



# Variations in the association between education and self-reported health by race/ethnicity and structural racism

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## ABSTRACT

Research has documented a longstanding association between education achievement and physical health outcomes. However, research has suggested that the health benefits gained from education differ by race, with minoritized racial groups generally experiencing poorer health and fewer health benefits from education. One potential explanation for this phenomena of “diminished returns” is the influence of structural racism. The purpose of this paper is to assess how structural factors at the state level are associated with self-reported health and the association between education and health. Utilizing a sample (N = 6819) from the NLSY dataset, measures of structural racism (political participation, employment and job status, education attainment and judicial treatment) were used to assess the hypotheses. Results indicated significant differences in key areas, with some nuanced findings – indicating that structural racism is an important health factor. These indicators of structural racism are discussed in the context of complexity of linked lives. Further research regarding structural racism, education, health and developmental stages is warranted.

There are multiple social determinants of health that have been associated with health disparities. One social determinant of health, education, has a well-documented (Brunello et al., 2016; Cutler and Lleras-Muney, 2006a; Ross & Wu, 1995; Silles, 2009; Zimmerman & Woolf, 2014) association with self-reported health, however, many researchers have assumed that the magnitude of the association between education and health is the same across populations, rather than varying among certain areas or certain groups of people. Assari and colleagues (Assari, 2018, 2019; Assari et al., 2021) have suggested minoritized groups are experiencing fewer health benefits from education. Structural racism (measured by state) has been one possible explanation for this phenomenon, as differences in health outcomes such as myocardial infarction and breast cancer rates have been noted in states of differing levels of structural racism (Lukachko, 2014), (Eldridge & Berrigan, 2022) The purpose of this study was to estimate the variation in the association between education and health by race/ethnicity and structural racism indicators at the state of residence level.

## 1. Background

### 1.1. Health disparities

Health disparities among minoritized groups are well documented. . In the US, despite efforts made to alter these trends, the disparities have continued to grow, (Zajacova & Lawrence, 2018). Within the United States, individuals who are Black are twice as likely to die from heart disease, are more likely to have diabetes, hypertension, asthma and have a life expectancy four years less than those who are White (CDC, 2021). Health disparities have been related to social determinants of health including race/ethnicity rather than to any differences in biology. This was made clear during the COVID-19 pandemic, Blacks within the United States were hospitalized and died from the virus more than Whites (Boulware, 2020). These differences were attributed to structural factors like accessibility to healthcare, and types of exposure (i.e. employment, housing) (Boulware, 2020; Chowkwanyun & Reed, 2020; DeSouza et al., 2021). Thus, there is a need to understand the influence of larger structural factors that lead to these health disparities.

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## 1.2. Education and health

There is a longstanding connection between education and health – highlighting that greater educational attainment is associated with better health longitudinally (Cutler and Lleras-Muney, 2006a), (Ross & Wu, 1995), (Cutler & Lleras-Muney, 2010), (Meara et al., 2008). Although there is no single mechanism which fully accounts for this association, research has shown that education is associated with health behaviors (Cutler & Lleras-Muney, 2010), economic status (Adler et al., 1994), and healthcare benefits (Ross & Wu, 1995) and provides more opportunity to accrue tangible and intangible resources (Zajacova & Lawrence, 2018).

For the “average” individual, estimated self-rated health and life expectancy significantly increase with more education. Cutler and Lleras-Muney suggest that average life expectancy increases by approximately .16–.6 years for each year of education attained (Cutler and Lleras-Muney, 2006a). The benefits reaped are shown to increase as individuals receive high school (or GED), Associates, Bachelors or other professional degrees (Zajacova and Lawrence, 2021). Those who attain a college degree can expect to live up to 7–10 years longer on average than those without a degree (Meara et al., 2008), (Hummer & Hernandez, 2013).

Schoeni et al. suggested that eliminating morbidity and mortality disparities for people with less than a college education would have an economic value of \$1 trillion annually for the US (Schoeni et al., 2011). Woolf et al. provided estimates that suggested that promoting staying in school through high-school would reduce health disparities significantly and save eight times more lives than could be saved through advances in drugs and other medical devices (Woolf et al., 2007). This is often referred to as the education “gradient” in that more education is associated with better health (Adler et al., 1994), (Cutler and Lleras-Muney, 2006b). However, health gaps between Whites and Blacks persist and even widen as education attainment increases even while accounting for factors such as income and wealth (Bell et al., 2020). The “gradient” is essentially steeper for White individuals who appear to experience greater benefits from education than do Black individuals. Rather than creating equality, education potentially widens the already existing health gap between those in minoritized populations and Whites (Holmes & Zajacova, 2014). Thus Schoeni et al. and Woolf et al. provided needed insight into the importance of education, but did not fully explore whether or not this gradient would be equivalent for all racial or ethnic groups (Schoeni et al., 2011), (Woolf et al., 2007).

## 1.3. Diminishing returns

Assari has used the term “diminished returns,” to describe the phenomenon of Black Americans not experiencing the same health benefits from socioeconomic factors (including education) that Non-Latino Whites may experience in the US (Assari, 2018), (Assari, 2019), (Assari et al., 2018), (Assari et al., 2020). As postulated by Assari, the increase of education does not reduce the gap, but apparently continues to increase it (Assari, 2018). In fact, Black people may sacrifice their health in order to gain education or earn higher incomes. As was shown in a sample of college students, Black and Hispanic individuals who earned a college education experienced more depressive symptoms (score were 6.07 and 5.65 respectively) on average than those who were Non-Latino White (4.55) (Gaydosh et al., 2018). Metabolic syndrome was also more prevalent in Non-Latino Black students (35%) and Hispanic students (32%) than Non-Latino White students (26%), noting how structural stressors and barriers differentially impacted different racial groups (Gaydosh et al., 2018). Assari explores certain structural factors which may be influencing the relationship between education and health (Assari, 2018). In this, Assari notes how Black individuals may obtain the same amount of education, but the education does not lead to the same level of income. Thus, those in minoritized populations (especially Black Americans) continue to experience diminished returns

from increased education when compared to Non-Latino White individuals. This theory aligns with other research which has shown a consistent, if not growing, gap between Non-Latino White and Non-Latino Black individuals self-rated health as education increases (Holmes & Zajacova, 2014). Thus, minoritized populations may be working hard, yet are not experiencing the same returns when compared to their Non-Latino White counterparts – in fact their health may even suffer because of it.

## 1.4. Structural racism and health disparities

One possible reason for these diminishing returns may be structural forms of racism. This paper uses the definition from Boynton-Jarrett et al. stating that structural racism is “An organized system of generating and perpetuating opportunities within society differentially based on racial hierarchy” (Boynton-Jarrett et al., 2021). This often takes the form of “policies, laws and structures that designate and maintain differential and unequal value of individuals and groups based on their race.”

Although structural racism may exist to some degree in all areas of the United States, there are measurable differences by state (Ag é nor et al., 2021)– (Riley, 2018). In line with the previous definition of Structural Racism, Lukachko identified four sets of indicators of structural racism at the state level including political participation, employment and job status, educational attainment and judicial treatment (Lukachko, 2014). With these four sets of indicators, they assessed differences in reported myocardial infarctions between Non-Latino Black and Non-Latino White individuals by state (Lukachko, 2014). Those Black citizens living in states with higher structural racism were more likely to report experiencing a myocardial infarction in the last year compared to those living in states with lower structural racism. There was either no association, or a protective advantage for White citizens – highlighting how racism can lead to greater health burdens for Black Americans, and the need to further research how living in different areas may affect individuals living there (Lukachko, 2014), (Boulware, 2020). Although the four sets of indicators of structural racism have been utilized in areas such as heart health or breast cancer (Lukachko, 2014), (Eldridge & Berrigan, 2022), to our knowledge these four measures have not been utilized to understand the variations in the direct association between education and health.

## 1.5. Gaps in the literature

Two things have been clearly shown in the literature 1) structural racism influences health outcomes within the United States (Lukachko, 2014), (Groos et al., 2018) and 2) there are racial differences in how education is associated with self-rated health – showing diminished returns for Black Americans when compared to those who are White (Assari, 2018). What is still unknown is the degree to which structural racism at the state level influences the association between education and self-rated health, and whether structural racism indicators at the state level influence individual self-rated health directly.

## 1.6. Purpose of the current study

The purpose of the current study was to estimate the variability in the association between education and self-rated health that could be attributed to race/ethnicity and indicators of structural racism at the state level. We use a large nationally representative dataset (National Longitudinal Study of Youth, 1997; NLSY97), to test the hypothesis that when indicators of structural racism are higher, those in minoritized populations would show a weaker association between education and self-reported health compared to White participants, while when indicators of structural racism are lower, those in minoritized populations will show a stronger association between education and self-reported health compared to their counterparts in states with higher structural

racism.

## 2. Data and methods

### 2.1. Sample

The sample used for this project came from the National Longitudinal Study of Youth 1997. Close to 9000 youth between the ages of 12 and 16 were included in the sample of the NLSY97, which was stratified by race, urban vs rural residence, and whether the parent was active in the military. The study was designed to document the transition from school to work and into adulthood. The NLSY97 followed these youth from 1997 annually to 2011, and then biannually in 2013, 2015, and 2017. Data about general health was collected at each wave.

The NLSY97 sample was constructed by randomly selecting housing units within the strata. There are two samples, the cross-sectional sample and a supplemental sample that oversampled for race/ethnicity. When a housing unit was selected, all age-eligible youth were interviewed, thus there are multiple respondent households in the sample and thus siblings related by blood, marriage, and/or adoption. The sample can be weighted by a base weight which is the inverse of the probability of selecting that housing unit, making adjustments for screener nonresponse, subsampling of youths, combining the cross sectional and supplemental samples, and non-response in any subsequent wave of data collection. Finally, post stratification occurred to make the sample representative of the population of youth in the US. The original NLSY97 sample had a 92.2% response rate for eligible youth. Given multiple informant households, only one participant from a household was selected for the current project to decrease the nonindependence of responses in the same household. This created an overall sample size of 6819.

Most of the data of the NLSY97 is publicly available, however, NLSY97 also collected data on state of residence at each wave of data collection. This data is protected, and analysts need to apply to have access to the residence data. Participants come from all 50 states and the District of Columbia as well as some US territories.

The sample for the current project included all participants who had data on their state of residence in 1997 without repeating selected households ( $N = 6733$ ) or including the District of Columbia (9 participants). The demographic data used was race/ethnicity, sex of participant, parent education level, poverty ratio of the family in 1997, and the participant's highest level of education achieved to date.

There were 1734 Black or African American participants included, 49% were male. The parent education variable was computed by using the mother's education if it was available, the father's education level if the mother's was not available. Once this was computed, missing data (16.5%) was replaced with the race/ethnicity group mean. Among the Black participants 90.7% of the parents had a high school education or less, with 3.1% having a college degree. NLSY97 provides the poverty ratio comparing the household income of the participant to the poverty line in the year the data was collected. The poverty ratio for 1997 was used for this project. This ratio is highly skewed and kurtoid in the dataset and thus a natural log transformation was used. If the poverty ratio was missing (28.3%), it was replaced with the group mean. For the Black participants the average natural log of the poverty ratio was 4.83 ( $sd = 1.031$ ).

There were 1386 Latinx participants, 51.7% were male. Ninety-three percent of the parents had a high school education or less, with 3% having a college degree. The average natural log of the poverty ratio for the Latinx participants was 4.88 ( $sd = 1.00$ ). There were 3596 White participants in the study sample, 50.9% were male. Eighty percent of the parents had a high school degree or less, with 7.6% of the parents having a college degree. The average natural log of the poverty ratio for the White participants was 5.64 ( $sd = 0.776$ ). In a MANOVA comparing the three race/ethnic groups on parent education and income, both were significant Wilks Lambda = 0.74;  $p < .001$ ). Parent education was

statistically different among all the groups, with Non-Latino White participants having parents with the most education (mean = 2.89), followed by Non-Latino Black (mean = 2.26) and then Latinx (mean = 1.57). The Non-Latino White participants reported the highest income compared to the Non-Latino Black and Latinx participants.

### 2.2. Measures

#### 2.2.1. Participant level

**Participant education.** The highest grade level completed was used to compute the participant's education. If the participant had more than a high school education they were coded as 2, and if they had a high school degree or less, they were coded as 1. Of the Black participants, 52.1% had more than a high school education. Of the Latinx participants, 49.1% had more than a high school education. Of the White participants, 63.3% had more than a high school education. This binary variable was used as a predictor of self-reported general health in the models.

**Self-Reported General Health at age 29.** A single item about the participant's general health was asked at each wave of data collection. This item was "In general how is your health?" The response options were excellent, very good, good, fair, and poor. This item was coded so that excellent and very good were coded as 1 and the other categories were coded as 0. The response to this question at the wave of data collection when the participant was 29 or as close to 29 as possible was used. We elected to use age 29 since that is the latest data we had for all participants (i.e. so that the 12 year cohort could be included). We elected to use excellent and very good health because early adults, on average, would not be suffering from chronic conditions and we would expect them to have excellent health in comparison to older adults.

Of the Non-Latino Black participants, 56.5% reported very good or excellent health. Of the Latinx participants, 51.2% reported very good or excellent health. Of the Non-Latino White participants, 64.2% reported very good or excellent health. There was more missing data for this variable than any other (14% for Non-Latino Black participants, 18.3% for Latinx, and 21.4% for Non-Latino White). We elected not to replace this data and used the EM algorithm in all analyses. In a chi-square analysis of the distribution of each race/ethnicity group for reporting very good or excellent health or not, the chi-square test was significant ( $\chi^2(2) = 61.78$ ,  $p < .001$ ). Non-Latino White participants were more likely to report very good to excellent health in comparison to Non-Latino Black and Latinx participants.

#### 2.2.2. State level variables

**2.2.2.1. Structural racism indicators.** We followed the work of Lukachko et al. (Lukachko, 2014) who developed indicators for structural racism. These indicators were grouped into four themes: political participation, education attainment, employment and job status, and judicial treatment. These data are publicly available and Table 1 provides the indicator and the source of the data along with the year it was collected. For the most part, we used data from the 2010 census and stayed as close to 2010 as possible. Data was available for all 50 states and the District of Columbia, with some states having small numbers of Latinx or Non-Latino Black Americans making the estimate of the ratio impossible.

**Political Participation** indicators came from the US Census of 2010. These were the relative proportions of Blacks to Whites and Latinx to Whites who were registered to vote and actually voted, as well as those elected to state legislatures (found at National Conference of State Legislatures: [ncsl.org](https://www.ncsl.org)).

**Educational Attainment** was indicated by the ratio of Blacks to Whites who had a college degree (again not available for Latinx) from the US Census Bureau available by state for 2010.

Following Lukachko et al. we used a median split of the structural

**Table 1**  
Structural Racism Indicators with their sources and year.

Indicator	Source	Year
<i>Political Participation</i>		
Non-Latino Black to Non-Latino White Ratio of registered voters	US Census Bureau	2010
Latinx to Non-Latino White Ratio of registered voters	US Census Bureau	2010
Non-Latino Black to Non-Latino White Ratio of voters	US Census Bureau	2010
Latinx to Non-Latino White Ratio of voters	US Census Bureau	2010
Non-Latino Black to Non-Latino White Ratio of state legislators	National Conference of State Legislatures	2015
Latinx to Non-Latino White Ratio of state legislators	National Conference of State Legislatures	2015
<i>Employment and Job Status</i>		
Non-Latino Black to Non-Latino White Ratio in managerial positions	US Department of Labor and Statistics	2010
Non-Latino Black to Non-Latino White Ratio in professional positions	US Department of Labor and Statistics	2010
Non-Latino Black to Non-Latino White Ratio employed in civilian labor force	US Department of Labor and Statistics	2010
Latinx to Non-Latino White Ratio employed in the civilian labor force	US Department of Labor and Statistics	2010
Non-Latino Black to Non-Latino White Ratio unemployed	US Department of Labor and Statistics	2010
Latinx to Non-Latino White Ratio unemployed	US Department of Labor and Statistics	2010
<i>Educational Attainment</i>		
Non-Latino Black to Non-Latino White ratio of those with a college degree	US Census Bureau	2010
<i>Judicial Treatment</i>		
Non-Latino Black to Non-Latino White Ratio of those in prison	The Sentencing Project	Using Census Bureau Data 2010
Latinx to Non-Latino White Ratio of those in prison	The Sentencing Project	Using Census Bureau Data 2010
Non-Latino Black to Total Ratio of Felony Disenfranchisement	The Sentencing Project	Using Census Bureau Data 2010

racism indicators. If the score was above or at or below the median it was coded as 1 if the ratio suggested more structural racism (Lukachko, 2014). For Political Participation and Educational Attainment a ratio below 1 would suggest more structural racism.

*Employment and job status* indicators were ratios of Non-Latino Blacks to Non-Latino Whites and Latinx to Non-Latino Whites employed in the civilian labor force, and unemployed, as well as ratios of Non-Latino Blacks to Non-Latino Whites in managerial and professional positions (these were not available for Latinx). These data were available by state from the US Department of Labor & Statistics for 2010 (bls.gov).

*Judicial Treatment* indicators included ratios for Non-Latino Black to Non-Latino White imprisonment, Latinx to Non-Latino White imprisonment, and Non-Latino Black to Total Felony Disenfranchisement. These data came from the Sentencing Project (sentencingproject.org) for 2015.

For Employment and Job Status and Judicial Treatment a ratio above 1 indicated more structural racism, when the ratio was above the median for the states it was coded as 1.

### 2.3. Data analysis

We used multilevel modeling to estimate the impact of structural racism directly to self-rated health, and on the slope of education to health or the education gradient by race/ethnicity using *Mplus* 8.2 (Muth é n and Muth é n, 2009). The level 1 equation was a logistic regression predicting the odds of reporting very good or excellent health for each participant that included sex, parent education, log of the poverty ratio in 1997, education, race/ethnicity, and the interaction of

race/ethnicity and education. The level 2 equation used the state level variables to predict the variance in self-rated health and the variance in the interaction terms for race/ethnicity and education. We estimated separate equations for the different themes of structural racism rather than using all the structural racism variables in the same equation. To estimate the equations we used Maximum Likelihood with Robust Standard Errors and the EM Algorithm to account for the missing data in the general health question.

We then computed the probability of reporting very good or excellent health by using the mean of the demographic variable for each group (i.e. mean of the log poverty ratio if it was significant for Non-Latino Black, Latinx or Non-Latino White participants), and then using the education slope for those who had a high school education or less (coded as 1) and those who had more than a high school education (coded as 2) for each race/ethnicity group. The race/ethnicity groups were coded as 1 if the participant was a member of the group and 0 if not in the interaction terms, thus the interaction terms were estimates of the education gradient only for the specific race/ethnicity group.

## 3. Results

### 3.1. Preliminary analyses

Table 2 provides the samples sizes for each state and the number of indicators that showed higher structural racism for each state. The actual scores for each indicator by state can be found in the Appendix. There were five states that were not represented given their number of participants in the original sample and missing data: Nebraska, New Hampshire, Utah, West Virginia, and Wyoming. Table 3 provides the means, standard deviations, medians and ranges of the structural racism variables across the states. Using Optimal Design (Spybrook, Bloom, Congdon et al., 2013: www.wtgrantfoundation.org) with 40 clusters (states) with sample sizes ranging from 31 to 802, and an alpha of .05 with a binary outcome, the power for the models was estimated between 0.87 and 0.94.

Using only individual level data we calculated the odds and probability of reporting very good or excellent health among the Non-Latino Black, Latinx and Non-Latino White participants without taking other demographic characteristics or state of residence into account. These probabilities provide the average education gradient for health among the participants. These can be seen in Fig. 1 in both bar graph and line graph form. The line graph shows the slope or gradient of more education on the probability of reporting very good or excellent health. We tested whether this slope was equivalent across the groups using a chi-square difference test in fit. There was a loss of fit when setting these slopes equivalent ( $\Delta\chi^2(2) = 15.11$ ;  $p < .001$ ). We tested whether the Latinx and Non-Latino White participants' slopes were equivalent as well and also lost fit ( $\Delta\chi^2(1) = 4.241$ ;  $p < .05$ ). This suggested that the education gradient was not the same for the race/ethnicity groups with Non-Latino White participants showing the steepest gradient. That is Non-Latino White participants showed the most self-reported health benefits from more education compared to Latinx and then Non-Latino Black participants. Non-Latino Black participants showed the least self-reported health benefits from more education. Overall, Latinx participants showed higher probabilities of reporting very good or excellent health.

### 3.2. Multilevel model

*Unconditional Model.* We estimated an unconditional model with the demographic variables, education and the interaction terms for race/ethnicity and education taking state of residence into account but not using any of the state level variables to predict the intercept or health threshold or slopes (the education gradient for each race/ethnicity group). These results can be seen in Table 4. All the variables were significantly predictive of the odds of reporting very good or excellent

**Table 2**  
Sample sizes by State with number of structural racism indicator above the median (Total sample = 6733).

State	Sample Size	# of Structural Racism Indicators Above the Median
Alabama	155	7
Alaska	55	4
Arizona	169	5
Arkansas	32	7
California	802	8
Colorado	175	12
Connecticut	66	12
Delaware	38	3
Florida	236	2
Georgia	130	6
Hawaii	1	4
Idaho	1	8
Illinois	285	8
Indiana	212	8
Iowa	3	13
Kansas	72	9
Kentucky	50	8
Louisiana	96	7
Maine	1	8
Maryland	133	3
Massachusetts	99	12
Michigan	301	8
Minnesota	89	12
Mississippi	120	6
Missouri	190	4
Montana	72	7
Nebraska	0	10
Nevada	1	4
New Hampshire	0	8
New Jersey	195	6
New Mexico	41	6
New York	467	9
North Carolina	267	8
North Dakota	53	8
Ohio	163	6
Oklahoma	112	9
Oregon	50	6
Pennsylvania	277	12
Rhode Island	3	10
South Carolina	132	8
South Dakota	58	8
Tennessee	151	5
Texas	564	4
Utah	0	9
Vermont	78	4
Virginia	286	10
Washington	121	11
West Virginia	0	6
Wisconsin	117	11
Wyoming	0	4

health with males less likely to report very good or excellent health, those whose parents who had more education more likely to report very good or excellent health at age 29, those with higher household incomes in 1997, and those with more education were more likely to report very good or excellent health. The interaction terms for education and race/ethnicity were also significant for Non-Latino Black participants and Non-Latino White participants. The interaction was negative for Non-Latino Black participants suggesting that the education gradient was less for Non-Latino Black participants, while the interaction term was positive for Non-Latino White participants suggesting that the education gradient was higher for them. We again calculated the probabilities of reporting very good or excellent health among the race/ethnic groups using the group mean for the demographic variables, and calculating the probability for those with more than a high school education and those with a high school education or less in each race/ethnic group. These can be seen in Fig. 2 in both bar graph and line graph forms. Again, we see that the education gradient is steeper for Non-Latino White participants and they have a higher probability of reporting very good or

**Table 3**  
Structural Racism Areas ratio means, medians, and standard deviations and ranges across states.

	Mean Ratio	SD	Median	Range
<b>Political Participation</b>				
Non-Latino Black to Non-Latino White Registered to vote	.9211	.111	.9416	.66–1.13
Latinx to Non-Latino White Registered to vote	.700	.176	.7438	.17–1.00
Non-Latino Black to Non-Latino White Voted	.9022	.150	.911	.49–1.15
Latinx to Non-Latino White Voted	.584	.193	.5932	.07–.94
Non-Latino Black to Non-Latino White State Legislature Members	.105	.109	.055	0–.39
Latinx to Non-Latino White State Legislature Members	.063	.125	.017	0–.73
<b>Educational Attainment</b>				
Non-Latino Black to Non-Latino White Bachelor’s Degree Attainment	.754	1.06	.450	0–5.09
<b>Employment and Job Status</b>				
Non-Latino Black to Non-Latino White Managerial Positions	.604	.242	.576	0–1.24
Non-Latino Black to Non-Latino White Professional	.846	.248	.817	.41–2.07
Non-Latino Black to Non-Latino White Civilian Labor Employment	.917	.101	.906	.72–1.25
Latinx to Non-Latino White Civilian Labor Employment	1.04	.102	1.03	.85–1.28
Non-Latino Black to Non-Latino White Unemployment	1.895	.540	1.91	.78–3.44
Latinx to Non-Latino White Unemployment	1.493	.308	1.49	.94–2.13
<b>Judicial Treatment</b>				
Non-Latino Black to Non-Latino White Incarcerated	5.97	2.51	5.10	2.40–12.20
Latinx to Non-Latino White Incarcerated	1.42	.996	1.20	0–4.30
Non-Latino Black to Total Felony Disenfranchisement	3.94	2.15	.9416	1.51–13.72

excellent health (.820) when they have more than a high school education. In the following we report the results of the models using the four themes of structural racism, first reporting on the findings for the state level variables’ association with the general health threshold, and then the findings of the state level variables’ associations with the education gradient for each of the race/ethnicity groups.

*Conditional Model Political Participation.* The model for political participation included Non-Latino Black to Non-Latino White and Latinx to Non-Latino White ratios for voter registration by state, Non-Latino Black to Non-Latino White and Latinx to Non-Latino White ratios for voting, and Non-Latino Black to Non-Latino White and Latinx to Non-Latino White ratios for state legislators in each state. The results of this model can be seen in Table 5. At level 1, participant sex and poverty ratio in 1997 were significant. At level 2, Non-Latino Black to Non-Latino White voting was a significant predictor of the health threshold (−0.537). The direct association of Non-Latino Black to Non-Latino White voting behavior with the intercept decreased the probability of reporting very good or excellent health for all race/ethnic groups.

*Conditional Model Employment and Job Status.* In this model, the demographic variables and education were included at level 1, with Non-Latino Black to Non-Latino White ratio for managerial positions, Non-Latino Black to Non-Latino White ratio for professional positions, Non-Latino Black to Non-Latino White ratio for those employed in the civilian labor force, Latinx to Non-Latino White ratio for those employed in the civilian labor force, Non-Latino Black to Non-Latino White ratio of unemployed and Latinx to Non-Latino White ratio of unemployed at level 2. In this model, all the level 1 predictors were significant predictors of the intercept for self-reported health at age 29. At level 2, the Latinx to Non-Latino White ratio of those employed in the civilian labor

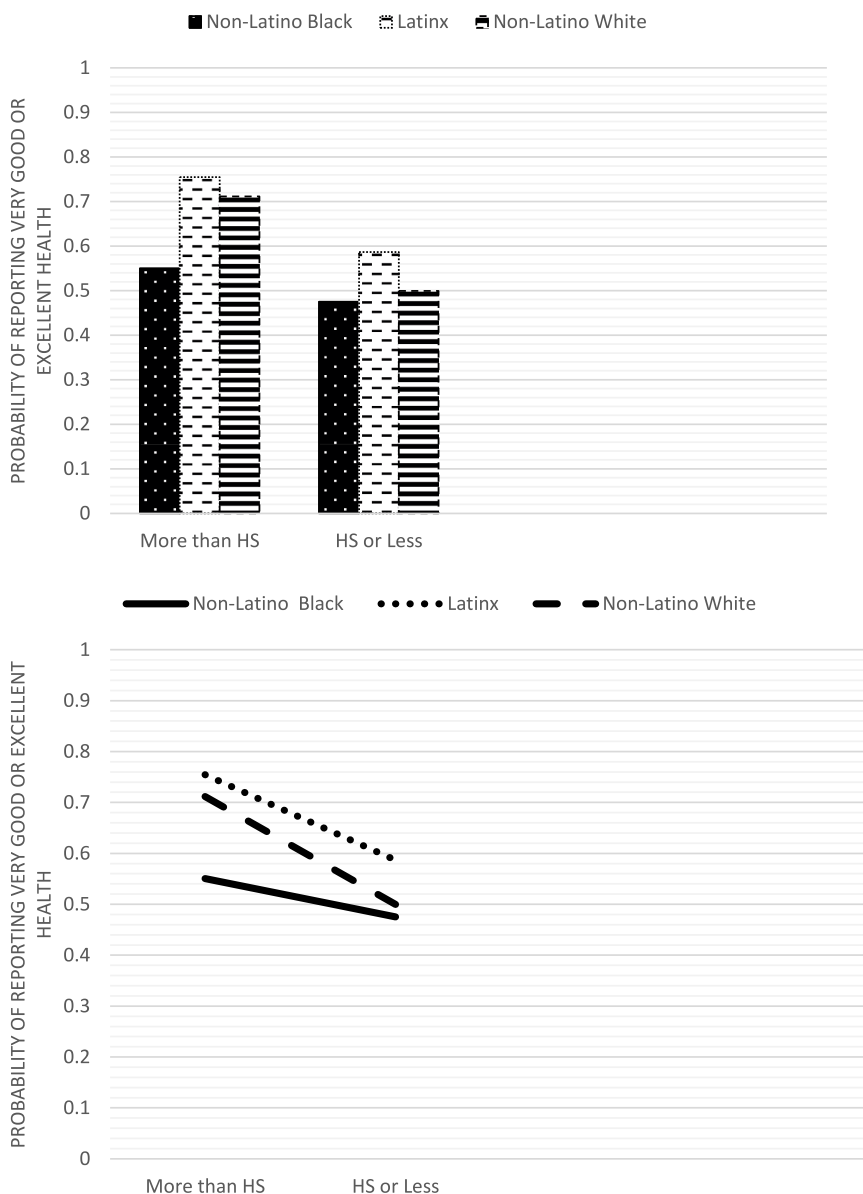


Fig. 1. Overall probability of reporting very good or excellent health by education and race/ethnicity.

**Table 4**  
Unconditional Model allowing slope from education to General Health as random taking state of residence into account.

	Estimate (SE)
General Health Threshold	.293(.375)
Sex	-.304(.060) <sup>a</sup>
Parent Education	.050(.021) <sup>a</sup>
Poverty Ratio	.119(.046) <sup>a</sup>
Education	.556(.085) <sup>a</sup>
Race/Ethnicity	-.314(.126) <sup>a</sup>
Interaction Education Slope for Non-Latino Black Participants	-.151(.044) <sup>a</sup>
Interaction Education Slope for Latinx Participants	-.008(.041)
Interaction Education Slope for Non-Latino White Participants	.348(.178) <sup>a</sup>

<sup>a</sup> p < .05.

force was associated with the intercept for health for all participants. It was a negative association, suggesting that as the ratio went below the median (suggesting higher structural racism) the odds of reporting very good or excellent health decreased. The results of this model can be seen

in Table 6.

*Conditional Model for Educational Attainment.* This model included the demographic variables and education at level 1, and the Non-Latino Black to Non-Latino White ratio of those with college degrees across the states at level 2. Again all the demographic variables were significant predictors of the intercept, along with education. The Non-Latino Black to Non-Latino White ratio of those with college degrees significantly predicted the variance in the intercept suggesting that when this ratio went below the median (more structural racism) the odds of reporting very good or excellent health decreased.

*Conditional Model for Judicial Treatment.* In the final model, the demographic variables and education were set to predict the intercept of general health at level 1, and the Non-Latino Black to Non-Latino White and Latinx to Non-Latino White ratios of those in prison, and the Non-Latino Black to Total ratio of Felony Disenfranchisement were used at level 2 to predict the variance in the intercept and slopes for the education gradient in each race/ethnic group. The results of this model can be seen in Table 8. In this model, participant sex, log poverty ratio from 1997, and education were significant predictors of the odds of reporting

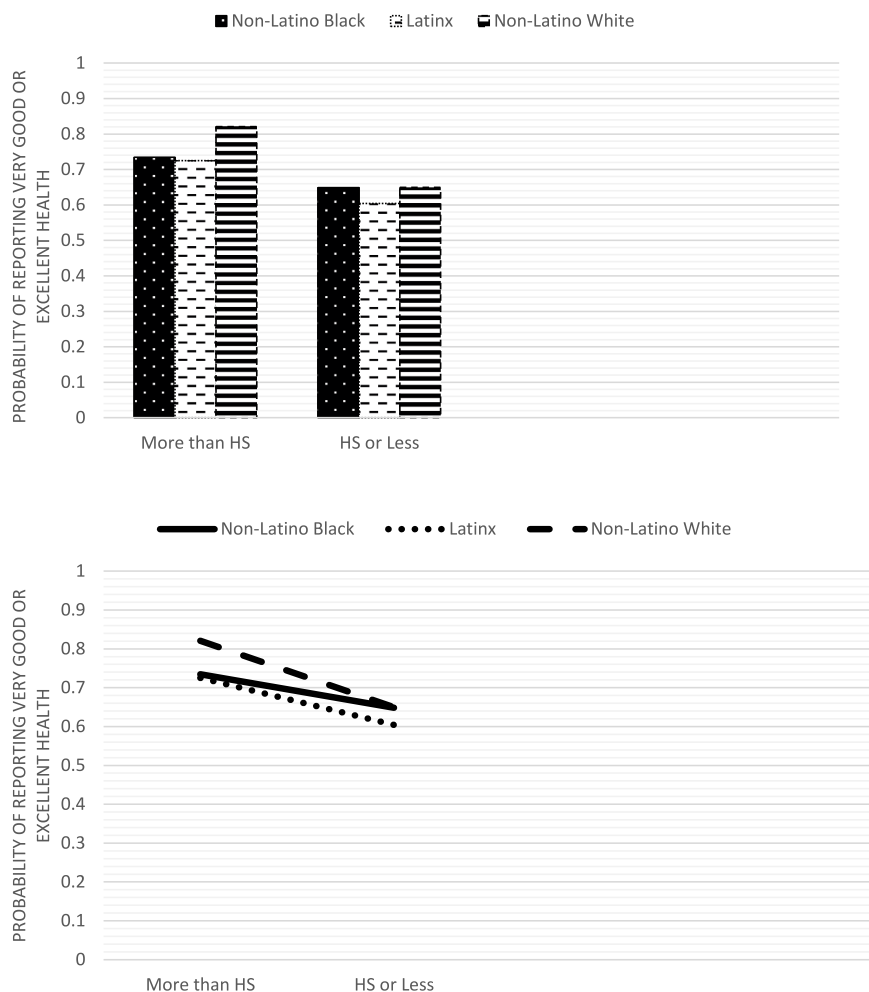


Fig. 2. Education Gradient by race/ethnicity controlling for sex, parent education, and poverty, taking state of residence into account.

very good to excellent health. The structural racism variables were not directly associated with the variance in the intercept for health at level 2.

3.3. Variations in the education gradient for Non-Latino Black participants

The slope for the association between education and health for Non-Latino Black Participants was not associated with the state level variables for political participation. In the model for employment and job status, the slope of education to health was associated with the ratio of Non-Latino Black to Non-Latino Whites in managerial positions (0.180) and the Non-Latino Black to Non-Latino Whites in the civilian labor force (0.229). In states with higher structural racism in the form of employment and job status, the probability for Non-Latino Black participants reporting very good to excellent health was 0.588 while the probability was .619 for their counterparts in states with lower structural racism (see Fig. 4). The difference between those who completed more than high school and those who completed high school or less increased in states with lower structural racism (0.0894 vs 0.06). That is Non-Latino Black participants reap fewer benefits from more education in states with higher structural racism in these forms.

The education gradient for Non-Latino Black participants was also associated with the ratio of Non-Latino Black to Non-Latino White citizens with college degrees (.409; See Table 7). In this case, Non-Latino Blacks in states with higher structural racism had a higher probability

of reporting very good to excellent health (more than high school 0.6614, high school or less 0.5657). In states with lower structural racism the probabilities were .4809 versus 0.464. In states where relatively more Non-Latino Black citizens compared to Non-Latino White citizens had a college degree the education gradient is lower for Non-Latino Black citizens (difference in probabilities = .0169). The education gradient for Non-Latino Black participants was not associated with structural racism indicators for the judicial treatment theme.

3.4. Variations in the education gradient for Latinx participants

In the political participation model the Non-Latino Black to Non-Latino White voter registration and Non-Latino Black to Non-Latino White voting were significant predictors of the slope of education to health for Latinx participants. The probabilities of reporting very good or excellent health under conditions of higher and lower structural racism in the form of political participation can be seen in Fig. 3. The probability of reporting very good to excellent health under conditions of higher structural racism for Latinx participants with more than a high school education was 0.2859, and for those with high school or less it was 0.2473 (difference = 0.0386). For Latinx participants in states with lower structural racism in political participation the probabilities were .427 and .3795 respectively (difference = 0.0475). Thus Latinx participants in states with higher structural racism have a lower probability of reporting very good to excellent health and show a smaller education gradient than those in states with lower structural racism. Latinx

**Table 5**  
Conditional Model for Political Participation by Race/Ethnic Group.

	Estimate (SE)
General Health Threshold	-.209(.427)
Sex	-.302(.058)*
Parent Education	.044(.025)
Poverty Ratio	.127(.040)*
Education	.318(.203)
Race/Ethnicity	-.327(.277)
State Level Vars	
NLB/NLW Voter Registration Ratio	.472(.453)
L/NLW Voter Registration Ratio	.356(.285)
NLB/NLW Voter Ratio	-.537(.274)*
L/NLW Voter Ratio	-.639(.665)
NLB/NLW State Legislature Ratio	-.103(.196)
L/NLW State Legislature Ratio	-.253(.181)
Education slope For Black Participants	-.179(.356)
State Level Vars	
NLB/NLW Voter Registration Ratio	-.491(.619)
L/NLW Voter Registration Ratio	-.117(.171)
NLB/NLW Voter Ratio	.457(.506)
L/NLW Voter Ratio	.338(.285)
NLB/NLW State Legislature Ratio	-.233(.320)
L/NLW State Legislature Ratio	.143(.087)
Education slope For Latinx Participants	-.120(.300)
State Level Vars	
NLB/NLW Voter Registration Ratio	-.672(.115)*
L/NLW Voter Registration Ratio	-.015(.245)
NLB/NLW Voter Ratio	.587(.224)*
L/NLW Voter Ratio	.447(.323)
NLB/NLW State Legislature Ratio	-.116(.120)
L/NLW State Legislature Ratio	.141(.153)
Education slope For White Participants	.391(.576)
State Level Vars	
NLB/NLW Voter Registration Ratio	-.056(.474)
L/NLW Voter Registration Ratio	-.187(.107)
B/NLW Voter Ratio	.149(.347)
L/NLW Voter Ratio	.222(.429)
NLB/NLW State Legislature Ratio	.139(.119)
L/NLW State Legislature Ratio	.008(.091)

\*p < .05.

NLB= Non-Latino Black; NLW=Non-Latino White; L = Latinx.

participants benefit less from more education under conditions of higher structural racism for political participation.

In the employment and job status model For Latinx participants, the slope or education gradient was predicted by the Non-Latino Black to Non-Latino White ratio of professional positions (-0.161)), Latinx to Non-Latino White ratio of those in the civilian labor force (0.076), Non-Latino Black to Non-Latino White ratio of unemployed (0.114) and Latinx to Non-Latino White ratio of unemployed (0.219: See results in Table 6). For Latinx participants living in states with higher structural racism in this area the probability of reporting very good to excellent health with more than a high school degree was 0.607, while it was 0.461 for those with high school or less (difference = 0.145). Latinx participants living in states with less structural racism in this area the probability of reporting very good to excellent health with more than a high school degree was 0.619 and with a high school degree or less 0.503 (difference = 0.116). These results suggest that structural racism increased the education gradient favoring those with more education, while lower levels of structural racism decreased the gradient and slightly increased the probability of reporting very good to excellent health for Latinx participants.

In the model for education attainment at the state level, the ratio of Non-Latino Black to Non-Latino White citizens with a bachelor's degree explained variation in the education gradient for Latinx participants (0.422). In states with higher structural racism the probability of reporting very good to excellent health for those with more than a high school education was 0.566 and with high school or less it was 0.5148. In states with lower structural racism the probabilities were .4611 and .4103 respectively (see Fig. 5). The difference or education gradient was

**Table 6**  
Conditional Model for Employment and Job Status by Race/Ethnic Group.

Variable	Estimate(Standard Error)
General Health 29	-.035(.262)
Sex	-.304(.061)*
Parent education	.045(.020)*
Poverty Ratio (natural log)	.121(.036)*
Education (1, hs or less: 2 more than hs)	.369(.062)*
Race/ethnicity	-.320(.084)*
State Level Variables	
NLB/NLW Managerial Positions	-.326(.169)
NLB/NLW Professional positions	.195(.639)
NLB/NLW Ratio Civilian Labor Employed	.066(.170)
L/NLW Ratio Civilian Labor Employed	-.414(.137)*
NLB/NLW Unemployed	-.300(.293)
L/NLW Unemployed	-.013(.155)
Slope of Education to Health Black Participants	-.123(.098)
NLB/NLW Managerial Positions	.180(.072)*
NLB/NLW Professional positions	-.081(.204)
NLB/NLW Civilian Labor Employed	.229(.099)*
L/NLW Civilian Labor Employed	.156(.177)
NLB/NLW Unemployed	-.025(.261)
L/NLW Unemployed	-.188(.204)
Slope of Education to Health Latinx Participants	.106(.075)
NLB/NLW Managerial Positions	.007(.081)
NLB/NLW Professional positions	-.161(.069)*
NLB/NLW Civilian Labor Employed	-.027(.082)
L/NLW Civilian Labor Employed	.076(.032)*
NLB/NLW Unemployed	.114(.046)*
L/NLW Unemployed	.219(.044)*
Slope of Education to Health White Participants	.321(.125)*
NLB/NLW Managerial Positions	.294(.152)
NLB/NLW Professional positions	-.038(.376)
NLB/NLW Civilian Labor Employed	-.156(.109)
L/NLW Civilian Labor Employed	.296(.131)*
NLB/NLW Unemployed	.231(.199)
L/NLW Unemployed	-.089(.126)

\*P < .05; NLB=Non-Latino Black; NLW=Non-Latino White; L = Latinx.

**Table 7**  
Conditional Model for Education Attainment.

Variable	Estimate (SE)
Gh1th29	-.099(.390)
Sex	-.303(.059)*
Parent education	.048(.022)*
Poverty Ratio	.119(.033)*
Education	.350(.070)*
Race/ethnicity	-.340(.163)*
State Level Variables	
NLB/NLW of college degrees	-.418(.123)*
Slope of Education to Health Black Participants	-.282(.133)*
NLB/NLW of college degrees	.409(.112)*
Slope of Education to Health Latinx Participants	-.142(.021)*
NLB/NLW of college degrees	.422(.015)*
Slope of Education to Health White Participants	.395(.156)*
NLB/NLW of college degrees	.218(.098)*

\*p < .05; NLB/NLW= Ratio of Non-Latino Black to Non-Latino White.

virtually the same in (0.0512 and 0.0511), but the probabilities were lower in states with lower structural racism, suggesting that Latinx participants benefitted to some degree from this form of structural racism.

The probabilities of reporting very good or excellent health by education, race/ethnicity and conditions of structural racism for judicial treatment can be seen in Fig. 6. The education gradient for Latinx participants was explained by the two ratios for those in prison (Non-Latino Black to Non-Latino White and Non-Latino White to Latinx) For Latinx participants, the probability of reporting very good to excellent health in states with higher structural racism who had more than a high school education was 0.674 and those with a high school degree or less it was 0.558 (difference = 0.116; see Fig. 6). For Latinx participants in states



**Table 8**  
Conditional Model Results by race/ethnicity for Judicial Treatment.

Variable	Estimate(SE)
Gh1th29	.140(.599)
Sex	-.297(.058)*
Parent education	.048(.026)
Poverty Ratio	.119(.038)*
Education	.435(.188)*
Race/ethnicity	-.306(.336)
State Level Variables	
NLB/NLW for imprisonment	.001(.400)
L/NLW for imprisonment	-.345(.267)
NLB to Total ratio Felony Disenfranchisement	.030(.228)
Slope of Education to Health Black Participants	
NLB/NLW for imprisonment	-.082
L/NLW ratio for imprisonment	.090(.103)
NLB to Total ratio Felony Disenfranchisement	.117(.310)
Slope of Education to Health White Participants	
NLB/NLW for imprisonment	-.167(.134)
L/NLW ratio for imprisonment	.054(.058)
NLB to Total ratio Felony Disenfranchisement	-.089(.015)*
Slope of Education to Health Latinx Participants	
NLB/NLW for imprisonment	.169(.054)*
L/NLW ratio for imprisonment	.136(.123)
NLB to Total ratio Felony Disenfranchisement	.330
Slope of Education to Health White Participants	
NLB/NLW for imprisonment	.087(.361)
L/NLW ratio for imprisonment	.196(.162)
NLB to Total ratio Felony Disenfranchisement	-.043(.220)

\*p < .05; NLB=Non-Latino Black; NLW=Non-Latino White; L = Latinx.

with lower structural racism the probabilities were .632 and .525 respectively (difference = 0.107). Again these results suggest some benefit to Latinx participants in states with higher structural racism in the theme of judicial treatment. The probability of reporting very good to excellent health is higher for those with more than a high school degree and the gradient is slightly steeper. For those in states with lower structural racism the gradient is flatter thus those with less education are not as different from those with more education.

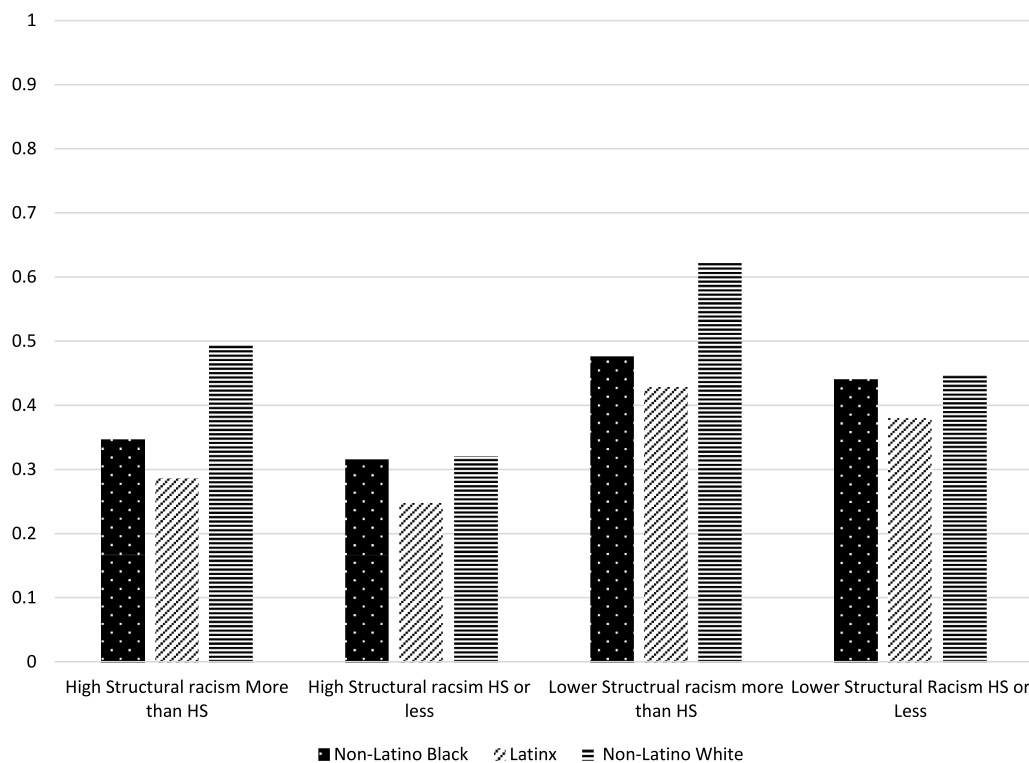
### 3.5. Variations in the education gradient for Non-Latino White participants

Variance in the slope or education gradient for Non-Latino White participants was not explained by any of the structural racism indicators for political participation, one of the indicators in the employment and job status model (Latinx to Non-Latino White ratio in civilian labor force estimate = 0.296), the ratio of Non-Latino Black to Non-Latino White citizens with a college degree (estimate = 0.218), and none of the indicators of structural racism from the judicial treatment model. In the employment and job status model, the probability of reporting very good to excellent health for Non-Latino White participants living in states with higher structural racism with more than a high school degree was 0.6516, and those with a high school degree or less it was 0.4614 (difference = 0.1902). The probabilities for those living in states with lower structural racism were 0.6192 and 0.5028 respectively (difference = 0.1164). Thus under conditions of higher structural racism Non-Latino White participants reaped more benefit from more education than their counterparts in states with lower structural racism.

In the model for education attainment, the probability of reporting very good to excellent health for Non-Latino White citizens with more than a high school education in states with higher structural racism was 0.8659 (see Fig. 5), and for those with high school or less it was 0.5505 (difference = 0.3154). In states with lower structural racism the probabilities were .6748 and .4962 respectively (difference = 0.1786). Again, these findings suggest that Non-Latino White participants in states with higher structural racism reap more benefits from more education than their counterparts in states with lower structural racism.

## 4. Discussion

This paper explored the association of indicators of structural racism (political participation, employment and job status, educational



**Fig. 3.** Probability of reporting Very Good or Excellent Health Under Conditions of More or Less Structural Racism for Political Participation for Non-Latino Black, Latinx and Non-Latino White Participants.

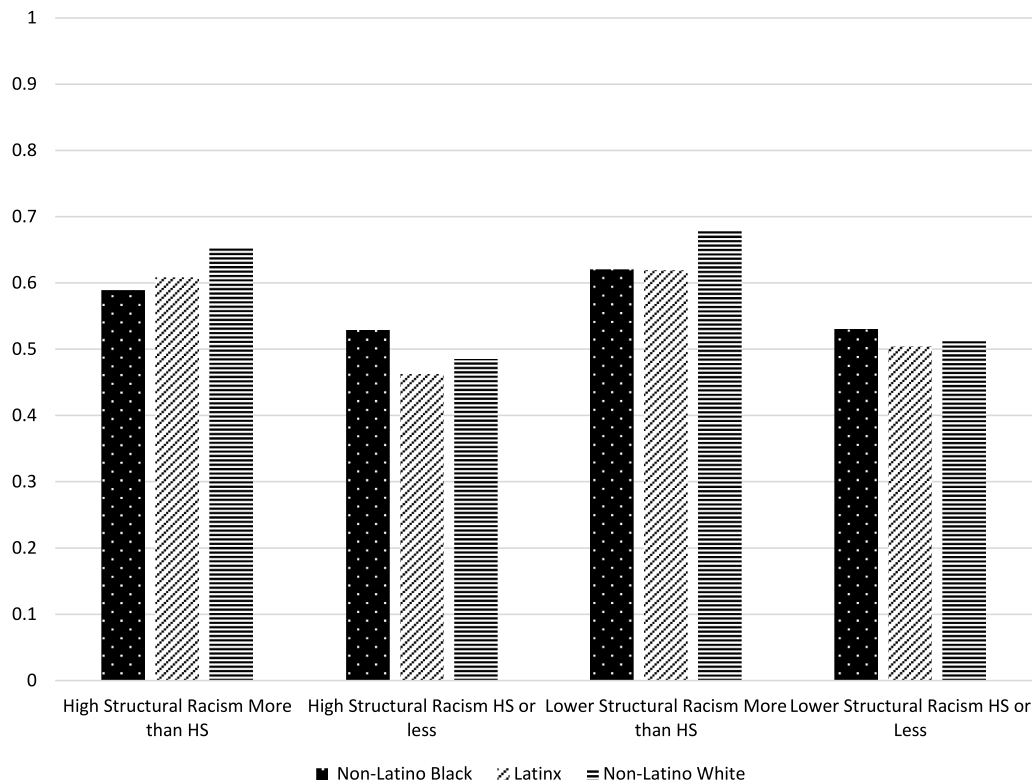


Fig. 4. Probabilities of reporting very good or excellent health under conditions of more or less structural racism for employment and job status for non-latino black, latinx and non-latino white participants.

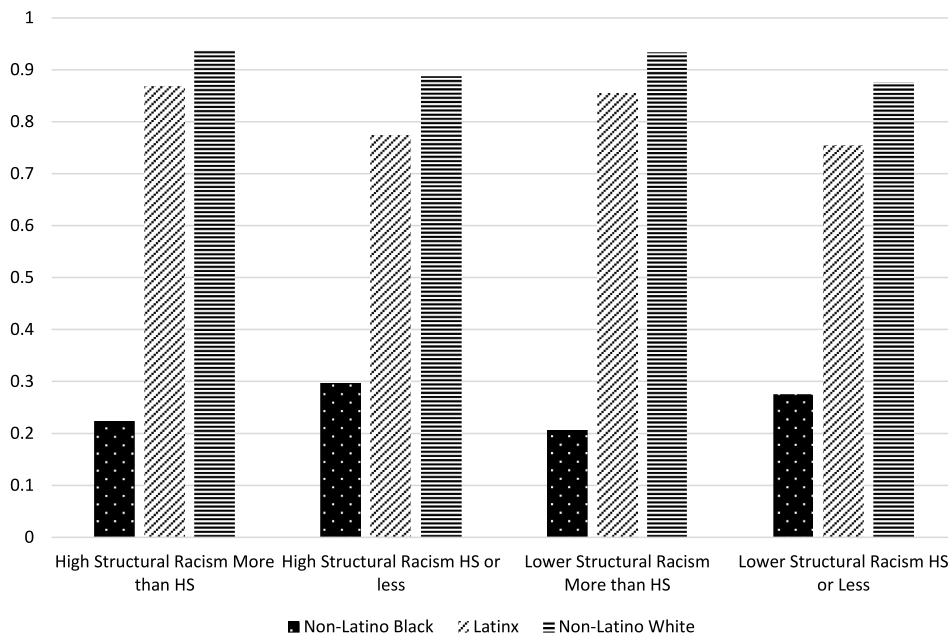
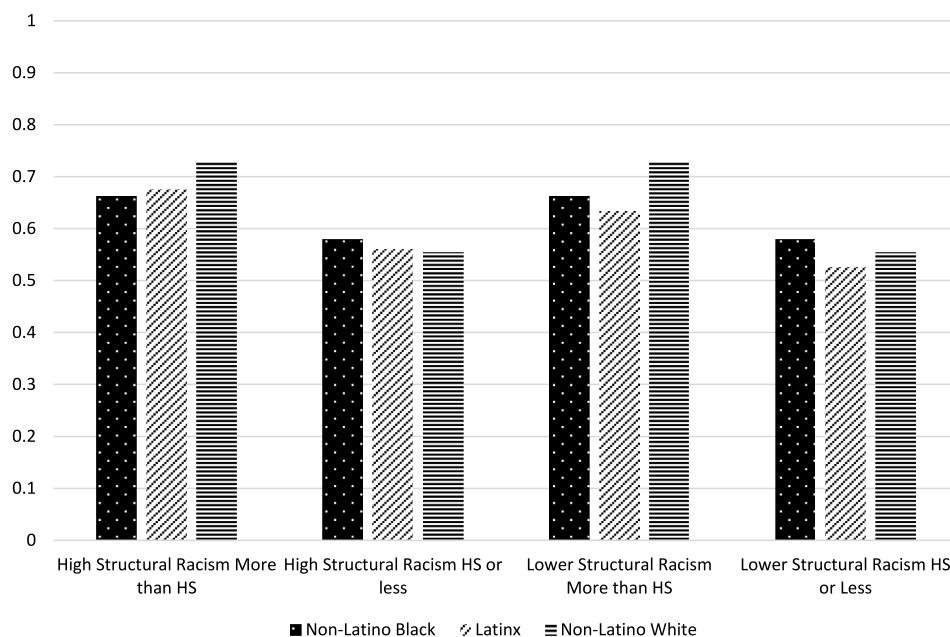


Fig. 5. Probabilities of reporting very good or excellent health under conditions or more or less structural racism for education attainment for non-latino black, latinx and non-latino white participants.

attainment and judicial treatment) on self-reported health, as well as the influence of these measures on the education gradient. Our study provides evidence that some these indicators of structural racism are directly associated with self-rated health and indirectly related through

the education gradient. Importantly, our findings suggest that structural racism is a critical factor above and beyond the effects of sex, parent education, poverty, education and race/ethnicity – all of which have been previously associated with health and education outcomes.



**Fig. 6.** Probabilities of reporting very good or excellent health under conditions of more or less structural racism for judicial treatment for non-latino black, latinx and non-latino white participants.

Our findings highlight the adolescent-emerging adulthood phase as an important time to understand structural racism. In line with suggestions by Gee et al., structural racism appears to influence multiple elements of development, including health and education (Gee et al., 2012). Our preliminary analyses showed that the education gradient differed between racial groups, with Non-Latino Whites experiencing more health benefits from the education they attain, followed by Latinx and Non-Latino Black individuals – differences which remained between Non-Latino Black and Non-Latino White individuals even when accounting for state of residence. These findings are in line with previous research documenting similar phenomenon, making it clear that minoritized populations experience diminished returns from their education when compared to Non-Latino White individuals – independent of location (Assari, 2018), (Assari et al., 2021), (Holmes & Zajacova, 2014), (Gaydosh et al., 2018).

#### 4.1. Findings supportive of hypotheses

The results of the study show the associations among various forms of structural racism and the variations in the association between education and health by race/ethnicity. Higher structural racism sometimes narrowed the gap both among the race/ethnicity groups, and between those with more or less education within those groups. Other forms of structural racism increased the gap among the groups and between those with more or less education. We hypothesized that higher structural racism would weaken the association between education and health, which would decrease the gap between those with more or less education. This was not always the case.

We found that elements of voter registration and participation were directly associated with a decrease in the probability of reporting very good or excellent health, and were associated with the education gradient for Latinx participants, but not Non-Latino Black or Non-Latino White participants. However, when controlling for these indicators of structural racism the education gradient decreased and was no longer significant and the interaction terms for education and race/ethnicity changed as well. The interaction term for Non-Latino Black participants was more negative (decreasing the education gradient, flattening the gap), and the interaction term for Non-Latino White participants was

higher (increasing the gap between those with more and less education).

The employment and job status model had mixed findings, showing that structural racism both increased and decreased the education gradient among the different groups. Thus, some forms of structural racism increased the gap in self-reported health by education, while other forms decreased the gap thus diminishing the returns on more education, or leveling the field for health outcomes.

Our measures of structural racism in education maintained that education attainment is largely beneficial for all racial groups. However, participants in states with higher structural racism had a higher probability of reporting very good or excellent health. It may be in states with a lower ratio of Non-Latino Black to Non-Latino White citizens with a bachelor's degree, actually have fewer people with a bachelor's degree over all, so that those with more education seem to reap even more benefits. This can also be interpreted in the reverse, in states with lower structural racism under this theme, those with less education are not at the same level of disadvantage as their counterparts in states with higher structural racism.

Lastly, the judicial treatment model showed some benefits for Latinx groups in instances of greater structural racism, but neither Non-Latino Black nor Non-Latino White participants' education gradient were associated with these indicators of structural racism.

Increased structural racism in the form of political participation, employment and judicial treatment significantly decreased the probability of reporting very good or excellent health for at least one group of minoritized participants. These findings were supportive of previous research suggesting that structural racism alters health outcomes (Lukachko, 2014) and that education differentially benefits minoritized populations in comparison to Non-Latino White individuals (Gaydosh et al., 2018). Thus, the location in which individuals lived made a difference. However, not all findings were as clear.

#### 4.2. Mixed findings

Interestingly, in terms of political participation, Non-Latino White participants had a higher probability of reporting better health in instances of lower structural racism. These are different than the findings from Lukachko in that more equal levels of political participation did not

benefit Non-Latino White individuals (Lukachko, 2014). This study builds on findings by Lukachko in suggesting that multiple populations may suffer in areas of high structural racism, not just the minoritized group (Lukachko, 2014). In many areas structural racism seemed to be detrimental to all racial groups, or the structural impairments of one minoritized group seemed to negatively impact a separate minoritized group, and furthermore in other instances structural racism showed to have some benefits – even for groups that were minoritized. This may indicate that there are other factors at play, or that structural racism may have larger, unknown consequences which influence the health of the population. Thus, minimizing structural racism could be beneficial to the health of all individuals and racial groups in these areas, not just the health of a specific minoritized populations. Future research should explore to what degree structural racism may lead to less than desired outcomes for the total population– not just minoritized populations.

The findings are further nuanced, and complex – but existing research can help to understand such findings. In their study, Gee et al., provide interesting context which may explain why we found such differential outcomes (Gee et al., 2012). They refer to “linked lives” or the interdependence of individuals as a term to understand that discriminatory or racist acts towards one group of people has consequences for all groups of people, even if they are indirect. Thus, discriminating against one group may bring unintended negative consequences for another group. Furthermore, the interdependence of groups may lead them to unite or join together in ways that strengthen them that would not have occurred otherwise. Thus, racism may harm or strengthen groups depending on the interdependent reaction of the group, and may explain the differences that we see in outcomes. Certainly, research should continue to attempt to identify and understand such patterns.

#### 4.3. Limitations

One limitation of our study lies in the difficulty of measuring structural racism. There are multiple ways to measure structural racism, and this paper focused only on four of them, but followed the outline of Lukachko, which had similarly sought to understand health factors (Lukachko, 2014). Structural racism is also inherently difficult to isolate. Because structural racism is so large and prevalent, there is no state or geographical area which has no structural racism. Because it is impossible to isolate we cannot eliminate all possible underlying factors, however, the study sought to eliminate any other extraneous factors by following the guidance of previous studies (Lukachko, 2014), (Groos et al., 2018).

We also used self-reported health measures to assess health of the individuals, which may not be a completely reliable way to assess individual health. However self-reported health has been shown to be a reliable and valid indicator of underlying health conditions (Sokol et al., 2017).

We also only used state of residence in the beginning of the data collection for NLSY97. It is possible that participants moved and were no longer in the same state at age 29. The question remains about whether the state of residence during formative years is more influential than the state of residence during adulthood.

#### 5. Conclusion

This study added to previous literature suggesting that in comparison to Non-Latino White individuals, minority populations experience differential health benefits from education attained. Furthermore, this study added that structural racism measured at the state level was significantly associated with differences in self-reported health, and was significantly associated with differences in the education gradient, mostly widening the gap between those with more education or less.

#### Ethics statement

The project was done using secondary data. Data collection was completed by the Bureau of Labor Statistics and followed appropriate ethical procedures.

The authors received no funding for this project.

#### Author statement

**Riley Whiting:** Conceptualization, Writing- Original draft preparation.

**Suzanne Bartle-Haring:** Supervision, Software, Writing- Reviewing and Editing Methodology.

**Shared Responsibilities:** Data curation, Visualization, Investigation, Validation.

#### Declaration of competing interest

None.

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