Original Contribution

Experiences of Discrimination and Incident Type 2 Diabetes Mellitus: The Multi-Ethnic Study of Atherosclerosis (MESA)

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Experiences of discrimination are associated with increased risk of adverse health outcomes; however, it is unknown whether discrimination is related to incident type 2 diabetes mellitus (diabetes). We investigated the associations of major experiences of discrimination (unfair treatment in 6 situations) and everyday discrimination (frequency of day-to-day experiences of unfair treatment) with incident diabetes among 5,310 participants from the Multi-Ethnic Study of Atherosclerosis, enrolled in 2000–2002. Using Cox proportional hazards models, we estimated hazard ratios and confidence intervals, adjusting for demographic factors, depressive symptoms, stress, smoking, alcohol, physical activity, diet, waist circumference, and body mass index. Over a median follow-up of 9.4 years, 654 diabetes cases were accrued. Major experiences of discrimination were associated with greater risk of incident diabetes when modeled continuously (for each additional experience of discrimination, hazard ratio = 1.09, 95% confidence interval: 1.01, 1.17) or categorically (for ≥2 experiences vs. 0, hazard ratio = 1.34, 95% confidence interval: 1.08, 1.66). Similar patterns were observed when evaluating discrimination attributed to race/ethnicity or to a combination of other sources. Everyday discrimination was not associated with incident diabetes. In conclusion, major experiences of discrimination were associated with increased risk of incident diabetes, independent of obesity or behavioral and psychosocial factors. Future research is needed to explore the mechanisms of the discrimination-diabetes relationship.

discrimination; Multi-Ethnic Study of Atherosclerosis (MESA); obesity; race/ethnicity; stress; type 2 diabetes mellitus

Abbreviations: BMI, body mass index; CI, confidence interval; HR, hazard ratio; MESA, Multi-Ethnic Study of Atherosclerosis.

The adverse association between discrimination and mental health is well established. Studies have identified associations of discrimination with depression, distress, anxiety, lack of well-being, and psychotic experiences (1–4). Growing evidence also suggests that more experiences of discrimination are related to poorer physical health (1, 3). Cross-sectional and longitudinal studies have reported associations of discrimination with a wide variety of physical health outcomes, including all-cause mortality, cardiovascular disease, hypertension, breast cancer, and asthma (5–10).

Discrimination is a form of psychosocial stress that is thought to influence health through both physiological and behavioral mechanisms. Chronic experiences of stress are

considered most deleterious because they are more likely to result in long-term changes in physiological or behavioral responses that ultimately influence disease susceptibility (11, 12). This would include more subtle forms of day-to-day discrimination, as well as major experiences of discrimination that continue to have lasting consequences long after the actual experience has ended (13). Stress leads to negative emotional states, which may trigger activation of the hypothalamic-pituitary-adrenal axis, causing an increase in glucocorticoid exposure, resulting in immunosuppression and hyperglycemia (14, 15). Stress may also influence health by leading to adverse behavioral coping responses (1, 3, 16). Studies have demonstrated an association between discrimination and adverse

health behaviors such as smoking, high alcohol consumption, reduced physical activity, and poor dietary habits [17–19] as well as measures of adiposity, including greater body mass index (BMI), waist circumference, and visceral fat [20–23].

Given the mechanisms by which stress is thought to affect health, it is plausible that experiences of discrimination increase the risk of developing type 2 diabetes mellitus (diabetes). For example, discrimination may increase stress and depressive symptoms, thus leading to adverse coping behaviors, such as poor dietary habits, which increases the risk of obesity and diabetes. However, to our knowledge, no studies have examined the associations of discrimination and incident diabetes.

Furthermore, despite the increasing number of studies examining the relationship between discrimination and health, several questions remain unanswered. For example, existing research has focused largely on racial discrimination or overall mistreatment, primarily in African Americans, and less is known about other types of discrimination and physical health outcomes or whether these associations differ in other racial/ethnic groups [1, 2]. Also, few studies have examined whether the association between discrimination and health differs according to whether the discrimination was due to race or other sources of unfair treatment [6, 8, 24], and the evidence is not consistent as to whether chronic, everyday experiences of discrimination are more influential than major experiences of discrimination [2]. A recent review paper by Lewis et al. [4] called for additional research to disentangle the associations of different types of discrimination on health outcomes.

The purpose of this study was to evaluate whether self-reported experiences of discrimination are related to incident diabetes over a 10-year period in a population-based cohort including 4 racial/ethnic groups. We hypothesized that major experiences of discrimination and everyday discrimination are associated with a greater risk of developing diabetes. Additionally, we separately evaluated major experiences of discrimination self-attributed to race/ethnicity versus other sources in relation to diabetes risk. Given that the relationship between discrimination and adverse health events may differ by demographic characteristics, we also examined potential differences in associations of discrimination and incident diabetes by race/ethnicity, age, and sex.

METHODS

Study population

The Multi-Ethnic Study of Atherosclerosis (MESA) is an ongoing cohort study of adults who were initially recruited in 2000–2002 (examination 1) from 6 different field centers in the United States (Baltimore, Maryland; Chicago, Illinois; St. Paul, Minnesota; Los Angeles, California; New York, New York; and Forsyth County, North Carolina). Additional examinations occurred at approximately 2-year intervals (examination 2: 2002–2004, examination 3: 2004–2005, examination 4: 2005–2007, and examination 5: 2010–2013). At recruitment, the 6,814 participants—who self-identified as African American (28%), Chinese (12%), Hispanic (22%), or non-Hispanic

white (38%)—were aged 45–84 years and did not have known cardiovascular disease. For the present study, participants were excluded if they had baseline type 1 ($n = 10$) or type 2 diabetes ($n = 849$), defined by fasting blood glucose ≥ 126 mg/dL or use of glucose-lowering medications, or were missing data on diabetes status ($n = 24$), did not complete both discrimination questionnaires at baseline ($n = 129$), had no follow-up visits ($n = 319$), or were missing data on family income ($n = 173$). The final sample comprised 5,310 persons. Institutional review board approval was obtained at each study site, and written informed consent was obtained from all participants.

Discrimination

Discrimination was assessed at baseline using a modified version of the Major Experiences of Discrimination Scale and the Everyday Discrimination Scale [25]. See Web Table 1 (available at https://academic.oup.com/aje) for complete questionnaires. These scales were originally developed for the Detroit Area Study in Michigan and have demonstrated reliability and validity [20, 25–28]. Major experiences of discrimination were assessed by asking participants to report whether they had ever been treated unfairly (yes/no) in 6 situations. A summary score was created by assigning a value of 0 for each negative response and 1 for each affirmative response (range, 0–6). Few participants reported more than 2 experiences of discrimination; therefore this summary score was categorized into 3 groups (0, 1, or ≥ 2 situations), with those reporting no discrimination (score = 0) serving as the reference group. For each affirmative response, participants were asked to select 1 reason why they believed they were treated unfairly (race/ethnicity, gender, age, religion, physical appearance, sexual orientation, income level/social class, or other). Similar summary scores were created for discrimination specifically attributed to race/ethnicity and to other sources by summing the number of times a respondent selected each attribute. Both scores have ranges of 0–6, and for analyses they were categorized as 0, 1, or ≥ 2 situations. Other sources of discrimination not attributed to race/ethnicity were combined due to small sample sizes.

Day-to-day experiences of discrimination, such as being treated with less respect than others, were assessed using the 9-item Everyday Discrimination Scale [25]. Participants were asked how often they experienced discriminatory events in their everyday life without reference to why they believed they were treated unfairly. Response options were on a 6-point scale: 1 = almost every day; 2 = at least once a week; 3 = a few times a month; 4 = a few times a year; 5 = less than once a year; and 6 = never. Items were reverse coded and summed, with higher scores indicating greater frequency of day-to-day discrimination. Summed scores were then averaged across the 9 items to create an everyday discrimination score (range, 1–6). After examining the distribution of scores, they were categorized into approximate quartiles: none (score = 1; 25.4%), low (score >1 and <1.5; 27.3%), moderate (score 1.5–2; 25.5%), or high (score >2; 21.8%).

Diabetes

The primary outcome was incident diabetes as defined by the 2003 American Diabetes Association criteria: fasting glucose ≥126 mg/dL, use of oral hypoglycemic medication and/or insulin, or self-reported physician diagnosis of diabetes (29). Incident diabetes was identified at one of 4 follow-up examinations that took place in 2002–2003, 2004–2005, 2005–2007, and 2010–2011. Follow-up time was defined as time between the baseline visit and either an incident diabetes event or the last clinic visit attended, whichever occurred first.

Covariates

Baseline age, field center, race/ethnicity (African American, Chinese, Hispanic, non-Hispanic white), sex, marital status (married/living with partner, widowed, divorced or separated, never married), education (less than high school diploma, high school diploma or some college/technical school, college degree or more), and annual family income (<$20,000, $20,000–$49,999, ≥$50,000) were included in all models. Psychosocial covariates included chronic stress, assessed using the 5-item Chronic Burden Scale (30), and depressive symptoms were measured with the 20-item Center for Epidemiologic Studies Depression Scale (31). Behavioral covariates included alcohol use (none or light drinker, moderate drinker, heavy drinker), smoking (current smoker, former smoker, never smoker), physical activity (metabolic equivalents of physical activities in minutes per week) as measured by the MESA Typical Week Physical Activity Survey, and diet quality score as calculated in prior MESA reports (9 food groups assessed using a food frequency questionnaire) (32, 33). Measures of obesity included BMI and waist circumference. Weight and height were assessed using a balance beam scale and stadiometer, respectively. BMI was calculated as weight in kilograms divided by height in meters squared. Waist circumference was measured at the level of the umbilicus.

Statistical analyses

Time to incident diabetes was modeled with Cox proportional hazards models. Major experiences of discrimination and everyday discrimination were included as predictors in separate models as both continuous and categorical variables. Initial models adjusted for baseline sociodemographic characteristics because these could be potential confounders of the discrimination-diabetes association. Based on findings from previous research indicating a relationship between discrimination and mental health outcomes, adverse health behaviors, and obesity, we consider these characteristics potential mediators of the relationship between discrimination and diabetes. Our theoretical model can be summarized as follows: discrimination → stress/depression → adverse health behaviors → obesity → diabetes. Therefore, in model 2 we also adjusted for chronic stress and depressive symptoms, assessed at baseline. In model 3 we further adjusted for behavioral covariates, including baseline alcohol use, smoking, physical activity and diet quality. Finally, in model 4 we additionally adjusted for obesity, using BMI and waist circumference. Interpretation of results follows from our theoretical model and accordingly

differs by the statistical model being evaluated. For example, attenuation of the effect estimate after adjustment for the covariates in model 1 is interpreted as evidence of substantial confounding by 1 or more of the adjustment variables. By contrast, attenuation of the effect estimate after adjustment for the covariates in models 2, 3, or 4 is interpreted as evidence of mediation by 1 or more of the adjustment variables.

We also examined interactions with race/ethnicity, age, and sex by including cross-product terms in the models. For all models, the proportional hazards assumption was tested by inspection of log-minus-log survival versus log survival curves by including time-covariate interactions for the discrimination measures in the final models. All statistical analyses were conducted using SAS, version 9.4 (SAS Institute, Inc., Cary, North Carolina). All tests were 2-sided, with statistical significance set at $P < 0.05$.

RESULTS

Participant characteristics

As seen in Table 1, nearly 58% of the population reported no major experiences of discrimination, 23% reported discrimination in one situation, and 20% discrimination in 2 or more situations. All participant characteristics significantly differed by discrimination category ($P < 0.001$). Participants reporting greater levels of discrimination were more likely to be younger, African American, male, never married or divorced/separated, and have greater levels of education and income. Those reporting higher levels of discrimination were also more likely to be smokers, have higher levels of alcohol use, more depressive symptoms and chronic stress, higher levels of physical activity, greater mean BMI and waist circumference, and lower diet quality.

Approximately 18% of the total sample attributed at least 1 experience of discrimination to race/ethnicity ($n = 973$), and 31% attributed experience of discrimination to other causes ($n = 1,636$). Discrimination attributed to race/ethnicity was reported most frequently for African Americans (44.8%), followed by Hispanics (20.2%), Chinese (11.9%), and non-Hispanic whites (4.1%). Discrimination attributed to other causes was reported most frequently for non-Hispanic whites (35.9%), followed by African Americans (35.0%), Hispanics (27.3%), and Chinese (14.4%; data not shown).

Major experiences of discrimination and incident diabetes

A total of 654 cases of incident diabetes were confirmed during a median follow-up of 9.4 years (range, 0.87–11.38). The incidence per 1,000 person-years was 21.7 in Hispanics, 19.8 in African Americans, 16.1 in Chinese, and 11.6 in non-Hispanic whites. The hazard ratios and 95% confidence intervals of incident diabetes according to the number of major experiences of discrimination are presented in Table 2. For each additional experience of overall discrimination reported, there was a 12% increased risk of incident diabetes after controlling for demographic factors (hazard ratio (HR) = 1.12, 95% confidence interval (CI): 1.04, 1.19). This association remained significant after additionally controlling for

Table 1. Baseline Participant Characteristics Overall and According to Number of Major Experiences of Discrimination, Multi-Ethnic Study of Atherosclerosis, United States, 2000–2002

| Characteristic | All participants | | No. of Major Experiences of Discrimination[a] | | | | | | | | |
| | | | 0 | | | 1 | | | ≥2 | | |
	No. of Participants	Mean (SD)	No. of Participants	%[b]	Mean (SD)	No. of Participants	%[b]	Mean (SD)	No. of Participants	%[b]	Mean (SD)
Total[c]	5,310		3,062	57.7		1,195	22.5		1,053	19.8	
Age, years		61.4 (10.2)			62.6 (10.3)			60.5 (9.9)			58.8 (9.7)
Race/ethnicity											
African American	1,300		494	38.0		327	25.2		479	36.9	
Chinese	641		498	77.7		87	13.6		56	8.7	
Hispanic	1,103		662	60.0		231	20.9		210	19.0	
Non-Hispanic white	2,266		1,408	62.1		550	24.3		308	13.6	
Sex											
Female	2,826		1,730	61.2		601	21.3		495	17.5	
Male	2,484		1,332	53.6		594	23.9		558	22.5	
Education											
Less than a high diploma	810		584	72.1		144	17.8		82	10.1	
High-school diploma or some college	2,446		1,430	58.5		542	22.2		474	19.4	
College degree or higher	2,054		1,048	51.0		509	24.8		497	24.2	
Marital status											
Married/living with partner	3,285		1,993	60.7		714	21.7		578	17.6	
Widowed	631		412	65.3		132	20.9		87	13.8	
Divorced or separated	904		419	46.4		244	27.0		241	26.7	
Never married or prefer to not answer	490		238	48.6		105	21.4		147	30.0	
Annual family income, $											
<20,000	1,129		719	63.7		218	19.3		192	17.0	
20,000–49,999	1,902		1,095	57.6		444	23.3		363	19.1	
≥50,000	2,279		1,248	54.8		533	23.4		498	21.9	
Alcohol use											
Nondrinker	2,467		1,529	62.0		515	20.9		423	17.2	
Light drinker	1,962		1,063	54.2		473	24.1		426	21.7	
Moderate drinker	474		251	53.0		109	23.0		114	24.1	
Heavy drinker	367		195	53.1		89	24.3		83	22.6	
Smoking status											
Never smoker	2,690		1,679	62.4		549	20.4		462	17.2	
Former smoker	1,949		1,058	54.3		490	25.1		401	20.6	
Current smoker	671		325	48.4		156	23.3		190	28.3	

Table 1.   Continued

| Characteristic | All participants | | No. of Major Experiences of Discrimination[a] | | | | | | | | |
| | | | 0 | | | 1 | | | ≥2 | | |
	No. of Participants	Mean (SD)	No. of Participants	%[b]	Mean (SD)	No. of Participants	%[b]	Mean (SD)	No. of Participants	%[b]	Mean (SD)
Depressive symptoms score[d]		7.4 (7.4)			6.8 (6.9)			7.2 (6.8)			9.4 (9.1)
Chronic stress burden score[e]		1.2 (1.2)			0.9 (1.1)			1.4 (1.2)			1.7 (1.3)
Physical activity, MET-minutes/week		5,875 (5,895)			5,490 (5,516)			6,190 (5,694)			6,640 (6,997)
Diet quality score[f]		13.5 (4.4)			13.8 (4.4)			13.4 (4.5)			13.0 (4.5)
Body mass index[g]		28.0 (5.3)			27.5 (5.1)			28.3 (5.1)			28.9 (5.7)
Waist circumference, cm		97.0 (14.1)			96.2 (14.0)			97.9 (13.8)			98.6 (14.5)
Major experiences of discrimination score[h]		0.7 (1.1)			0.0 (0.0)			1.0 (0.0)			2.6 (0.8)
Everyday discrimination score[i]		1.6 (0.7)			1.4 (0.5)			1.7 (0.6)			2.1 (0.8)

Abbreviations: MET, metabolic equivalent of task; SD, standard deviation.

[a] A linear trend over "major experiences of discrimination" categories was tested using linear regression (continuous variables) or χ^2 test of independence (categorical variables); all associations were significant ($P < 0.001$).

[b] Percentages are based on row values; due to rounding, percentages may not always add up to 100%.

[c] Number of participants varied slightly because of missing data on some covariates.

[d] Higher scores indicate more depressive symptoms (range, 0–60).

[e] Higher scores indicate greater levels of stress (range, 0–5).

[f] Higher scores indicate a healthier diet (range, 0–27).

[g] Body mass index was calculated as weight (kg)/height (m)^2.

[h] Higher scores indicate more major experiences of discrimination (range, 0–6).

[i] Higher scores indicate more everyday experiences of discrimination (range, 1–6).

psychosocial factors (model 2), behavioral factors (model 3), and obesity (model 4), although the strength of the association was slightly attenuated (model 4: HR = 1.09, 95% CI: 1.01, 1.17). When modeled categorically, individuals reporting discrimination in ≥2 situations had a 40% increased risk of incident diabetes compared with those reporting no discrimination after controlling for demographic factors. This association remained significant after additionally controlling for psychosocial and behavioral factors, as well as obesity (model 4: HR = 1.34, 95% CI: 1.08, 1.66).

When examining the association of discrimination attributed to race/ethnicity with incident diabetes, there was a positive trend and consistent association across all continuous models (model 1: HR = 1.09, 95% CI: 0.99, 1.21; model 4: HR = 1.09, 95% CI: 0.98, 1.21). When modeled categorically, individuals reporting race/ethnicity discrimination in 2 or more situations had a 36% greater risk of developing diabetes compared with those who reported no race/ethnicity discrimination after controlling for demographic factors (HR = 1.36, 95% CI: 1.02, 1.80). The association was not attenuated after additionally controlling for psychosocial factors, behavioral factors, and obesity (HR = 1.36, 95% CI: 1.01, 1.84). There were no statistically significant interactions by age, sex, or race/ethnicity (data not shown). However, in exploratory analyses, we further examined associations of racial/ethnic discrimination and incident diabetes by racial/ethnic group (see Web Table 2). Although precision was low in subgroup analyses, individuals who self-identified as Chinese, Hispanic, and non-Hispanic white, but not African American, reporting discrimination in 2 or more situations tended to have higher risk of developing diabetes, although the associations were not always statistically significant.

When examining major experiences of discrimination attributed to causes other than race/ethnicity, for each additional experience of discrimination reported, there was a 13% increased risk of incident diabetes (HR = 1.13, 95% CI: 1.02, 1.25). This association remained significant after additionally controlling for psychosocial and behavioral factors but was attenuated after controlling for obesity (HR = 1.08, 95% CI: 0.97, 1.20). Individuals reporting discrimination attributed to other causes in 2 or more situations were also at increased risk of incident diabetes, although the association was attenuated after additionally controlling for behavioral factors and obesity (model 4: HR = 1.22, 95% CI: 0.93, 1.60).

Everyday discrimination and incident diabetes

Everyday discrimination, modeled as a continuous or categorical variable, was not associated with incident diabetes in any of the tested models (see Table 3).

DISCUSSION

Major experiences of discrimination were associated with greater risk of incident type 2 diabetes mellitus over a median follow-up of 9.4 years in this multiethnic, population-based cohort study. These associations were largely independent of age, sex, race/ethnicity, marital status, income, education,

depressive symptoms, other psychosocial and behavioral factors, and obesity. Furthermore, the association between major experiences of discrimination and diabetes was present regardless of whether the discrimination was attributed to race/ethnicity or to other causes. The risk of incident diabetes was greatest in those who reported 2 or more major experiences of discrimination, indicating a potential threshold effect, with no greater risk observed in those reporting only 1 experience of discrimination. Our findings add to the growing body of literature demonstrating an association between discrimination and physical health outcomes (1, 3), and are novel: To our knowledge this is the first study to identify a relationship between discrimination and diabetes incidence.

While few studies have looked at the associations of stressful experiences and type 2 diabetes, Mooy et al. (34) found that the number of stressful life events was associated with prevalent diabetes in a cross-sectional sample of Caucasian adults aged 50–74 years. Our findings complement the existing literature on stress and diabetes by showing that major experiences of discrimination, a form of stress, are associated with incident diabetes. Somewhat surprisingly, we observed minimal attenuation in associations after controlling for psychosocial and behavioral factors as well as obesity, indicating that these potential mediators did not explain the relationship between discrimination and incident diabetes. A theory by Bjorntorp (35, 36) may provide an alternate explanation for the biological plausibility of the stress-diabetes association: This theory states that a defeatist reaction to stress leads to activation of the hypothalamic-pituitary-adrenal axis, resulting in endocrine abnormalities, including high cortisol and low sex-steroid levels, which antagonize the actions of insulin. Furthermore, this hormonal imbalance is associated with visceral adiposity, which plays an important role in the development of diabetes. Further research is needed to clarify the mechanisms through which discrimination may lead to diabetes risk.

Major experiences of discrimination that were attributed to race/ethnicity conferred similar risk of incident diabetes as did discrimination attributed to other causes. Relatively few prior studies have considered the source of discrimination (racial vs. other) when examining the association between discrimination and physical health outcomes (6, 24, 37). Sims et al. (24) found that the associations between major experiences of discrimination and prevalent hypertension were similar, regardless of whether the discrimination was attributed to racial or nonracial factors. Everson-Rose et al. (6) observed a greater risk of incident cardiovascular events in those who experienced both racial and nonracial discrimination, compared with those exposed to 1 type of discrimination only. Roberts et al. (37) found that nonracial discrimination was associated with risk of hypertension among African American women in the Pitt County Study, while racial discrimination was not. Our findings provide evidence that the association between racial bias and physical health outcomes is not distinct from unfair treatment occurring due to other causes, indicating that similar mechanisms may underlie the association of various types of discrimination with health outcomes.

Our data suggest that experiences of discrimination in major life situations, or more conspicuous sources of discrimination,

Table 2. Hazard Ratios for Incident Type 2 Diabetes Mellitus According to Number of Major Experiences of Discrimination, Multi-Ethnic Study of Atherosclerosis, United States, 2000–2013

	No. of Major Experiences of Discrimination											
	Continuous[a]			0			1			≥2		
	No. of Participants	HR	95% CI	No. of Participants	HR	95% CI	No. of Participants	HR	95% CI	No. of Participants	HR	95% CI
Overall												
No. at risk	5,310			3,062			1,195			1,053		
No. of events	654			349			141			164		
Person-years	40,556			23,179			9,303			8,075		
Incidence rate[b]		16.1			15.1			15.2			20.3	
Model[c]												
Model 1		1.12	1.04, 1.19		1.00	Referent		1.05	0.86, 1.29		1.40	1.14, 1.71
Model 2		1.10	1.02, 1.19		1.00	Referent		1.03	0.84, 1.26		1.37	1.11, 1.69
Model 3		1.10	1.02, 1.19		1.00	Referent		1.03	0.84, 1.27		1.37	1.10, 1.70
Model 4		1.09	1.01, 1.17		1.00	Referent		1.04	0.85, 1.29		1.34	1.08, 1.66
Attributed to race/ethnicity												
No. at risk				4,337			581			392		
No. of events				496			92			66		
Person-years				33,164			4,405			2,988		
Incidence rate[b]					15.0			20.9			22.1	
Model[c]												
Model 1		1.09	0.99, 1.21		1.00	Referent		1.27	1.00, 1.61		1.36	1.02, 1.80
Model 2		1.08	0.98, 1.20		1.00	Referent		1.24	0.97, 1.57		1.34	1.00, 1.79
Model 3		1.09	0.98, 1.21		1.00	Referent		1.26	0.98, 1.61		1.36	1.01, 1.85
Model 4		1.09	0.98, 1.21		1.00	Referent		1.22	0.95, 1.57		1.36	1.01, 1.84
Attributed to other sources												
No. at risk				3,674			1,121			515		
No. of events				433			147			74		
Person-years				27,910			8,642			4,005		
Incidence rate[b]					15.5			17.0			18.5	
Model[c]												
Model 1		1.13	1.02, 1.25		1.00	Referent		1.23	1.01, 1.49		1.36	1.06, 1.75
Model 2		1.11	1.01, 1.23		1.00	Referent		1.20	0.99, 1.46		1.33	1.03, 1.72
Model 3		1.10	1.00, 1.23		1.00	Referent		1.21	0.99, 1.48		1.29	0.99, 1.69
Model 4		1.08	0.97, 1.20		1.00	Referent		1.20	0.99, 1.47		1.22	0.93, 1.60

Abbreviations: CI, confidence interval; HR, hazard ratio.

[a] Continuous variable for the number of items selected on the Major Experiences of Discrimination Scale, with values ranging from 0–6.

[b] Values are expressed as incidence rate per 1,000 person-years.

[c] Model 1 included covariates for age, gender, race/ethnicity, marital status, family income, education, and study field center. Model 2 additionally adjusted for depressive symptoms and chronic stress burden. Model 3 additionally adjusted for alcohol use, smoking status, physical activity, and diet quality. Model 4 additionally adjusted for body mass index and waist circumference.

Table 3. Hazard Ratios for Incident Type 2 Diabetes Mellitus According to Frequency of Everyday Discrimination, Multi-Ethnic Study of Atherosclerosis, United States, 2000–2013

	Frequency of Everyday Discrimination[a]														
	Continuous			None			Low			Moderate			High		
	No. of Participants	HR	95% CI	No. of Participants	HR	95% CI	No. of Participants	HR	95% CI	No. of Participants	HR	95% CI	No of Participants	HR	95% CI
No. at risk	5,310			1,347			1,452			1,355			1,156		
No. of events	654			160			163			175			156		
Person-years	40,556			9,673			10,946			10,721			9,215		
Incidence rate[b]		16.1			16.5			14.9			16.3			16.9	
Model[c]															
Model 1		0.99	0.88, 1.11		1.00	Referent		0.96	0.77, 1.20		1.14	0.91, 1.43		1.09	0.86, 1.39
Model 2		0.99	0.87, 1.12		1.00	Referent		0.96	0.76, 1.20		1.14	0.91, 1.44		1.09	0.84, 1.41
Model 3		1.00	0.88, 1.14		1.00	Referent		0.96	0.76, 1.22		1.15	0.90, 1.46		1.14	0.87, 1.49
Model 4		0.97	0.85, 1.10		1.00	Referent		0.94	0.75, 1.19		1.06	0.83, 1.36		1.07	0.82, 1.40

Abbreviations: CI, confidence interval; HR, hazard ratio.

[a] The continuous variable for the number of items selected on the Everyday Discrimination Scale had values ranging from 1–6. After examining the distribution of scores, they were categorized into approximate quartiles: none (score = 1; 25.4%), low (score >1 and <1.5; 27.3%), moderate (score 1.5–2; 25.5%), or high (score >2; 21.8%).

[b] Values are expressed as incidence rate per 1,000 person-years.

[c] Model 1 included covariates for age, gender, race/ethnicity, marital status, family income, education, and study field center. Model 2 additionally adjusted for depressive symptoms and chronic stress burden. Model 3 additionally adjusted for alcohol use, smoking status, physical activity, and diet quality. Model 4 additionally adjusted for body mass index and waist circumference.

have lasting consequences for diabetes risk whereas experiences of more subtle forms of day-to-day discrimination do not. Given that chronic, everyday stressors are generally more strongly associated with disease onset as compared with acute stressors (4, 12, 16), we were surprised by the lack of association between everyday discrimination and incident diabetes. However, these more subtle types of unfair treatment may not have the same influence as major experiences of discrimination. Several other studies have found weak or no associations between everyday discrimination and various physical health outcomes. For example, investigators have reported associations between major experiences of discrimination, but not everyday discrimination, with incident breast cancer (8) and prevalent hypertension (24). A prior MESA publication found an association between both major experiences of discrimination and everyday discrimination with incident cardiovascular events; in that study, everyday discrimination showed a weaker association and was significant only in men (6). While the mechanisms explaining these findings are unclear, it appears that major experiences of discrimination may have differential associations with specific health outcomes as compared with everyday experiences of discrimination. It is also possible that recall of major forms of discrimination is more accurate than for everyday discrimination.

We found no significant differences in associations by race/ethnicity, age, or sex. This suggests that the risk of diabetes as a result of discrimination does not appear to differ across demographic characteristics. However, our power to detect differences by race/ethnicity was limited. Consistent with the existing literature (6, 23), the prevalence of self-reported discrimination differed substantially by race/ethnicity, with African Americans reporting higher levels than all other racial/ethnic groups.

This study has multiple limitations that should be noted. Experiences of discrimination were assessed via self-report, and therefore subject to recall and social desirability bias. Discrimination was assessed at baseline only, and it is possible that a participant's experience of discrimination may have changed during the follow-up period, leading to misclassification bias. Studies have found that some disadvantaged groups may cope with discrimination by denying or minimizing its occurrence (2), thus leading to underreporting of experiences of discrimination. This may explain why, in our sample, people with lower socioeconomic status were less likely to report having experienced discrimination. Nonetheless, if underreporting occurred, the discrimination-diabetes association would have been biased toward the null. Detailed data were not collected on coping methods. Active coping strategies, such as seeking social support, may be effective in preventing the adverse health consequences associated with discrimination (38). Future studies should include assessment of coping methods, because coping may potentially mediate the association between discrimination and health outcomes. Finally, while the study is relatively large for a multiracial/multiethnic cohort, the numbers in some subgroups were somewhat small. This was especially true for the Chinese and Hispanic groups, and may have hindered our ability to detect racial/ethnic differences in associations between discrimination and incident diabetes.

Strengths of this study included the use of data from a large, prospective multiracial/multiethnic cohort. Discrimination was assessed using 2 scales, which allowed for a more in-depth examination of the role of discriminatory events on diabetes incidence. Furthermore, the Major Experiences of Discrimination Scale used in this study assesses unfair treatment generally and then asks for specific attributions. Evidence suggests that this method of assessing discrimination reduces bias in comparison with studies that ask about specific types of discrimination first (4). We used an objective assessment of diabetes and were also able to control for many potential confounders and mediators in our analyses.

In conclusion, we found that major experiences of discrimination were associated with incident diabetes in a diverse sample of middle-aged to older adults, even after controlling for potential confounders and mediators. This association remained when examining discrimination attributed to race/ethnicity or other causes. Given that this is the first study to examine the relationship between discrimination and incident diabetes, it is important for future studies to confirm these findings and to further explore the mechanisms linking discrimination and diabetes.

investigators and institutions is available at http://www.mesa-nhlbi.org.

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