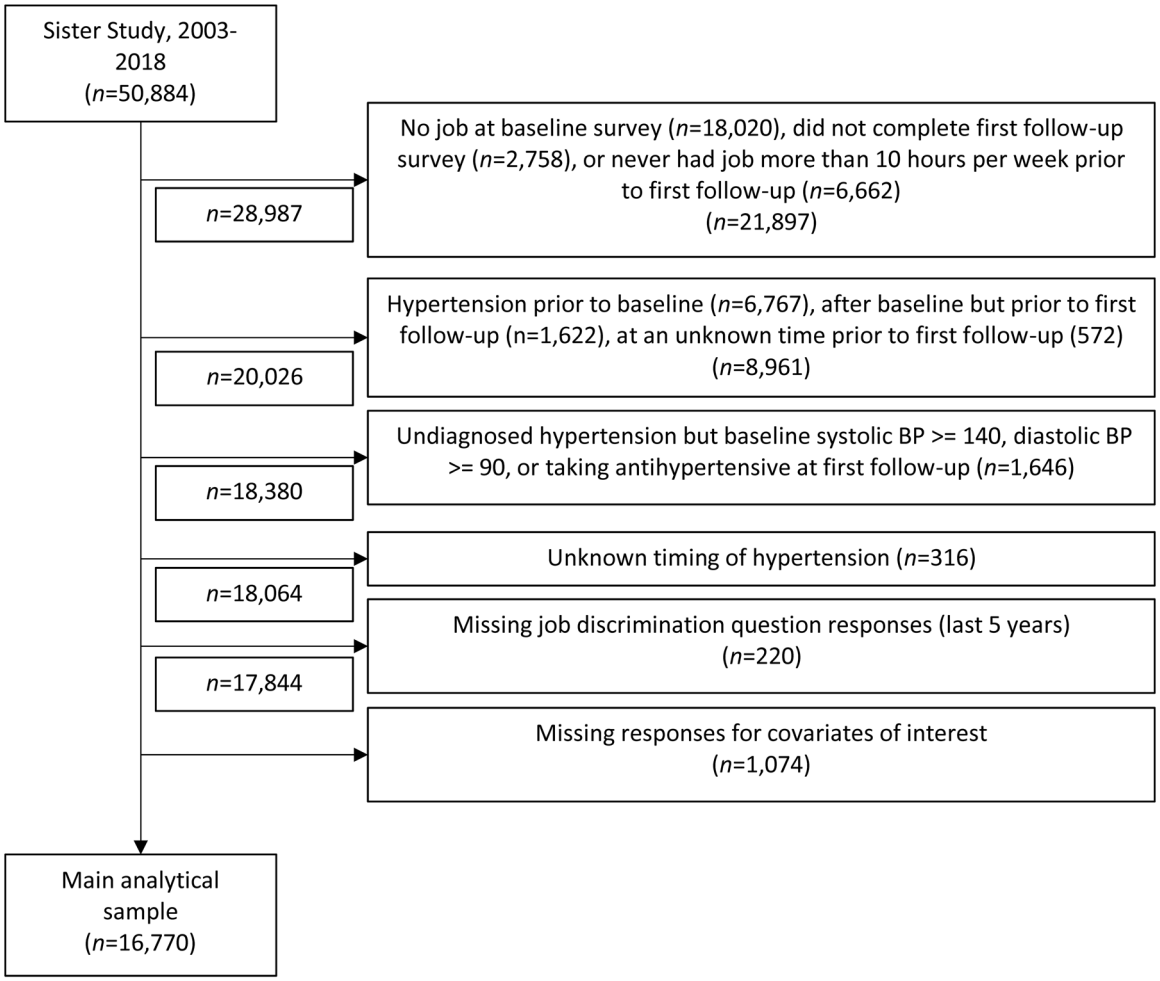

FIGURE 1 Flow chart of main analytical sample inclusion.

hypertension between baseline and first follow-up (1622), or unknown timing of diagnosis but with a response indicating hypertension before first follow-up (572). We excluded from analysis 1646 participants who were not diagnosed with hypertension before the first follow-up but who had measured systolic blood pressure over 140 mm Hg or diastolic blood pressure over 90 mm Hg at the baseline survey, or who were taking an antihypertensive at the first follow-up survey. An additional 316 participants were excluded because of unknown timing of hypertension diagnosis. Finally, 1294 participants were missing answers to job discrimination questions or covariates of interest. The process of sample selection yielded a final analytical sample of 16,770 individuals.

2.2 | Measures

2.2.1 | Exposure assessment: Perceived job discrimination

The first detailed follow-up survey contained a module on stress and coping. Participants who had ever held a job of at least 10 h per week for a year or longer were asked whether they had ever been treated unfairly in job hiring, promotion, or firing due to any of five characteristics: sex, age, race or ethnicity, sexual orientation, or illness or medical condition. If so, participants were asked whether they had experienced this in the last 5 years. We analyzed these responses in four ways: (1) we created an indicator for whether the participant had experienced at least one of the five types of discrimination, (2) we included each of the five categories as variables in the analysis, (3) we created a sum score of the different types of discrimination each participant had experienced, and (4) we conducted stratified analyses among strata of participants corresponding to discrimination types (e.g., discrimination based on age by age group). We used perceived job discrimination in the last 5 years instead of job discrimination ever as the exposure for the primary analysis to be able to adjust for potential confounders measured at baseline. Otherwise, time-varying covariates that could be affected by earlier job discrimination measured at baseline (e.g., perceived stress) would be potential mediators, leading to inappropriate adjustment.[20] Using discrimination in this more recent period also likely reduced concerns about measurement error related to recall.[21]

2.2.2 | Outcome assessment: Hypertension incidence

We determined status and dates of hypertension diagnosis using self-reported data on new diagnoses from doctors or other health professionals on the annual update questionnaires or detailed follow-up questionnaires. If missing, diagnosis dates were imputed using the median of the range in which they could have been diagnosed based on information reported in the data from the full set of questionnaires.

2.2.3 | Covariates

Covariates were included because they were thought to be deconfounders (causes of exposure and outcome, or causes of one—exposure or outcome—also associated with the other) or causes of only the outcome and therefore potentially helpful in statistical precision.[20,22] The covariates below are grouped by adjustment sets used in analysis described below and were collected at the baseline enrollment survey unless otherwise noted. We used multiple adjustment sets given uncertainty about the roles of variables as confounders. Adjustment Set 1 included sociodemographic characteristics and characteristics upon which discrimination was based, including race/ethnicity, age, educational attainment, household income, marital status, sexual orientation, and baseline health status. Set 2 included the previous set plus behavioral and work-related factors, including pack-years of cigarette smoking, weekly alcohol consumption, metabolic equivalent of task (MET)-hours of physical activity for leisure/exercise, hours worked per week, number of jobs, and occupation category for the longest-held current job. Set 3 included the previous two sets, plus biological factors, including BMI, systolic and diastolic blood pressure, stress score, waist-to-hip ratio, prior diagnosis of diabetes or high cholesterol, menopause status, and parity. Set 4 included the previous sets, plus experience of racial/ethnic discrimination in at least one of five ways (e.g., being treated unfairly in housing, interactions with police, or interactions in stores or restaurants) or experience of discrimination based on sexual orientation, both assessed at first follow-up. Each adjustment set also included the time between baseline enrollment and first follow-up, when our study's follow-up began. This time varied across participants, and for participants with short times, it was possible for experience of job discrimination to pre-date the measurement of the baseline covariates.

2.2.4 | Potential effect measure modifiers

We assessed potential heterogeneity of the estimated association of job discrimination with incident hypertension across categories of race/ethnicity, age, sexual orientation, self-rated health, educational attainment, occupation category of longest-held job, or annual household income.

2.3 | Statistical analysis

We summarized the characteristics of the overall analytical sample and by exposure status. Covariates were collected at baseline (average of 2.8 years before the first follow-up), and discrimination questions were assessed at the first follow-up. We chose perceived job discrimination in the past 5 years as the primary exposure rather than having ever perceived job discrimination so that the exposure was more likely to occur after the covariate measurement, thus reducing the degree to which the adjusted models would be adjusting for mediators instead of potential confounders.

To test our hypothesis that perceived job discrimination is associated with a higher risk of incident hypertension, we used Cox proportional hazards regression models to estimate hazard ratios (HR) with 95% confidence intervals (CI), using participant age as the time variable in the model. We used clustered standard errors to account for the 1242 pairs of sisters included in the analysis (about 14% of the total sample). Follow-up began at the first follow-up survey, when exposure information was collected. We fit models adjusted for the sets of covariates described above and reported results for each set.

In addition to our primary analysis with the full analytical sample, we conducted analyses with exposure to each specific type of job discrimination, stratified by the categories of that variable (e.g., the exposure of race-based job discrimination with analysis stratified by race).

To assess whether race/ethnicity, age, sexual orientation, self-rated health, educational attainment, occupation category of longest-held job, or annual household income modified the association of at least one form of perceived job discrimination with incident hypertension, we used pooled models that included interaction terms between the potential modifier and the binary job discrimination variable, adjusting for the complete set of covariates. We also used models stratified by race to estimate race-specific HRs.

We conducted multiple sensitivity analyses to assess potential sources of potential bias. First, we assessed the impact of potential misclassification of hypertension before baseline by excluding participants who had measured systolic blood pressures of at least 130 mm Hg or diastolic blood pressures of at least 80 mm Hg.[23] Second, we conducted an analysis only considering person-time and diagnoses through the third detailed follow-up survey (2014–2016) to ensure more consistent hypertension diagnosis criteria during follow-up, given that the American Heart Association (AHA) and American College of Cardiology (ACC) changed guidelines to redefine hypertension using 130 mm Hg systolic blood pressure and 80 mm Hg diastolic blood pressure instead of 140 mm Hg and 90 mm Hg, respectively, in late 2017.[24] Third, we excluded medical discrimination from the composite exposure in case uncontrolled confounding drove observed associations with medical discrimination. Fourth, we additionally included in the cohort those whose last reported jobs before the baseline survey ended less than 5 years before the first follow-up survey and those who reported working full- or part-time jobs for at least 1 year between August 1, 2008, and the follow-up

survey to most closely capture those who worked in the 5 years before exposure assessment. Fifth, we considered the timing of the covariate and exposure measurements. For people with shorter length of time between the baseline data collection and first follow-up, it was possible for the job discrimination experience to pre-date the measurement of the baseline covariates. For these people, adjusting for some covariates may attenuate the estimated total effect towards null by blocking mediating paths. Given this uncertainty, we report results from models adjusted for multiple sets of covariates. We also conducted an analysis using ever experience of job discrimination as the exposure instead of job discrimination in the last 5 years, expecting the adjusted association to be closer to the null than in the primary analysis because some of the baseline covariates would be more likely to be mediators, occurring after earlier experiences of job discrimination.

3 | RESULTS

3.1 | Study population characteristics

Among the 16,770 participants in the primary analytical sample, the mean age at baseline was 51.5 (standard deviation [SD]: 7.4) years. Table 1 shows the study sample's sociodemographic, behavioral, and biological characteristics. The majority (88.3%) were white, 5.7% were Black (Hispanic/Latina or Non-Hispanic/Latina), 3.7% were Non-Black Hispanic/Latina, and 2.4% were Asian, American Indian/Alaskan Native, or Hawaiian/Pacific Islander. About 96.9% of participants identified as heterosexual, 1.9% were homosexual, 1.1% were bisexual, and 0.1% were asexual. Most participants reported excellent (47.5%) or very good (36.6%) health, with 13.1% reporting good health and only 2.8% reporting fair or poor health.

3.2 | Report of job discrimination in the past 5 years

Almost a quarter of the participants (23.2%) perceived that they ever faced at least one of five forms of job discrimination—1766 (10.5%) in the last 5 years. Compared to the other racial and ethnic groups, Black participants reported job discrimination most frequently in every category, with 19.6% reporting job discrimination based on race and 25.2% reporting at least one of the five types in the last 5 years (Table 2). In comparison, 4.0% of Non-Black Hispanic/Latina participants reported racial job discrimination, and 11.3% reported at least one type. Age-based job discrimination was about twice as high (7.9%) among participants older than the median age (54.6 years) as among participants younger than the median (3.7%). However, high proportions of younger participants reported every other type of job discrimination. Job discrimination based on sexual orientation was most common among participants who identified as homosexual (8.0%), though sex-related (6.7%) and age-related (7.0%) job discrimination were almost as common among those participants as well. Similarly, among those in fair or poor health, 8.8% reported illness-related job discrimination, 8.2% reported sex-related job discrimination, and 10.3% reported age-related job discrimination in the last 5 years.

Report of job discrimination followed other social gradients. For example, higher proportions of participants with lower annual household income, more jobs worked, never married or widowed/divorced/separated status, or more hours worked per week reported job discrimination. However, participants with higher education were more likely to report job discrimination in most categories. Report of job discrimination by all covariates categories is shown in Supporting Information: Appendix Table 1. Participants with multiple identities or characteristics associated with higher likelihood of reported discrimination were often even more likely to report at least one form of discrimination, though intersections of certain identities and characteristics had few participants. For example, there were only 14 Black participants who identified as homosexual, bisexual, or asexual.

3.3 | Association between job discrimination and hypertension risk

Overall, 3226 participants (19.2%) reported incident hypertension during a median follow-up of 9.7 years (interquartile range 8.2–11.0 years). Cumulative incidence of hypertension was 22.9% among those who reported at least one type of discrimination in the past 5 years, compared to 18.8% among those who did not (Table 1). Patterns of cumulative incidence by participant characteristics are shown in Supporting Information: Appendix Table 2.

Report of at least one type of job discrimination in the 5 years before the first follow-up survey was associated with a higher hazard of incident hypertension in each of the Cox proportional hazards models adjusting for different covariates (Table 3). The estimated HR was somewhat attenuated in the models adjusting for more covariates, but the estimated HR of 1.14 (95% CI: 1.02–1.27) in the model adjusting for all covariates indicated an elevated risk of hypertension. The models including each of the five types of job discrimination separately in the same model produced unstable estimates with wide uncertainty intervals. We did not find evidence of a dose–response relationship, and uncertainty intervals were wide.

Estimates of the associations between characteristic-specific job discrimination and hypertension, stratified by identity characteristics (e.g., the HR for hypertension among younger participants facing age-based discrimination) had wide CIs (Supporting information: Appendix Figure 1).

3.4 | Effect-measure modification

There was no evidence of race/ethnicity, age, sexual orientation, self-rated health, educational attainment, or annual household income modifying the association of job discrimination on risk of incident hypertension on the multiplicative scale.

TABLE 1 Characteristics of working women according to their experience of job discrimination, Sister Study.

	Total sample *N* = 16,770	Perceived at least one type of job discrimination[a] in last 5 years *N* = 1,766	Did not perceive job discrimination[a] in last 5 years *N* = 15,004
Cumulative incidence of hypertension during follow-up, %	19.2%	22.9%	18.8%
Race/Ethnicity, %			
Non-Hispanic White	88.3%	79.3%	89.3%
Black	5.7%	13.6%	4.7%
Non-Black Hispanic/Latina	3.7%	4.0%	3.7%
Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander	2.4%	3.2%	2.3%
Age (years) at baseline, mean (SD)	51.5 (7.4)	51.5 (6.8)	51.5 (7.4)
Age at first follow-up, %			
54.6 years (median) or younger	51.5%	49.9%	51.7%
Older than 54.6 years (median)	48.5%	50.1%	48.3%
Sexual orientation, %			
Heterosexual	96.9%	95.2%	97.1%
Homosexual	1.9%	2.7%	1.8%
Bisexual	1.1%	2.0%	1.0%
Asexual	0.1%	0.1%	0.1%
Self-rated health, %			
Excellent	47.5%	37.1%	48.8%
Very good	36.6%	38.6%	36.4%
Good	13.1%	19.1%	12.4%
Fair or Poor	2.8%	5.2%	2.5%
Educational attainment, %			
Some College or Less	27.6%	25.7%	27.8%
Associate, Technical, or Bachelor's Degree	43.8%	41.4%	44.0%
Graduate Degree	28.6%	32.9%	28.1%
Childhood socioeconomic status (self-rated), %			
Well off	7.1%	7.4%	7.1%
Middle income	64.8%	60.4%	65.3%
Low income	22.7%	24.1%	22.5%
Poor	5.4%	8.2%	5.1%
Marital status, %			
Married/living as married	77.1%	66.4%	78.4%
Widowed/divorced/separated	16.9%	24.5%	16.0%
Never married	6.0%	9.1%	5.6%

(Continues)

TABLE 1 (Continued)

	Total sample N = 16,770	Perceived at least one type of job discrimination[a] in last 5 years N = 1,766	Did not perceive job discrimination[a] in last 5 years N = 15,004
Current job count, %			
1	93.0%	90.1%	93.3%
2+	7.0%	9.9%	6.7%
Household income, last year (USD), %			
Less than $20,000	1.9%	2.9%	1.7%
$20,000 to $49,999	14.8%	19.9%	14.2%
$50,000 to $99,999	42.4%	43.0%	42.4%
$100,000 to $200,000	33.0%	27.9%	33.6%
More than $200,000	7.9%	6.3%	8.1%
Hours worked per week, mean (SD)	38.2 (12.6)	41.4 (12.1)	37.8 (12.6)
Longest job worked (occupational category), %			
Professional and related occupations	39.6%	33.6%	40.3%
Sales and office occupations	26.1%	26.8%	26.0%
Management, business, and financial occupations	24.2%	29.5%	23.6%
Service occupations	6.7%	5.8%	6.9%
Production, transportation, and material moving occupations	2.0%	2.5%	1.9%
Other (military, unemployed, volunteer, student, retired, homemaker, construction, maintenance, farming, fishing, forestry, or not reported)	1.4%	1.8%	1.3%
Pack-years smoked, mean (SD)	4.7 (9.8)	5.6 (11.0)	4.6 (9.6)
Alcohol, drinks per week, mean (SD)	2.9 (4.5)	2.6 (4.1)	3.0 (4.6)
Physical activity, sports/exercise (MET-hours per week), mean (SD)	15.7 (18.8)	15.2 (19.0)	15.7 (18.8)
Body-Mass Index (kg/m^2), mean (SD)	26.1 (5.2)	27.3 (5.7)	25.9 (5.1)
Systolic blood pressure (mm Hg), mean (SD)	109.1 (10.8)	109.8 (10.5)	109.0 (10.8)
Diastolic blood pressure (mm Hg), mean (SD)	69.8 (7.7)	70.4 (7.8)	69.8 (7.7)
Waist-hip ratio, mean (SD)	0.8 (0.1)	0.8 (0.1)	0.8 (0.1)
Perceived stress score, mean (SD)	2.7 (2.6)	3.6 (3.0)	2.6 (2.5)
High cholesterol, %	22.0%	24.4%	21.7%
Diabetes, %	1.4%	2.4%	1.3%
Entered menopause, %	50.6%	51.4%	50.5%

TABLE 1 (Continued)

	Total sample $N = 16,770$	Perceived at least one type of job discrimination[a] in last 5 years $N = 1,766$	Did not perceive job discrimination[a] in last 5 years $N = 15,004$
Parity, %			
0	22.0%	26.0%	21.6%
1–2	54.7%	53.5%	54.9%
3+	23.3%	20.6%	23.6%
Other racial/ethnic discrimination (ever), %	10.2%	26.6%	8.2%
Other sexual orientation discrimination (ever), %	7.1%	17.3%	6.0%

Abbreviation: SD, standard deviation.

[a]Types of job discrimination were discrimination based on race, gender, age, sexual orientation, and health status.

There was also no evidence of a difference in HRs when stratifying by race/ethnicity, but wide CIs limited comparison (Supporting information: Appendix Figure 2).

3.5 | Sensitivity analyses

Figure 2 shows results from multiple sensitivity analyses. Using stricter exclusion criteria—excluding those with systolic blood pressure over 130 mm Hg or diastolic blood pressure over 80 mm Hg at baseline instead of 140 mm Hg or 90 mm Hg—reduced the analytical study population by 2411 participants, 901 later diagnosed with incident hypertension. The hazard of incident hypertension in women who reported any form of job discrimination in the last 5 years was 1.19 (1.05–1.36) times higher than that in women reporting no discrimination in the model adjusting for all covariates. Excluding person-time and cases diagnosed after the third detailed follow-up survey also slightly increased the point estimate of the association between job discrimination and incident hypertension (HR = 1.17 [1.01–1.35]) compared to the primary analysis, though the CI widened because of the shorter follow-up (average time to hypertension, other censoring, or end of follow-up was reduced from 8.8 years to 5.3 years). Combining these sensitivity analyses, the estimated HR was 1.24 (1.05–1.47). Evidence about a potential dose–response relationship between number of types of job discrimination reported and hypertension risk varied across sensitivity analyses but was limited by wide CIs (Supporting Information: Appendix Figure 3).

Excluding medical discrimination in the past 5 years from the combined exposure measure and using at least one form of discrimination out of the remaining four types had little impact on the estimated HR (1.10 [0.98–1.24]) compared to the HR estimated in the primary analysis (1.14 [1.02–1.27]).

Additionally including those who worked at some point during the 5 years before exposure assessment (but who were not employed at the time of the baseline survey) brought the cohort from 16,770 to 19,231 people. Results were similar to those in the primary analysis, including the estimated HR for hypertension with at least one form of discrimination compared to none (1.13 [1.02–1.26]).

Cumulative incidence of hypertension was 20.5% in the group having reported ever experiencing at least one type of job discrimination, while it was 18.8% in those reporting having never experienced job discrimination (Supporting Information: Appendix Table 3). In an unadjusted model, we estimated the hazard of hypertension among those having ever faced job discrimination was 1.10 (1.02–1.19) times that of those who had never. However, this estimated association disappeared after adjustment for all covariates (HR = 1.00, 95% CI: 0.92–1.09; Figure 2).

4 | DISCUSSION

In this large prospective cohort of working women in the United States, the experience of recent job discrimination based on at least one of five characteristics—sex, age, race, sexual orientation, and/or medical conditions—was associated with a higher hazard of incident hypertension. Sensitivity analyses restricting the sample to individuals without high measured blood pressure and shortening follow-up to ensure more consistent diagnosis criteria resulted in broadly similar but slightly stronger estimated associations. We found little evidence that sociodemographic factors modified the estimated associations on a multiplicative scale. This study adds to the weight of evidence that occupational psychosocial factors and stressors may lead to a higher risk of hypertension.

There is an abundance of evidence for the role of stress in the etiology of cardiovascular disease. Stress has been described as a primary biological mechanism through which discrimination can impact health, including hypertension.[8,25,26] Prior studies have often—but not always—found broader perceived discrimination measures to be associated with a higher risk of hypertension.[7,9–12,27]

TABLE 2 Prevalence (%) of five types of perceived job discrimination in the last 5 years, by participant characteristics, analytical sample from Sister Study.

		Type of job discrimination in last 5 years, % (95% CI)					
	n (%)	Any	Sex	Age	Race	Sexual orientation	Medical
Full analytical sample	16,770 (100%)	10.5 (10.1–11.0)	4.7 (4.4–5.1)	5.7 (5.4–6.1)	1.8 (1.6–2.0)	0.6 (0.5–0.8)	1.6 (1.4–1.8)
Cumulative incidence of hypertension during follow-up							
No	13,544 (80.8%)	10.0 (9.5–10.6)	4.6 (4.3–5.0)	5.4 (5.0–5.8)	1.8 (1.6–2.0)	0.6 (0.5–0.7)	1.4 (1.2–1.6)
Yes	3,226 (19.2%)	12.6 (11.4–13.7)	5.1 (4.4–6.0)	7.0 (6.2–8.0)	1.9 (1.5–2.5)	0.9 (0.6–1.3)	2.4 (1.9–3.0)
Race/ethnicity							
Non-Hispanic White	14,802 (88.3%)	9.5 (9.0–9.9)	4.4 (4.1–4.8)	5.4 (5.1–5.8)	0.6 (0.4–0.7)	0.6 (0.5–0.7)	1.5 (1.3–1.7)
Black	951 (5.7%)	25.2 (22.5–28.1)	8.6 (6.9–10.6)	9.4 (7.6–11.4)	19.6 (17.1–22.2)	1.6 (0.9–2.6)	2.9 (2.0–4.2)
Non-Black Hispanic/Latina	622 (3.7%)	11.3 (8.9–14.0)	4.2 (2.7–6.1)	5.5 (3.8–7.6)	4.0 (2.6–5.9)	0.6 (0.2–1.6)	1.3 (0.6–2.5)
Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander	395 (2.4%)	14.2 (10.9–18.0)	7.1 (4.8–10.1)	8.6 (6.0–11.8)	2.5 (1.2–4.6)	0.5 (0.1–1.8)	2.3 (1.0–4.3)
Age (years) at first follow-up							
54.6 years (median) or younger	8638 (51.5%)	10.2 (9.6–10.9)	5.5 (5.0–6.0)	3.7 (3.3–4.1)	2.3 (2.0–2.6)	0.7 (0.5–0.9)	1.8 (1.6–2.1)
Older than 54.6 years (median)	8132 (48.5%)	10.9 (10.2–11.6)	3.9 (3.5–4.3)	7.9 (7.3–8.5)	1.3 (1.1–1.6)	0.6 (0.5–0.8)	1.4 (1.1–1.7)
Sexual orientation							
Heterosexual	16,255 (96.9%)	10.3 (9.9–10.8)	4.7 (4.3–5.0)	5.6 (5.3–6.0)	1.8 (1.6–2.0)	0.5 (0.4–0.6)	1.5 (1.3–1.7)
Homosexual	314 (1.9%)	15.3 (11.5–19.8)	6.7 (4.2–10.0)	7.0 (4.4–10.4)	1.9 (0.7–4.1)	8.0 (5.2–11.5)	3.8 (2.0–6.6)
Bisexual	190 (1.1%)	18.4 (13.2–24.7)	7.4 (4.1–12.1)	9.5 (5.7–14.6)	1.6 (0.3–4.5)	2.6 (0.9–6.0)	5.8 (2.9–10.1)
Asexual	11 (0.1%)	18.2 (2.3–51.8)	0.0 (<0.1–28.5)	18.2 (2.3–51.8)	9.1 (0.2–41.3)	0.0 (<0.1–28.5)	0.0 (<0.1–28.5)
Self-rated health							
Excellent	7971 (47.5%)	8.2 (7.6–8.8)	3.8 (3.4–4.3)	4.6 (4.2–5.1)	1.3 (1.1–1.6)	0.5 (0.3–0.7)	0.6 (0.4–0.8)
Very good	6139 (36.6%)	11.1 (10.3–11.9)	5.0 (4.5–5.6)	6.2 (5.6–6.8)	1.9 (1.6–2.3)	0.6 (0.4–0.8)	1.6 (1.3–1.9)
Good	2195 (13.1%)	15.4 (13.9–16.9)	6.5 (5.5–7.6)	7.5 (6.4–8.7)	3.2 (2.5–4.1)	1.2 (0.8–1.8)	4.0 (3.2–4.9)
Fair or Poor	465 (2.8%)	19.8 (16.3–23.7)	8.2 (5.8–11.0)	10.3 (7.7–13.5)	2.6 (1.3–4.5)	1.1 (0.4–2.5)	8.8 (6.4–11.8)

Abbreviation: CI, confidence interval.

TABLE 3 Adjusted hazard ratios for incident hypertension, comparing participants reporting job discrimination to those reporting none in the last 5 years, Sister Study.

	Model adjustment sets							
	Adjustment set A[a]		Adjustment set B[b]		Adjustment set C[c]		Adjustment set D[d]	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Model 1: Any job discrimination								
Any discrimination	1.19	1.07–1.33	1.19	1.07–1.33	1.16	1.04–1.29	1.14	1.02–1.27
Model 2: Specific job discrimination								
Sex-based discrimination	1.06	0.89–1.28	1.06	0.89–1.27	1.04	0.86–1.25	1.02	0.85–1.23
Age-based discrimination	1.09	0.93–1.27	1.08	0.93–1.27	1.07	0.92–1.25	1.06	0.91–1.24
Race-based discrimination	0.83	0.62–1.10	0.85	0.64–1.12	0.85	0.63–1.14	0.83	0.62–1.12
Sexual orientation-based discrimination	1.35	0.91–1.99	1.30	0.88–1.91	1.29	0.86–1.94	1.18	0.78–1.80
Medical condition-based discrimination	1.36	1.07–1.73	1.35	1.06–1.71	1.35	1.05–1.72	1.33	1.04–1.70
Model 3: Dose–response								
1 type of job discrimination	1.19	1.06–1.35	1.20	1.06–1.35	1.17	1.03–1.32	1.15	1.02–1.31
2+ types of job discrimination	1.19	0.99–1.44	1.18	0.97–1.42	1.14	0.93–1.39	1.09	0.89–1.34

Note: All models are Cox proportional hazards models with standard errors clustered on sisters.

Abbreviations: BMI, body mass index; CI, confidence interval; HR, hazard ratio.

[a]Model included sociodemographic characteristics and characteristics upon which discrimination was based including race/ethnicity, age, educational attainment, household income, marital status, sexual orientation, and baseline health status, as well as time between baseline and first follow-up.

[b]Model included covariates from the previous model plus behavioral and work-related factors including smoking, alcohol consumption, sports/exercise physical activity, hours worked per week, number of jobs, and occupation category for the longest-held current job.

[c]Model included covariates from previous models plus biological factors including BMI, baseline systolic and diastolic blood pressure, stress score, waist-to-hip ratio, prior diagnosis of diabetes and/or high cholesterol, menopause status, and parity.

[d]Model included covariates from previous models plus having experienced other forms of discrimination (nonjob-related discrimination) based on race or sexual orientation.

A wide range of studies have examined associations between racial discrimination and hypertension.[7] Notably, one recent study using data from the National Health and Retirement Study reported associations in men but not women.[11] However, studies in the United States examining associations of workplace discrimination with hypertension, largely relying on cross-sectional data, have yielded mixed results.[15–17] Our findings suggest a positive association between job discrimination and hypertension, similar to another recent study using longitudinal data.[18] The longitudinal nature of the Sister Study strengthens the temporal evidence for causal interpretation, and the size of our analytical sample (16,770) was substantially larger than those of previous studies (3794; 356; 1202; and 1246), strengthening statistical precision.[15–18]

Studies of associations between job discrimination and sleep and of associations between sleep and hypertension using data from the Sister Study have also examined effect-measure modifications by factors like race/ethnicity, age, self-rated health, and menopausal status, in some cases finding significant interactions.[23,28] We did not identify sociodemographic characteristics that strongly modified associations between job discrimination and incident hypertension using interactions in our pooled models. Even absent heterogeneous effects on the multiplicative scale, groups with a higher incidence of job discrimination or higher incidence of hypertension could face greater overall hypertension risk attributable to discrimination. For instance, Black women experienced a higher cumulative incidence of hypertension than women of other racial/ethnic groups in our study, including among those reporting having never experienced job discrimination (Supporting Information: Appendix Table 2). The same estimated HR would have a larger impact on absolute hazard of Black women than other women if they have a higher baseline hazard. Additionally, we observed that certain groups were more likely to report job discrimination. Among them were women who were Black; identified as homosexual, bisexual, or asexual; had worse self-rated health; or had low annual household incomes. Higher rates of exposure to job discrimination in these groups or others with more frequent reports of job discrimination may lead to a higher absolute burden of hypertension related to job discrimination, even if the effect of job discrimination on hypertension does not differ between groups.

There were several limitations in our study. First, we lacked precise timing of job discrimination experiences. We utilized perceived experiences of job discrimination in the past 5 years (rather than ever) to reduce the possibility that baseline covariates were mediators rather than confounders. Second, job discrimination questions only captured discrimination based on sex, age, race or ethnicity, sexual orientation, and illness or medical condition. People can experience discrimination due to other causes. Third, we relied on self-reported hypertension diagnosis by clinicians. It is possible

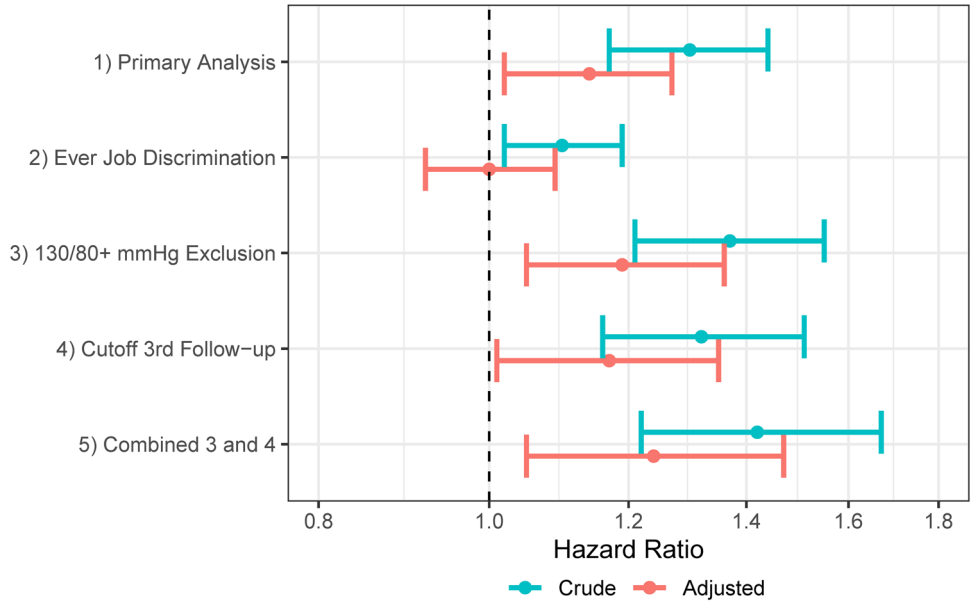

FIGURE 2 Estimated hazard ratios for future incident hypertension, comparing participants reporting at least one type of job discrimination to those reporting none in the past 5 years, comparison of sensitivity analyses. (1) Primary analytical sample, Differences from primary analysis as follows: (2) Ever job discrimination (exposure defined as report of ever experiencing at least one type of job discrimination instead of in the last 5 years), (3) 130/80+ mm Hg exclusion (exclusion of individuals with blood pressure measured over 130 mm Hg systolic or 80 mm Hg diastolic at baseline), (4) Cutoff follow-up at the third follow-up survey 2014–2016 (cutoff for consistent hypertension diagnosis guidelines), and (5) Combined (combining 3 and 4). Crude estimate uses age as time scale in Cox proportional hazards regression without covariates. Adjusted model adjusted for sociodemographic characteristics and characteristics upon which discrimination was based including race/ethnicity, age, educational attainment, household income, marital status, sexual orientation, and baseline health status, as well as time between baseline and first follow-up; behavioral and work-related factors including smoking, alcohol consumption, sports/exercise physical activity, hours worked per week, number of jobs, and occupation category for the longest-held current job; biological factors including body mass index, baseline systolic and diastolic blood pressure, stress score, waist-to-hip ratio, prior diagnosis of diabetes and/or high cholesterol, menopause status, and parity; and having experienced other forms of discrimination (nonjob-related discrimination) based on race or sexual orientation.

that there is differential misclassification of hypertension if patterns of healthcare utilization differ based on the experience of job discrimination. Excluding individuals with high measured blood pressure (systolic or diastolic using the post-2017 guideline values) slightly strengthened the estimated associations between job discrimination and hypertension. Fourth, the criteria for hypertension diagnosis have changed over time. Excluding person-time and events occurring after the third detailed follow-up survey (before the ACC and AHA guideline changes) also slightly strengthened the estimates of association. Fifth, hypertension was assessed through participant knowledge of their medical diagnosis. Lack of diagnosis or lack of awareness of diagnosis may bias results.[29] If non-differential with respect to the exposure, outcome misclassification often attenuates estimated effects. Rates of diagnosis and awareness, which vary across characteristics like race, age, and socioeconomic position, shape how estimates would be impacted across groups and identities.[29,30] Sixth, we are not able to rule out that there are confounders for which we were unable to adjust. Seventh, the composition of the Sister Study cohort, a cohort of women whose biological sisters were diagnosed with breast cancer and consisting of a certain age range, may impact the transportability of results to other populations. For instance, the women in the cohort could be more sensitive to perceiving discrimination based on medical conditions or more likely to be receiving medical surveillance and therefore diagnosed with hypertension.[28]

There are several opportunities for future research to build on and clarify these findings. Analyses that are able to incorporate more extensive and longitudinal measurement of perceived job discrimination would not only better establish the timing of the exposure and potential time-varying confounders/mediators, but they would also reduce the potential for measurement error in the exposure related to recall that may vary by social identities.[21] The questions we used to assess discrimination were constrained to job hiring, firing, and promotion; however, people may perceive job discrimination in other ways, for instance with respect to how their employer prioritizes their well-being. There may be other dimensions of discrimination related to employment to explore. While there is evidence that discrimination causes physiological stress responses, which are linked to cardiovascular risks, including hypertension, the precise causal pathways from discrimination to hypertension could be explored in additional detail. Structural racism and structural discrimination can affect health, including hypertension, through multiple pathways, but individuals do not always recognize these structures. Assessment of structural racism in addition to perceived

racial job discrimination, for instance, could be used to better understand the broader impact of racial discrimination. Mediation analyses could examine the role of sleep or other potential intermediate factors in the causal pathway between job discrimination and hypertension.[23,28] Alternative pathways, such as behavioral responses to perceived discrimination, may also change hypertension risk and could be further explored.[6] We observed a higher prevalence of perceived job discrimination in people belonging to minoritized groups, who were more likely to face discrimination in other settings. Characterizing how other types of discrimination and stressors may affect the perception of job discrimination and the association between perceived job discrimination and hypertension could help better define the causal process and identify individuals at the highest risk.

Perceived discrimination is an important stressor that likely has a range of negative health consequences through multiple causal pathways.[6] We found evidence that perceived job discrimination in particular is associated with incident hypertension. Employer policies and workplace interventions can leverage an extensive body of literature that describes types of discrimination and proposes methods for reducing job discrimination based on different identities or characteristics.[31] A better understanding of the mechanisms through which discrimination affects health can also help identify ways for organizations to mitigate health impacts in individuals who have been harmed.

AUTHOR CONTRIBUTIONS

Study concept: Jian Li. *Study design:* Jian Li and Chandra L. Jackson. *Acquisition of data:* Dale P. Sandler. *Statistical Analysis:* Matthew M. Coates and Onyebuchi A. Arah. *Interpretation of data:* Matthew M. Coates, Onyebuchi A. Arah, Timothy A. Matthews, Dale P. Sandler, Chandra L. Jackson, and Jian Li. *Drafting of the manuscript:* Matthew M. Coates. *Critical revision of the manuscript for important intellectual content:* Matthew M. Coates, Onyebuchi A. Arah, Timothy A. Matthews, Dale P. Sandler, Chandra L. Jackson and Jian Li. *Administrative, technical, and material support:* Dale P. Sandler and Chandra L. Jackson. *Obtaining funding and study supervision:* Dale P. Sandler, Chandra L. Jackson, and Jian Li. *Final Approval:* Matthew M. Coates, Onyebuchi A. Arah, Timothy A. Matthews, Dale P. Sandler, Chandra L. Jackson, and Jian Li.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from National Institute of Environmental Health Sciences. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from https://sisterstudy.niehs.nih.gov/English/data-requests.htm with the permission of National Institute of Environmental Health Sciences.

ETHICS APPROVAL AND INFORMED CONSENT

The study was approved by the institutional review board of the National Institute of Environmental Health Sciences, and written informed consent was provided by each participant.

DISCLAIMER

None.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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