SSM - Population Health 7 (2019) 100306

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

Article

Discrimination in health care and biomarkers of cardiometabolic risk in U.S. adults

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ARTICLE INFO

Keywords:
United States
discrimination
health care
biomarker
cardiometabolic risk factors
cardiovascular disease

ABSTRACT

Introduction: Discrimination in health care settings is associated with poor health outcomes and may be especially harmful to older adults who are more likely to have existing risk factors or medical conditions that require on-going care. The purpose of this study is to investigate the associations between patient-reported health care discrimination and biomarkers of cardiometabolic risk.

Methods: We used 2008–2014 data from the Health and Retirement Study, a nationally representative study of US adults ages 50+ (n = 12,695 participants contributing up to 16,179 observations) to examine the association between patient-reported experiences of health care discrimination and biomarkers of cardiometabolic risk: high sensitivity C-reactive protein (CRP), Hemoglobin A1c (HbAlc), high-density lipoprotein (HDL), total cholesterol, cystatin C and blood pressure and whether relationships were modified by race/ethnicity (non-Hispanic White, non-Hispanic Black, or Hispanic) or gender. We fit generalized estimating equation (GEE) models specifying a binomial distribution and logit link to account for dependency of repeated measures on individuals.

Results: Health care discrimination was associated with higher odds of CRP > 3 mg/L (OR: 1.20 (95% CI: 1.10, 1.30) and HbA1c > 6.5% (OR: 1.23 (95% CI: 1.10, 1.38) but not associated with other biomarkers of cardiometabolic health in the sample as a whole. However, subgroup differences were detected. While health care discrimination was positively associated with elevated HbA1c for non-Hispanics, it was inversely associated with HbA1c for Hispanics.

Conclusions: Health care discrimination was associated with increased cardiometabolic risk based on selected biomarkers.

Introduction

It is well accepted that encounters between patients and providers can either support or hinder health promotion and chronic disease management (Cooper et al., 2012; LaVeist, Pollack, Thorpe, Fesahazion & Gaskin, 2011; Laveist & Nuru-Jeter, 2002; Saha, Arbelaez, & Cooper, 2003). Increasingly, research shows discrimination as an important factor in patient-provider interactions. Discrimination in the health care setting has been related to lower use of health care services (Burgess, Ding, Hargreaves, van Ryn & Phelan, 2008; Crawley, Ahn, & Winkleby, 2008; Trivedi & Ayanian, 2006) and lower perceived quality of care (Sorkin, Ngo-Metzger, & De Alba, 2010). Health care discrimination may be especially important for older adults who are more likely to have existing risk factors or medical conditions that require on-going care. Studies show that discriminatory experiences may reduce engagement with the medical care system and lead to deteriorating quality of care. Provider bias and other elements of the doctor-patient relationship have been associated with satisfaction, utilization of health care services, and patient outcomes (Cooper et al., 2012; Institute of Medicine (IOM), 2001; LaVeist et al., 2011; Laveist & Nuru-Jeter, 2002; Saha et al., 2003; Smedley, Stith, & Nelson, 2003). Hence, health care discrimination can negatively impact patient-provider interactions and relationships, leading to poorer adherence, less follow-up, and unmet medical needs. Experiences of health care discrimination can also increase stress, which can negatively impact cardiovascular health.

Discrimination is especially important in the context of racial and ethnic disparities. There remain persistent racial and ethnic disparities in quality of health care (Fiscella & Sanders, 2016). Furthermore, numerous studies demonstrate health disparities in chronic diseases such as diabetes (Gaskin et al., 2014), hypertension, and cardiovascular

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https://doi.org/10.1016/j.ssmph.2018.10.006
Received 18 May 2018; Received in revised form 9 October 2018; Accepted 10 October 2018

disease (Pool, Ning, Lloyed-JObes & Allen, 2017) with racial and ethnic minorities experiencing higher incidence and worse health outcomes (Crook & Peters, 2008). A 2003 Institute of Medicine (IOM) report reviewed hundreds of studies and concluded that provider bias, prejudice, and stereotyping of patients may contribute to racial and ethnic disparities in health care (Smedley et al., 2003). Racial and ethnic disparities in cardiovascular care provides some of the strongest and most consistent evidence of health care bias. Even after controlling for racial differences in access to care, disease severity, comorbidities, and refusal rates, there remain differences in receipt of clinically-appropriate care by race/ethnicity (Smedley et al., 2003). Similarly, there is consistent evidence documenting differences in quality of care by race/ethnicity after accounting for health insurance coverage and other barriers to accessing care (Saha et al., 2003). This paper examines whether discrimination in the health care setting may be a mechanism by which cardiometabolic disparities exist. We summarized the hypothesized relationships between health care discrimination and biomarkers of cardiometabolic risk in the Online Supplementary Fig. S1.

Cardiometabolic risk is associated with a host of negative health outcomes including mortality, cardiovascular disease, and diabetes (Ford, 2005). Previous research examining the impact of discrimination on biomarkers of cardiometabolic health have been inconsistent and few studies have focused on discrimination in the health care setting per se. We review literature examining the associations between discrimination, including but not limited to health care discrimination, and cardiometabolic health below.

Previous studies have examined the association between discrimination and cardiometabolic risk factors, including blood pressure; HbA1c; and C-reactive protein (CRP), a marker of inflammation and a predictor of coronary heart disease (Angelidis et al., 2013). Self-reported lifetime discrimination has been associated with greater hypertension prevalence among African Americans (Sims et al., 2012). However, other studies reported no association between discrimination and blood pressure (Barksdale, Farrug, & Harkness, 2009; Cozier, Palmer, Horton, Fredman, Wise & Rosenberg, 2006; Peters, 2004) and some reported an inverse association (Krieger, 1990; Krieger & Sidney, 1996). A systematic review of self-reported discrimination and hypertension found discrimination to be associated with hypertensive status but not resting blood pressure (Dolezsar, McGrath, Herzig & Miller, 2014).

Previous studies investigating the association between discrimination and HbA1c were restricted to respondents with diabetes (Peek, Wagner, Tang, Baker & Chin, 2011; Piette, Bibbins-Domingo, & Schillinger, 2006), and mainly focused on racial discrimination, (Assari, Lee, Nicklett, Moghani Lankarani, Piette & Aikens, 2017; Peek et al., 2011) rather than other or multiple forms of unfair treatment (e.g., gender and/or age), and have primarily used geographically limited samples such as Piette and colleagues' study examining health care discrimination and diabetes outcomes in San Francisco (Piette et al., 2006). The few studies that have examined the relationship of overall, racial, or socioeconomic status discrimination with CRP reported mixed results, with some studies finding no associations (Albert, Ravenell, Glynn, Khera, Halevy & de Lemos, 2008; Kershaw et al., 2016; Stepanikova, Bateman, & Oates) or associations only in selected subsamples (Beatty, Matthews, Bromberger & Brown, 2014; Cunningham et al., 2012; Van Dyke et al., 2017). To our knowledge, no studies have specifically evaluated the relationship between health care discrimination and cholesterol or cystatin C, both important indicators of cardiometabolic function: the former in relation to CVD and the latter in relation to kidney function.

The objective of this paper is to empirically investigate the association between health care discrimination and a range of biomarkers of cardiometabolic risk —HbAlc, cholesterol, blood pressure, C-reactive protein (CRP), and cystatin C— in a national sample of older adults. As described above, the impact of discrimination on biomarkers may vary by the type of discrimination. Since some previous studies have found gender and racial differences in the associations between discrimination and health outcomes (Cunningham et al., 2012; Krieger, 1990), it is important to investigate potential subgroup differences. The literature suggests that income and educational attainment may also impact how discrimination is experienced and interpreted. Prior studies show that higher socioeconomic groups are more likely to experience and report experiencing discrimination (Borrell et al., 2007; Bratter & Gorman, 2011). Additionally, coping mechanisms may vary between socioeconomic groups, impacting the degree to which experiences of discrimination initiate a biological stress response (Krieger & Sidney, 1996; Nuru-Jeter et al., 2018).These findings suggest the need for allowing for interactions by race and SES. Furthermore, older adults may have different health care needs, and the impact of health care discrimination on cardiometabolic risk may vary by age. We use data from the Health and Retirement Study to evaluate whether the associations between discrimination in a health care setting and cardiometabolic biomarkers are modified by race/ethnicity, wealth, income, age, or gender. We also examine self-reported reasons for discrimination such as discrimination based on race/ancestry, gender, etc.

Last, nearly all prior work on discrimination and biomarkers has focused on differences in average levels or differences in probability of a binary indicator of an unhealthy biomarker level. However, evaluating associations across the distribution of the biomarker may reveal more about impacts on population health or health inequalities. To examine whether the relationship between discrimination and the biomarkers differs across the outcome distribution, for example whether the association with discrimination is more marked for people with already high levels of the biomarkers, we fitted quantile regression models examining the 25th, 50th, and 75th percentiles of the distribution of each biomarker.

Methods

We use data from the Health and Retirement Study (HRS), a nationally representative study of U.S. adults ages 50+ initiated in 1992 to understand the interacting social, economic, and health dynamics of an expanding older population of US adults. To maintain representativeness, new cohorts of individuals who have aged into HRS eligibility are added every six years; such a cohort was enrolled in 2010. The current analyses use data from 2008-2014 (years when questions on discrimination in health care were included in the survey). Questions on experiences of discrimination were fielded and biomarkers collected in each biennial wave to a rotating, random sample of 50% of HRS participants who completed the in-person interview during that wave. Data were collected from the other half of the core participants in alternate waves. Thus, every four years, there are repeated measurements on patient-reported discrimination and biomarkers for the same half sample. Sample sizes varied by year but ranged from N = 8,131 in 2008 to N = 10,734 in 2010 (Table 1). Additional information on the analytic sample by follow-up year and percent missing are included in Online Supplementary Materials (Fig. S2, Table S1). This study was determined exempt by the University of California, San Francisco Institutional Review Board.

Health care discrimination

In HRS, discrimination is assessed using the Everyday Discrimination Scale (short-version) which assesses chronicity of discrimination in six different social situations (Sternthal, Slopen, & Williams, 2011). For this analysis, we examined responses to the item asking how frequently in their day to day life, respondents receive poorer service or treatment than other people from doctors or hospitals. Response options were coded on a 6-point Likert scale ranging from "never" to "almost every day." Following our previous research (Nguyen, Vable, Glymour & Nuru-Jeter, 2018), discrimination in health care was coded as a dichotomous variable ("never" vs any). Participants

Table 1
Demographic characteristics of analytic sample, U.S. Health and Retirement Study 2008–2014.

Characteristic	2008 (n = 8131) No. (%)	2010 (n = 10734) No. (%)	2012 (n = 9729) No. (%)	2014 (n = 9326) No. (%)
Any health care discrimination	1283 (18.5)	1424 (17.4)	1255 (17.1)	1268 (16.6)
Age (Mean, SD)	67 (9.8)	65 (10.5)	66 (10.0)	67 (9.6)
Male	3626 (44.6)	4961 (46.2)	4457 (45.8)	4283 (45.9)
Race/ethnicity				
White	6496 (79.9)	8363 (77.9)	7561 (77.7)	7220 (77.4)
Black	746 (9.2)	1074 (10.0)	982 (10.1)	940 (10.1)
Hispanic	656 (8.1)	920 (8.6)	824 (8.5)	819 (8.8)
Years of Schooling (Mean, SD)	13.0 (4.7)	13.4 (6.0)	13.6 (6.8)	13.6 (6.4)
Married/Partnered	5247 (64.5)	7152 (66.6)	6226 (64.0)	6068 (74.3)
Currently Employed	3304 (40.7)	4956 (46.7)	4341 (44.7)	3918 (42.1)
Wealth (Median, Interquartile range)	153,575 (389,650)	130,815 (348,000)	136,472 (386,363)	145,000 (397,698)
Biomarkers				
Blood pressure (sys > 140 OR dia > 90 mm Hg)	2239 (33.5)	2799 (32.8)	2340 (28.6)	2184 (27.8)
CRP (> 3 mg/L)	2414 (38.6)	2442 (31.3)	2261 (31.3)	
HbA1c (> 6.5%)	868 (13.8)	974 (12.3)	1086 (15.1)	
HDL (< 40 for males, < 50 mg/dL for females)	1718 (30.4)	2340 (30.0)	2198 (29.8)	
Total cholesterol (> 240 mg/dL)	1180 (19.3)	1156 (14.8)	1031 (13.9)	
Cystatin C (> 1.25 mg/L)	1327 (21.2)	1712 (21.9)	1891 (27.2)	

Numbers are weighted applying year-specific weights to represent the US non-institutionalized population age 50+.

reporting any frequency of discrimination were asked a follow-up question about the reasons for the discrimination. Response options were collapsed and categorized as follows: 1) race/ancestry/national origin, 2) gender, 3) age, 4) religion, 5) weight/physical appearance, 6) physical disability, 7) sexual orientation, and 8) financial status. Participants could mark all that apply.

Outcomes

Systolic and diastolic blood pressure were measured as the average of three consecutive readings with 45 second intervals in the sitting position. These measurements were available for the years 2008–2014. HRS collected blood-based biomarkers beginning in 2006. The current study used biomarkers for the years 2008–2012. Consent rates for blood spot tests were 85% in 2008 (Crimmins et al., 2013), 85% in 2010 and 87% in 2012 (Crimmins, Faul, Kim & Weir, 2015). To account for assay and laboratory variability in biomarker values, HRS data are released with NHANES equivalent assay values (Crimmins et al., 2015).

We use clinically meaningful cut-points for the biomarkers available in HRS to determine cardiometabolic health risk—3 mg/L or higher for CRP (Ridker, 2003) and 6.5% or higher for HbA1c (American Diabetes Association, 2014). For HDL, we used < 40 mg/dL for men and < 50 mg/dL for women (American Heart Association, 2012). Total cholesterol of > 240 mg/dL was considered high (American Heart Association, 2012). For blood pressure, systolic blood pressure > 140 or diastolic blood pressure > 90 mm Hg was considered high (National Heart Lung and Blood Institute, 2012), and a cut-point of 1.25 mg/L or higher was used for cystatin C (Peiris, Chandrasena, & Lanerolle, 2008).

Covariates

Because several covariates could be conceptualized as confounders or as mediators, we built three successive models with adjustment for additional covariates in each model. In the first model, we adjusted for demographics: age, gender, race/ethnicity (non-Hispanic Black,Hispanic, and non-Hispanic White (referent)), educational attainment (continuous years of schooling), and indicators for year of interview. In the second model, we added time-varying adult SES markers: log-household size adjusted wealth (with negative wealth recoded as 0), log-household size adjusted income (with negative income coded as 0), current employment status (yes/no), marital status (married/partnered vs. not married/partnered), and health insurance (yes/no). In the third model, we additionally adjusted for self-reported health outcomes, health behaviors, and personality measures at the time of the assessment of health care discrimination. These included self-reported health status (poor/fair versus good/very good/excellent), body mass index (< 25, 25–29, 30+ kg/m^2), physical activity (vigorous physical activity > 1 per week vs < 1), alcohol consumption (no drinks, more than zero and fewer than 2 drinks /day, 2+ drinks/day), ever smoked (yes/no), elevated depressive symptoms (yes/no where yes was defined as reporting ≥3 depressive symptoms on a modified 8-item Centers for Epidemiologic Studies-Depression [CES-D] scale in the past two weeks) (Radloff, 1977), and scales for the following personality measures: optimism, pessimism, and cynical hostility (Smith, Fisher, Ryan & Clarke, 2013). These scales have good internal consistency (2008 Cronbach's alpha for optimism: 0.79; pessimism: 0.76; cynical hostility: 0.79) (Smith et al., 2013). Discrimination has been found to affect health behaviors, and physical and mental health status (Lewis, Cogburn, & Williams, 2015; Pascoe & Smart Richman, 2009). Since the third set of covariates includes several variables potentially affected by experiences of health care discrimination, we consider model 2 our primary results and model 3 to be supplementary analyses shedding light on potential mediators. As time-varying covariates, wealth, income, employment status, marital status, employment status, health insurance status, self-reported health, health behaviors, and personality measures were updated with each wave of data.

Statistical analyses

To examine the associations between health care discrimination and dichotomous biomarker variables, we fit generalized estimating equation (GEE) models specifying a binomial distribution and logit link with an exchangeable working correlation structure to account for dependency of repeated measures on individuals. Models were weighted using the average of the HRS sampling weights in the years where the individual participated.

Given previous evidence, we tested for interactions of health care discrimination with both race/ethnicity, gender, wealth, income, and age by including interaction terms between health care discrimination and the potential modifiers. Approximately 3% of participants were classified as "Other" racial/ethnic group. These individuals are retained in the analysis with an indicator variable, but we do not present results for this group due to small sample size and heterogeneity.

While ordinary least squares regression models contrast the mean

outcome value among exposed and unexposed, quantile regression models allow us to contrast the qth quantile of the outcome among the exposed and unexposed. To examine whether the relationship between discrimination and the biomarkers differs across the outcome distribution, quantile regression models were fitted and specifying observations were clustered by IDs. The quantile regression procedure did not allow us to simultaneously identify repeated measures and utilize weights. To apply sampling weights to the quantile regression models, we created copies of individuals based on the average of the HRS sampling weights in the years where the individual participated.

We created 35 data sets using multivariate imputation using chained equations (MICE) to impute values for missing exposure, covariate and outcome information. Results adjusting for model 2 covariates were very similar to unimputed results (Online supplementary Tables S2-S4) with the exception that the associations of discrimination with cystatin C and blood pressure became statistically significant using the imputed data sets whereas they were marginally significant in the unimputed results (Online supplementary Table S2). Given that some procedures used for sensitivity analyses had difficulty incorporating both imputations and sampling weights and to present the more conservative effect estimates, we show unimputed results in the main text. Results using imputed data sets examining main effects and multiplicative interactions are presented in the Online Supplementary Materials.

In sensitivity analyses, we also investigated whether the association observed between health care discrimination and blood pressure was biased by censoring among patients taking anti-hypertensive medications using interval regression models (intreg procedure in Stata).

Results

The mean age of respondents was 65–67 years across waves, the majority were White (78–80%), and approximately 55% of the study sample were women (Table 1). Reports of health care discrimination were common with 18% and 17% of participants reporting experiencing any health care discrimination in 2008 and 2014, respectively (Online supplementary Table S5). The most common reason for discrimination were race/ancestry, gender, age, and financial status (Online supplementary Table S6).

After adjustment for socio-demographics and indicators for year of interview (model 1, Table 2), report of any health care discrimination was positively associated with elevated CRP (OR: 1.24; 95% CI: 1.14, 1.34), HbA1c (OR: 1.26; 95% CI: 1.13, 1.41), and cystatin C (OR: 1.13; 95% CI: 1.03, 1.24). After additional adjustment for wealth, income, current employment status, marital status, major chronic conditions, and health insurance status (insured/not insured) (model 2), any health care discrimination remained positively associated with CRP (OR: 1.20; 95% CI: 1.11, 1.31) and HbA1c (OR: 1.23; 95% CI: 1.10, 1.38). Further adjustment for self-reported health behaviors, self-rated health, depressive symptoms, and personality measures (model 3), showed that health care discrimination was inversely associated with blood pressure (OR: 0.88 95% CI: 0.80, 0.97). Model 3 covariates include potential mediators such as health status, personality measures, and health behaviors. Thus, the results of model 3 represents estimates of controlled direct effects (CDE), which is the estimated effect of health care discrimination on the biomarkers that is not mediated by model 3 covariates. In this observational study, the estimates of the CDE rely on the assumption of no unmeasured exposure-outcome confounding, no unmeasured mediator-outcome confounding, and no mediator-outcome confounding affected by the exposure. Effect estimates for all the covariates are included in the Online supplementary Tables (Tables S11-S16).

We examined whether the associations between health care discrimination and the biomarkers were modified gender and race/ethnicity. We used Bonferroni correction for each set of interaction results with the new p-value threshold being 0.008 (0.05/6 tests). There were no statistically significant multiplicative interactions between health care discrimination and gender for any biomarker, adjusting for model 2 covariates (Online supplementary Table S7). There was a significant multiplicative interaction between discrimination and Hispanic ethnicity with adjustment for model 2 covariates for HbA1c (Discrimination*Hispanic interaction OR: 0.43; 95% CI: 0.27, 0.68). These interaction results suggest that whereas report of any health care discrimination was associated with increased risk of elevated HbA1c among Whites (referent), it changed direction among Hispanics (Table 3). Among Whites (referent), report of any health care discrimination was associated with an OR of 1.39 for HbA1c > 6.5, but among Hispanics, report of any health care discrimination was associated with an OR of 0.60 (1.39 ×0.43) (Table 3). In supplemental analyses, we also examined interactions between discrimination and wealth, income, and age, and no interactions were statistically significant after adjustment for multiple testing (Online Supplementary Table S8).

Interaction or effect measure modification is scale dependent (Vander Weele, 2012), so results may differ between absolute and relative scales. In our study, absolute probability estimates reveal a

Table 2
Association between report of any health care discrimination and biomarkers, U.S. Health and Retirement Study 2008–2014.

	Model 1			Model 2			Model 3		
	OR	95% CI		OR	95% CI		OR	95% CI	
CRP (> 3 mg/L)	1.24	1.14	1.35***	1.20	1.11	1.31**	1.06	0.97	1.17
HbA1c (> 6.5%)	1.26	1.13	1.41***	1.23	1.10	1.38***	1.07	0.95	1.22
HDL (< 40 for males, < 50 mg/dL for females)	1.08	0.98	1.18	1.05	0.96	1.14	0.94	0.85	1.04
Total cholesterol (> 240 mg/dL)	1.00	0.89	1.11	1.00	0.90	1.12	1.05	0.93	1.19
Blood pressure (sys > 140 OR dia > 90 mm Hg)	0.93	0.86	1.00	0.93	0.86	1.00	0.88	0.80	0.97*
Cystatin C (> 1.25 mg/L)	1.13	1.03	1.24*	1.09	0.99	1.20	0.99	0.88	1.11

Models 1: adjusted for age, gender, race/ethnicity (non-Hispanic Black and Hispanic vs non-Hispanic White (referent), educational attainment (continuous years of schooling).
Models 2: Model 1 + log-household size adjusted wealth, log-household size adjusted income, current employment status (yes/no), marital status (married/partnered vs. not married/partnered), health insurance status (yes/no) and indicators for year of interview.
Models 3: Model 2 + self-reported health (poor/fair versus good/very good/excellent), body mass index categories (< 25, 25–29, 30+ kg/m2), physical activity (vigorous physical activity > 1 per week vs < 1), alcohol consumption (no drinks, more than zero and fewer than 2 drinks /day, 2+ drinks/day), ever smoked (yes/no), depression (yes/no where yes was defined as reporting ≥3 depressive symptoms on a modified 8-item Centers for Epidemiologic Studies-Depression [CES-D] scale in the past two weeks), optimism, pessimism, and cynical hostility.
* $p < 0.05$,
** $p < 0.01$,
*** $p < 0.001$

Table 3
Association between report of any health care discrimination and biomarkers, allowing for discrimination by race/ethnicity interactions, U.S. Health and Retirement Study 2008–2014.

	Model 1			Model 2			Model 3		
	OR	95% CI		OR	95% CI		OR	95% CI	
CRP (> 3 mg/L)									
Health Care Discrimination	1.25	1.14	1.37***	1.22	1.11	1.33***	1.04	0.94	1.16
Discrimination*Black	0.95	0.69	1.29	0.94	0.69	1.29	1.18	0.83	1.69
Discrimination*Hispanic	0.97	0.69	1.37	0.92	0.65	1.31	1.16	0.78	1.72
HbA1c (> 6.5%)									
Health Care Discrimination	1.43	1.26	1.62***	1.39	1.23	1.58***	1.17	1.01	1.34
Discrimination*Black	0.86	0.60	1.22	0.88	0.61	1.25	0.86	0.57	1.29
Discrimination*Hispanic	0.44	0.28	0.70**	0.43	0.27	0.68***	0.64	0.39	1.05
HDL (< 40 for males, < 50 mg/dL for females)									
Health Care Discrimination	1.10	1.00	1.22*	1.07	0.97	1.18	0.94	0.84	1.05
Discrimination*Black	0.90	0.64	1.26	0.93	0.66	1.30	0.95	0.66	1.39
Discrimination*Hispanic	1.20	0.83	1.72	1.16	0.80	1.67	1.38	0.92	2.08
Total cholesterol (> 240 mg/dL)									
Health Care Discrimination	0.66	0.91	1.15	1.03	0.91	1.16	1.09	0.96	1.24
Discrimination*Black	1.02	0.67	1.57	1.01	0.65	1.56	1.04	0.65	1.64
Discrimination*Hispanic	0.69	0.41	1.14	0.70	0.42	1.17	0.64	0.37	1.10
Blood pressure (sys > 140 OR dia > 90 mm Hg)									
Health Care Discrimination	0.90	0.83	0.98*	0.90	0.83	0.98*	0.82	0.73	0.90***
Discrimination*Black	1.12	0.83	1.45	1.13	0.87	1.48	1.27	0.91	1.77
Discrimination*Hispanic	1.22	0.91	1.63	1.21	0.90	1.63	1.68	1.17	2.43**
Cystatin C (> 1.25 mg/L)									
Health Care Discrimination	1.18	1.07	1.31***	1.15	1.03	1.27	1.04	0.92	1.18
Discrimination*Black	0.78	0.54	1.12	0.79	0.54	1.14	0.82	0.53	1.26
Discrimination*Hispanic	0.64	0.41	0.99*	0.60	0.38	0.93	0.45	0.26	0.77***

Bonferroni corrected p-value threshold is 0.008
Models 1: adjusted for age, gender, race/ethnicity (non-Hispanic Black and Hispanic vs non-Hispanic White (referent), educational attainment (continuous years of schooling).
Models 2: Model 1 + log-household size adjusted wealth, log-household size adjusted income, current employment status (yes/no), marital status (married/partnered vs. not married/partnered), health insurance status (yes/no) and indicators for year of interview.
Models 3: Model 2 + self-reported health (poor/fair versus good/very good/excellent), body mass index categories (< 25, 25–29, 30+ kg/m2), physical activity (vigorous physical activity > 1 per week vs < 1), alcohol consumption (no drinks, more than zero and fewer than 2 drinks /day, 2+ drinks/day), ever smoked (yes/no), depression (yes/no where yes was defined as reporting ≥3 depressive symptoms on a modified 8-item Centers for Epidemiologic Studies-Depression [CES-D] scale in the past two weeks), optimism, pessimism, and cynical hostility.
* $p < 0.05$,
** $p < 0.01$,
*** $p < 0.008$;

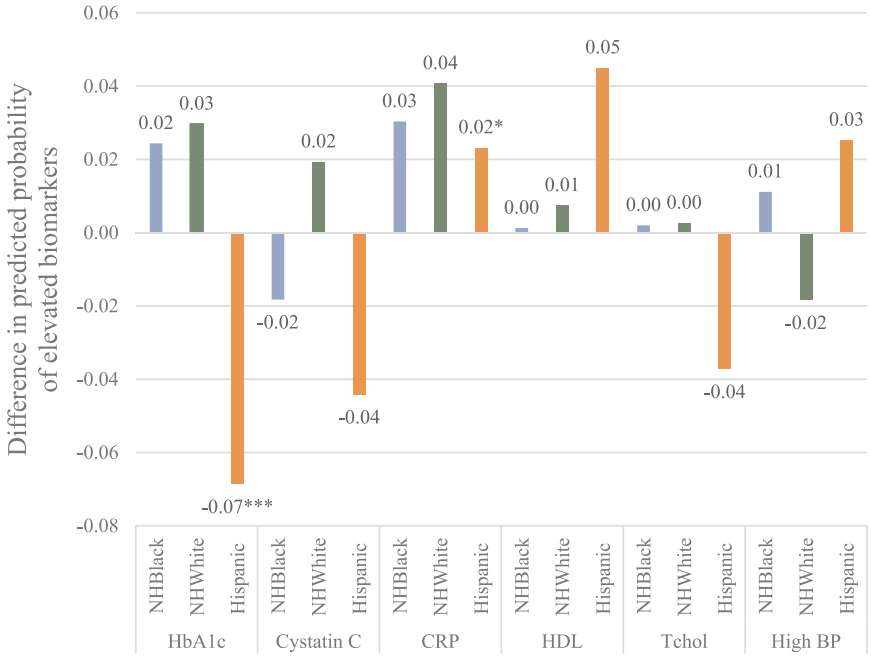

Fig. 1. Absolute difference in the rate of elevated biomarkers comparing participants who reported health care discrimination to participants who did not report health are discrimination, by ethnicity, U.S. Health and Retirement Study 2008–2014. P-values for the tests of the differences in estimated effects of non-Hispanic Blacks and Hispanics compared to non-Hispanic Whites (referent) are equal to zero *p < 0.05 ** p < 0.01 ***p < 0.008; Bonferroni corrected p-value threshold is 0.008.

similar pattern as estimates on the relative (multiplicative) scale. Reporting any health care discrimination was associated with a 0.7 percentage point lower risk of having elevated HbA1c among Hispanics, adjusting for model 2 covariates (Fig. 1). Non-Hispanic Blacks and non-Hispanic Whites who report discrimination in the health care setting have a 0.2 and 0.3 percentage point increase in risk, respectively, of having elevated HbA1c compared to non-Hispanic Blacks and non-Hispanic Whites who did not report health care discrimination. The estimated effects for HbA1c is significantly different for Hispanics than Non-Hispanic Whites ($p < 0.008$) (Fig. 1).We investigated whether the association observed between health care discrimination and blood pressure was biased by censoring among patients taking anti-hypertensive medications using interval regression models. Interval regression models assume that measured blood pressure among people using anti-hypertensive medication is likely to be lower than that individual's untreated blood pressure would be. For participants currently using anti-hypertensive medications, interval regression results therefore assume their actual blood pressure is as high or higher than their measured blood pressure. The intreg procedure allows us to specify lower and upper bounds for different participants. For participants who were taking blood pressure medication, the lower bound was defined as the observed blood pressure value, and the upper bound was set at the highest reasonable value observed in our sample (234 mm Hg for systolic and 148 mm Hg for diastolic blood pressure). If a participant was not using antihypertensive medications, the lower and upper bounds were set as that person's observed blood pressure values. The interval regression models were fitted, specifying observations that were clustered by participant ID to obtain valid standard errors. Interval regression models adjusting for model 2 covariates indicated that report of any health care discrimination was associated with a 2.20 mm Hg lower systolic blood pressure (95% CI: -4.70, 0.30) and 1.20 mm Hg lower in diastolic blood pressure (95% CI: -2.87, 0.48).

Quantile regression results (Online supplementary Table S5), adjusting for model 2 covariates, indicated the associations between report of health care discrimination and CRP and HbA1c were stronger at the higher end of the outcome distribution. For total cholesterol, cystatin C, systolic blood pressure, and diastolic blood pressure, the strength of the associations were similar across quantiles (Online supplementary Table S9).

As a supplemental analysis, we examined the associations between reason for discrimination and the biomarkers among participants who reported health care discrimination. There were not consistent differences between the various reasons for discrimination and the biomarkers examined. Discrimination based on weight/physical appearance was associated with CRP, HbA1c, cystatin C, and HDL in Model 2, but these associations became non-significant when adjusting for Model 3 covariates. Some covariates in Model 3 may be especially important confounders such as BMI for discrimination based on weight/physical appearance (Online Supplementary Table S10). Future work may consider examining associations between attribution and cardiometabolic risk factors, stratified by race to investigate any potential racial differences.

Discussion

In this national sample of older adults, experiences of health care discrimination were common. Patient-reported experiences of health care discrimination were associated with elevated CRP and HbA1c after adjusting for demographic and socioeconomic characteristics, health insurance status, and year of interview. Stronger estimated effects of patient-reported discrimination were observed among those at the higher end of the distribution of CRP and HbA1c. The associations between health care discrimination and HbA1c and CRP are consistent with prior literature examining discrimination in selected subsamples for HbA1c (Peek et al., 2011; Piette et al., 2006; Ryan, Gee, & Griffith, 2008) and CRP (Beatty et al., 2014; Cunningham et al., 2012; Van Dyke et al., 2017).

Health care discrimination may impact biomarkers of cardiometabolic risk in several ways. First, experiences of discrimination in the health care setting may lead to less engagement with the medical care system. Experiences of health care discrimination has been associated having unmet need for health care utilization(Lee, Ayers, & Kronenfeld, 2009), delay in seeking health care, and lower adherence to medical care (Casagrande, Gary, LaVeist, Gaskin & Cooper, 2007). Experiences of discrimination can also produce a stress responses including cardiovascular reactivity (Merritt, Bennett, Williams, Edwards & Sollers, 2006) and has been associated with unhealthy behaviors (Pascoe & Smart Richman, 2009). Previous studies have also found inverse associations between discrimination and blood pressure (Chae, Nuru-Jeter, & Adler, 2012; Krieger & Sidney, 1996). One hypothesized reason is that denying the experience of discrimination may be a maladaptive coping response and increase one's blood pressure Krieger & Sidney, (1996). The implicit assumption is that people who reported the lowest level of discrimination may be in fact be experiencing discrimination but cognitively attributing the interactions to other reasons (Nuru-Jeter et al, 2009). However, recognizing discrimination and framing it as such allows you to address it and seek support for it and may provide a buffer against the adverse effects. Future work is needed to explicityly examine factors hypothesized to account for these counerintuitive findings.

Our measure of health care discrimination was patient-reported, which is dependent on participants making sense of their interactions and asserting when they think experiences are discriminatory. Further, discrimination can be subtle (Pascoe & Smart Richman, 2009) and as a result ambiguous, which reduces the likelihood of reporting especially among socially disadvantaged groups (Crocker & Major, 1989). The experience, interpretation, and reporting of health care discrimination is complex and may be dependent on the respondents' social experiences and identity. In the Bay Area Health Study of 91 African American men, there was no significant main effect of racial discrimination on hypertension. However, among African American men with an implicit anti-Black bias (implicit association test, and indicator of racial identity and potentially of internalized racism), there was a significant positive association between racial discrimination and hypertension; whereas an implicit pro-Black Bias was associated with reduced risk of hypertension (Chae et al., 2012). Further research is needed to examine potential reporting bias in the discrimination-blood pressure association.

While we found discrimination in the health care setting to be associated with CRP and HbA1c, it is important to understand whether the lack of association with the other measured biomarkers is due to some form of reporting bias, unmeasured confounding, compensatory or psychological resilience processes generally associated with psychosocial adaptation to stress, or because the type or severity of discrimination commonly experienced is not sufficient to affect the selected biomarkers. Encounters with discrimination may not always be straightforward and can include subtle body language, and behaviors. Measures of discrimination including validated measures rely on the person to make sense of their experiences and report whether they experienced discrimination. Under-reporting of discrimination would likely produce null or inverse findings. Since this is an observational study, one study limitation is unmeasured confounding. Certain confounders may be more strongly associated with exposure and outcome and thus potentially bias results to a greater degree. Thus, while we control for the same set of covariates, the relationships among the various covariates, discrimination exposure, and biomarkers may differ across the different biomarkers. In addition, we evaluated biomarkers individually. Future work should examine the interplay among multiple biomarkers; and should consider the degree to which reported events were appraised as stressful.

To our knowledge, this is the first study to empirically evaluate the association between health care discrimination and cholesterol and

cystatin C. Another possibility for the null findings is that experiences of health care discrimination do not have large effects on the observed biomarkers in our population of older Americans. This is consistent with the age as a leveler hypothesis (Ferraro & Farmer, 1996), which states that the problems of aging affect everyone equally and may even outweigh the stress associated with disadvantaged social status, thereby leveling disparities between social groups. However, further work is needed to explore these findings as others have found the opposite where aging exacerbates the problems associated with disadvantaged social status (i.e., double jeopardy) and some have found that selective mortality may explain diminished disparities in older age (Carreon & Noymer, 2011; Ferraro & Farmer, 1996).

There was evidence of interaction between health care discrimination and Hispanic ethnicity for models examining HbA1c; the positive associations between reported health care discrimination and HbA1c changed direction for Hispanics compared to non-Hispanics. This finding is consistent with prior evidence that the association between self-reported discrimination and both physical (Ryan, Gee, & Laflamme, 2006) and mental health (Gee, Ryan, Laflamme & Holt, 2006) may be attenuated among Hispanics. Resources such as ethnic identity or social support may be one explanation for these results (Denner, Kirby, Coyle & Brindis, 2001; Noh & Kaspar, 2003; Ryan et al., 2006). Further, using pan-ethnic groups (i.e., Hispanics), may mask significant heterogeneity within groups.

Limitations of this study include that our measure of health care discrimination is patient-reported. Individuals may appraise an event as discriminatory but use coping strategies that limit their ability or willingness to report the event (e.g., denial, ignoring it, reinterpretation of events) (Krieger & Sidney, 1996; A. Nuru-Jeter et al., 2009). Patients may also be unable to recognize discriminatory actions, especially those that are more subtle and ambiguous, potentially leading to substantial measurement error. However, patient-reported experiences of discrimination are of intrinsic importance since internal appraisal is associated with behavioral responses and is a critical component in predicting biological stress responses (Dickerson, Gable, Irwin, Aziz & Kemeny, 2009; Dickerson, Gruenewald, & Kemeny, 2004; Kressin, Raymond, & Manze, 2008; Utsey, 1998). Clinician-patient encounters are also likely to be affected by patients' past experiences with discrimination, regardless of objective indicators of care processes.

Limitations notwithstanding, this paper has several strengths. This study utilized a large, national sample of older Americans to investigate the influence of patient-reported experiences of health care discrimination on biomarkers of cardiometabolic risk. To our knowledge, the relationships between health care discrimination, cholesterol, and cystatin C have not been formally evaluated. We also controlled for a comprehensive list of socio-demographics, health history, and insurance status to reduce confounding. In this study, patient-reported experiences of health care discrimination are associated with greater risk of elevated CRP and HbA1c. Understanding specific aspects of health care encounters that increase reported health care discrimination such as physician-patient encounters, provider mistrust, and physician-decision-making style may inform efforts to reduce discrimination in health care settings.

Conflict of interest

None.

Funding

Dr. Nguyen's work was supported by the American Heart Association Western States Affiliate Postdoctoral Fellowship. Award Number 16POST29660005 and the National Institute On Minority Health And Health Disparities of the National Institutes of Health under Award Number K99MD012615. The study sponsors had no role in study design; collection, analysis, and interpretation of data; writing the report; and the decision to submit the report for publication.

Ethics statement

This study was determined exempt by the University of California, San Francisco Committee Institutional Review Board.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ssmph.2018.10.006.

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