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Intersectional inequities in COVID-19 mortality by race/ethnicity and education in the United States, January 1, 2020–January 31, 2021

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Abstract

Background: Although educational attainment is a routinely reported data element on US death certificates, data on COVID-19 deaths were not reported by educational level, let alone stratified by race/ethnicity and education, in government health statistics during the first year of the pandemic under the Trump administration. On February 2, 2021, the US National Center for Health Statistics published a national-level data table of COVID-19 deaths stratified by race/ethnicity and education, newly enabling intersectional analysis of inequities in relation to racialized and educational groups.

Methods: We analyzed all COVID-19 deaths recorded for January 1, 2020 through January 31, 2021 (N = 413,196) in relation to individual-level death certificate data on race/ethnicity and educational level, and corresponding US population data. We calculated rates per 100,000 person-years and associated 95% confidence limits, and estimated incidence rate ratios (IRR) using saturated Poisson loglinear models. Following STROBE guidelines for the presentation of interactions, we computed IRRs for (a) racial/ethnic inequities within educational groups; (b) educational inequities within racial/ethnic groups; and (c) intersectional inequities relative to a common reference group (Non-Hispanic Whites with a postgraduate degree).

Results: First, regarding racialized inequities in COVID-19 mortality, crude rates were significantly greater among Non-Hispanic Blacks (IRR 1.3, 95% CI 1.3, 1.3), Hispanics (IRR 1.1, 95% CI 1.1, 1.1), and Non-Hispanic American Indian or Alaskan Natives (IRR 1.7, 95% CI 1.7, 1.7) and lower among Non-Hispanic Asian Pacific Islanders (IRR 0.6, 95% CI 0.6, 0.6) compared with Non-Hispanic Whites. Second, substantially elevated rates occurred for persons with less than a high school education (IRR 5.3, 95% CI 5.3, 5.3), high school graduates (IRR 3.4, 95% CI 3.4, 3.4), and some college (IRR 1.3, 95% CI 1.3, 1.3) relative to those with a postgraduate degree; rates among college graduates were virtually identical to those with a postgraduate degree. Analysis of joint inequities by race/ethnicity and education relative to a common reference group (Non-Hispanic Whites with a postgraduate degree, the theoretically most advantaged group) showed that inequities in mortality are dominated by the steep educational gradient in all groups, with those in the less than high school group having rate ratios ranging from 3.3 (Non-Hispanic Asian Pacific Islanders) to 7.8 (Non-Hispanic American Indian and Alaskan Natives) relative to the reference group and those in the high school graduate group having rate ratios ranging from 2.1 (Hispanics and Non-Hispanic Asian Pacific Islanders) to 3.5 (Non-Hispanic Whites and Non-Hispanic American Indian or Alaskan Natives). We found strong statistical evidence of interaction between race/ethnicity and educational attainment on both the additive and multiplicative scales.

Conclusions: The release of these long overdue data on COVID-19 mortality rates by race/ethnicity and educational attainment provide valuable insight into who has borne the unequal burden of COVID-19 death in the United States. Timely reporting of COVID-19 outcomes by race/ethnicity, socioeconomic measures including education and occupation, age, and gender must be a priority to ensure transparency and accountability and to support action to reduce the continuing impact of the pandemic on those most adversely impacted by structural injustice.

Introduction

Calls to improve the reporting of race/ethnicity in data on deaths due to COVID-19 in 2020 [1] have contributed to a greater appreciation of the inequitably greater mortality burden experienced by US populations of color, with Non-Hispanic Black, Hispanic, and Non-Hispanic American Indian and Alaskan Native populations experiencing substantially elevated mortality risk relative to their Non-Hispanic White and Non-Hispanic Asian Pacific Islander counterparts [2]. However, simply reporting inequities by racialized group alone does little to explain why these inequities exist or to how they can be reduced or eliminated. For example, although educational attainment is a routinely reported data element on US death certificates [3, 4], data on COVID-19 deaths were not reported by educational level, let alone stratified by race/ethnicity and education, in government health statistics during the first year of the pandemic under the Trump administration.

On February 2, 2021, the US National Center for Health Statistics published a national-level data table of COVID-19 deaths stratified by race/ethnicity and education [5], signaling what is hopefully a renewed commitment to data transparency and accountability under the newly elected Biden-Harris administration. These data permit the first analysis of COVID-19 mortality inequities jointly by race/ethnicity and individual level socioeconomic position. In this paper, we report on an intersectional analysis of these data and discuss implications for understanding the drivers of inequities in COVID-19 deaths in the US.

Methods

Data Sources

We obtained cumulative provisional counts of death for COVID-19 (ICD-10 code U07.1 as an underlying or multiple cause of death) for the period January 1, 2020 through January 31,

2021 (N=413,196) from the US National Center for Health Statistics [5]. We excluded 10,810 deaths with unknown education and 1,682 with unknown race, accounting for 2.6% and 0.4% of the total reported COVID-19 deaths respectively.

For analysis, we used the CDC categories for race/ethnicity, provided as: Non-Hispanic White (NHW), Non-Hispanic Black (NHB), Hispanic (H), Non-Hispanic Asian Pacific Islander (NHAPI), Non-Hispanic American Indian and Alaskan Native (NHAIAN), and Non-Hispanic More Than One Race (NHMTOR) [5]. Due to small numbers, we report rates for NHMTOR in Table 1 but do not present them in the figures. We categorized levels of educational attainment as less than high school (combining 8th grade or less and 9-12 grade with no diploma), high school graduate (high school graduate or GED-completed), some college (combining some college credit but no degree and associate's degree), college graduate (Bachelor's degree), or postgraduate degree (combining master's degree and doctorate or professional degree).

We obtained estimates of population counts by educational attainment for those 18 years and over in 2020 by race and Hispanic origin from the Annual Social and Economic supplement of the US Census Bureau's Current Population Survey [6]. Although the COVID-19 death data include deaths of all ages, the number of COVID-19 deaths among individuals 0-17 years old is very small (191 out of 443,107 total COVID-19 deaths (0.04%) as of February 6, 2021) [7] and so we consider error introduced by the age mismatch to be negligible if we interpret computed rates as applicable to the population 18 years and older. We treat these population counts as representative of a year of person-time under observation, given that the first recorded COVID-19 deaths in the US occurred in early February.

Statistical Analysis

We calculated rates per 100,000 person-years and associated 95% confidence limits using standard formulae [8] and present these in Table 1. To estimate incidence rate ratios (IRR), we fit saturated Poisson loglinear models for the count of COVID-19 deaths by race/ethnicity, education, and the interaction of race/ethnicity and education, with log(population) as an offset. Following STROBE guidelines for the presentation of interactions [9], we present incidence rate ratios (IRR) in Table 2 for (a) racial/ethnic inequities within educational groups; (b) educational inequities within racial/ethnic groups; and (c) intersectional inequities relative to a common reference group (Non-Hispanic Whites with a postgraduate degree). Note that, because of the large case numbers in this surveillance dataset, confidence limits for IRRs are extremely narrow.

To describe the intersectional effects [10] of the categories for racialized groups and education on COVID-19 mortality (Table 3), we characterize the interaction of race/ethnicity and education relative to Non-Hispanic Whites with a postgraduate degree (the theoretically most advantaged group) on the multiplicative and additive scales. For the multiplicative scale, we interpret the interaction terms from the Poisson model. To characterize interaction on the additive scale, we calculate the relative excess risk due to interaction (RERI) based on exponentiated regression coefficients from the Poisson model and obtain standard errors via the delta method [11]. For comparisons where the reference racial/ethnic contrast is protective among those with a postgraduate degree (i.e. among Hispanics and Non-Hispanic Asian Pacific Islanders), we follow recommended practice and recode Non-Hispanics Whites to be "exposed" for these comparisons [12].

Results

Figure 1a shows the distribution of educational attainment by race/ethnicity for adults age 18 and over in 2020. Compared to Non-Hispanic Whites, Non-Hispanic Blacks, Hispanics, and Non-Hispanic American Indian or Alaskan Natives were disproportionately represented in lower education categories, while Non-Hispanic Asian Pacific Islanders were more likely to be college graduates or to hold a postgraduate degree (chi-squared p-value<0.001).

Figure 1b presents crude COVID-19 mortality rates by race/ethnicity (aggregating over education groups). Crude rates were significantly greater among Non-Hispanic Blacks (IRR 1.3, 95% CI 1.3, 1.3), Hispanics (IRR 1.1, 95% CI 1.1, 1.1), and Non-Hispanic American Indian or Alaskan Natives (IRR 1.7, 95% CI 1.7, 1.7) and lower among Non-Hispanic Asian Pacific Islanders (IRR 0.6, 95% CI 0.6, 0.6) compared with Non-Hispanic Whites.

Figure 1c shows a strong inverse gradient in COVID-19 mortality rates by educational attainment, with substantially elevated rates observed for those with less than a high school education (IRR 5.3, 95% CI 5.3, 5.3), high school graduates (IRR 3.4, 95% CI 3.4, 3.4), and some college (IRR 1.3, 95% CI 1.3, 1.3) relative to those with a postgraduate degree. Rates among college graduates were virtually identical to those with a postgraduate degree.

Figure 1d stratifies simultaneously by race/ethnicity and educational attainment and shows variation in the steepness of the educational gradient within racial/ethnic group as well as pronounced differences in the racial/ethnic inequities within educational group. In particular, while the highest rates in all racial/ethnic groups were observed among those with less than a high school education, rates among high school graduates were similarly elevated among Non-Hispanic Whites, Non-Hispanic Blacks, and Non-Hispanic American Indian or Alaskan Natives, compared with Hispanics and Non-Hispanic Asian Pacific Islander. Meanwhile, COVID-19

mortality rates were relatively similar among Non-Hispanic Whites, Non-Hispanic Blacks, and Hispanics in the most educated groups, while some differentiation between rates in these groups was seen for Non-Hispanic American Indian or Alaskan Natives (whose rates were higher in each education category relative to Non-Hispanic Whites) and Non-Hispanic Asian Pacific Islanders (for whom the rate among those with a postgraduate degree was substantially lower).

These contrasts are further visualized in Figure 2, which presents (a) racial/ethnic rate ratios within educational group, (b) educational rate ratios within racial/ethnic group, and (c) an intersectional comparison relative to rates observed among Non-Hispanic Whites in the most educated group. Corresponding IRRs and 95% Cis are presented in Table 2. Figure 2a highlights effect measure modification of racial/ethnic inequities across educational categories: Non-Hispanic Black rates were not appreciably different from Non-Hispanic White rates in the lowest education categories, whereas a moderately increased risk of COVID-19 death for Non-Hispanic Blacks emerges for those with some college education or higher (IRR=1.3, 95% CI 1.2, 1.3) compared to Non-Hispanic Whites in the same educational category (summarized in Table 2). In contrast, significantly elevated rates are seen among Non-Hispanic American Indian or Alaskan Natives relative to Non-Hispanic Whites in all educational groups with the exception of high school graduates, with the magnitude of the disparity varying from 1.3 to 2.0. Meanwhile, though Hispanics were observed to have higher crude mortality rates relative to Non-Hispanic Whites (Figure 1b), within strata of educational attainment, Hispanics have substantially decreased mortality rates, as do Non-Hispanic Asian Pacific Islanders.

As shown in Figure 2b, a strong educational gradient in COVID-19 mortality rates is observed in every racial/ethnic group, with the most extreme mortality rates observed for those with less than a high school diploma and high school graduates. The steepness of the gradient

varies, with a markedly steeper gradient observed among Non-Hispanic Asian Pacific Islanders due to their substantially lower rates among postgraduates.

Visualization of the joint inequities by race/ethnicity and education relative to a common reference group (here, Non-Hispanic Whites with a postgraduate degree, the theoretically most advantaged group) shows that inequities in mortality are dominated by the steep educational gradient in all groups, with those in the less than high school group having rate ratios ranging from 3.3 (Non-Hispanic Asian Pacific Islanders) to 7.8 (Non-Hispanic American Indian and Alaskan Natives) relative to the reference group and those in the high school graduate group having rate ratios ranging from 2.1 (Hispanics and Non-Hispanic Asian Pacific Islanders) to 3.5 (Non-Hispanic Whites and Non-Hispanic American Indian or Alaskan Natives). Nevertheless, there is also strong statistical evidence of interaction between racialized groups and educational attainment on both the additive and multiplicative scales, as summarized in Table 3.

Discussion

The release of these long overdue data on COVID-19 mortality rates by race/ethnicity and educational attainment provide valuable insight into who has borne the unequal burden of COVID-19 death in the United States. In particular, the magnitude of the inequities in COVID-19 mortality rates by education, both overall and within racial/ethnic groups, speaks to the excess mortality burden tied to socioeconomic deprivation and occupational hazards among people in all racial/ethnic groups, whereby risk of exposure to SARS-Cov-2 is greatest among those working in public facing, essential jobs, documented to be predominantly low wage precarious jobs with limited or no sick pay and disproportionately employing workers of color [13,14].

In contrast, the excess mortality risk experienced by Non-Hispanic American Indian or Alaskan Natives across educational groups reflects the extent to which concentrated outbreaks in

this community, particularly in the summer of 2020, were particularly devastating. Given potential misclassification of NHAIAN deaths on death certificates [15], the rates we calculated may well be underestimates and, if misclassification is more common among lower education groups, educational inequities may be understated.

It is interesting to note that within educational categories, Hispanic mortality rates were consistently lower than rates among Non-Hispanic Whites. This suggests that the overall increased mortality rates experienced by Hispanics is driven in large part by their over-representation in more disadvantaged education groups. Similarly, for the non-Hispanic Black population, their equivalent mortality rates to Non-Hispanic Whites in the two lowest educational strata, and their only slightly elevated risk in the higher educational strata suggests that it is the inequities in educational distribution that drive the overall higher crude rates among the non-Hispanic Black vs non-Hispanic White populations.

While we found that education, by virtue of the excessively large mortality inequities experienced by those with less than a high school education or who are high school graduates, is a strong driver of observed racialized inequities, there is nevertheless strong statistical evidence of interaction between racialized group and education in relation to COVID-19 mortality on both multiplicative and additive scales for all racial/ethnic and educational groups. Thus, it is insufficient to conceive of individual education as "explaining" racial/ethnic inequities as the variation in contrasts across racial/ethnic groups show that socioeconomic inequities are "racialized" and, conversely, that racial/ethnic inequities are exacerbated in more socioeconomically privileged groups. This is not a new pattern, and once again points to how analyzing health inequities requires a "both/and," not "either/or," approach to addressing structural injustice involving inequitable race and class relations [14,16,17].

While these data provide insight into the social patterning of COVID-19 inequities, there are several important limitations to note. Firstly, the accuracy of reported educational attainment on death certificates has been observed to vary with age, with previous empirical research suggesting that individuals who did not graduate from high school are sometimes misclassified as having obtained a high school diploma, especially among persons aged 65 and older [4,18]. The net effect may be to deflate the mortality rate among those with less than a high school diploma and to inflate it among high school graduates, which suggests that the differences we detected between these two categories may be even greater than the data suggest. Secondly, we note that more granular data by age were not available for this analysis. Since US people of color tend to have a younger age distribution compared to the US non-Hispanic white population and since we have also previously reported substantially increased racial/ethnic inequities in COVID-19 mortality at younger ages [2], these analyses likely understate the extent of racial/ethnic inequities that would be visible if age-adjustment were possible.

Additionally, the available data are national and represent a full year of aggregated death records. Thus, we are unable to account for geographical differences in racial/ethnic or educational inequities or for the fact that US populations of color in different parts of the country may have experienced peak COVID-19 mortality rates at different points during the year [19]. Nor do our analyses take into account the overall excess mortality linked to the COVID-19 pandemic, including deaths not classified as COVID-19 due to inequities in access to COVID-19 testing, as well as deaths caused by not by infection, but nevertheless reflecting the impact of the pandemic (e.g., cardiovascular mortality not linked to infection but to limited access to health care) [20]. These data limitations point to the urgent need for timely and detailed data on COVID-19 mortality and excess deaths by race/ethnicity, education, and geography over time.

In the context of the extremely high COVID-19 case and mortality rates observed in the United States in 2020, it is unfortunately not surprising to see the persistence of racialized and socioeconomic inequities and the devastating impact on poor communities and communities of color. Given the lackluster federal response to the pandemic in 2020, including failure to enact substantial coronavirus relief or workplace protections that would have enabled working families to avoid putting themselves at risk through continued work during lockdowns [14], the unequal burden of the pandemic is once again falling on those most subjected to racialized and economic injustice. Issues with vaccine distribution and barriers to access threaten to further exacerbate COVID inequities [21,22]. Timely reporting of COVID-19 outcomes by race/ethnicity, socioeconomic measures including education and occupation, age, and gender must be a priority to ensure transparency and accountability and to support action to reduce the continuing impact of the pandemic on those most adversely impacted by structural injustice.

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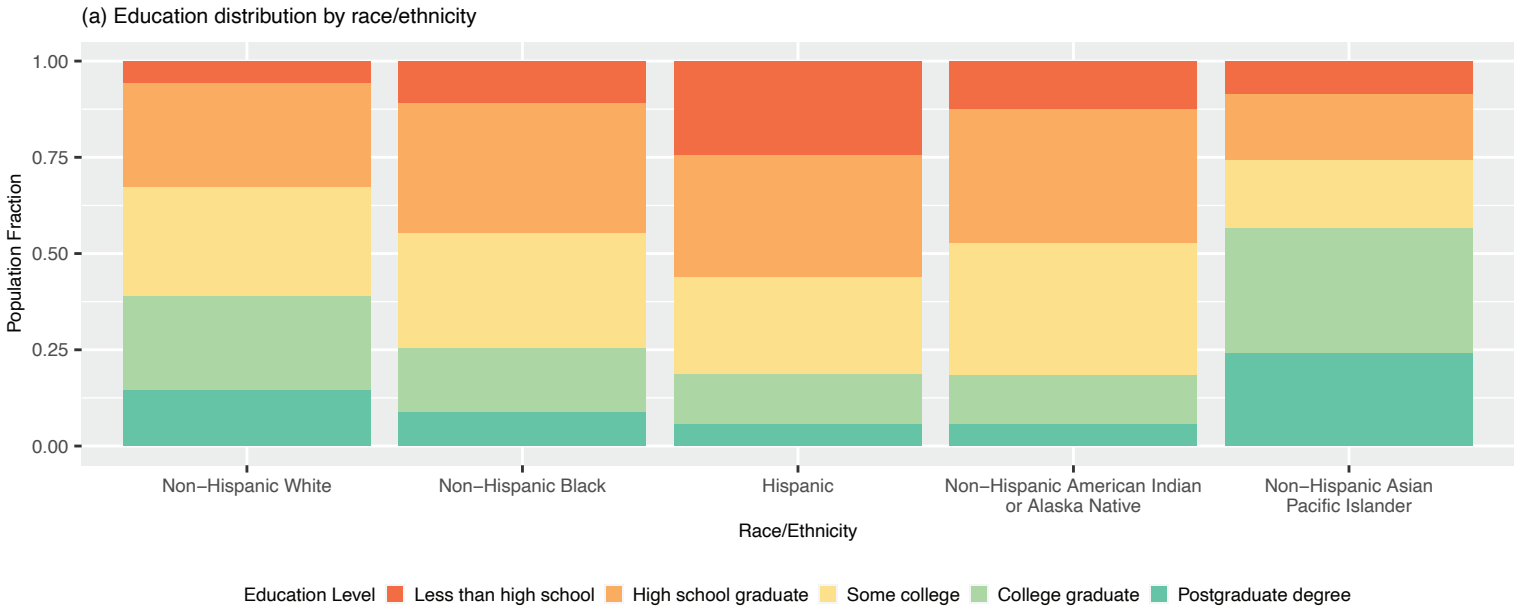
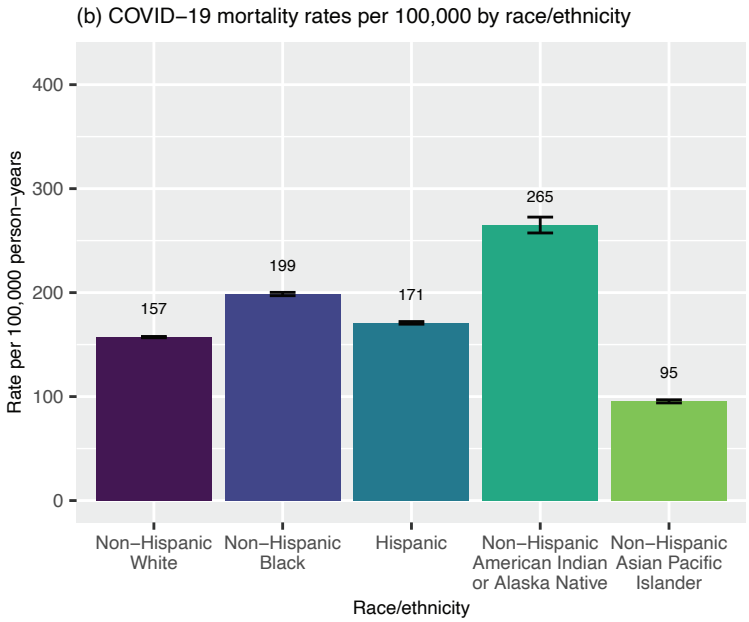
FIGURES

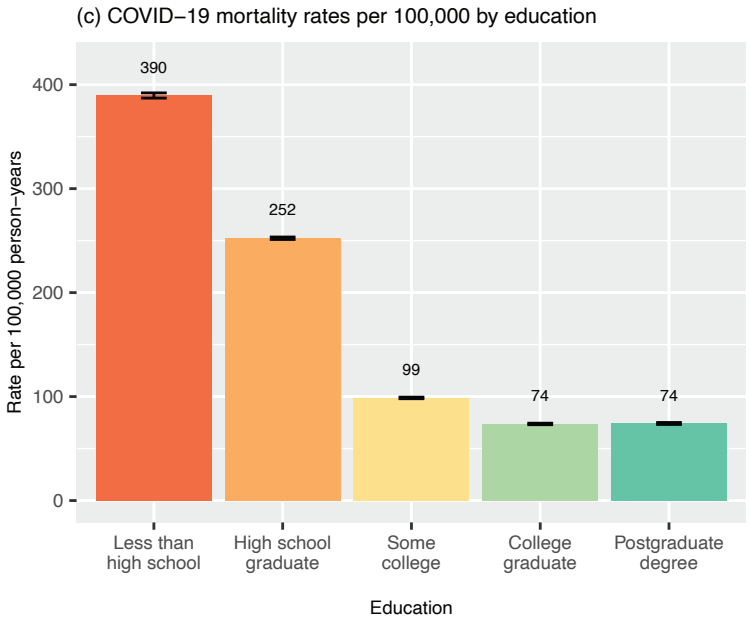
Figure 1: (a) Distribution of educational attainment by race/ethnicity in the United States (US) (2020) and US COVID-19 mortality rate per 100,000 (b) by race/ethnicity, (c) by educational attainment, and (d) by race/ethnicity and educational attainment, January 1, 2020 - January 30, 2021.

Figure 2: US COVID-19 mortality rate ratios (a) by race/ethnicity within education group, (b) by education within racial/ethnic group, and (c) relative to Non-Hispanic whites with a postgraduate degree (intersectional comparison), January 1, 2020 - January 30, 2021.

Figure 1: (a) Distribution of educational attainment by race/ethnicity in the United States (US) (2020) and US COVID-19 mortality rate per 100,000 (b) by race/ethnicity, (c) by educational attainment, and (d) by race/ethnicity and educational attainment, January 1, 2020 - January 30, 2021







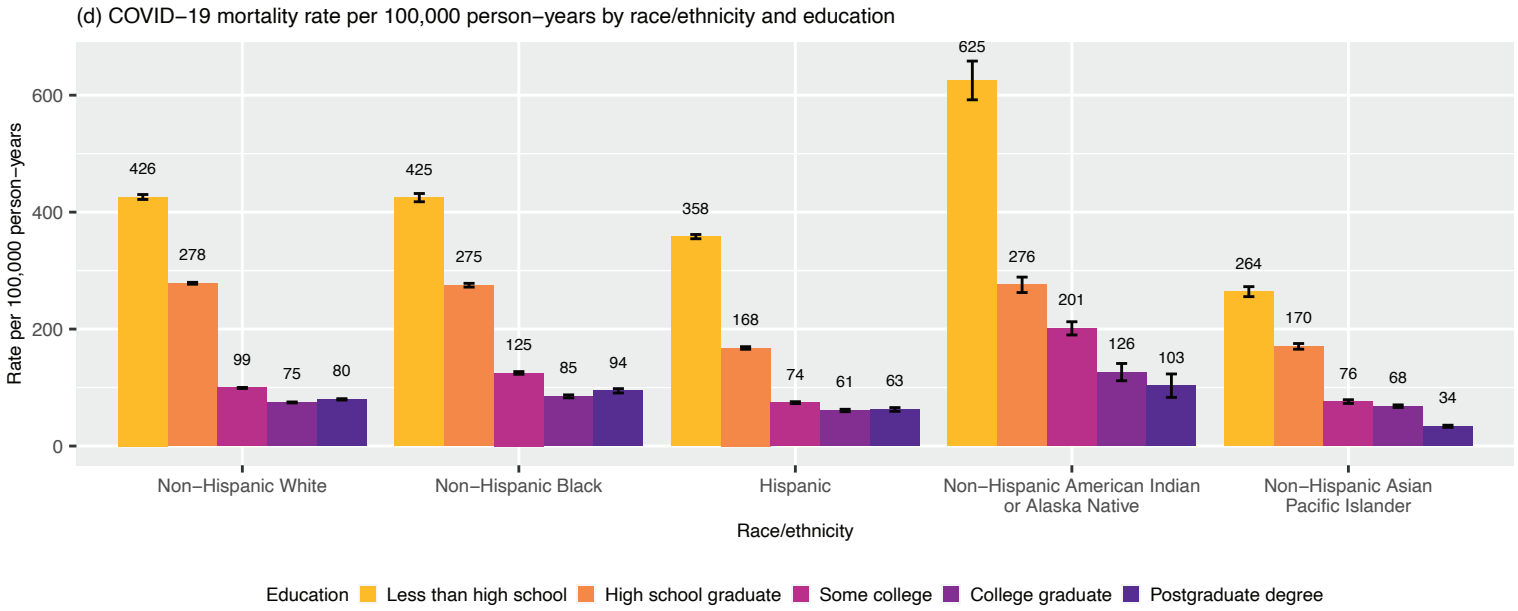
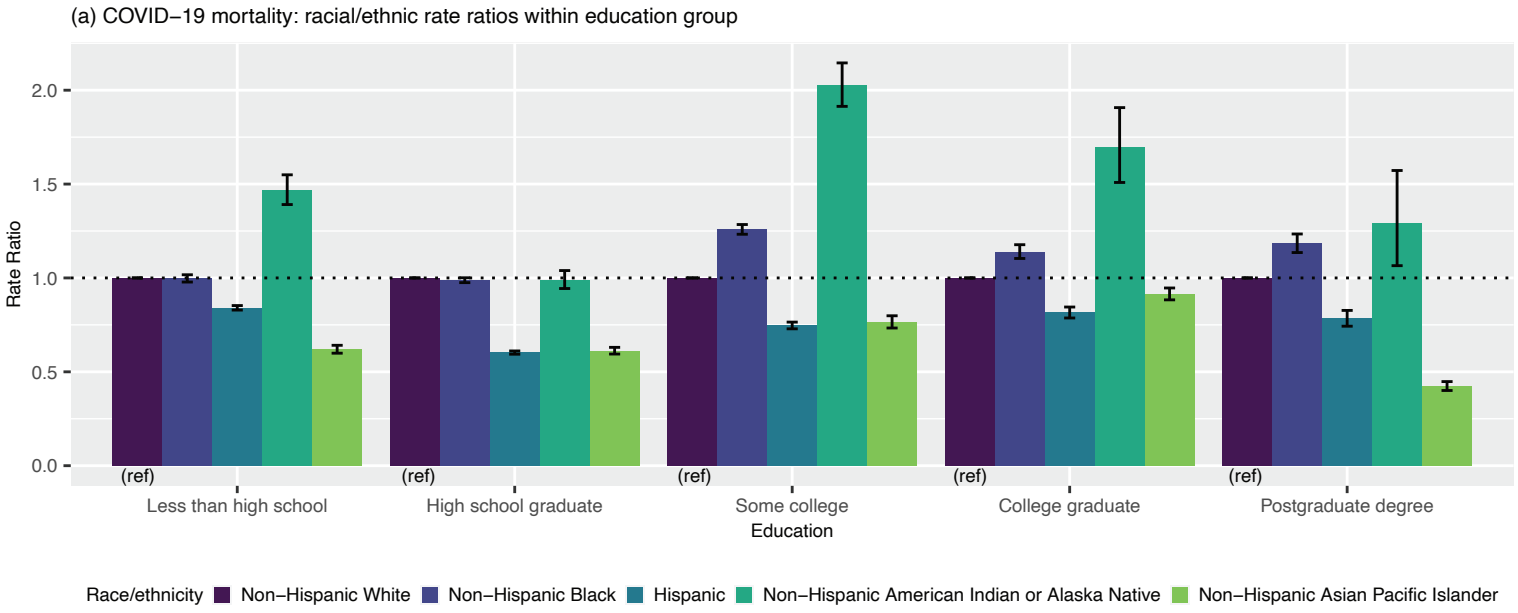
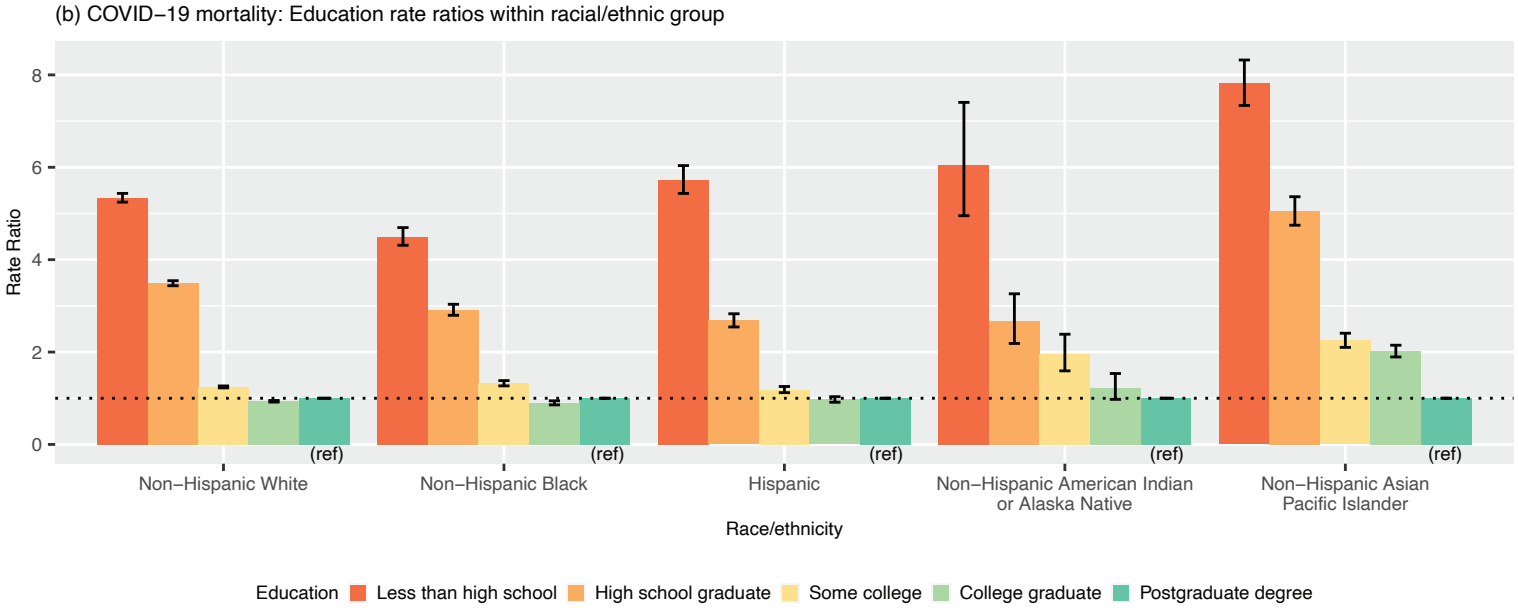


Figure 2: US COVID-19 mortality rate ratios (a) by race/ethnicity within education group, (b) by education within racial/ethnic group, and (c) relative to Non-Hispanic whites with a postgraduate degree (intersectional comparison), January 1, 2020 - January 30, 2021





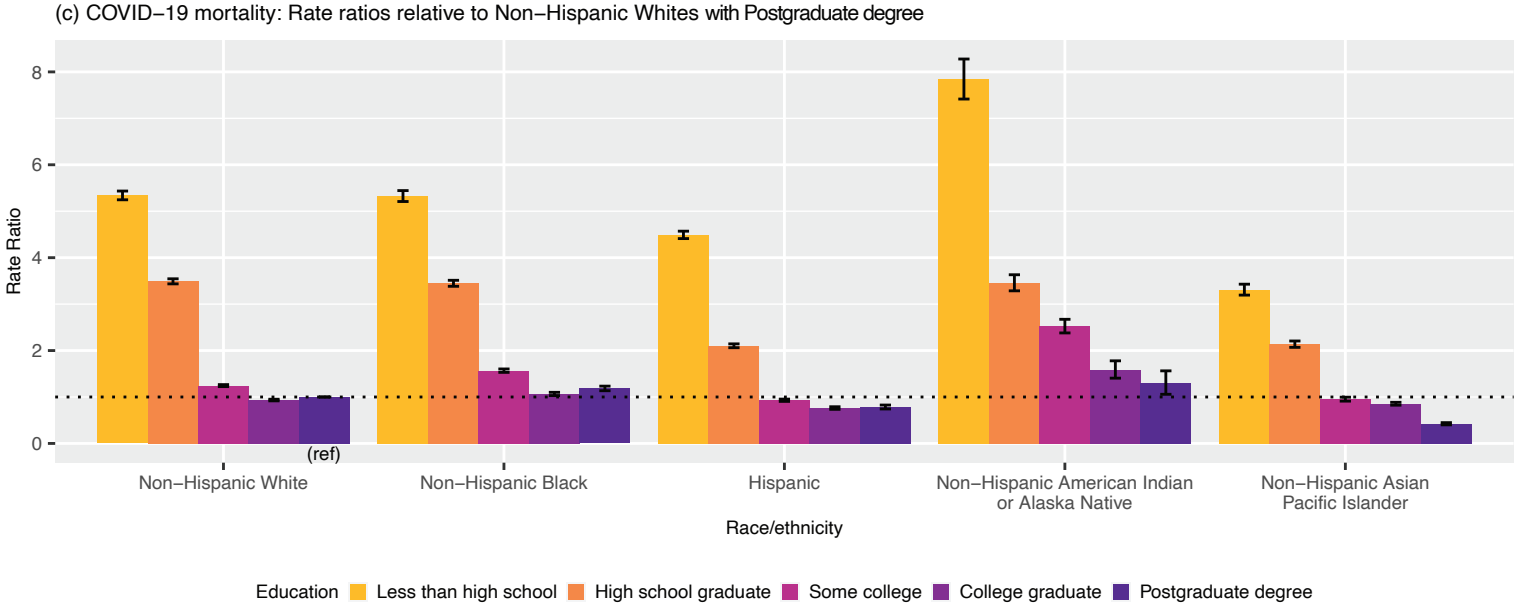


Table 1: COVID-19 deaths and population (age>18 years old) by race/ethnicity and education, United States, January 1, 2020 – January 31, 2021.

Race/ethnicity	Education Level	Deaths	Population	Rate per 100,000 person-years	(95% CI)	
Non-Hispanic White	Less than high school	38,901	9,133,850	425.9	(421.7	, 430.1)
	High school graduate	117,989	42,386,917	278.4	(276.8	, 280.0)
	Some college	44,812	45,121,322	99.3	(98.4	, 100.2)
	College graduate	29,030	38,951,487	74.5	(73.7	, 75.4)
	Postgraduate degree	18,073	22,658,100	79.8	(78.6	, 80.9)
Non-Hispanic Black	Less than high school	13,876	3,266,618	424.8	(417.7	, 431.8)
	High school graduate	27,922	10,153,475	275.0	(271.8	, 278.2)
	Some college	11,306	9,046,789	125.0	(122.7	, 127.3)
	College graduate	4,265	5,020,760	84.9	(82.4	, 87.5)
	Postgraduate degree	2,505	2,653,225	94.4	(90.7	, 98.1)
Hispanic	Less than high school	36,848	10,289,390	358.1	(354.5	, 361.8)
	High school graduate	22,267	13,278,610	167.7	(165.5	, 169.9)
	Some college	7,864	10,603,696	74.2	(72.5	, 75.8)
	College graduate	3,351	5,514,294	60.8	(58.7	, 62.8)
	Postgraduate degree	1,443	2,307,930	62.5	(59.3	, 65.7)
Non-Hispanic American Indian or Alaska Native	Less than high school	1,368	218,814	625.2	(592.1	, 658.3)
	High school graduate	1,671	606,139	275.7	(262.5	, 288.9)
	Some college	1,212	602,276	201.2	(189.9	, 212.6)
	College graduate	282	223,071	126.4	(111.7	, 141.2)
	Postgraduate degree	102	98,802	103.2	(83.2	, 123.3)
Non-Hispanic Asian Pacific Islander	Less than high school	3,668	1,389,342	264.0	(255.5	, 272.6)
	High school graduate	4,718	2,768,312	170.4	(165.6	, 175.3)
	Some college	2,217	2,917,205	76.0	(72.8	, 79.2)
	College graduate	3,617	5,307,947	68.1	(65.9	, 70.4)
	Postgraduate degree	1,318	3,901,258	33.8	(32.0	, 35.6)
Non-Hispanic More Than One Race	Less than high school	212	330,245	64.2	(55.6	, 72.8)
	High school graduate	478	1,006,035	47.5	(43.3	, 51.8)
	Some college	304	1,280,062	23.7	(21.1	, 26.4)
	College graduate	154	773,498	19.9	(16.8	, 23.1)
	Postgraduate degree	100	307,642	32.5	(26.1	, 38.9)

Table 2: Summary of inequities in COVID-19 mortality by race/ethnicity and educational attainment, United States, January 1, 2020-January 31, 2021.

Educational attainment	Race/ethnicity	Racial/ethnic rate ratios within education group		Race/ethnicity	Educational attainment	Education rate ratios within racial/ethnic groups		Rate ratios relative to Non-Hispanic Whites with a postgraduate degree	
		IRR	(95% CI)			IRR	(95% CI)	IRR	(95% CI)
Less than high school	Non-Hispanic White	1.0	(reference)	Non-Hispanic White	Less than high school	5.3	(5.2 , 5.4)	5.3	(5.2 , 5.4)
	Non-Hispanic Black	1.0	(1.0 , 1.0)		High school graduate	3.5	(3.4 , 3.5)	3.5	(3.4 , 3.5)
	Hispanic	0.8	(0.8 , 0.9)		Some college	1.2	(1.2 , 1.3)	1.2	(1.2 , 1.3)
	Non-Hispanic American Indian or Alaska Native	1.5	(1.4 , 1.5)		College graduate	0.9	(0.9 , 1.0)	0.9	(0.9 , 1.0)
	Non-Hispanic Asian Pacific Islander	0.6	(0.6 , 0.6)		Postgraduate degree	1.0	(reference)	1.0	(reference)
High school graduate	Non-Hispanic White	1.0	(reference)	Non-Hispanic Black	Less than high school	4.5	(4.3 , 4.7)	5.3	(5.2 , 5.4)
	Non-Hispanic Black	1.0	(1.0 , 1.0)		High school graduate	2.9	(2.8 , 3.0)	3.4	(3.4 , 3.5)
	Hispanic	0.6	(0.6 , 0.6)		Some college	1.3	(1.3 , 1.4)	1.6	(1.5 , 1.6)
	Non-Hispanic American Indian or Alaska Native	1.0	(0.9 , 1.0)		College graduate	0.9	(0.9 , 0.9)	1.1	(1.0 , 1.1)
	Non-Hispanic Asian Pacific Islander	0.6	(0.6 , 0.6)		Postgraduate degree	1.0	(reference)	1.2	(1.1 , 1.2)
Some college	Non-Hispanic White	1.0	(reference)	Hispanic	Less than high school	5.7	(5.4 , 6.0)	4.5	(4.4 , 4.6)
	Non-Hispanic Black	1.3	(1.2 , 1.3)		High school graduate	2.7	(2.5 , 2.8)	2.1	(2.1 , 2.1)
	Hispanic	0.7	(0.7 , 0.8)		Some college	1.2	(1.1 , 1.3)	0.9	(0.9 , 1.0)
	Non-Hispanic American Indian or Alaska Native	2.0	(1.9 , 2.1)		College graduate	1.0	(0.9 , 1.0)	0.8	(0.7 , 0.8)
	Non-Hispanic Asian Pacific Islander	0.8	(0.7 , 0.8)		Postgraduate degree	1.0	(reference)	0.8	(0.7 , 0.8)
College graduate	Non-Hispanic White	1.0	(reference)	Non-Hispanic American Indian or Alaska Native	Less than high school	6.1	(5.0 , 7.4)	7.8	(7.4 , 8.3)
	Non-Hispanic Black	1.1	(1.1 , 1.2)		High school graduate	2.7	(2.2 , 3.3)	3.5	(3.3 , 3.6)
	Hispanic	0.8	(0.8 , 0.8)		Some college	1.9	(1.6 , 2.4)	2.5	(2.4 , 2.7)
	Non-Hispanic American Indian or Alaska Native	1.7	(1.5 , 1.9)		College graduate	1.2	(1.0 , 1.5)	1.6	(1.4 , 1.8)
	Non-Hispanic Asian Pacific Islander	0.9	(0.9 , 0.9)		Postgraduate degree	1.0	(reference)	1.3	(1.1 , 1.6)
Postgraduate degree	Non-Hispanic White	1.0	(reference)	Non-Hispanic Asian Pacific Islander	Less than high school	7.8	(7.3 , 8.3)	3.3	(3.2 , 3.4)
	Non-Hispanic Black	1.2	(1.1 , 1.2)		High school graduate	5.0	(4.7 , 5.4)	2.1	(2.1 , 2.2)
	Hispanic	0.8	(0.7 , 0.8)		Some college	2.2	(2.1 , 2.4)	1.0	(0.9 , 1.0)
	Non-Hispanic American Indian or Alaska Native	1.3	(1.1 , 1.6)		College graduate	2.0	(1.9 , 2.1)	0.9	(0.8 , 0.9)
	Non-Hispanic Asian Pacific Islander	0.4	(0.4 , 0.4)		Postgraduate degree	1.0	(reference)	0.4	(0.4 , 0.4)

Table 3: Intersectional interaction analysis of inequities in COVID-19 mortality by race/ethnicity and education, United States, January 1, 2020 – January 31, 2021.

Race/ethnicity	Educational attainment	Multiplicative interaction			Additive interaction		
		exp(β)	(95% CI)	Sub vs. supermultiplicative	RERI*	(95% CI)	Sub vs. superadditive
Non-Hispanic White	Less than high school	-			-		
	High school graduate	-			-		
	Some college	-			-		
	College graduate	-			-		
	Postgraduate degree	-			-		
Non-Hispanic Black	Less than high school	0.8	(0.8 , 0.9)	submultiplicative	-0.2	-(0.3 -, 0.1)	subadditive
	High school graduate	0.8	(0.8 , 0.9)	submultiplicative	-0.2	-(0.3 -, 0.2)	subadditive
	Some college	1.1	(1.0 , 1.1)	supermultiplicative	0.1	(0.1 , 0.2)	superadditive
	College graduate	1.0	(0.9 , 1.0)	null	-0.1	-(0.1 , 0.0)	null
	Postgraduate degree	-			-		
Hispanic†	Less than high school	0.9	(0.9 , 1.0)	submultiplicative	0.8	(0.7 , 0.9)	superadditive
	High school graduate	1.3	(1.2 , 1.4)	supermultiplicative	1.5	(1.4 , 1.5)	superadditive
	Some college	1.0	(1.0 , 1.1)	null	0.1	(0.1 , 0.2)	superadditive
	College graduate	1.0	(0.9 , 1.0)	null	-0.1	-(0.1 , 0.0)	null
	Postgraduate degree	-			-		
Non-Hispanic American Indian or Alaska Native	Less than high school	1.1	(0.9 , 1.4)	null	2.2	(1.7 , 2.7)	superadditive
	High school graduate	0.8	(0.6 , 0.9)	submultiplicative	-0.3	-(0.6 , 0.0)	subadditive
	Some college	1.6	(1.3 , 1.9)	supermultiplicative	1.0	(0.7 , 1.3)	superadditive
	College graduate	1.3	(1.0 , 1.7)	supermultiplicative	0.4	(0.0 , 0.7)	superadditive
	Postgraduate degree	-			-		
Non-Hispanic Asian Pacific Islander†	Less than high school	0.7	(0.6 , 0.7)	submultiplicative	3.4	(3.1 , 3.7)	superadditive
	High school graduate	0.7	(0.6 , 0.7)	submultiplicative	1.8	(1.7 , 2.0)	superadditive
	Some college	0.6	(0.5 , 0.6)	submultiplicative	-0.7	-(0.8 -, 0.5)	subadditive
	College graduate	0.5	(0.4 , 0.5)	submultiplicative	-1.2	-(1.3 -, 1.0)	subadditive
	Postgraduate degree	-			-		

* RERI = Relative Excess Risk due to Interaction

† Recoded for interaction analysis so that Non-Hispanic White is "exposed" and Hispanic or Non-Hispanic Asian Pacific Islander is the reference category for race/ethnicity.