Version of Record: https://www.sciencedirect.com/science/article/pii/S0277953621006407
Manuscript_15672aabf180b567b8894adb3d15b028

The Effect of Racial Discrimination on Mental and Physical Health: A Propensity Score Weighting Approach

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Introduction

Racism has been described as a fundamental cause of health disparities between racial/ethnic minorities and White people in the United States (Paradies et al., 2015; Phelan & Link, 2015). Racism represents a complex network of interlocking systems where structural inequity prevents racial/ethnic minority groups from full participation in society across multiple domains and undermines their health (Reskin, 2012). However, at each structural location, racial discrimination also remains an insidious workhorse that compromises the daily and long-term health of racial/ethnic minority people (Benner et al., 2018; Cave et al., 2020; Lee et al., 2020; Pascoe & Smart Richman, 2009). The consistent link between racial discrimination and worse health has led to the theorization that racial discrimination itself may be a causal factor of worse health (Goosby et al., 2018). Indeed, many studies show that racial discrimination is associated with a cascade of physiological responses that can compromise physical health such as dysregulated cortisol secretion, higher C-reactive protein, higher systolic and diastolic blood pressure, and augmented heart rate variability (Goosby et al., 2015; Korous et al., 2017; Lockwood et al., 2018; Ryan et al., 2006). Racial discrimination has also been directly linked to worse mental (Pascoe & Smart Richman, 2009; Schmitt et al., 2014) and general physical health (Ryan et al., 2006; Schulz et al., 2006). Despite the preponderance of evidence showing a negative association between racial discrimination and worse health, there has yet to be a study that utilizes propensity score weighting (PSW) to strengthen the evidence for causal links between racial discrimination and worse mental and physical health. In the current study, we made use of a combined data from two national samples, the National Survey of American Life (NSAL) and the National Latino and Asian American Study (NLAAS), and used a PSW approach to estimate the causal effect of experiencing racial discrimination for several mental

and physical health outcomes.

Discrimination is defined as the "differential treatment of members of groups by both individuals and social institutions" (Williams & Mohammed, 2009, p. 21). Although there have been legal victories for racial/ethnic minority people that have partly mitigated the overt legal discrimination before the Civil Rights Act in 1964, more subtle and chronic forms of racial discrimination still affect the everyday lives of racial/ethnic minority people in the U.S. Indeed, a recent survey by the Pew Research Center (Pew Research Center, 2019) found that majority of Black, Hispanic, and Asian individuals reported experiencing discrimination or unfair treatment because of their race/ethnicity. Given the pervasiveness of racial discrimination, numerous research studies have been conducted to understand the consequences of racial discrimination for the health of racial/ethnic minority people, and the results consistently show that racial discrimination is pernicious for individuals' mental and physical health (Benner et al., 2018; Cave et al., 2020; Pascoe & Smart Richman, 2009; Schmitt et al., 2014). For example, studies have consistently found that, among Black, Asian, and Hispanic groups, racial discrimination is positively associated with greater odds of depression and substance use disorders (Chou et al., 2012; Clark et al., 2015; Gee et al., 2007; Ornelas & Hong, 2012). In terms of physical health outcomes, scholars have argued that racial discrimination may partly explain racial/ethnic health disparities (Goosby et al., 2018; Hudson et al., 2013; Lockwood et al., 2018). Further, although Asian Americans tend to fair better than other racial/ethnic minorities in terms of BMI (Nam, 2013), cardiovascular disease (CVD; Lockwood et al., 2018), and self-rated health (SRH; Kimbro et al., 2012), when they are exposed to racial discrimination, it is associated with higher BMI (Gee et al., 2008), CVD (Lockwood et al., 2018), and worse SRH (Pascoe & Smart Richman, 2009). The finding that racial discrimination mitigates potential health advantages

even among racial/ethnic minorities people across several outcomes lends credence to the potential causal link between racial discrimination and worse health.

Although most studies suggest a clear link between racial discrimination and health, the majority of these studies are correlational in nature, leaving the question about the causal effect of racial discrimination partly unanswered. Initial efforts to examine racial discrimination as a causal factor have been shown in several experimental lab studies that manipulated perceptions of discrimination through Cyberball paradigm, imagined scenes, and speech and debate tasks (Harrell et al., 2003). The advantage of experimental design is that participants are randomly allocated to different conditions of discrimination, through which the confounding factors between discrimination and outcomes are removed. This step provides more rigorous evidence about racial discrimination as a causal factor. A meta-analysis (Schmitt et al., 2014) synthesizing fifty-four experimental studies on the consequences of discrimination found the negative effects of discrimination on psychological well-being (d = -.25). Similarly, more recent empirical studies found that lab-induced racial discrimination impaired alcohol and sexual-risk cognition (Stock et al., 2017) and triggered unhealthy eating behaviors (Hayman Jr et al., 2015). While these studies provide evidence of the causal effect of discrimination, their lab-based experimental designs are often influenced by the nature of the setting, the stimuli, and participants' responses, and thus lack ecological validity (Schmuckler, 2001). Moreover, experimental designs can only approximate very limited aspects of real-life discriminatory experiences with very limited ability to mimic the full range of real-life discriminatory experiences.

One way to resolve the challenges posed by experimental studies is to utilize statistical approaches that capitalize on correlational data, which can capture more subtle aspects of racial

discrimination. One such modeling strategy is PSW which involves weighting participants based on a set of covariates to compare them on a treatment variable (Miller et al., 2016). The set of the covariates are selected based on their known associations with treatment assignment and the outcome of interest. The goal of PSW is to achieve balanced distributions of the covariates across the treatment and control groups, which mimics the covariate balance from randomization (Schafer & Kang, 2008). In other words, propensity scores weight participants' responses so that they only differ on whether they are in the treatment or control group. By ruling out the influence of covariates, the PSW approach allows the closest possible approximation to a randomized experiment (Miller et al., 2016). Therefore, PSW is more advantageous than the traditional regression analyses as it can reduce selection bias, producing a less biased estimate of the effect of racial discrimination on health (Miller et al., 2016). In the current study, the treatment group consists of racial/ethnic minority individuals who reported experiencing racial discrimination and the control group consists of those who reported no racial discrimination. We also include a range of socio-demographic characteristics (i.e., age, race/ethnicity, sex, socioeconomic status, marital status, and geographic location) that have known associations with individuals' reports of discrimination and health. Using propensity scores, we can create treatment and control groups that are identical on these socio-demographic characteristics, so that participants only differ on whether they experienced racial discrimination or not. This step allows us to strengthen the causal estimates for the links between racial discrimination and health.

In addition to examining the causal effect of racial discrimination on health, in line with intersectionality theory (Bowleg & Bauer, 2016; Crenshaw, 1991), our study also places attention on whether the effect of racial discrimination on health differs by socio-demographic characteristics (i.e., age, race/ethnicity, sex, socioeconomic status, marital status, geographic

location, and insurance status). Younger age has been associated with a stronger negative association between discrimination and health (Benner et al., 2018; Schmitt et al., 2014; Wheaton et al., 2018). The association between experiences of racial discrimination and health has also been found to vary across race and ethnicity such that the link between racism and mental health was stronger for Asian Americans and Latino compared to Black Americans (Paradies et al., 2015). The link between racial discrimination and health has also been shown to vary by sex. For example, one study found that men were more likely to engage in substance use in the face of racial discrimination (Wiehe et al., 2010). In terms of socioeconomic status (SES), the association between racial discrimination and health has been shown to vary by SES with some studies showing a stronger association among high SES racial/ethnic minorities (Assari et al., 2018) and others showing a stronger association among low SES racial/ethnic minorities (Brondolo et al., 2009). Racial/ethnic minority people with a higher SES may be exposed to racial discrimination in contexts that afford them a higher SES (e.g. educational and employment settings) which undermines the typical health benefits of higher SES (Hudson et al., 2012). Married individuals have better health outcomes than divorced, single, and never married individuals (Kiecolt-Glaser & Newton, 2001), and racial discrimination can affect the relationship quality of racial/ethnic minority couples (Trail et al., 2012). Moreover, owing to the results of socio-historical and local politics, the association between racial discrimination and health outcomes varies by geographic location (Chae et al., 2015; Kim et al., 2017). Lastly, insurance coverage has been found to relate to health outcomes and there are racial disparities in access to health insurance (Brown et al., 2000). Together, these socio-demographic factors are a cohesive set of variables that are found to relate to both experiences of racial discrimination and health and may moderate the effect of racial discrimination on health. Examining the moderating

factors has the potential to address divergent findings in the literature and provide novel insights about relevant factors that intersect with racial discrimination to impact health.

Current Study

In the current study, we aim to provide further evidence for a causal link between experiencing racial discrimination and worse health. To address this aim, we use a combined dataset of two nationally representative datasets: the National Survey of American Life (NSAL) and the National Latino and Asian American Study (NLAAS). The combined data have a robust discrimination measure as well as large samples of Black, Asian, and Latino participants, which allow us to compare participants who report experiencing racial discrimination to those who do not experience racial discrimination in a sample of people known to be more likely to experience racial discrimination. We use PSW to balance the treatment and control groups across several socio-demographic characteristics to reduce selection bias and provide a robust estimate of the causal link between racial discrimination and health. We compare these two groups across several health indicators to examine whether causal links exist between racial discrimination and various health domains. Specifically, we examine if experiencing racial discrimination is linked with a higher CVD risk, worse SRH, higher BMI, a higher probability of a depression disorder, and a higher probability of a substance use disorder. Second, in line with intersectionality theory, we examine whether the effect of racial discrimination on health was moderated by socio-demographic characteristics (i.e., age, race/ethnicity, sex, socioeconomic status, marital status, geographic location, and health insurance coverage).

Method

Participants

Data were drawn from a combined dataset of two nationally representative data sets,

NSAL (Jackson et al., 2004) and NLAAS (Alegria et al., 2004) because they are the largest datasets of racial/ethnic minorities with robust discrimination measures. Since there are no contemporary national surveys with large samples of racial/ethnic minorities or robust discrimination measures, we are limited to using these twenty-year-old datasets. Both NSAL and NLAAS datasets were conducted in the U.S from 2001-2003 among adults (18 and older) to investigate racial/ethnic differences in mental disorders and psychological distress. Participants engaged in interviews that were primarily conducted using laptop computer-assisted personal interview methods in respondents' homes. Data collection for both datasets used multi-stage probability sampling strategies to make estimation and inference for population characteristics (Heeringa et al., 2004). The NSAL is the largest study of Black Americans' mental health in the U.S. to date, and it included three survey populations: African American, Afro-Caribbean, and White American. We used the term Black American hereafter to comprehensively capture individuals with any known African black ancestry. The NSAL consisted of 6,082 participants (59% African American, 27% Afro-Caribbean, and 14% White; 62% female). The mean household income was $35,832 (household income top-coded at $200,000). Almost one-quarter of the sample (23%) completed less than 12 years of schooling, whereas 42% reported 13 or more years of education. The NLAAS includes a national sample of Latino and Asian American adults with the following eight ethnic subgroups including: Mexicans, Puerto Ricans, Cubans, other Latinos, Chinese, Vietnamese, Filipinos, and other Asians. NLAAS respondents included 4,649 adults (53% Latino, 43% Asian American, 4% White non-Hispanic; 54% female). Half of the NLAAS sample reported 13 years or more of education, whereas 28% indicated 11 or fewer years of education. The mean household income for the sample was $57,592 (household income top-coded at $200,000). Since the current study focused on racial minorities, we excluded White

participants from our analyses. Our analytical sample only included racial/ethnic minority participants (i.e., Black, Latino, and Asian) who reported ever experiencing any racial discrimination (treatment group, $N = 4358$) and individuals who did not report ever experiencing any kind of racial discrimination (control group, $N = 1836$).

Measures

Perceived racial discrimination. In the NSAL and NLAAS datasets, perceived racial discrimination was measured using the 9-item Everyday Discrimination Scale (EDS; Williams et al., 1997). The questions in this measure were preceded by the words "*In your day-to-day life how often have any of the following things happened to you*" followed by statements such as, "*You receive poorer service than other people at restaurants or stores*". Participants rated each item on a scale ranged from 1 to 6: "*almost every day*" (1), "*at least once a week*" (2), "*a few times a month*" (4), "*less than once a year*" (5), "*never*" (6). If the participant rated any of the nine items "*less than once a year*" (5) or more frequently, the participant was then asked to report the reason they believe they were discriminated against (e.g., attribution tied to race, sex, weight, etc.). We recoded responses into a dichotomous variable, such that individuals who attributed their discrimination experiences to their race, ethnicity, or skin color received a score of 1, and individuals who did not experience any form of racial discrimination received a score of 0. The EDS measure has been validated and widely used in Black (Clark et al., 2004), Latino (Perez et al., 2009), and Asian American samples (Gee et al., 2007).

Cardiovascular disease risk. In both datasets, participants were asked to indicate whether a doctor/health professional had identified problems related to cardiovascular health (i.e., high blood pressure, diabetes, heart trouble; 0 = *no*, 1 = *yes*). Participants who indicated that they ever had any of these problems were classified as having cardiovascular disease.

General physical health. For both surveys, participants provided a general rating of their physical health. Participants responded to the question, "How would you rate your overall physical health at the present time?" on a scale ranging from "*excellent*" (1) to "*poor*" (5). The scale was recoded so higher scores reflected better self-reported health (SRH).

BMI. Obesity was calculated from self-reported heights and weights using the formula of weight (kilograms) divided by height (meters^2).

Depression disorder and substance use disorder. The Composite International Diagnostic Interview (CIDI; Kessler et al., 2003) developed by the World Health Organization (1990) was used to assess the presence of major depressive disorder and substance use disorder in this study. As a structured interview, the CIDI is designed to be administered by testers to evaluate different DSM-IV mental health disorders. The CIDI has been widely utilized to assess psychiatric disorders in epidemiological and cross-cultural studies and has shown sufficient concordance with the Structured Clinical Interview for DSM-IV for assessing major depressive episodes (Williams et al., 2007). For this study, individuals meeting hierarchical criteria for either major depressive disorder or dysthymia disorder within the past 12 months on the CIDI were considered to have a depression disorder in the current study. Individuals meeting hierarchical criteria for alcohol abuse or drug abuse disorder within the past 12 months on the CIDI were considered to have substance use disorder.

Covariates. Propensity scores were estimated for the treatment and control groups based on nine socio-demographic variables designed to rule out potential alternative explanations for any links between discrimination and health outcomes. This set of variables included: age, race/ethnicity (i.e., Black, Latino, and Asian American), sex (i.e., male or female), educational attainment (i.e., < 12 years of education, 12 years of education, 13-15 years of education, and

16+ years of education), employment status (i.e., employed, not employed, and not in the labor force), income-poverty ratio, marital status (i.e., married, divorced, never married), Census region (i.e., Northeast, Midwest, South, and East), and health insurance coverage (0 = *no*, 1 = *yes*). The income-poverty ratio ranged from 0 to 16 with anything higher than 16 top-coded at 17. The income-poverty ratio corresponds to the federal poverty thresholds, such that 0 means below the poverty line, 1 means at the poverty line, and scores above two correspond to 100% increases above the poverty threshold (e.g., 3 = 300% above the poverty line). The income-poverty ratio was defined relative to the federal poverty line (0 = *poor*, 1-2 = *near-poor*, 3+ = *non-poor*; Kessler et al., 2005). In addition to being used to match the discrimination groups, these same variables were also included as covariates and interacted with the treatment in all models (Schafer & Kang, 2008). For categorical and dichotomous variables, we either use the largest group or the group that makes meaningful comparisons as the reference group (i.e., Black, male, < 12 years of education, full-time employment, non-poor, married, South, and no health insurance).

Analytic Plan

We utilized several R packages in our analyses which included *cobalt* (Greifer, 2020a), *MatchIt* (Ho et al., 2011), *WeightIt* (Greifer, 2020b), *twang* (Ridgeway et al., 2014), and *CBPS* (Fong et al., 2019).

We first tested the balance of the covariates to identify differences in the covariates between the treatment and control groups prior to applying matching or propensity scores. Finding differences by covariates across the treatment and control groups provided additional justification for the need to balance the covariates with PSW. We then examined matching and several PSW models to identify which method provided the best covariate balance by assessing

standardized mean differences between the two groups and the effective sample size, which indicated the sample size needed to achieve the same level of precision. The method with standardized mean differences closest to zero and the largest effective sample was selected. We tested four propensity score methods: nearest neighbor matching (Rosenbaum, 2002), inverse propensity weights (IPW; Austin, 2011), covariate balancing propensity scores (CBPS; Imai & Ratkovic, 2014), and generalized boosted regression trees (GBM; McCaffrey et al., 2004). All methods accounted for sampling weights (Zubizarreta, 2015).

Following the selection of the propensity score model, we tested a naïve estimate of racial discrimination on the outcomes of interest without the propensity scores and covariates. This model helped to compare results with and without the propensity score weights. We then estimated a doubly robust (Schafer & Kang, 2008) model utilizing a weighted linear regression where the weights were propensity scores from the selected propensity score model. More specifically, this model included whether participants experienced racial discrimination, the main effects of all covariates, and interactions between racial discrimination and each covariate. From the model, we estimated the average treatment effect among the treated (ATT), which provided an estimate of the effect of racial discrimination on each health outcome among participants who reported experiencing racial discrimination (Gerber & Green, 2012). We used HC2 heteroskedastic standard errors to account for non-normality in the variables and any potential model misspecification. Although CVD risk, depression disorder and substance use disorder were dichotomous outcomes, we estimated a linear regression model. Thus, the linear regression model becomes a linear probability model (Aldrich & Nelson, 1990), which in our case, indicated the probability of a mental health disorder or CVD risk; although this violated the assumption of normally distributed errors, utilization of robust standard errors provided unbiased

standard errors (Gomila, 2020). Results of the models with SRH and BMI as the outcomes were interpreted as typical ordinary least squares linear regressions.

For the linear regressions, all covariates were centered at the mean of the group that experienced racial discrimination. By centering the variables at the mean of the group that reported racial discrimination, the coefficient of racial discrimination remained an unbiased estimate of ATT after including covariates and treatment by covariate interactions. The full sample had missing data on the outcome variables, and the analyses were run on the data where participants missing on outcome variables were dropped due to low levels of missing data (Dong & Peng, 2013). There were 120 participants (2%) missing for CVD, 249 participants (4%) missing for BMI, 119 participants (2%) missing on depression disorder, and 229 participants (3%) missing on substance use disorder.

Results

In the first section of the results, we discuss the covariate balance between the group that reported racial discrimination (i.e., the treatment group) and the group that did not report racial discrimination (i.e., the control group). We considered standardized mean differences and percentage differences greater than .10 as unbalanced (Austin, 2009). Several variables differed between participants who reported racial discrimination and participants who did not report racial discrimination (See Table 1). Compared to the no discrimination group, the racial discrimination group was about five years younger, had a higher household income, had a larger proportion of Black participants, a smaller proportion of Asian participants, a smaller proportion of Latino participants, had a larger proportion of people who were employed, had smaller proportion of people not in the labor force, had a smaller proportion of people with zero to eleven years of education, had a lower proportion of people who were married, had a larger

proportion of people who were never married, and had a smaller proportion of people from the West. The imbalance of several covariates between the racial discrimination group and the no racial discrimination group provided further justification for testing several methods to balance the groups on the covariates.

Next, we examined the overlap in the distribution of covariates between the racial discrimination group and the no racial discrimination group using propensity scores calculated by the weighted logit regression (See Figure 1). A visual analysis of the distributions indicated that there was a decent overlap of the propensity scores between the two groups. We compared the balance of covariates using nearest neighbor matching, IPW, CBPS, and GBM. The CBPS and GBM model provided the best and similar balance in the covariates (See Figure 2). However, the effective sample size in the control group was a bit larger for GBM compared to CBPS, so we used the GBM propensity score weights in our next set of analyses (See Table 2).

The results of the naïve estimates of racial discrimination on each outcome (See Table 3) indicated that there was not a difference between participants who did and did not report racial discrimination on CVD risk (b = .005, 95% CI [-.02, .03]). However, compared to participants who did not report racial discrimination, experiencing discrimination was associated with about a tenth of a point improvement in SRH (b = .12, 95% CI [.06, .19]), a one-point higher BMI (b = 1.14, 95% CI [.84, 1.44]), a 2% increase in the probability of having a depression disorder (b = .02, 95% CI [.01, .04]), and a 2% increase in the probability of having a substance use disorder (b = .02, 95% CI [.01, .02]).

Following the naïve estimation of the effect of racial discrimination on each health outcome, we added the propensity score weights, the full set of covariates, and the treatment by covariate interactions to improve the precision of our estimate of the association between racial

discrimination and each health outcome and to test for treatment covariate interactions (See Table 4). For CVD risk, participants who experienced racial discrimination had higher CVD risk (*b* = .04, 95% CI [.00, .07]) compared to those who did not report experiencing racial discrimination. However, the effect of racial discrimination on CVD risk was moderated by race/ethnicity (*b* = .07, 95% CI [.01, .14] for Latino; *b* = .09, 95% CI [.00, .18] for Asian American), and sex (*b* = .07, 95% CI [.01, .14]). These interactions suggested that the association between racial discrimination and CVD risk was stronger for Latino and Asian participants compared to Black participants and stronger for women compared to men.

For SRH health, participants who experienced racial discrimination had worse SRH (*b* = -.12, 95% CI [-.20, -.03]) compared to participants who did not experience racial discrimination. However, the effect of experiencing racial discrimination for SRH was moderated by not being in the labor force (*b* = .30, 95% CI [.07, .52]), having 13-15 years of education (*b* = .34, 95% CI [.10, .57]), and having health insurance (*b* = -.23, 95% CI [-.41, -.04]). These interactions indicated that the association between racial discrimination and worse SRH was stronger for those who had health insurance compared to those without health insurance, weaker for those who were not in the labor force compared to those working full time, and weaker for those with 13-15 years of education compared to those with less than 12 years of education.

In terms of BMI, there was no association between racial discrimination and BMI (*b* = .29, 95% CI [-.17, .75]) compared to participants who did not experience racial discrimination. There were no statistically significant interactions between racial discrimination and covariates for BMI.

For depression disorder, we found that participants who experienced racial discrimination had a 3% higher probability of having a depression disorder (*b* = .03, 95% CI [.01, .04])

compared to participants who did not experience racial discrimination. However, the association between racial discrimination and the probability of a depression disorder was moderated by geographic region (*b* = .05, 95% CI [.01, .08]) and health insurance (*b* = -.05, 95% CI [-.08, -.02]). These interactions indicated that the association between racial discrimination and depression disorder was stronger for participants in the West compared to the South, and weaker for participants with health insurance compared to those without health insurance.

Lastly, we found that participants who experienced racial discrimination had a 2% higher probability of having a substance use disorder (*b* = .02, 95% CI [.01, .02]) compared to participants who did not experience racial discrimination. However, the association between racial discrimination and substance use disorder was moderated by age (*b* = -.001, 95% CI [-.001, -.0003]), sex (*b* = -.02, 95% CI [-.03, -.01]), and unemployment (*b* =.03, 95% CI [.01, .05]). These interactions indicated that there was a weaker association between racial discrimination and a substance use disorder for older participants, and female compared to male, but a stronger association for those who were unemployed compared to those who were working full time.

Discussion

Prior reviews and meta-analyses have documented discrimination's pernicious effects on the physical and mental health of individuals in the U.S. (Benner et al., 2018; Cave et al., 2020; Pascoe & Smart Richman, 2009; Schmitt et al., 2014). However, most of this research has been correlational in nature and could not provide evidence of a causal association between racial discrimination and health. Some previous experimental studies found a null effect of racial discrimination (Schmitt et al., 2014) partly because the real-experience of discrimination is hard to be manipulated in a laboratory setting. The current study used a PSW approach, which under the right conditions approximates randomization, in order to strengthen the evidence for a causal

estimate of racial discrimination on racial/ethnic minority individuals' CVD risk, SRH, BMI, depression disorder, and substance use disorder with an analytical dataset produced by merging two nationally representative surveys.

Prior to using the propensity score weights, there were noteworthy demographic differences between the racial discrimination and non-racial discrimination groups, even though the magnitude of the differences was small. The non-discrimination group was older, which aligns with research suggesting that racial/ethnic minority people report greater levels of discrimination at younger ages (Wheaton et al., 2018). Black participants had the greatest representation in the racial discrimination group, which corresponds with the research demonstrating that Black Americans tend to have the highest reports of racial discrimination compared to other races/ethnicities (Lee et al., 2019). This is potentially due to the long history of racism targeted specifically at Black Americans (Reskin, 2012). Further, those who were not in the labor force and had lower levels of education had a greater representation in the non-discrimination group, while those who were employed had greater representation in the racial discrimination group. Although work and education afford necessary access to economic resources, there are notable inequalities in these contexts that expose racial/ethnic minority people to discriminatory treatment (Hudson et al., 2012). There was a greater representation of never-married participants in the discrimination group and greater representation of the married or cohabitating group in the non-discrimination group—while marriage does not prevent racial discrimination, it may offer social benefits that mitigate the perception of racial discrimination that are unavailable to singletons (Trail et al., 2012). Lastly, a greater number of people living in the West were in the non-discrimination group, which may be explained by the different historical and sociopolitical histories in the West (Dwyer-Lindgren et al., 2016). Although the

purpose of this study was to balance participants across these demographic characteristics, these baseline differences highlight important demographic variability related to racial discrimination.

Results from the linear regression with PSW showed that experiencing racial discrimination significantly predicted an increase in the probability of CVD risk, depression disorder, and substance use disorder within the past 12 months, and worse SRH. This result bring the literature one step closer in considering racial discrimination as a causal factor for worse health among racial/ethnic minority people although the effect size of the effects in the current study was relatively small. Specifically, we found that compared with participants who did not experience racial discrimination, those who experienced racial discrimination had a 5% higher probability of CVD risk, 0.12 points lower SRH, 3% higher probability of having depression disorder, and 2% higher probability of having substance use disorder. However, there was no difference in BMI across the discrimination and no discrimination groups. The small effect size of CVD risk and the null effect for BMI may be partly explained by metabolic factors as research has shown that racial discrimination might be a slightly distal predictor of health outcomes but a more immediate predictor for metabolic biomarkers (Goosby et al., 2018). Future studies can include important metabolic factors (e.g., allostatic load) as control variables to provide a stronger causal estimate. Researchers may also want to include metabolic factors as mediators in a causal model to tease apart the mechanisms through which discrimination affects health. For the small effect size on depression and substance use disorder, it may be due to the overall low prevalence of either disorder in the analytic sample (6% for depression and 1.7% for substance use disorder). These rates are also lower than the prevalence rate of each disorder during 2001-2003 when the data were collected—rates ranged from 4.2%-12% for depression (González et al., 2010), between 6.9% -12.1% for alcohol use disorders, and 1.4% - 2.4% for drug use

disorders (Falk et al., 2008).

In examining the potential moderators of the effect of racial discrimination on health, we found moderating effects of race/ethnicity, age, sex, SES (i.e., educational levels, employment status), geographic region, and health insurance status. Investigating the interactions between sociodemographic characteristics and racial discrimination acknowledges that people experience discrimination at the intersection of their unique set of multiple identities (Crenshaw, 1991). The variability in how discrimination is associated with health across socio-demographic characteristics speaks to the importance of taking an intersectional approach to this research question (Bowleg & Bauer, 2016). Specifically, our results showed that the effect of discrimination on CVD risk was stronger for Latino and Asian participants compared to Black participants and for women compared to men. These results are surprising given that Black people and males tend to report more racial discrimination and have a higher prevalence of cardiovascular disease than other racial groups and females (Lee et al., 2019; Morris et al., 2018). Our results also showed that the effect of discrimination on the probability of a substance use disorder was weaker for women compared to men and for older participants compared to younger participants. This is consistent with the prior literature which found that males and younger people have a higher tendency to engage in substance use as a way to cope with discrimination than females and older adults (Assari et al., 2019).

In terms of SES, there were nuances in the moderating roles of different aspects of SES. Specifically, we found that higher educational attainment buffered the negative effects of racial discrimination on SRH, which is consistent with the research showing the protective effects of higher educational attainment for health (Allen et al., 2019). For employment status, we found that being fully employed had a stronger association between racial discrimination and SRH (vs.

those who were not in the labor force). This aligns with prior research documenting the exposure to racial discrimination at work and its consequences for racial minorities' physical health (Triana et al., 2015). We also found that unemployed participants had a stronger association between discrimination and the probability of a substance use disorder when compared to fully employed participants. The additional stress of unemployment may strengthen the link between racial discrimination and substance use (Henkel, 2011).

In addition, we found that that the association between racial discrimination and health differed by geographic regions. Specifically, we found that the association between racial discrimination and the probability of a depression disorder was stronger for participants in the West compared to those in the South. Our results echoed the finding by Kim and colleagues (2017) that perceived racial discrimination had a stronger impact on psychiatric disorders for Black people in the West than those in the South. This finding can be partly explained by the perceived region norms. That is, discrimination tends to be more pervasive and be viewed as "status quo" in the South (Kim et al., 2017) and thus may not be a source of distress compared to other geographic regions. The results may also be further explained by research demonstrating that the geographic distribution of racism does not fully align with perceptions that racial discrimination is more pervasive in the South (Chae et al., 2015).

Lastly, our results indicated that compared with individuals who did not have health insurance, those with health insurance showed a weaker association between racial discrimination and depression disorder as well as a stronger association between racial discrimination and worse SRH. Individuals with health insurance may be likely to receive mental healthcare services that may prevent them from developing serious mental health disorders. At the same time, although access to medical services provides opportunities to receive health care

treatment, racial/ethnic minorities also experience discrimination in health care settings, which may deter or delay them from seeking treatment for more general health issues (Lee et al., 2009).

Strengths and Limitations

It is difficult to find causal links when studying the negative effects of discrimination on health. Yet, the preponderance of evidence indicates that racial/ethnic minority people, who are also most likely to experience racial discrimination, often have worse health outcomes. Accounting for socio-demographic covariates while comparing those who did and did not report discrimination allowed us to glean insight into a possible causal effect of discrimination on CVD risk, SRH, BMI, and the probability of depression disorder and substance use disorder. Although we found small effects, to the best of our knowledge, this is the first study that applied PSW to investigate racial discrimination as a deleterious causal effect of worse physical and mental health. Thus, our study adds to a body of research that increasingly centers on the causal effect of racial discrimination on health among racial/ethnic minority people.

The current study has some limitations that should be noted. First, these data are twenty years old, and recent research suggests that the prevalence of discrimination had increased in recent years (Lee et al., 2019)—thus although these data are still some of only nationally representative data with large samples of racial/ethnic minority people, the impact of racial discrimination on these health outcomes may be underestimated. Second, our study used cross-sectional data, which limited us from fully disentangling the temporal ordering of discrimination and health outcomes. We encourage future studies to incorporate longitudinal designs with a propensity matching approach to further enhance the causal inferences between racial discrimination and health. Third, while a methodological strength of PSW is its ability to balance the treatment and control groups across several covariates that have known relations with racial

discrimination and each outcome, they are also limited by the covariates available to be included in the model. We were not able to account for all covariates that may have been related to racial discrimination or the outcomes, such as medical history, neighborhood characteristics, structural inequalities, and racial trauma. Future studies should explore a larger set of covariates in newer datasets that measure many of covariates shown to be related to racial discrimination and health.

Fourth, although these data had strong clinical measures of depression and substance use, we were limited in our ability to measure health with more modern medical, biological, and epigenetic measures of health—future studies should employ these methods in conjunction with PSW. Fifth, discrimination was operationalized as lifetime racial discrimination; however, this way of conceptualizing racial discrimination ignores the variability in the frequency and intensity of discrimination. In addition, conceptualizations of interpersonal racial discrimination have expanded since these data were collected. Racial/ethnic minority people can be subjected to different forms of discrimination, including covert, overt, and vicarious discrimination. Therefore, future studies should examine various forms of racial discrimination and their relations to health. However, despite the expanded scope of racial discrimination, the fact remains that experiencing racial discrimination (in all forms) has always and continues to persistently compromise the health of racial/ethnic minority people. Finally, it is not difficult to imagine that chronic exposure to racial discrimination over time might exacerbate these effects or that the effect of racial discrimination may not be linear and vary over time; thus, future research should examine the causal effect of racial discrimination on health prospectively to examine if the cumulative effects of racial discrimination exacerbate changes in each outcome and allow for non-linear relationships between racial discrimination and health outcomes.

Conclusion

Racial discrimination remains persistent in the lives of racial/ethnic minority people in the U.S. An overwhelming amount of research shows that racial discrimination is linked with worse mental and physical health across a variety of study methods, social contexts, racial/ethnic groups. Our study provides the first attempt to apply a PSW approach to a nationally representative sample of racial/ethnic minority people. The results of the study bolster evidence for the causal link between the harmful effects of racial discrimination and the health of racial/ethnic minority people. Across several health indicators, we found that people who reported experiencing racial discrimination had worse health. While the effects were small, the scope of these associations was limited to any experience of racial discrimination, which highlights the probable conclusion that when racial/ethnic minority people experience repeated and chronic discrimination, it has a cumulative deleterious effect on their health that may partly explain racial/ethnic health disparities. On balance, our study provides an important step in elucidating the causal effect of racial discrimination on health but given the limitations of this dataset and the current social climate, more modern national surveys of this size and scope are needed.

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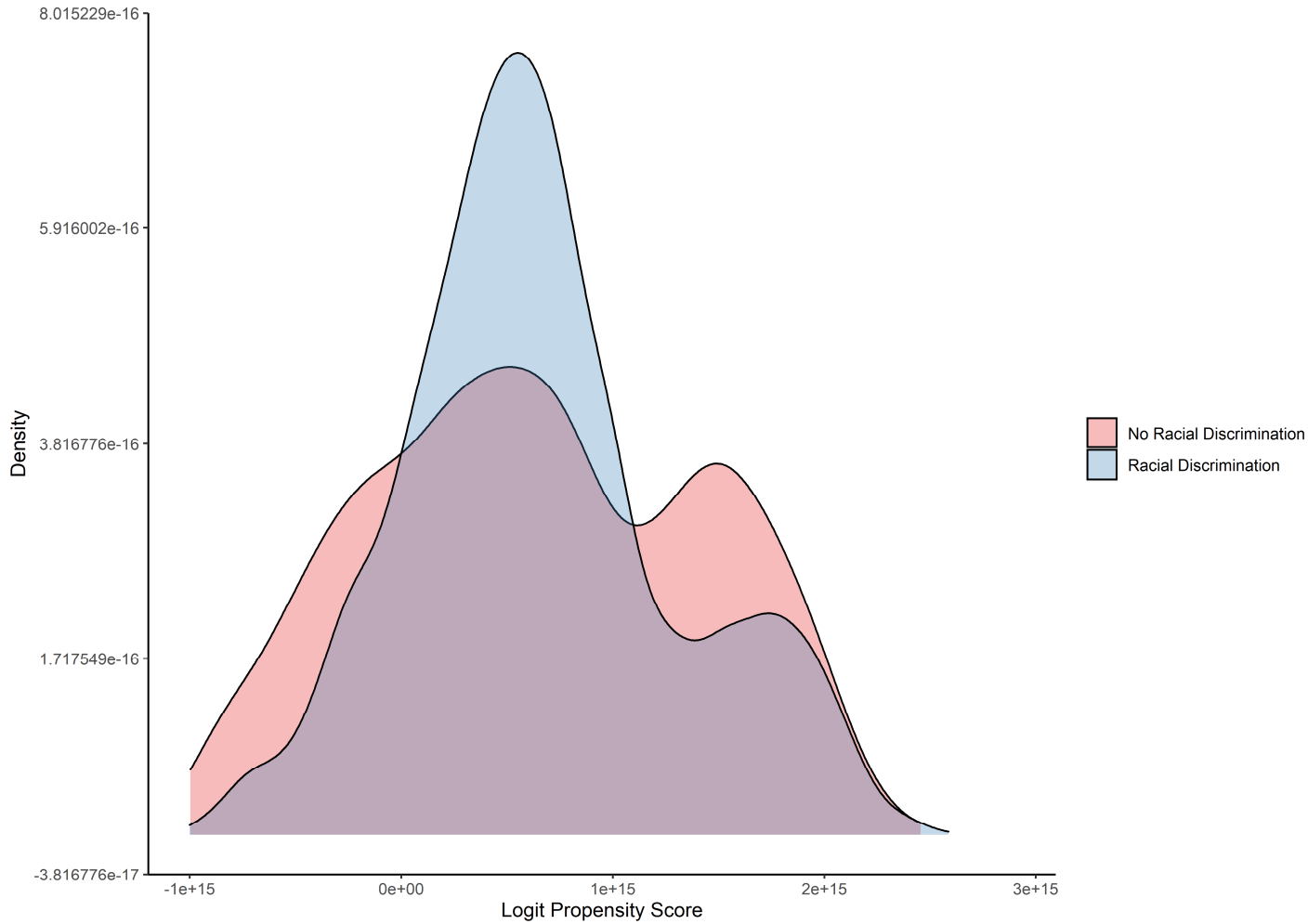

Fig. 1. Covariate balance with logit propensity scores.

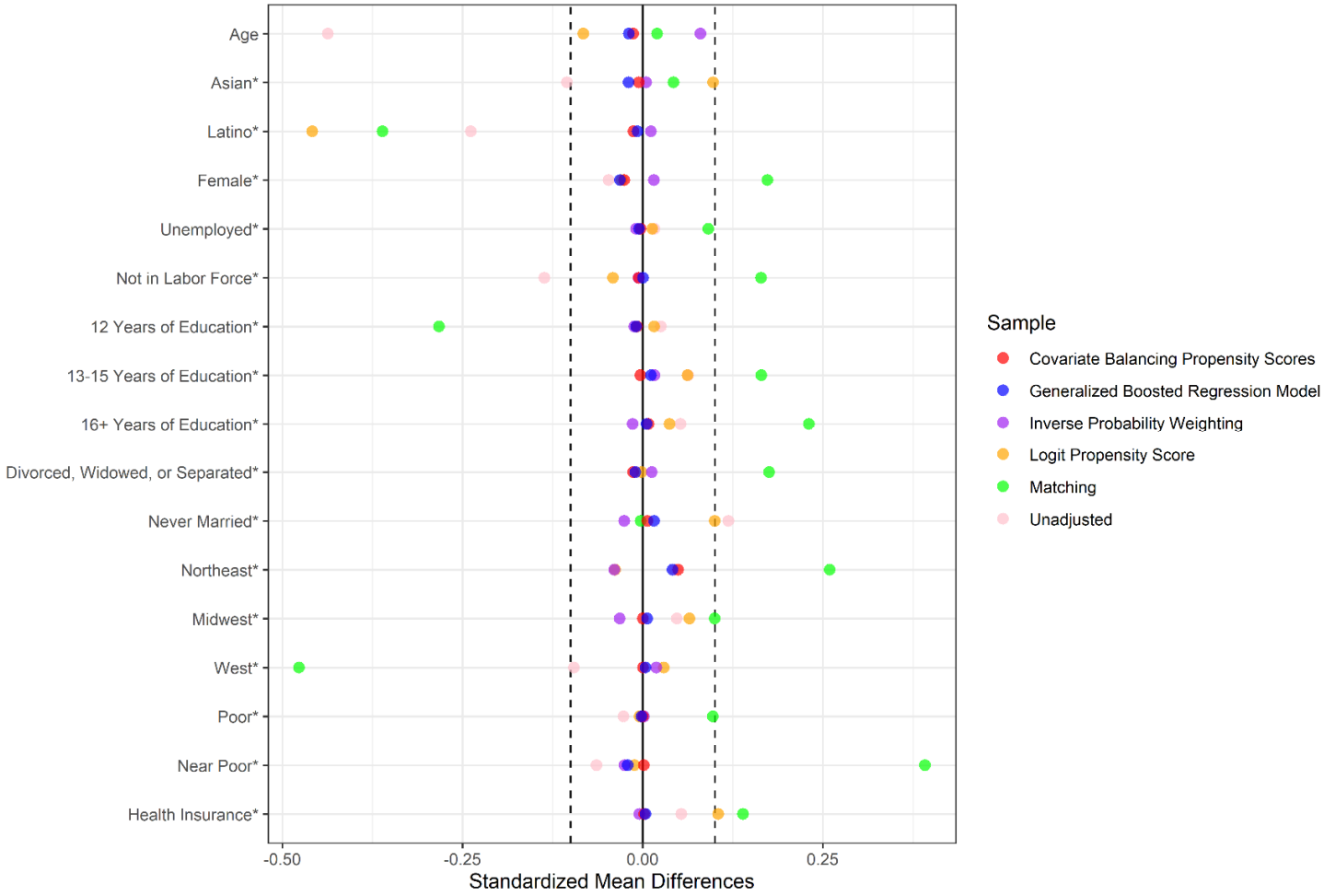

Fig. 2. Comparison of covariate balance methods. Note that variables with a star are raw percentage differences.

Table 1. Covariate balance table for outcome and covariate variables prior to weighting.

	Racial Discrimination		No Racial Discrimination		
Variable	Mean /%	SD	Mean /%	SD	Difference[a]
Age	39.98	14.26	46.87	17.14	-0.45
Black	60.5%	--	26.2%	--	0.34
Asian	18.1%	--	28.6%	--	-0.11
Latino	21.4%	--	45.2%	--	-0.24
Female	55.3%	--	60.0%	--	-0.05
Employed	69.8%	--	57.8%	--	0.12
Unemployed	9.1%	--	7.5%	--	0.02
Not in Labor Force	21.0%	--	34.7%	--	-0.14
Education - 0-11 years	22.1%	--	36.2%	--	-0.14
Education - 12 years	29.2%	--	26.7%	--	0.03
Education - 13-15 years	25.7%	--	19.3%	--	0.06
Education - 16+ years	23.1%	--	17.8%	--	0.05
Married or Cohabiting	49.4%	--	60.5%	--	-0.11
Divorced Separated Widowed	22.2%	--	23.0%	--	-0.01
Never Married	28.5%	--	16.6%	--	0.12
Northeast	26.0%	--	21.6%	--	0.04
Midwest	10.0%	--	5.3%	--	0.05
South	40.4%	--	40.0%	--	0.00
West	23.6%	--	33.1%	--	-0.10
Poor	9.8%	--	12.4%	--	-0.03
Near Poor	39.2%	--	45.6%	--	-0.06
Not Poor	51.1%	--	42.0%	--	0.09
Health Insurance	80.6%	--	75.2%	--	0.05

Note. [a]Differences between continuous variable (i.e., age) represent Cohens *d*, and differences between categorical variables are raw percentage differences.

Table 2. Effective sample sizes for across balancing methods.

	Control	Treated
N	1836	4358
Logit Propensity Scores	641.76	2208.20
Matched	3.94	4358.00
Inverse Probability Weighting	381.88	2343.83
Covariate Balance Propensity Scores	850.75	4358.00
Generalized Boosted Regression Trees	862.03	4358.00

Table 3. Naïve estimates.

Outcomes	*b*	*SE*	*LL*	*UL*
Cardiovascular Disease	0.01	0.01	-0.02	0.03
Self-Reported Health	0.12	0.03	0.06	0.19
Body Mass Index	1.14	0.15	0.84	1.44
Depression Disorder	0.02	0.01	0.01	0.04
Substance Use Disorder	0.02	< 0.001	0.01	0.02

Table 4. Effect of experienced racial discrimination on the outcome variables using propensity score method (generalized boosted regression trees).

	Cardiovascular Disease			Self-Reported Health[a]			Body Mass Index[a]			Depression Disorder			Substance Use Disorder		
Variable	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
Intercept	**0.25**	**0.01**	**<0.01**	**3.56**	**0.04**	**<0.01**	**27.29**	**0.22**	**<0.01**	**0.04**	**0.01**	**<0.01**	**0.004**	**<0.012**	**0.03**
Experienced discrimination	**0.04**	**0.02**	**0.03**	**-0.12**	**0.04**	**0.01**	0.29	0.23	0.21	**0.03**	**0.01**	**<0.01**	**0.02**	**<0.013**	**<0.01**
Age	**0.01**	**<0.001**	**<0.01**	**-0.01**	**<0.001**	**<0.01**	**0.04**	**0.01**	**0.01**	<0.01	<0.001	0.24	-0.001	<0.001	0.38
Latino	**-0.15**	**0.03**	**<0.01**	-0.07	0.08	0.43	**-1.45**	**0.44**	**<0.01**	**0.04**	**0.01**	**0.01**	-0.002	0.01	0.73
Asian American	**-0.21**	**0.04**	**<0.01**	0.09	0.11	0.38	**-5.07**	**0.62**	**<0.01**	0.01	0.01	0.47	-0.01	0.01	0.50
Female	-0.05	0.03	0.13	-0.02	0.08	0.83	0.41	0.42	0.33	0.02	0.01	0.11	-0.005	0.004	0.19
Unemployed	0.04	0.05	0.42	-0.15	0.13	0.25	-0.47	0.65	0.46	0.02	0.03	0.38	-0.004	<0.014	0.33
Not in labor force	**0.13**	**0.03**	**<0.01**	**-0.67**	**0.10**	**<0.01**	-0.65	0.49	0.19	0.02	0.02	0.28	-0.004	<0.013	0.12
12 years education	0.02	0.04	0.66	0.03	0.09	0.76	-0.51	0.49	0.30	<0.01	0.02	0.83	-0.01	0.01	0.35
13-15 years education	0.02	0.04	0.68	-0.10	0.11	0.33	0.23	0.59	0.70	<0.01	0.02	0.95	-0.01	0.01	0.10
16+ years education	-0.04	0.04	0.33	**0.28**	**0.11**	**0.01**	-0.94	0.57	0.10	-0.02	0.02	0.32	-0.01	0.01	0.06
Div/Sep/Wid	0.02	0.04	0.58	-0.03	0.10	0.75	0.05	0.56	0.93	**0.06**	**0.02**	**0.01**	<0.015	<0.014	0.25
Never married	0.01	0.04	0.73	0.05	0.10	0.61	-0.05	0.56	0.93	<0.01	0.01	0.91	-<0.011	<0.014	0.80
Northeast	-0.04	0.04	0.26	0.11	0.10	0.30	-0.19	0.54	0.72	-0.02	0.02	0.33	<0.011	<0.013	0.85
Midwest	-0.02	0.06	0.78	-0.08	0.15	0.58	0.27	0.91	0.77	0.03	0.04	0.45	-<0.012	<0.012	0.30
West	0.01	0.04	0.74	**-0.29**	**0.09**	**<0.01**	-0.23	0.60	0.70	-0.02	0.01	0.14	0.01	0.01	0.27
Poor	-0.012	0.04	0.97	-0.07	0.14	0.59	0.22	0.65	0.73	0.05	0.03	0.12	-<0.013	<0.012	0.12
Near Poor	0.01	0.03	0.67	-0.09	0.09	0.30	-0.51	0.48	0.28	<0.01	0.02	0.84	<0.014	<0.013	0.22
Health Insurance	-0.01	0.03	0.68	**0.21**	**0.08**	**0.01**	-0.34	0.45	0.45	0.02	0.01	0.07	-0.01	0.01	0.30
Discrimination × Age	<0.012	<0.001	0.14	<0.013	<0.013	0.31	-0.01	0.02	0.50	0.001	<0.001	0.20	**-0.001**	**<0.001**	**<0.01**
Discrimination × Latino	**0.07**	**0.03**	**0.03**	0.02	0.09	0.84	0.70	0.49	0.16	-0.01	0.02	0.49	-0.01	0.01	0.40
Discrimination × Asian	**0.09**	**0.05**	**0.04**	-0.11	0.12	0.37	0.73	0.67	0.28	-0.03	0.02	0.07	-0.01	0.01	0.24
Discrimination × Female	**0.07**	**0.03**	**0.02**	-0.10	0.09	0.22	0.02	0.45	0.96	0.01	0.01	0.56	**-0.02**	**0.01**	**<0.01**
Discrimination × Unemployed	-0.03	0.05	0.55	0.13	0.14	0.35	-0.04	0.72	0.95	-0.01	0.03	0.67	**0.03**	**0.01**	**0.01**
Discrimination × Not in labor force	-0.04	0.04	0.23	**0.30**	**0.11**	**0.01**	0.28	0.55	0.61	0.03	0.02	0.17	0.01	0.01	0.09
Discrimination × 12 years education	-0.07	0.04	0.09	0.10	0.11	0.36	0.50	0.55	0.37	-0.01	0.02	0.80	-0.01	0.01	0.16
Discrimination × 13-15 years education	-0.05	0.05	0.33	**0.34**	**0.12**	**<0.01**	-0.44	0.65	0.49	<0.01	0.02	0.89	-0.01	0.01	0.31
Discrimination × 16+ years education	-0.02	0.05	0.62	0.03	0.12	0.79	-0.06	0.63	0.92	0.02	0.02	0.46	-0.01	0.01	0.51
Discrimination × Div/Sep/Wid	-0.02	0.05	0.72	-0.07	0.11	0.55	-0.38	0.61	0.53	-0.01	0.03	0.80	0.01	0.01	0.13
Discrimination × Never married	0.02	0.04	0.57	-0.07	0.10	0.50	-0.98	0.60	0.10	0.02	0.02	0.19	0.01	0.01	0.41
Discrimination × Northeast	0.02	0.04	0.54	-0.16	0.11	0.15	-0.11	0.58	0.85	0.03	0.02	0.15	-0.001	0.01	0.87
Discrimination × Midwest	0.03	0.07	0.62	-0.03	0.16	0.83	0.52	0.96	0.59	<0.012	0.04	0.95	0.01	0.01	0.36
Discrimination × West	-0.04	0.04	0.31	0.18	0.10	0.08	0.48	0.65	0.46	**0.05**	**0.02**	**0.01**	-0.003	0.01	0.85
Discrimination × Poor	0.06	0.05	0.27	-0.07	0.15	0.63	-0.28	0.73	0.71	-0.04	0.04	0.25	0.01	0.01	0.23

Discrimination × Near Poor	-0.01	0.04	0.85	-0.01	0.10	0.95	0.65	0.52	0.21	-<0.011	0.02	0.95	<0.013	0.01	0.66
Discrimination × Health Insurance	0.06	0.04	0.09	**-0.23**	**0.09**	**0.02**	0.85	0.51	0.09	**-0.05**	**0.02**	**<0.01**	-0.01	0.01	0.55

Note. Div/Sep/Wid = Divorced, Separated, Widowed. Significant results are bolded. [a]Indicates variables that were continuous outcomes.