



# Structural racism and the education gradient for early all-cause mortality

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## ABSTRACT

There are clear connections between education achieved and health over the course of a lifetime, with higher education achievement being associated with better health. However, the association between education and mortality have differed by race, with minoritized populations reaping fewer benefits from education attained. This paper aims to understand the moderating effect of structural racism (measured at the state level) on the association between education and all-cause early mortality for Black and White participants. We utilize a nationally representative longitudinal sample of youth (NLSY97), and estimates of structural racism for each state through measures of political participation, employment and job status, education attainment ratios, and judicial treatment. Random effects models were then utilized to compare associations between Black and White participants, and assess the association of education on early mortality. Results indicate significant, yet nuanced findings in each of the models assessed suggesting that Black and White participants experienced diminished returns of education on the probability of early mortality. Findings support previous research suggesting that structural racism is costing all citizens, but is especially harmful for minoritized populations.

The purpose of the current study was to investigate the moderating effect of structural racism assessed at the state level on the association between education and all-cause mortality in a representative sample of young adults. Shields et al. (2017) suggest that premature mortality (death between the ages of 25 and 64) has decreased over the past 40 years, but the rate of premature mortality remains higher for Black individuals and other ethnic minorities compared to White individuals in the US. These rates also vary by states in the US (Montez et al., 2019). One factor that may explain the differences by race and variations across the states is through variations in structural racism at the state level. There is wide support for the association between premature mortality and years of education (Bijwaard, Myrskylä, Tynelius & Rasmussen, 2017; Chadeau-Hyam et al., 2020; Davies, Dickson, Smith, van den Berg, & Windmeijer, 2018; Laine et al., 2020; Liu, Chen, et al., 2019; Leive & Ruhm, 2021; Montez et al., 2019). More highly educated adults have lower premature mortality rates than those who are less educated. The gap between lower education and more education has been growing since the mid 1980's (Montez et al., 2019).

## 1. Structural racism

Although there is ample evidence for the association between education and premature mortality, the literature is less clear about

differences among ethnic/racial groups, and what factors might create those differences. One factor that may create those differences is racism. O'Brien et al. (2020) and Bailey, Feldman and Basset (2021) suggest a broader call for considering how racism impacts population health. Several authors make distinctions among various forms of racism that are discussed in the literature. There are three levels often discussed: structural or institutional racism, cultural racism and individual-level discrimination (Bailey et al., 2021; O'Brien et al., 2020; Williams et al., 2019). Neblett (2019) defines these different levels. He defines individual racism/individual-level discrimination as beliefs in the superiority of one's race characterized by enactments between individuals that maintain power differentials. Neblett (2019) defines cultural racism as an intergenerational world view with beliefs in the superiority of one group over another that is ingrained in institutions, belief systems and everyday actions. Although there is no official definition of structural racism, all definitions make it clear that "racism is not simply the result of private prejudices held by individuals, but is also produced and reproduced by laws, rules, and practices sanctioned and even implemented by various levels of government and embedded in the economic system as well as in cultural and societal norms." (Bailey et al., 2021, p. 768). Even more problematic is that structural racism can persist in governmental and institutional policies in the absence of actors who are explicitly racist (Williams et al., 2019). Williams et al. (2019) and others

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(i.e. [Gravlee, 2020](#); [Montez et al., 2019](#); [Neblett, 2019](#)) suggest that persistent racial inequities in health need to be understood in the context of stable racialized social structures that determine risk, opportunities and resources that drive health.

## 2. Disparities in early mortality by education level

Even with these calls to understand how racism may shape racial inequities in health, many researchers assume that the education gradient for health and mortality is similar for all groups of people and thus, few explore ethnic/racial group differences with some exceptions. [Assari \(2018\)](#) and colleagues ([Assari & Bazargan, 2019](#); [Assari et al., 2017](#); [Assari & Lankarani, 2018](#)) have developed the Minority Diminishing Returns Theory. In this theory, it is proposed that individuals from minoritized populations reap less health benefits from socioeconomic factors (i.e. education) than do their White counterparts.

[Zang and Kim \(2021\)](#) demonstrated that those with a college degree have lower mortality rates in young adulthood, however, this education gradient varied by race/ethnicity. Thus, not everyone benefited equally from higher education. The Black/White gap in life expectancy is actually greater at higher levels of education ([Gaydosch et al., 2018](#)). [Gaydosch and colleagues \(2018\)](#) demonstrated that a college degree provided a protective advantage against depressive symptoms in all individuals, but that it only provided a protective advantage against metabolic syndrome for White individuals. Black participants in the ADD-Health dataset with a college degree were more likely to have metabolic syndrome than their less educated counterparts, and White individuals who had a college degree. [Gaydosch, Schorpp, Chen, Miller, and Harris \(2017\)](#) discuss these findings as “skin deep resilience” suggesting that upward mobility for Black Americans may come at a cost. [Williams et al. \(2019\) in reviewing](#) the literature on health disparities suggested that at every level of education and income, Blacks have a lower life expectancy at age 25 than Whites, and Latinx. Blacks with a college degree or more have a lower life expectancy than White or Latinx who graduated from high school.

By combining [Assari's \(2018\)](#) Minority Diminishing Returns Theory and the notion that structural racism may be a mechanism that explains these diminishing returns, researchers could get a more nuanced view of how racism impacts the association between education and early mortality among varying ethnic/racial groups. That is, it is not just being a member of a minoritized group that leads to the diminishing returns of education on health outcomes, but the presence of racism and how it impacts minoritized population health and the association between education and health that leads to these diminishing returns.

## 3. Structural racism and health outcomes

[Groos et al. \(2018\)](#) performed a systematic review of the literature on structural racism and health outcomes to determine how structural racism was quantified. They found 20 articles in the last 10 years that met their inclusion criteria. [Groos et al. \(2018\)](#) suggested that much of the research conducted to understand how racism impacts health has been dominated by individual level perceptions of discrimination using self-report. They suggest that the lag in research on structural forms of racism as a root cause of health inequities is due in part to determining how to quantify them. Although some would say that structural racism depends on historical context, and/or it may be specific to the domain of health that is being investigated, [Groos, et al. \(2018\)](#) called for valid, replicable, and theoretically sound measures of structural racism. These are urgently needed to build the evidence of the costs of structural racism on population health. With this sort of evidence, then interventions may be created that could counteract the costs and end structural racism.

Of the 20 articles reviewed, structural racism was quantified within specific domains like housing patterns, perceptions of structural racism in social institutions, socioeconomic status, criminal justice,

immigration and border enforcement, political participation, and workplace. Most of the research was conducted in the context of Black-White racial group comparisons. In total, the articles reviewed showed that structural racism was associated with disparities in health outcomes in terms of violent crime, stress, preterm birth, cancer survival, birth weight, mortality, adherence to hypertensive treatment, psychological well-being, rate of myocardial infarction, infant mortality, self-rated health, and mean arterial pressure, among others ([Groos et al., 2018](#)).

One of the studies included in [Groos et al.'s \(2018\)](#) review was by [Lukachko et al. \(2014\)](#) who examined structural racism at the state level with publicly available data, and the incidence of myocardial infarction. [Lukachko et al. \(2014\)](#) defined structural racism as “the systematic exclusion of non-White racial groups from resources and mobility in society as a means to secure or maintain power.” (page 44). The authors used state-level variation in indicators of structural racism including political participation, employment and job status, educational attainment, and incarceration to differentially predict the prevalence of myocardial infarction among Blacks and Whites in the US using a national dataset (National Epidemiologic Survey on Alcohol and Related Conditions). [Lukachko et al. \(2018\)](#) demonstrated that structural racism and race interacted such that Blacks who lived in states with higher levels of most domains of structural racism had greater odds of myocardial infarction, and Whites in those same states had lower odds. Thus, structural racism provided Whites with a protective advantage, while disadvantaging the Blacks in the study depending on the domain of structural racism.

[Wallace et al. \(2015\)](#) and [Wallace et al. \(2017\)](#) did two subsequent studies using [Lukachko et al.'s \(2014\)](#) indicators of structural racism at the state level. In their work, [Wallace et al. \(2015\)](#) demonstrated that structural racism indicators were associated with small-for-gestational-age at birth for both Black and White mothers. [Wallace et al. \(2017\)](#) demonstrated that these same indicators of structural racism were associated with Black infant mortality, with higher inequity in unemployment being associated with a 5% increase in Black infant mortality. Decreased racial inequity in educational attainment was associated with a 10% reduction in Black infant mortality. None of the structural racism indicators were associated with White infant mortality.

## 4. Current study

In order to continue to contribute to the growing body of literature about the association between structural racism and health outcomes, the current study used the same structural racism indicators as [Lukachko et al. \(2014\)](#) to determine the moderating influence of structural racism on the education gradient for early mortality taking race of participant into account. With ample evidence that education levels are predictive of early mortality, and the growing body of literature that suggests that the education gradient varies by race/ethnicity and income, we hypothesize that 1) those in minoritized populations (i.e. Black) will not reap the same benefits from education as a protective advantage against early all-cause mortality as the White population. More specifically, Black participants with the same education level as White participants will have a higher early all-cause mortality rate than those White participants. Second, we hypothesize that the rates of early all-cause mortality and the education gradient for early all-cause mortality will vary by structural racism variables measured for the state of residence. Specifically, Black participants in states with higher structural racism will have the highest rates of early all-cause mortality and the education gradient (the association between education and mortality) will be weaker in those states.

## 5. Methods

### 5.1. Sample

The sample used for the current study came from the National Longitudinal Study of Youth 1997 (NLSY97) conducted by the US Bureau of Labor Statistics. 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 nonresponse to the survey and reasons for that nonresponse were collected at each wave.

The NLSY97 sample was constructed by randomly selecting housing units within the strata with two samples, the cross-sectional sample and a supplemental sample that oversampled for race/ethnicity. All age-eligible youth were interviewed within a selected housing unit, thus there were 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.

There is publicly available data from the NLSY97 as well as restricted data including state of residence at each wave of data collection. 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 or including the District of Columbia (9 participants) who identified as White or Black (n = 5365). The demographic data used were 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, and mortality based on the reasons for nonresponse at each wave.

The final sample consisted of 50.6% males, who were on average 14.4 years of age (sd = 1.48) in 1997. There were 1754 Black participants and 3611 White participants. Forty-three percent of the sample had a high-school degree or less and 57.4 percent had more than a high school education as of 2017. The average log of the poverty ratio for the youth’s household in 1997 was 5.28 (sd = 0.978). The mothers of the participants had a range of education levels with 46.3% having less than a high school degree, 36.2% having a high school degree and the rest having some college to graduate degrees. Fathers of the participants had a similar range of education levels with 48% having less than a high school education, 30.8% having a high school education and the rest having some college to a graduate degree.

### 5.2. Measures

**Participant education.** The highest grade level completed at the last wave of data collection that the individual participated in the study 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 White participants, 63.3% had more than a high school education. This binary variable was used as a predictor of mortality. We elected to use education as

a binary variable because this has been done in most the research on education and mortality in the past and provides an easier interpretation of the results for graphing purposes.

**Self-reported Health in 1997.** Health in 1997 was assessed with a single item asking the participant to rate their general health. This item was “In general how is your health?” The response options were excellent, very good, good, fair, and poor. Self-rated health has been found to be a robust indicator of health and mortality (c.f. Sokol et al., 2017).

**Participant Demographics.** We included participant sex, and log of the poverty ratio for the household income in 1997 in the equations to predict mortality.

**All-cause Mortality.** At each wave of data collection, interviewers noted the reason for nonresponse. One of the reasons was mortality, but there were no specifics about causes of death. We used the interviewers’ reason for nonresponse as an indicator of all-cause mortality in the sample. There was an overall 2.3% mortality rate in the sample. Average age at death was 25.05 (sd = 5.39) with a range of 15–25 years of age. Table 1 provides the frequency of death by age for the sample. Those who died during the course of the data collection waves were part of the study on average for 10.47 years out of the 20 possible years of the study (sd = 5.32). We had data at each wave of data collection for mortality. If the participant was still living they were coded as 0, if the participant had died they were coded as 1 and as missing at each subsequent data collection.

**Structural Racism Indicators.** We followed the work of Lukachko et al. (2014) who developed indicators for structural racism. These indicators were grouped into four themes: political participation, employment and job status, education attainment, and judicial treatment. The is publicly available. 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. impossible.

**Political Participation.** These indicators came from the US Census of 2010. These were the relative proportions of Blacks 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: [nclsl.org](http://nclsl.org)).

**Employment and job status.** These indicators were ratios of Blacks to Whites employed in the civilian labor force, and unemployed, as well as ratios of Blacks to Whites in managerial and professional positions. These data were available by state from the US Department of Labor & Statistics for 2010 ([bls.gov](http://bls.gov)).

**Table 1**  
Frequency of death at each age.

Age	N
15	2
16	4
17	4
18	16
19	9
20	4
21	7
22	9
23	9
24	8
25	12
26	10
27	5
28	8
29	11
30	8
31	9
32	9
33	8
34	5
35	3

Total Deaths = 160 from original sample of 5365.

**Educational Attainment.** This was indicated by the ratio of Blacks to Whites who had a college degree from the US Census Bureau available by state for 2010.

**Judicial Treatment.** These indicators included ratios for Black to White imprisonment, Latinx to White imprisonment, and Black to Total Felony Disenfranchisement (those who were sentenced because of committing a felony, cannot vote). These data came from the Sentencing Project ([sentencingproject.org](http://sentencingproject.org)) for 2015. We also included the Black to White ratio of prisoners on death row in each state for 2010 available from the Bureau of Justice Statistics (<http://usdoj.org>).

Following Lukachko et al. (2014) we used a median split of the structural racism indicators. If the score was above the median it was coded as 1 if the ratio suggested more structural racism. If the score was at or below the median it was coded as 0. That is, for example, the ratio of educational attainment was Black residents of a state who attained a college degree over the White residents in the state who attained a college degree. The median was 0.45. If that ratio increased to 1, it would suggest that there was a 1 to 1 ratio of Black to White residents with a college degree indicating less structural racism. Thus a ratio larger than 0.45 was coded as 0, with a ratio equal to or smaller than 0.45 was coded as 1. As another example, the median for the Black to White imprisonment ratio was 5.10 (i.e. there were 5 Black prisoners for every 1 White prisoner). If that ratio increased it would be an indicator of more structural racism, thus anything above 5.1 was coded as 1, while anything at or below the median was coded 0.

### 5.3. Data analysis plan

We used a random effects model comparing associations between Black participants and White participants with a discrete time survival analysis strategy in *Mplus* 8.2 (Muthen and Muthen, 2017) to test our hypotheses. First, we created a latent variable for mortality using each time period in the NLSY1997 data set (1998–2017) as indicators, if the participant died in a year their score on the indicator was 1, and then all scores after that were missing. If the participant did not die their score in that year was 0. All the loadings of the indicators on the latent variable were set to 1 and the variance was set to 0 (Muthen & Muthen, 2012; Singer & Willett, 2003). This analysis provides thresholds for each year that can be used to calculate the hazard probability. We selected a discrete time survival model because the participants in the NLSY1997 were “exposed” for the same amount of time (20 years), and of similar ages at the beginning of that time. We used the latent variable as the dependent variable in a random effects model with health in 1997, poverty ratio, and education level, and state level structural racism variables as predictors (preliminary analyses suggested that sex of participant was not a significant predictor). The education slope was the random effect. We followed Lukachko et al.’s (2014) data analysis plan in that we did not assume that participants were representative of the state of residence but of the population, so that the state level variables although repeated were considered any state with that particular score, rather than a particular state with that score. Thus, we could treat the data as a “one level” model rather than as a multilevel model.

We also used a group comparison procedure to test whether the education gradient and its variation with structural racism variables were different between Black and White participants. We compared the parameters using a Wald  $\chi^2$  test, comparing the magnitude of the estimates for the structural racism variables on mortality directly, and on the education gradient. We used MLR in *Mplus* which provides maximum likelihood estimation with robust standard errors.

## 6. Results

There was very little missing data for the variables needed. The only imputation that was conducted was for the poverty ratio variable (26% missing), we used linear interpolation to replace missing on this variable. Table 2 provides the means, medians and ranges of the state level

**Table 2**

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

	Mean Ratio	SD	Median	Range
<b>Political Participation</b>				
Black to White Registered to vote	.9211	.111	.9416	.66–1.13
Black to White Voted	.9022	.150	.911	.49–1.15
Black to White State Legislature Members	.105	.109	.055	0–.39
Latinx to White State Legislature Members	.063	.125	.017	0–.73
<b>Educational Attainment</b>				
Black to White Bachelor’s Degree Attainment	.754	1.06	.450	0–5.09
<b>Employment and Job Status</b>				
Black to White Managerial Positions	.604	.242	.576	0–1.24
Black to White Professional	.846	.248	.817	.41–2.07
Black to White Civilian Labor Employment	.917	.101	.906	.72–1.25
Black to White Unemployment	1.895	.540	1.91	.78–3.44
<b>Judicial Treatment</b>				
Black to White Incarcerated	5.97	2.51	5.10	2.40–12.20
Black to White Death row Inmates	.626	.805	.456	0–4.0
Black to Total Felony Disenfranchisement	3.94	2.15	.9416	1.51–13.72

structural racism variables. We also determined the number of participants who moved to a different state between 1997 and 2010 (the year for when the structural racism indicators were generated). There were 1800 cases in which there was no data on the state of residence in 2017. All participants had state of residence data in 1997. Of the participants who reported a state of residence in 2010, none reported having changed their state of residence. As of 2017, 75.4% reported living in the same state of residence as in 1997. Given that a majority of participants remained in the same state of residence and there is no research to suggest which state of residence (the one lived in during adolescence or the current state of residence) matters the most in terms of its moderating effect on early mortality and education, we elected to use state of residence in 1997.

### 6.1. “Unconditional” model

We first estimated a model with no structural racism variables to test whether the education gradient was statistically different between the Black and White participants, and also test whether the thresholds for mortality were statistically different. The results of these tests can be seen in Table 3. The Wald tests suggested that there were no statistically significant differences in the education gradient (effect of education on mortality), or the mortality thresholds. The education gradient was significant and negative, suggesting that with more education there was less of a chance of early mortality. These results did not support our first hypothesis that Black participants with the same education level as White participants would have a higher early all-cause mortality rate. Given the rarity of the event, we show the hazard probabilities for both Black and White participants separately but use the same scale for the y axis in Fig. 1. The dashed lines in the figure represent those with more than a high school education, with their rate close to 0 throughout the exposure period for both Black and White participants (note that for the White participants the dashed line is completely covered by the solid line). The solid line represents those with High School education or less, and though the rate is quite minimal is higher for the Black participants than for the White participants.

### 6.2. Model results

**Political Participation Model.** The results of the models that included the structural racism variables as themes, can be seen in

**Table 3**

Education Gradient for mortality and Mortality Thresholds for the “unconditional” model controlling for self-reported health in 1997, and poverty ratio in 1997.

	Black Participants (se) 95% CI	White Participants (se) 95% CI	Wald $\chi^2$ Test (df)
Education Gradient	-1.218(.290)*	-1.462 (.275)* -2.00:	.376(1)
Mortality Threshold			
1998	5.416	7.704	
1999	6.800	6.092	
2000	5.699	7.008	
2001	5.696	7.007	
2003	6.792	7.006	
2004	6.097	5.905	
2005	4.993	7.002	
2006	5.684	5.494	
2007	5.394	6.080	
2008	5.165	6.995	
2009	6.079	6.588	
2010	6.772	6.587	
2011	4.821	6.586	
2013	5.376	5.735	
2015	4.810	6.293	
2017	4.444	5.372	19.21(17)

\*significantly different than 0 at  $p < .05$ .

Table 4 with the Wald tests that tested for differences in the estimates of the paths as well as the thresholds for mortality. Included in Table 4 are also the 95% confidence intervals for the estimates. For the political participation model, the education gradient remained significant for Black participants, but was no longer significant for White participants. This suggests that when controlling for these forms of structural racism in the model, Black participants with a high-school education or less continue to be at higher risk for early mortality than those with more than a high school education. Education no longer provides a protective advantage for White participants, but the probability of early mortality is lower for all White participants regardless of education level. None of the structural racism variables were significantly predictive of early all cause mortality or the variation in the education gradient.

**Employment and Job Status Model.** The model that included indicators of structural racism around employment and job status showed an increase in the education gradient for both Black and White participants compared to the unconditional model. That is, when controlling for these forms of structural racism, both Black and White participants see a larger gap in early all cause mortality based on education. However, this gap is slightly larger for White participants than Black participants (but not statistically different). That is, White participants tended to reap more of a protective advantage when having more than a high school education, than their Black counterparts. Again, however, none of the structural racism indicators were statistically predictive of early all-cause mortality or the variation in the education gradient.

**Educational Attainment Model.** The model that included the ratio of Black to White citizens with a bachelor’s degree also demonstrated an increase in the education gradient when this was controlled for. For Black participants, when this form of structural racism was controlled for in the model, the education gradient was almost twice the size as in the unconditional model (-2.98 vs -1.21). This same increase was not demonstrated for the White participants. Educational attainment at the state level was also predictive of early all cause mortality, and the variation in the education gradient for Black participants but not White participants. Although the Wald test was not significant, the confidence intervals for the effect of educational attainment on the variation of the education gradient between the two groups did not overlap, suggesting a difference. These results can be seen in Fig. 2. For the Black participants, having a high school education or less puts them more at risk for early mortality under regardless of the Black to White ratio of educational

attainment level in the state (the solid and dotted lines completely overlap). However, comparing the hazard probabilities between Figs. 1 and 2, shows that the probability of mortality decreased when controlling for education attainment at the state level. The bigger difference was for the White participants. When controlling for educational attainment at the state level, White participants with a high school education or less appeared to be at higher risk for early mortality than in the unconditional model. It may be the case that when the ratio of Black to White citizens who have a bachelor’s degree increases to 1, that actually fewer citizens have a bachelor’s degree overall, and this increased the education gradient for White citizens, providing more of a protective advantage for those with more education, while this same protective advantage is not seen for Black citizens.

**Judicial Treatment Model.** In the model including indicators of structural racism under the theme of judicial treatment, the education gradient was no longer significant for Black participants and although larger in magnitude, no longer significant for White participants. This suggests that when controlling for the ratios of Black to White persons in prison, Black to White persons on death row, and the Black to White ratio of those with felony disenfranchisement at the state level, then education no longer provides a protective advantage against early mortality. The structural racism indicators were not statistically predictive of early mortality, but the felony disenfranchisement ratio trended toward significance in explaining variability in the education gradient for Black participants ( $p = .065$ ). This was not the case for White participants, none of the structural racism variables were predictive of mortality or the variation in the education gradient. Given the need to understand how structural racism is associated with health outcomes, we elected to create a hazard probability figure for these associations even though the estimate was not statistically significant at conventional levels. The hazard probabilities can be seen in Fig. 3. In the figure for Black participants, probability of early mortality is higher for those in states with less structural racism (dotted line) than those in states with more structural racism (solid line). For White participants, when controlling for these forms of structural racism, the probability of early mortality is close to 0 regardless of education level. It should be noted that y axis markers vary across the figures. The markers for Fig. 3 are some of the “highest” probabilities. It is not clear why when controlling for these forms of structural racism that the education gradient increases for Black participants in states with lower structural racism and the probability of early all cause mortality increases. In states with higher structural racism, the education gradient disappears for Black participants and the probability of early mortality decreases as well.

The results of the separate analyses under the 4 themes for the indicators of structural racism partially supported our second hypothesis: that the rates of early all-cause mortality and the education gradient for early all-cause mortality would vary by structural racism variables measured for the state of residence. We found that the education gradient varied when controlling for different indicators of structural racism, but only education attainment at the state level was predictive of both early mortality and the variation in the education gradient. We did not find that Black participants in states with higher structural racism had the highest rates of early all-cause mortality nor that the education gradient (the association between education and mortality) was weaker in those states for Black participants.

## 7. Discussion

The purpose of this project was to test two hypotheses: first, those in minoritized populations (i.e. Black) will not reap the same benefits from education as a protective advantage against early all-cause mortality as the White population. More specifically, Black participants with the same education level as White participants will have a higher early all-cause mortality rate than those White participants. In a Wald test, the association between education and early mortality was not found to be statistically different for Black and White participants. For both Black

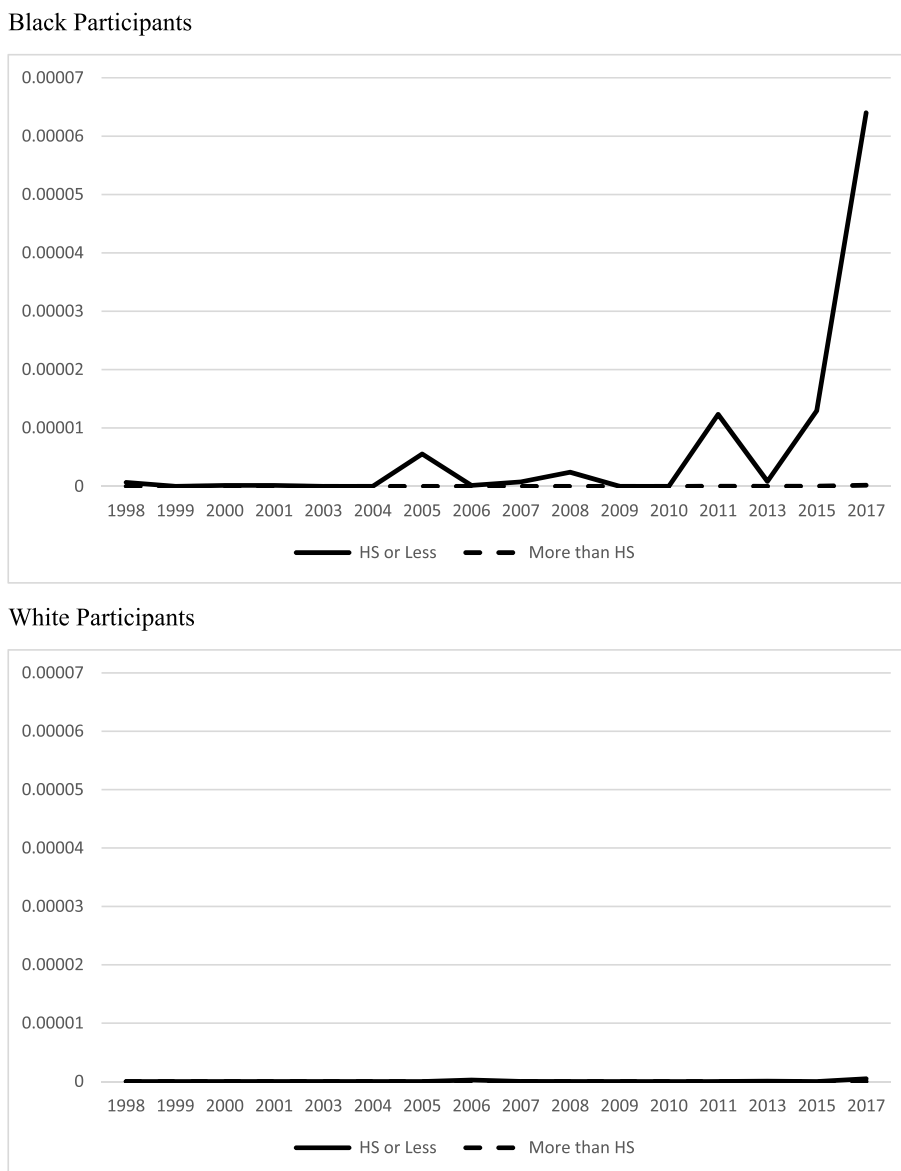


Fig. 1. Unconditional Model for hazard probabilities of early mortality by education level for Black and White participants.

and White participants the association was negative, suggesting that with more education, the probability of early mortality decreased.

Our second hypothesis was that the rates of early all-cause mortality and the education gradient for early all-cause mortality would vary by structural racism variables measured for the state of residence. Specifically, we proposed that Black participants in states with higher structural racism would have the highest rates of early all-cause mortality and the education gradient (the association between education and mortality) would be weaker in those states. Although the education gradient varied when controlling for the various indicators of structural racism, only one indicator of structural racism, educational attainment, was associated with the rate of early mortality and the variation in the education gradient. For Black participants, living in a state with a lower ratio of Black to White citizens with a bachelor's degree, the probability of early mortality decreased, and the education gradient was weakened with higher structural racism.

The variation in the education gradient when controlling for the various themes of structural racism is worth noting. As can be seen in Table 4, for the Black participants, when controlling for political participation, and employment and job status, the education gradient is virtually unchanged, while controlling for educational attainment the

education gradient was larger, and while controlling for judicial treatment the gradient was sharply decreased. A larger negative number suggests a larger gap in the probability of early mortality between those with a high-school education or less, and those with more than a high school education. A smaller negative number indicates a flattening of that gap, or that education no longer is a predictor of early mortality. The shifts in the education gradient were different for the White participants. The gap was decreased when controlling for political participation, increased with controlling for employment and job status, stayed the same for education attainment, and increased for judicial treatment. These variations as well as the lack of consistency in which indicators of structural racism were significant, suggest that these indicators may not be indicators of the same construct, or structural racism is made up of multiple constructs that may not be interrelated. Much more research needs to be conducted with these same and other indicators of structural racism.

Assari (2018) proposed the Minority Diminishing Returns Theory to explain the differences in the education gradient for health outcomes for minoritized populations. The results of the current study suggest that returns on more education also depend on at least one indicator of structural racism at the state level (educational attainment). When

**Table 4**  
Random Effects Model Results for Black and White Participants by Structural Racism Variables<sup>a</sup>.

Variable	Black Participants		White Participants		Wald $\chi^2$ Test (df) <sup>b</sup>
	Effect on Mortality (se)	Effect on Education Gradient (se)	Effect on Mortality (se)	Effect on Education Gradient (se)	
	(95% CI)	(95%CI)	(95%CI)	(95%CI)	
Unconditional Model	-1.218(.290)*		-1.462 (.275)*		
Education	(-1.785: .650)		(-2.00: .924)		
<b>Political Participation</b>					
Education	-1.465(.354)*		-.616 (.324)		
	(-2.02: .771)		(-1.25:0.18)		
Black/White Registered Voters	-.407(1.18)	.404(.663)	-.292(1.36)	-.233(.984)	
	(-2.72:1.90)	(-.895:1.70)	(-2.95:2.37)	(-2.16:1.69)	
Black/White Voted	-.621(1.15)	.119(.653)	.936(1.35)	-.616(.954)	
	(-2.88:1.64)	(-1.16:1.39)	(-1.70:3.58)	(-2.48:1.25)	
Black/White State Legislators	.887(1.33)	-.053(1.00)	1.40(.783)	-.502(.521)	28.13(22)
	(-1.734:3.51)	(-2.019:1.91)	(-.129:2.94)	(-1.52: .519)	
<b>Employment and Job Status</b>					
Education	-1.572(.649)*		-2.307(.598)*		
	(-2.844: .301)		(-3.45: 1.13)		
Black/White Managerial Positions	.260(1.064)	-.081(.897)	.561(.736)	-.423(.541)	
	(-1.82:2.34)	(-1.84:1.68)	(-.881:2.00)	(-1.48: .636)	
Black/White Professional Positions	1.019(1.016)	-.634(.824)	.064(.694)	.431(.532)	
	(-.973:3.011)	(-2.25: .982)	(-1.29:1.42)	(-1.61:1.47)	
Black/White Civilian Labor	-1.923(1.086)	1.13(.819)	-1.497(.960)	.931(.678)	
	(-4.05: .207)	(-.475:2.73)	(-3.38: .385)	(-.397:2.26)	
Black/White Unemployment	.894(1.055)	-.500(.755)	-.381(.760)	-.060(.521)	21.047(24)
	(-1.17:2.96)	(-1.98: .980)	(-1.87:1.11)	(-1.08: .961)	
<b>Educational Attainment</b>					
Education	-2.398(.659)*		-1.179(.436)*		
	(-3.69: 1.10)		(-2.033: .324)		
Black/White Bachelor's Degree	-1.190(.428)*	1.205(.273)*	.358(.775)	-.495(.561)	25.913(18)
	(-2.039: .351)	(.669:1.74)	(-1.16:1.88)	(-1.59: .605)	
<b>Judicial Treatment</b>					
Education	-.523(.844)		-2.143(2.20)		
	(-2.17:1.31)		(-6.45:2.17)		
Black/White Imprisonment	-1.54(1.22)	.127(.899)	-.018(1.02)	-.098(.741)	
	(-3.93: .853)	(-1.36:1.89)	(-2.02:1.98)	(-1.55:1.35)	
Black/White Death row inmates	-.293(1.15)	-.860(.863)	-.190(2.37)	.033(1.82)	
	(-2.55:1.97)	(-2.55: .832)	(-4.84:4.46)	(-3.54:3.61)	
Black/Total Felony	1.038(1.04)	-1.212(.658) <sup>c</sup>	-.430(2.14)	.371(1.64)	29.33(22)
Disenfranchisement	(-1.00:3.08)	(-2.50: .076)	(-4.63:3.77)	(-2.85:3.59)	

\*p < .05.

c.p = .065.

<sup>a</sup> Poverty ratio at 1997 and self-reported health in 1997 were used as controls in all models at the mean for each group.

<sup>b</sup> The Wald test was performed for all paths in the model and all thresholds except for the paths from self-reported health and poverty ratio which were set equivalent between the groups.

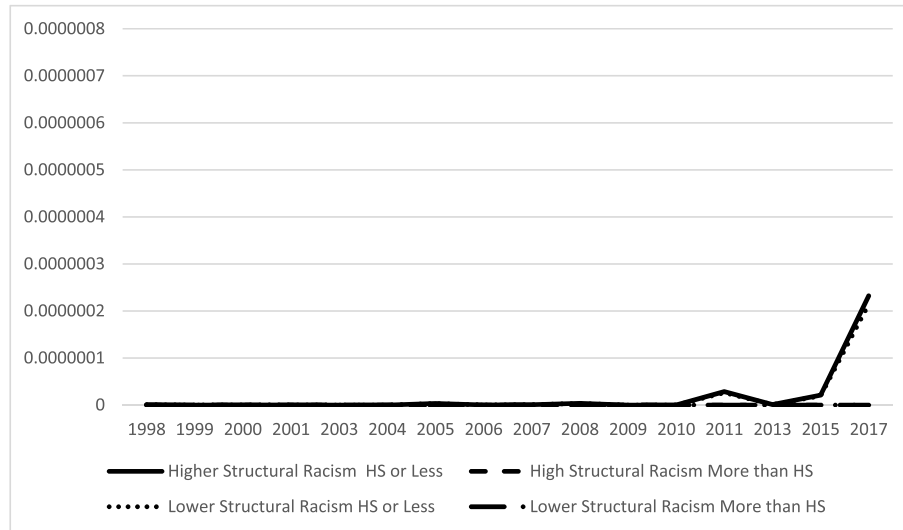
including educational attainment at the state level, Black participants showed a decrease in returns on more education, but a decrease in the probability of early mortality as well. It was also the case that some of the indicators of structural racism increased the gradient or created a larger gap in the probability of premature mortality between those with more and those with less education. This was true for all participants as well, not just those in minoritized populations. This evidence supports the idea that structural racism may be costing all citizens not just minoritized populations, although Black individuals seemed to be assuming the greatest cost in the education gradient overall.

Montez et al. (2019) showed that the education gradient for adult mortality varied by state (without including indicators of structural racism) and that those with the lowest levels of education were put at increasing risk for mortality, while mortality rates for those with more education remained stable. That is, adults with less education have shorter life expectancies than adults with more education, and this gap has been increasing over the last several decades (Bosworth, 2018). Montez et al. (2019) explained their findings by suggesting that US states vary in policies, resources and opportunity structures which effects population health and that these effects can be independent of local residence and individual characteristics. The results of the current study support that there are varying education gradients by state, and by

controlling for indicators of structural racism, the education gradient also varied. These indicators may be implicating what Montez et al. (2019) suggested (i.e. policies, resources and opportunity structures). Montez et al. (2019) suggested that most studies use an individualist approach to the education gradient suggesting that education is a personal resource that leads to agency and human capital to acquire resources and avoid risks of mortality. Montez et al. (2019) and the results of the current study showed that taking an individualist approach overlooks the fact that context matters. "Individuals are embedded in epidemiological, socioeconomic, and policy contexts that may condition the effects of education on mortality." (Montez et al., 2019, p. 623).

Early mortality was rare in this sample with only 160 deaths of 5365 participants. The probability of dying young varied when controlling for different forms of structural racism at the state level and at least one of these variables also influenced the education gradient associated with the probability of early mortality as well. The probability of early mortality tended to be higher for Black participants in this study regardless of structural racism indicators, although this was not statistically significant given the rarity of the event. Bosworth (2018) suggested the disparity in all-cause mortality for those aged between 18 and 34 among Black versus White individuals was at 41.2%. The results of the current study provide a similar disparity among Black and White

### Black Participants



### White Participants

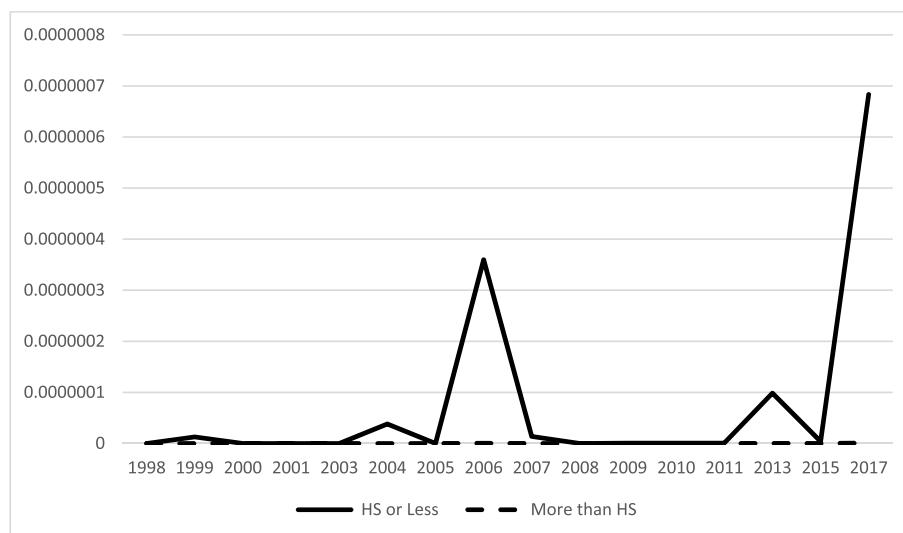


Fig. 2. Educational attainment model hazard probabilities.

participants.

It is important to note that White participants' probability of early mortality and education gradient was influenced by these forms of structural racism but not to the same degree as Black participants. In the case of education attainment at the state level, when controlling for this, the education gradient was wider for White participants. It may be the case that when the ratio of Black to White citizens with a bachelor's degree tends toward 1, that it actually means that fewer people in the state have a bachelor's degree. When that is the case, the education gradient increases for White citizens, meaning that White citizens with a high school education or less are at an even higher risk for early mortality than their more educated counterparts.

### 8. Limitations

There are more than likely other indicators of structural racism at the state level. The one's used in this study were the same as those used by Lukachko et al. (2014) who demonstrated an association between these indicators and the incidents of myocardial infarction among Black and White participants. Wallace and colleagues (Wallace et al., 2015; Wallace et al., 2017) used these indicators and showed associations with

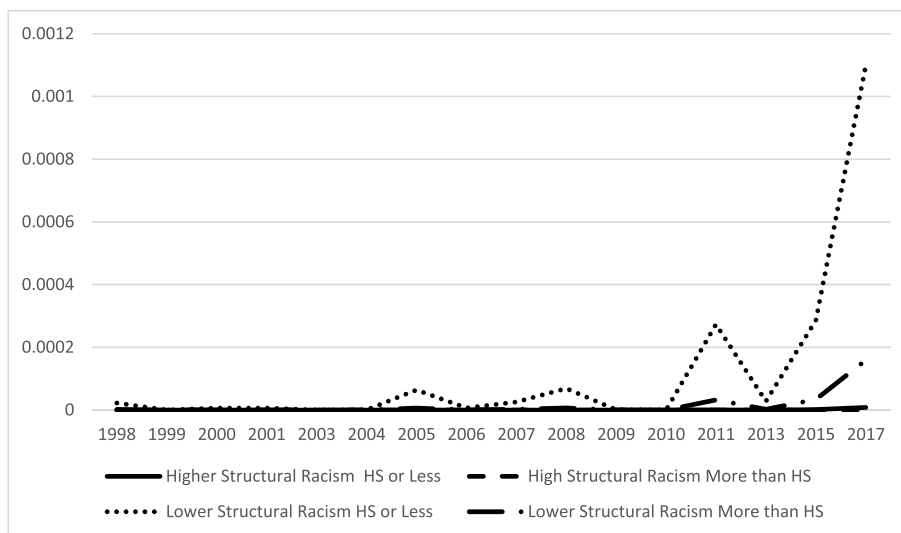
birthweight and infant mortality rates among Black and White populations across the US states. We were able to find the structural racism data staying close to 2010, but state of residence that was used for the study came from 1997 when the participants were still living with their families of origin. The current state of residence was not used, nor was migration to other states controlled for. The question remains about when, developmentally, structural racism has its strongest effects on life course trajectories. It may be that structural racism present during formative years is more impactful than in later years. This is a question for future research.

The results presented were not weighted. *Mplus* does not assign weights in the same way when using random effects modeling and rather than trying to determine the best way to use weighting in this study, we elected not to use weights, thus these results may not be representative of the US population of youth in 1997. We also had no information about the cause of death. Studies have suggested that increases in early mortality are due to drug overdoses and suicide (e.g. Shields et al., 2017; Olson et al., 2017). We had no way to determine cause of death for this study.

Thankfully, early mortality was extremely rare in this sample. This may be a reason for finding few conventionally statistically significant



### Black Participants



### White Participants

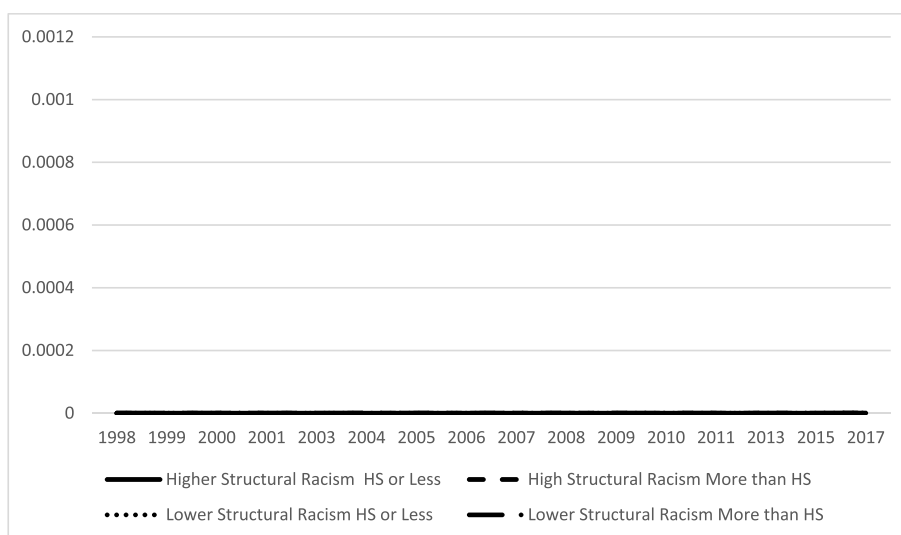


Fig. 3. Judicial treatment model hazard probabilities.

results. There is some debate about what level of statistical significance should be used for rare occurrences, and some suggest using Bayesian estimators and confidence intervals. Unfortunately, the version of *Mplus* available on the secure server did not allow for the use of a random effects model and Bayesian estimation. This is a suggestion for further research in this area.

### 9. Conclusions

Olson et al. (2017) reported that early life mortality rates (before the age of 50) are higher in the US than any other high-income country. The results of this study suggest that at least some of that disadvantage could be due to structural racism. There has been an increasing call for studies that focus on not only self-reported experiences of racism and discrimination, but for indicators of structural or institutional racism and how these effect health (i.e. Bailey et al., 2021; Neblett, 2019). The results of this study demonstrate that some indicators of structural racism matter not only for variations in the rate of early mortality, but also for how education is associated with the probability of early mortality. As we continue to study the effects of racism on health, it is also important to understand that social determinants of health, such as education, and

their advantages and disadvantages on health and health disparities also vary by structural racism. That is, even though we know that there are social determinants of health, we can not assume that all people will reap the same benefits or incur the same costs from these in the context of varying levels of structural racism.

### Author statement

Suzanne Bartle-Haring wrote the introduction, methods and results section and performed all statistical analyses. Riley Whiting reviewed the manuscript and wrote the discussion section in collaboration with first author.

### Ethical statement

The data for this project came from both the publicly available data from the NLSY97 dataset offered by the Bureau of Labor of Statistics. We also sought and received permission to use geocode data and analyzed all data within the NORC Enclave. The NLSY97 was approved as human subjects research by the BLS and the Ohio State University’s Behavioral and Social Science IRB.

## Declaration of competing interest

To the best of our knowledge there is not conflict of interest in the publishing of this manuscript.

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