

## Original Contribution

# Experiences With Everyday and Major Forms of Racial/Ethnic Discrimination and Type 2 Diabetes Risk Among White, Black, and Hispanic/Latina Women: Findings From the Sister Study

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Racial/ethnic discrimination may contribute to the risk of type 2 diabetes mellitus (T2DM), but few studies have prospectively examined this relationship among racially/ethnically diverse populations. We analyzed prospective data from 33,833 eligible Sister Study participants enrolled from 2003 to 2009. In a follow-up questionnaire (2008–2012), participants reported their lifetime experiences of everyday and major forms of racial/ethnic discrimination. Self-reported physician diagnoses of T2DM were ascertained through September 2017. Hazard ratios and 95% confidence intervals were estimated using Cox proportional hazards models, overall and by race/ethnicity. Mean age at enrollment was 54.9 (standard deviation, 8.8) years; 90% of participants self-identified as non-Hispanic (NH) White, 7% as NH Black, and 3% as Hispanic/Latina. Over an average of 7 years of follow-up, there were 1,167 incident cases of T2DM. NH Black women most frequently reported everyday (75%) and major (51%) racial/ethnic discrimination (vs. 4% and 2% of NH White women, respectively, and 32% and 16% of Hispanic/Latina women, respectively). While everyday discrimination was not associated with T2DM risk, experiencing major discrimination was marginally associated with higher T2DM risk overall (hazard ratio = 1.26, 95% confidence interval: 0.99, 1.61) after adjustment for sociodemographic characteristics and body mass index. Associations were similar across racial/ethnic groups; however, racial/ethnic discrimination was more frequently reported among racial/ethnic minority women. Antidiscrimination efforts may help mitigate racial/ethnic disparities in T2DM risk.

continental population groups; diabetes mellitus, type 2; ethnic groups; prospective studies; racism; social discrimination

Abbreviations: BMI, body mass index; CI, confidence interval; HR, hazard ratio; SES, socioeconomic status; T2DM, type 2 diabetes mellitus.

Type 2 diabetes mellitus (T2DM), the seventh leading cause of death in the United States, cost the United States \$327 billion in 2017, with 1 in 4 health-care dollars spent on individuals with T2DM (1, 2). More than 34 million US adults have T2DM, and currently non-Hispanic Black and Hispanic/Latina women are more likely to have T2DM than non-Hispanic White women (1). The number of adults diagnosed with T2DM is expected to triple between the years 2005 and 2050 (3), and T2DM prevalence is projected to increase by 208% among non-Hispanic Blacks and by 481% among Hispanics/Latinos, compared with a 113% increase

among non-Hispanic Whites (4), which suggests an alarming widening of racial/ethnic disparities in T2DM (1).

Conceptualized as differential treatment of specific groups by social systems (e.g., judicial, health-care) or differential treatment of individuals within systems or broader societies, discrimination may adversely impact health (5). Racial/ethnic discrimination, specifically, refers to differential treatment based on an individual's phenotypic race (6). Previous research suggests that racial/ethnic discrimination is positively associated with numerous health outcomes, including obesity, hypertension, T2DM, cardiovascular disease, and certain

cancers (7–11). In prior studies, non-Hispanic Black and Hispanic/Latino adults were more likely to report racial discrimination than non-Hispanic Whites (9, 12). Racial/ethnic discrimination may contribute to racial/ethnic disparities in T2DM incidence.

Hypothesized to affect T2DM incidence through structural, psychosocial, and behavioral pathways, both subtle/covert day-to-day experiences of racial/ethnic discrimination and overt discriminatory acts may independently and collectively have lasting effects on T2DM risk. At the structural level, systemic denial of goods and resources due to residential segregation can lead to poorer living conditions, decreased quality of/access to health care, and less healthy food availability among affected individuals (8). Psychosocial stress resultant from discriminatory experiences and behavioral pathways may manifest as, for instance, poor sleep hygiene/quality, unhealthy diet/nutrition, excessive alcohol consumption, and decreased physical activity (12, 13). These pathways could contribute to biological consequences that increase T2DM risk, such as increases in adiposity and endocrine abnormalities (8, 14–17).

Prior literature on this topic has largely been cross-sectional, lacked racial/ethnic diversity, or focused on outcomes related generally to diabetes rather than T2DM specifically (11, 18). Previous studies have also assessed discrimination that was not attributed to a particular identity; therefore, further research is needed to elucidate how the associations between racial/ethnic discrimination and T2DM may be distinct from associations with other forms of discrimination (e.g., sex, sexual orientation) (19, 20). To address this gap in the literature, we prospectively evaluated the associations of everyday (routine unfair treatment) and major (structural unfair treatment) racial/ethnic discrimination with T2DM risk among non-Hispanic White, non-Hispanic Black (referred to hereafter as White and Black), and Hispanic/Latina women enrolled in the Sister Study. We hypothesized that everyday and major forms of racial/ethnic discrimination would be positively associated with increased risk of T2DM. We also hypothesized that the positive association would vary by race/ethnicity, with greater risk among Black and Latina women compared with White women.

## METHODS

### The Sister Study cohort

The Sister Study is a prospective cohort study of 50,884 women that was designed to identify environmental and lifestyle risk factors for breast cancer. A detailed description of the study has been published previously (21). Women recruited throughout the continental United States and Puerto Rico were aged 35–74 years at enrollment (2003–2009). Eligible women were without a breast cancer diagnosis but had a full or half-sister diagnosed with breast cancer. At enrollment, study participants completed in-person examinations, self-administered questionnaires, and computer-assisted telephone interviews. Thereafter, participants completed computer-assisted telephone interviews or brief Web-based questionnaires annually and subsequent detailed follow-up questionnaires every 2–3 years.

The Sister Study is overseen by the institutional review boards of the National Institute of Environmental Health Sciences and the Copernicus Group. All participants provided written informed consent. The present study used data release 7.0, which includes follow-up through September 2017.

### Study participants

Participants were sequentially excluded from the study sample if they did not complete the racial/ethnic discrimination module ( $n = 4,984$ ), which was administered during the first follow-up (approximately 2 years after enrollment); if they had prevalent (at the time of racial/ethnic discrimination assessment) or unknown timing of T2DM ( $n = 4,394$ ); or if they had prevalent type 1 diabetes mellitus at baseline ( $n = 3$ ). We defined type 1 diabetes mellitus as a previous diagnosis of diabetes before age 20 years, use of insulin before age 20 years, or being aged 20–35 years, taking insulin continuously, and having a difference of  $\leq 1$  year between the start of insulin use and diabetes diagnosis. Participants were further excluded if they self-identified as a race/ethnicity other than White, Black, or Hispanic/Latina ( $n = 1,002$ ); had missing data for race/ethnicity ( $n = 10$ ); or had a history of cancer (excluding nonmelanoma skin cancer) ( $n = 3,832$ ) or stroke and/or cardiovascular disease ( $n = 2,378$ ) at the time of racial/ethnic discrimination assessment. Because of the differential likelihood of experiencing discrimination in Puerto Rico given its greater racial/ethnic homogeneity compared with the continental United States, residents of Puerto Rico ( $n = 448$ ) were analyzed separately (see Web Tables 1 and 2, available online at <https://doi.org/10.1093/aje/kwab189>). The final analytical sample in the main analysis comprised 33,833 participants (Web Figure 1). Compared with participants included in the analytical sample, excluded participants were more likely to self-identify as a racial/ethnic minority, more likely to be aged  $\geq 65$  years, of lower socioeconomic status (SES), a current or former smoker, obese, or postmenopausal, and more likely to report higher stress levels, physician-diagnosed depression, and multiple forms of discrimination (Web Table 3).

### Exposure ascertainment: racial/ethnic discrimination

During the first follow-up (approximately 2 years postenrollment), participants reported their lifetime experiences of perceived unfair treatment attributed to their race/ethnicity and reported whether these experiences had occurred within the past 5 years in a self-administered questionnaire. We assessed lifetime (ever) experience of everyday and major racial/ethnic discrimination separately (22). The assessment of everyday racial/ethnic discrimination included 3 questions that were adapted from the Everyday Discrimination Scale: being treated unfairly in receiving service at a store or restaurant; being treated as less intelligent, worthy, or honest; and experiencing people acting as if they are afraid of you (23). The assessment of major racial/ethnic discrimination included 3 questions about being treated unfairly in home renting, home buying, or mortgage lending; being treated unfairly in being stopped, searched, or threatened by the

police; and being treated unfairly in job hiring, promotion, or firing due to race/ethnicity. Affirmative responses to questions for each form of racial/ethnic discrimination were assigned a value of 1 and summed. Most participants had a summary score of 0 for both everyday and major racial/ethnic discrimination; therefore, we separately dichotomized lifetime everyday and major racial/ethnic discrimination as ever (any) vs. never (none). Similarly to previous literature, we also created a categorical variable that combined everyday and major racial/ethnic discrimination (22). The combined measure was categorized as both (ever experiencing both everyday and major racial/ethnic discrimination); either (ever experiencing either everyday or major racial/ethnic discrimination, but not both); and none (experiencing neither everyday nor major racial/ethnic discrimination).

### Outcome ascertainment: T2DM

In follow-up questionnaires (administered through September 15, 2017), participants provided a “yes” or “no” response to the question, “Has a doctor or other health-care provider ever told you that you had diabetes?”. If the participant reported “yes,” she also provided the date of diagnosis. Previous studies have found a high positive predictive value (82.2%) and a high negative predictive value (94.5%) for self-reported diabetes (24); therefore, participants who responded “yes” were assumed to have incident T2DM on the date provided, and those who responded “no” were assumed not to have incident T2DM. Participants who reported having received a T2DM diagnosis prior to the racial/ethnic discrimination assessment were excluded from the analyses.

### Potential modifiers: race/ethnicity

Participants were asked, “What race do you consider yourself to be?” (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, White) and “Do you consider yourself to be Hispanic or Latina?” (yes, no). Participants could self-identify with 1 or more of the racial categories. White, Black, and Hispanic/Latina participants were included in the analysis (Web Figure 1).

### Potential confounders

All covariates were measured at baseline and based on self-report (unless otherwise stated). Sociodemographic characteristics included age (years); educational attainment (high school diploma or less, some college or technical degree, or bachelor’s degree or more); current employment (yes, no (retired, unemployed, homemaker, or student)); current shift work (yes, no); annual household income (<\$20,000, \$20,000–\$49,999, \$50,000–\$99,999, or ≥\$100,000); marital status (married/living as married, single/never married, or divorced/separated/widowed); region of residence (Northeast, Midwest, South, or West); and self-reported childhood socioeconomic position (i.e., food insecurity while growing up, household educational attainment less than high school at participant age 13 years,

low income while growing up). Categorical health behaviors included cigarette smoking status (never, former, or current smoker) and alcohol consumption (nondrinker (never/former drinker), light/moderate drinker (≤7 drinks/week), or heavy drinker (>7 drinks/week)). Continuous health behavior measures included the following: 2000 Healthy Eating Index Score (possible range, 0–100), which was assessed using a modified version of the standardized self-administered Block 1998 food frequency questionnaire (25); amount (metabolic equivalent of task–minutes) of leisure-time, transportation-related, and work-related physical activity per week (26, 27); and a cumulative poor sleep score, which captures sleep duration, inconsistent sleep patterns, sleep debt, frequent napping, difficulty falling asleep, and difficulty staying asleep (22).

During baseline home visits, participants’ height (centimeters) and weight (kilograms) were objectively measured by trained study personnel. Body mass index (BMI; weight (kg)/height (m)<sup>2</sup>) was calculated from height and weight measurements and categorized as underweight/normal (≤24.9), overweight (25.0–29.9), or obese (≥30.0). Other clinical characteristics (yes, no) included current menopausal status and physician diagnosis of clinical depression. Stress-related characteristics included score on the 4-item Perceived Stress Scale (28) and ever (vs. never) experiencing other types of discrimination (discrimination based on sexual orientation or unfair treatment in job hiring, firing, or promotion due to sex, age, sexual orientation, or medical conditions).

### Statistical analysis

Accumulated person-time in the overall sample and for each racial/ethnic discrimination domain was collected from the first follow-up until a participant 1) reported a diagnosis of T2DM, 2) was lost to follow-up, 3) died, or 4) reached the end of follow-up. Cause-specific Cox proportional hazards regression models with age as the time scale were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for T2DM associated with everyday, major, and combined racial/ethnic discrimination, separately. Tests using Schoenfeld residuals and racial/ethnic discrimination × time (age) interaction terms indicated that the proportional hazards assumptions were met.

We examined the following sequential models, overall as well as stratified by race/ethnicity, and we tested the statistical significance of race/ethnicity × everyday/major racial/ethnic discrimination interaction terms. Model 1 adjusted for baseline sociodemographic characteristics, including continuous age, annual household income, marital status, educational attainment, and current employment status, as well as major discrimination (in analyses for everyday discrimination) and everyday discrimination (in analyses for major discrimination). Model 2 adjusted for sociodemographic characteristics and either form of racial/ethnic discrimination in model 1 plus BMI category, a strong potential mediator. We considered BMI a potential mediator because psychological stress related to discrimination may, for instance, contribute to unhealthy behaviors (e.g., poor sleep, physical inactivity) that are risk factors for higher BMI (29), and BMI measured at baseline is a likely mediator

between lifetime experiences of discrimination and T2DM incidence. All models for the overall population additionally adjusted for race/ethnicity.

We performed 9 separate sensitivity analyses to assess the difference in estimates when we 1) compared participants with any racial/ethnic discrimination with those with no racial/ethnic discrimination; 2) compared only individuals who reported that discrimination occurred at least 5 years prior to the discrimination assessment with participants who reported no racial/ethnic discrimination; 3) additionally adjusted for childhood socioeconomic position; 4) additionally adjusted for potential mediators, including baseline health behaviors and clinical characteristics; 5) treated each form of racial/ethnic discrimination as a continuous score (possible range, 0–3) among Black participants, since the prevalence was highest in this population; and stratified by potential effect modifiers, including 6) educational attainment, 7) shift-work status, and 8) obesity. Lastly, we 9) assessed associations between each mutually adjusted individual component of racial/ethnic discrimination (e.g., unfair home renting/home buying/mortgage lending) and T2DM. All analyses were conducted using SAS, version 9.4 (SAS Institute Inc., Cary, North Carolina). A 2-sided  $P$  value less than 0.05 was considered statistically significant.

## RESULTS

### Study participants

Among the eligible 33,833 participants, the mean age was 54.9 (standard deviation, 8.8) years; 90% self-identified as White, 7% as Black, and 3% as Hispanic/Latina (Table 1). Most participants were aged 35–64 years (85%), had attained a bachelor's degree or more (54%), were currently employed (68%), were married or living as married (77%), never smoked (58%), and were light/moderate drinkers (72%). The prevalence of ever experiencing everyday racial/ethnic discrimination was highest among Black women (75% vs. 4% for White women and 32% for Hispanic/Latina women). More than half of Black women (51%) reported ever experiencing major discrimination (vs. 2% (White) and 16% (Hispanic/Latina)). Similarly, Black women had the highest prevalence of experiencing both everyday and major discrimination (47% vs. 1% (White) and 12% (Hispanic/Latina)).

### Racial/ethnic discrimination and T2DM risk in the overall sample

Over a mean follow-up period of 6.9 years, there were 1,167 participants who reported a T2DM diagnosis. Everyday racial/ethnic discrimination was not associated with incident T2DM (Table 2). After adjustment for sociodemographic characteristics and everyday racial/ethnic discrimination, individuals who reported experiencing major racial/ethnic discrimination had a 25% higher risk of developing T2DM (HR = 1.25, 95% CI: 0.98, 1.61) than those reporting no discrimination. This marginal association remained after additional adjustment for BMI (HR = 1.26, 95% CI: 0.99, 1.61). Combined everyday and major racial/ethnic discrimi-

nation was not associated with incident T2DM in the overall sample (both vs. none: HR = 1.17 (95% CI: 0.87, 1.56); either vs. none: HR = 1.08 (95% CI: 0.86, 1.36)).

### Racial/ethnic discrimination and T2DM risk by race/ethnicity

Null associations between everyday racial/ethnic discrimination and incident T2DM did not vary by race/ethnicity. Prior to adjustment for BMI, data suggested that the association between major racial/ethnic discrimination and incident T2DM varied by race/ethnicity, with HRs of 1.67 (95% CI: 1.16, 2.39) among Whites, 1.11 (95% CI: 0.79, 1.56) among Blacks, and 0.59 (95% CI: 0.22, 1.60) among Latinas (major racial/ethnic discrimination  $\times$  race/ethnicity interaction:  $P < 0.10$ ). After adjustment for BMI, results were attenuated and did not vary by race/ethnicity; the interaction by race/ethnicity  $P$  value was greater than 0.10. However, White participants who reported major racial/ethnic discrimination had a 58% greater hazard of incident T2DM (HR = 1.58, 95% CI: 1.10, 2.26) than White participants who reported no major discrimination. There was a similar pattern by race/ethnicity for combined racial/ethnic discrimination. Estimated HRs for associations with combined racial/ethnic discrimination were positive among Whites and negative among Latinas; however, the interaction by race/ethnicity  $P$  value was greater than 0.10.

### Sensitivity analysis

When comparing participants who reported any racial/ethnic discrimination with participants who reported none, there was a marginal positive association with T2DM overall (HR = 1.11, 95% CI: 0.90, 1.36), and similar to the association with major discrimination in the main analysis, there was a suggestive positive association among Whites, a null association among Blacks, and a suggestive negative association among Latinas (Table 3). In comparisons of participants who reported that discrimination occurred at least 5 years prior to the assessment with participants who reported no discrimination, estimates were less precise and attenuated but were consistent with those of the main analysis (Web Table 4). Estimates were comparable across analyses with and without adjustment for childhood socioeconomic position (Web Table 5). After adjustment for additional potential mediators, including health behaviors and clinical characteristics, associations between major racial/ethnic discrimination and T2DM varied by race/ethnicity: There were positive associations among Whites (HR = 1.79, 95% CI: 1.13, 2.86) and Blacks (HR = 1.17, 95% CI: 0.65, 2.09), and associations were negative among Latinas (HR = 0.12, 95% CI: 0.01, 1.06; Web Table 6). However, there were few cases ( $n = 5$ ) among Latinas who reported experiencing major racial/ethnic discrimination. When everyday and major racial/ethnic discrimination were treated as continuous scores among Black women, everyday discrimination remained unassociated with incident T2DM, but Black participants who reported 2 types of major racial/ethnic discrimination had a 64% higher risk of incident T2DM



**Table 1.** Baseline Sociodemographic Characteristics, Health Behaviors, Clinical Characteristics, and Perceived Experiences of Racial/Ethnic Discrimination Among 33,833 Women in the Sister Study, 2003–2009

Characteristic	Racial/Ethnic Group							
	Total (n = 33,833; 100%)		NH White (n = 30,409; 90%)		NH Black (n = 2,435; 7%)		Hispanic/Latina (n = 989; 3%)	
	% <sup>a</sup>	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%	Mean (SD)
Sociodemographic characteristics								
Age, years		54.9 (8.8)		55.2 (8.8)		52.7 (8.1)		51.4 (8.8)
Age category, years								
35–64	85		84		93		92	
≥65	15		16		7		8	
Educational attainment								
High school or less	14		14		8		21	
Some college or technical degree	32		32		32		36	
Bachelor's degree or more	54		54		59		43	
Employment status								
Unemployed <sup>b</sup>	32		33		21		29	
Currently employed	68		67		79		71	
Shift work (yes)	15		15		13		13	
Annual household income, dollars								
<20,000	3		2		4		9	
20,000–49,999	19		18		22		24	
50,000–99,999	42		42		44		38	
≥100,000	37		38		30		29	
Marital status								
Married/living as married	77		79		55		73	
Single/never married	5		4		14		5	
Divorced/separated/widowed	17		16		31		21	
Region of residence								
Northeast	18		19		9		11	
Midwest	28		29		22		9	
South	32		29		61		42	
West	22		23		8		38	
Childhood SEP								
Food insecurity while growing up (yes)	8		7		15		20	
Household educational attainment less than high school at age 13 years (yes)	16		13		34		47	
Low household income <sup>c</sup> while growing up (yes)	31		29		54		49	

Table continues

Table 1. Continued

Characteristic	Racial/Ethnic Group							
	Total (n = 33,833; 100%)		NH White (n = 30,409; 90%)		NH Black (n = 2,435; 7%)		Hispanic/Latina (n = 989; 3%)	
	% <sup>a</sup>	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%	Mean (SD)
Health behaviors								
Smoking status								
Never smoker	58		57		69		69	
Former smoker	35		36		23		24	
Current smoker	7		7		9		7	
Alcohol consumption (past 12 months)								
Nondrinker (never/former drinker)	16		15		27		20	
Light/moderate drinker ( $\leq 7$ drinks/week)	72		72		68		73	
Heavy drinker ( $> 7$ drinks/week)	12		13		5		6	
Healthy Eating Index score <sup>d</sup>		72.3 (9.4)		72.4 (9.4)		71.4 (9.2)		70.9 (9.9)
Physical activity, MET-hours/week		3.8 (0.6)		3.8 (0.6)		3.6 (0.7)		3.7 (0.7)
Cumulative poor sleep score <sup>e</sup>		1.0 (1.2)		1.0 (1.2)		1.5 (1.3)		1.2 (1.2)
Clinical characteristics								
BMI <sup>f</sup>		27.0 (5.7)		26.7 (5.6)		30.4 (6.6)		27.5 (5.4)
BMI category								
Underweight/normal ( $\leq 24.9$ )	43		45		20		36	
Overweight (25.0–29.9)	32		32		34		38	
Obese ( $\geq 30.0$ )	25		23		46		26	
Menopausal (yes)	63		64		55		51	
Physician-diagnosed clinical depression (yes)	19		19		13		20	
Stress-related characteristics								
PSS-4 score		2.6 (2.7)		2.6 (2.6)		3.0 (2.9)		3.2 (2.9)
Other discrimination <sup>g</sup> (yes)	25		24		34		19	
Perceived racial/ethnic discrimination <sup>h</sup>								
Total score		0.3 (0.8)		0.1 (0.3)		2.3 (1.7)		0.7 (1.2)
Everyday discrimination								
Score		0.2 (0.6)		0.0 (0.2)		1.6 (1.1)		0.5 (0.8)
Ever <sup>i</sup>	10		4		75		32	
Major discrimination								
Score		0.1 (0.4)		0.0 (0.2)		0.8 (0.9)		0.2 (0.6)
Ever <sup>i</sup>	6		2		51		16	

Table continues

Table 1. Continued

Characteristic	Racial/Ethnic Group							
	Total (n = 33,833; 100%)		NH White (n = 30,409; 90%)		NH Black (n = 2,435; 7%)		Hispanic/Latina (n = 989; 3%)	
	% <sup>a</sup>	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%	Mean (SD)
Both types of discrimination combined								
Both	4		1		47		12	
Either	7		5		32		24	
None	88		95		21		64	

Abbreviations: BMI, body mass index; MET, metabolic equivalent of task; NH, non-Hispanic; PSS-4, Perceived Stress Scale 4; SD, standard deviation; SEP, socioeconomic position.

<sup>a</sup> Percentages may not add up to 100 because of rounding.

<sup>b</sup> Includes unemployed, homemaker, student, and retired.

<sup>c</sup> Participants were asked, "How would you characterize your family's income level during the majority of the time growing up?" Response options included "well-off," "middle-income," "low-income," or "poor." Low household income was dichotomized as yes (low-income or poor) versus no (well-off or middle-income).

<sup>d</sup> Healthy Eating Index scores can range from 0 to 100, with higher scores indicating a healthier diet.

<sup>e</sup> Cumulative poor sleep score was based on self-report of the following: habitual short or long sleep duration (<7 hours/night or day or >9 hours/night or day); inconsistent weekly sleep patterns (inconsistent bedtimes and wake-up times from week to week); sleep debt (≥2-hour difference between longest and shortest sleep durations); frequent napping (≥3 days/week vs. <3 days/week); difficulty falling asleep (taking >30 minutes to fall asleep, on average); and difficulty staying asleep (waking up ≥3 times/night on ≥3 nights/week vs. waking up <3 times/night on <3 nights/week).

<sup>f</sup> Weight (kg)/height (m)<sup>2</sup>.

<sup>g</sup> Includes unfair treatment due to sexual orientation, as well as in job hiring, firing, or promoting due to sex, age, sexual orientation, or medical conditions.

<sup>h</sup> Everyday discrimination includes being treated unfairly in receiving service at a store or restaurant; being treated as though you were less intelligent, worthy, or honest than others; and experiencing people acting as if they are afraid of you due to your race or ethnicity. Major racial/ethnic discrimination includes being treated unfairly in home renting, buying, or mortgage lending; being treated unfairly in being stopped, searched, or threatened by police; or being treated unfairly in job hiring, promotion, or firing due to your race or ethnicity. Combined discrimination: both = everyday and major discrimination; either = either everyday or major discrimination, but not both; none = neither everyday nor major discrimination.

<sup>i</sup> Data are presented as percentage of participants who endorsed at least 1 experience.

(HR = 1.64, 95% CI: 1.06, 2.56) compared with their within-race/ethnicity counterparts who reported none (Web Table 7). Although the numbers of cases were small after stratification, there was little variation by strata of educational attainment, shift work, and obesity status, and results were consistent with those of the main analysis (Web Tables 8–10). Lastly, when assessing individual components of discrimination, unfair treatment in home renting and buying/mortgage lending was the only component of major racial/ethnic discrimination that was positively associated with T2DM incidence (Web Table 11).

## DISCUSSION

In this large prospective cohort study of White, Black, and Hispanic/Latina women, major racial/ethnic discrimination was marginally associated with higher risk of incident T2DM. Everyday racial/ethnic discrimination and the combination of both everyday and major racial/ethnic discrimination were not associated with incident T2DM. However, the marginal association with major racial/ethnic discrimination

persisted after adjustment for sociodemographic and clinical characteristics, including a strong potential mediator, BMI. Compared with White women, major racial/ethnic discrimination was reported by over 25 times more Black women and 8 times more Hispanic/Latina women. Furthermore, T2DM incidence among Black and Hispanic/Latina women was higher than the incidence of T2DM among White women. The high prevalence of racial/ethnic discrimination and the higher incidence rate of T2DM among racial/ethnic minority women, along with the higher incidence of T2DM associated with experiencing major racial/ethnic discrimination overall, suggest that racial/ethnic discrimination may contribute to the high burden of T2DM overall and to racial/ethnic disparities in T2DM (30). As Ward et al. (30) discussed, it is important to assess disparities beyond statistical tests for interactions because both exposure prevalence and outcome incidence, as well as effect sizes, provide evidence of potential disparities. Further, absolute versus relative associations likely better reflect disparities when the baseline exposure prevalence (i.e., prevalence of racial/ethnic discrimination) greatly varies between subpopulations.

**Table 2.** Adjusted Hazard Ratios for Risk of Type 2 Diabetes Mellitus Among 33,833 Women in the Sister Study, Overall and by Race/Ethnicity, 2003–2017<sup>a</sup>

Perceived Racial/Ethnic Discrimination	No. of T2DM Cases by Racial/Ethnic Discrimination			Model 1 <sup>b</sup>		Model 2 <sup>c</sup>	
	Yes	No	Combined	HR	95% CI	HR	95% CI
Everyday discrimination (yes vs. no) <sup>d</sup>							
Total	181	986		0.95	0.75, 1.22	0.93	0.73, 1.18
NH White women	42	906		0.98	0.69, 1.38	0.93	0.66, 1.32
NH Black women	125	43		0.93	0.63, 1.38	0.93	0.63, 1.37
Hispanic/Latina women	14	37		1.05	0.54, 2.07	0.97	0.49, 1.92
Major discrimination (yes vs. no) <sup>e</sup>							
Total	127	1,040		1.25 <sup>f</sup>	0.98, 1.61	1.26	0.99, 1.61
NH White women	34	914		1.67	1.16, 2.39	1.58	1.10, 2.26
NH Black women	88	80		1.11	0.79, 1.56	1.15	0.81, 1.62
Hispanic/Latina women	5	46		0.59	0.22, 1.60	0.56	0.20, 1.55
Both types of discrimination combined <sup>g</sup>							
Total							
Both			94	1.17	0.87, 1.58	1.17	0.87, 1.56
Either			120	1.13	0.90, 1.42	1.08	0.86, 1.36
None			953	1.00	Referent	1.00	Referent
NH White women							
Both			9	1.30	0.65, 2.60	1.28	0.64, 2.56
Either			58	1.32	1.00, 1.74	1.22	0.92, 1.61
None			881	1.00	Referent	1.00	Referent
NH Black women							
Both			81	1.02	0.68, 1.53	1.05	0.70, 1.58
Either			51	0.89	0.57, 1.37	0.90	0.58, 1.39
None			36	1.00	Referent	1.00	Referent
Hispanic/Latina women							
Both			4	0.65	0.23, 1.88	0.58	0.20, 1.72
Either			11	0.93	0.46, 1.86	0.86	0.42, 1.72
None			36	1.00	Referent	1.00	Referent

Abbreviations: CI, confidence interval; HR, hazard ratio; NH, non-Hispanic; T2DM, type 2 diabetes mellitus.

<sup>a</sup> Women who reported racial/ethnic discrimination were compared with women who did not report racial/ethnic discrimination.

<sup>b</sup> Model 1: race/ethnicity (in the overall model) + continuous age + income + marital status + educational attainment + employment status + major discrimination (in everyday discrimination analyses) + everyday discrimination (in major discrimination analyses).

<sup>c</sup> Model 2: model 1 variables + body mass index.

<sup>d</sup> Everyday discrimination includes being treated unfairly in receiving service at a store or restaurant; being treated as though you were less intelligent, worthy, or honest than others; and experiencing people acting as if they are afraid of you due to your race or ethnicity.

<sup>e</sup> Major racial/ethnic discrimination includes being treated unfairly in home renting, home buying, or mortgage; being treated unfairly in being stopped, searched, or threatened by police; or being treated unfairly in job hiring, promotion, or firing due to your race or ethnicity.

<sup>f</sup> Discrimination × race/ethnicity interaction:  $P < 0.10$ .

<sup>g</sup> Combined discrimination: both = both everyday and major discrimination; either = either everyday or major discrimination, but not both; none = neither everyday nor major discrimination.

Several potential mechanisms may explain our observation that experiencing major racial/ethnic discrimination was associated with higher risk of T2DM. Major experiences of racial/ethnic discrimination may, for example, be associated with higher risk of T2DM through environmental

influences that have behavioral and biological consequences. For instance, being denied a mortgage loan or experiencing unfair treatment at work, leading to low job mobility, may result in individuals' residing in a segregated, low-SES neighborhood that lacks access to goods, services,



**Table 3.** Adjusted Hazard Ratios for Type 2 Diabetes Mellitus Among 33,833 Women in the Sister Study, Overall and by Race/Ethnicity, 2003–2017<sup>a</sup>

Combined Perceived Racial/Ethnic Discrimination <sup>b</sup>	No. of T2DM Cases	Model 1 <sup>c</sup>		Model 2 <sup>d</sup>	
		HR	95% CI	HR	95% CI
Total					
Either or both	214	1.14	0.92, 1.41	1.11	0.90, 1.36
None	953	1.00	Referent	1.00	Referent
NH White women					
Either or both	67	1.31	1.01, 1.71	1.22	0.94, 1.59
None	881	1.00	Referent	1.00	Referent
NH Black women					
Either or both	132	0.96	0.66, 1.40	0.98	0.67, 1.44
None	36	1.00	Referent	1.00	Referent
Hispanic/Latina women					
Either or both	15	0.84	0.45, 1.57	0.77	0.41, 1.45
None	36	1.00	Referent	1.00	Referent

Abbreviations: CI, confidence interval; HR, hazard ratio; NH, non-Hispanic; T2DM, type 2 diabetes mellitus.

<sup>a</sup> Women who reported any racial/ethnic discrimination were compared with women who did not report racial/ethnic discrimination.

<sup>b</sup> Combined discrimination: both = both everyday and major discrimination; either = either everyday or major discrimination, but not both; none = neither everyday nor major discrimination. Everyday discrimination includes being treated unfairly in receiving service at a store or restaurant; being treated as though you were less intelligent, worthy, or honest than others; and experiencing people acting as if they are afraid of you due to your race or ethnicity. Major racial/ethnic discrimination includes being treated unfairly in home renting, home buying, or mortgage lending; being treated unfairly in being stopped, searched, or threatened by police; or being treated unfairly in job hiring, promotion, or firing due to your race or ethnicity.

<sup>c</sup> Model 1: race/ethnicity (in the overall model) + continuous age + income + marital status + educational attainment + employment status.

<sup>d</sup> Model 2: model 1 variables + body mass index.

and environments that may promote healthy behaviors and reduced psychosocial stress (e.g., healthy food options, parks, safe sleeping environments), thus contributing to T2DM risk (31–33). Discrimination at work may result in succumbing to stereotype threats and working longer hours, leaving less time for physical activity. Further, psychological stress related to discrimination can contribute to unhealthy behaviors such as emotional overeating and poor sleep due to nighttime rumination over discriminatory events. These behaviors have been identified as risk factors for obesity (29) that can increase inflammation, and the obesity status of participants likely acts as a mediator on the pathway from discriminatory events to T2DM incidence.

Our finding that major racial/ethnic discrimination may contribute to T2DM risk was largely consistent with studies conducted among racially/ethnically diverse US adults (9, 11). In a prospective cohort study carried out among participants in the Multi-Ethnic Study of Atherosclerosis, categorically measured major experiences of general discrimination were associated with a 34% increased risk of T2DM in the multivariate models, and the authors found similar associations regardless of whether the discriminatory act was attributed to race/ethnicity (9). In the Multi-Ethnic Study of Atherosclerosis cohort, as in our study, there were no significant differences in the association between discrimination and T2DM by race/ethnicity (9). Consistent with our observations, everyday discrimination, alone, was

not associated with increased incidence of T2DM (9). In contrast to our study, results in the Black Women's Health Study suggested that women with the highest exposure to everyday racism had a 31% increased risk of diabetes and those with the highest exposure to lifetime racism had a 16% increased risk (11).

### Limitations and strengths

Our study had limitations. First, we relied on self-reported physician diagnosis of T2DM; however, self-reports of T2DM diagnosis have been validated as reliable (24). Nonetheless, self-reported data on confounders may be subject to measurement error, and this misclassification would likely have been nondifferential, resulting in a biased estimate towards the null. Second, perceived lifetime racial/ethnic discrimination was assessed at only 1 time point, which could have resulted in misclassification bias; however, experiences of racial/ethnic discrimination are often salient among those who experience discriminatory events and could result in prolonged embodiment of racial/discrimination, which could affect future health outcomes (34). Relatedly, cognitive biases like social desirability can lead to underreporting of discrimination and underestimation of its association with health outcomes (5). Furthermore, our measures of discrimination did not capture the recency, number, or severity of discriminatory events, which could provide details on

the burden of racial/ethnic discrimination and the potential impact on T2DM incidence. Third, our study population was limited to women, and associations between racial/ethnic discrimination and diabetes risk could vary between men and women. Sex variation in coping responses may result in men's responding differently to racial/ethnic discrimination than women (35). Fourth, although it is a strength that we investigated associations between racial/ethnic discrimination, in particular, and diabetes risk, we were unable to capture potential within-racial/ethnic-group heterogeneity of discrimination experiences among populations that include members of multiple marginalized groups (e.g., older racial/ethnic minorities of low SES who may experience multiple forms of discrimination) (36). Lastly, our study population was largely White, educated, and of high SES, which limited statistical power among racial/ethnic minority groups and may limit generalizability to lower-SES individuals. However, we expect that the potential biological pathways linking racial/ethnic discrimination to T2DM would be consistent across populations. Nonetheless, prior studies have suggested that the strength of risk factors for T2DM, like SES and BMI, varies by race/ethnicity (37). Future studies that are well-powered to further investigate potential effect modifiers along with race/ethnicity are warranted.

Despite these limitations, our study had several strengths. We employed a prospective study design with a large cohort of racially/ethnically diverse US women. We also investigated multiple types of racial/ethnic discrimination. Our study expands on the existing literature by demonstrating that major racial/ethnic discrimination may be associated with incident T2DM, which warrants further investigation of potential modification by race/ethnicity.

### Implications and future directions

Our finding that experiencing major racial/ethnic discrimination may be associated with greater risk of incident T2DM has several public health implications. Health-care providers may improve preventative care by inquiring about discrimination (along with other life stressors) and follow up such inquiries by suggesting mitigation strategies to reduce stress and encouraging healthy coping behaviors. Further, structural/institutional and personally mediated antidiscrimination efforts can produce socially desirable benefits and have the potential to assist in reducing the costly burden of T2DM in the United States. Future studies should use prospective, objectively measured data to address the current study's limitations. Further, a large sample of racial/ethnic minority participants would allow for more robust estimates of variation between and within racial/ethnic groups. For instance, previous literature has suggested variation in the perception of discrimination within members of the African diaspora and by Hispanic/Latino heritage (36, 38, 39), which has potential implications for how racial/ethnic discrimination may impact health outcomes within various racial/ethnic minority groups.

In conclusion, T2DM is a major public health concern, particularly among racial/ethnic minorities in the United States. This study suggests that major experiences of dis-

crimination, which are potential targets for intervention, may contribute to the high, costly burden of T2DM among women. The higher prevalence of racial/ethnic discrimination among Black and Hispanic/Latina women may contribute to greater T2DM incidence in these groups. Additional population-based studies are needed to understand the potential physiological mechanisms of perceived experiences of racial/ethnic discrimination in relation to T2DM, which may help mitigate racial/ethnic disparities in T2DM incidence and have a broader public health impact.

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The data sets generated during and/or analyzed during the current study are not publicly available due to privacy concerns. However, requests for data, including the data used in this analysis, may be made following procedures described on the Sister Study website ([www.sisterstudy.niehs.nih.gov](http://www.sisterstudy.niehs.nih.gov)) under the tab "For Researchers."

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