**Online Appendices for "Has Mortality Risen Disproportionately for the Least Educated?
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[Not for Publication]

Online Appendix A. Construction of Death Rates by Education Quartiles [Not for Publication]

This Appendix details our methods for constructing death rates by education quartile. Section A1 first describes specifics of the imputation procedure used to calculate deaths and population counts by years of education and demographic characteristics. These counts are then used to construct death rates by group, and represent the data used in estimating the main regressions of the paper. Section A2 then describes the procedure to age-standardize death rates by education quartile, which follow common practices from the literature.

A1. Procedure to Estimate Population and Deaths by Years of Education

To estimate death counts (the numerator in the death rate calculations), we sum all deaths for the specified cell by age, gender, educational attainment, year and race, using the *MCOD* data. We drop approximately 3,500 observations with missing age out of over 42.9 million recorded deaths during this period. Prior to 2003, information on single year of education is provided on the death certificates. Beginning in 2003, approximately 16 percent of deaths measure education in one of seven categories: 8th grade or less, 9-12th grades without a diploma, high school, some college (no degree), bachelor's degree, master's degree, or a doctorate/professional degree. By 2007, just over half of records classify education using these coarser groups, rather than single year of education, and in 2017, nearly all deaths are recorded using the seven education categories. For some classifications, we can reasonably assign a single year of education. Specifically, we treat high school graduation as 12 years of education, some college or associate's degree as 14 years, a bachelor's degree as 16 years, and a master's or doctorate/professional degree as 17 years of schooling. However, for the other education categories ("<= 8th grade" and "9-12th grade, no diploma"), this assignment cannot be done, since these broader categories include people with substantially different years of education; therefore, we develop an imputation procedure to use in these cases.

To implement the procedure, we first calculate the fraction of single year educational attainment, when these are provided, comprising each of the broader categories. For example, for deaths corresponding to grades 9 to 12 without a diploma, we calculate the percentages of deaths occurring among persons where the death certificate specifies 9, 10 and 11 years of education, respectively (and not just the broader education category). We then regress the percentages for each of these years of education on a quadratic trend in years and a full set of age, sex, and race interactions, with the sample restricted to those in the specified broader education categories (e.g. 9 to 12 years of education without a diploma). To ensure a large enough sample to make these extrapolations, we use wider than five-year age bins, specifically, combining those 25-39, 40-54 and 55-74 years of age. We restrict the time period for these regressions to be prior to and including 2010, since after that year fewer than 30 percent of deaths record single year of education. Next we use these estimates to predict the probability of persons with information only on the broad education category having the particular number of years of education, conditional on the three age aforementioned categories, age, sex, race and year of death.

A potential threat to this imputation strategy is that states adopting the broad education categories might have different distributions of within-category educational attainment to those that did not. To examine whether this was a problem, we first classified states according to whether they predominantly reported continuous years of education in 2010 versus those that primarily used the broader education categories. We then compared the distribution of deaths across these two classifications for those with 9, 10 and 11 years of education prior to 2003 (when all states used continuous education), conditional on having between 9 and 12 years of education (without a high school degree). We found that the distributions were nearly identical across the two types of states. We repeated this for those with 8th grade or less, and found similarly that the distribution of 0 through 8 years of education in the pre-2003 period was very similar between states that used different classification methods in 2010. Since the data includes over 2 million deaths each year, the distributions of educational attainment between the two groups of states are statistically significant at any conventional level based on chi-squared tests. However, the magnitudes of the differences in early years between states that later code education predominantly using categories as opposed to single years are extremely small. For example, 86.59% of deaths among those with either 10 or 11 years of education had 10 years of education in states that later use categories vs. 86.79% in states that later use single years. Among those with 8 years or less of education, 51.85% have 8 years in the states later using categories vs. 50.93% in states that continue to use single years in later years. These results suggest that the educational distributions in earlier years provide a useful indication of the predicted distributions in later ones.

Educational attainment is missing for roughly 5 percent of death certificates. We assume that the education distribution within a given year, race, sex, 5-year age bin is the same for these missing certificates as when education is reported, and include such deaths in the calculations using this allocation.

To estimate population counts, the denominator of death rates, we begin by assigning the number of years of education completed corresponding to the level of educational attainment, as measured in the American Community Survey (ACS). While information on education is available from the 2000 Census, our analysis suggested that these data were not fully consistent with those reported in the ACS. Since we also use the ACS for other years, we choose to exclusively use the ACS to maintain comparability over time. This procedure is straightforward for categories up to grade 12 starting in 2008, since these are measured in single year bins. Prior to 2008, grades below 8th grade were combined (nursery school to 4th grade, 5th and 6th grade, and 7th and 8th grade). We split these cases into each of the possible grades based on the distribution within a given race, sex and wide age bin among years 2008-2017. We record "no schooling completed", "nursery school, preschool", and kindergarten" as 0 years of education. We assume a high school degree is equivalent to 12 years, classify 12th grade without a diploma as 11 years of schooling, and less than one year of college as 12 years. We assign “1 or more years of college credit, no degree” or an associate’s degree as 14 years of schooling and assume that a college degree without additional education is equivalent to 16 years. Education beyond a college degree is coded as 17 years of education. Using ACS sample weights, we then calculate the distribution of education measured from 0 to 17 years (excluding 13 or 15 years) by 5-year age categories, gender, survey year (and sometimes race). Finally, we multiply these population shares by the SEER population data corresponding to the age, gender, year and usually race cells to estimate population counts by single year of education and demographic sub-group.

It is important to acknowledge the assumptions implied by proportionately assigning deaths across quartiles using our methods. Novosad, Ravkin and Asher (2020) note that the proportional assignment, which is also used by Meara, Richards, and Cutler (2008) and Bound et al. (2015), treats mortality rates as being flat within education bins, and only allows for changes discretely across bins. By contrast, their methods assume a continuous latent education rank distribution, with mortality rates weakly declining in this rank. Assuming a step-function of mortality with proportional assignment is undesirable when education bins are wide, but the assumption is less problematic when education is measured in single years of schooling, as in our analysis. Novosad, Ravkin and Asher (2020) consider four education bins (less than high school, high school, some college, and bachelor's degree or higher), while we split education into 16 bins (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 16 and 17 years, where 14 includes all those with more than a year of college but who did not graduate and 17 includes all with at least one year of post-graduate education). Given the finer granularity of our measure of educational attainment, we view the assumption of constant mortality rates within single year of education as reasonable and potentially advantageous to analyses that divide the sample into just four education categories. We also note that mortality rates do not always decline as education rises within each group, using our constructed single year of education. For each age-race-sex group, there is at least one instance where those with higher education (measured in single years) have higher mortality rates than those with less education. These non-monotonic mortality patterns generally occur at 10 years of schooling or less. We therefore prefer an approach that assumes a constant mortality rate within finely disaggregated education bins, rather than to assume mortality is necessarily weakly declining in educational rank for each group.

A2. Aggregation of Death Rates and Education Quartiles

The procedures described above result in education-quartile specific death rates calculated for demographic subgroups within 5-year age bins. In computing overall death rates for the aggregate group of 25-74 year olds, we adjust for changes over time in the age and education distributions over time by constructing weights for each 5-year age group *a* in education quartile *i*, based on 2017 population shares as:

$$W_{ai}^{2017} = \frac{P_{ai}^{2017}}{\sum_a P_{ai}^{2017}}, \tag{B1}$$

where P_{ai}^{2017} is the 2017 age group population for educational quartile *i* and $\sum_a P_{ai}^{2017}$ is the total 2017 population of that quartile. All of these calculations are done separately by sex, and so we exclude the sex subscripts shown in the main text of the paper. These aggregations are done based on age and education but not race groups, so the *r* subscript is not included. We then take the weighted average of death rates across age groups, standardized based on the 2017 age distribution:

$$\widehat{M}_{it} = \sum_a (W_{ai}^{2017} \times M_{ait}), \tag{B2}$$

where M_{ait} denotes the death rate for age-group *a* in education quartile *i* and year *t*, and $\widehat{M}_{it}$ denotes the corresponding overall age-adjusted death rate for quartile *i* in that year.

To describe broad changes in the education distribution, we similarly aggregate across groups and calculate quartile-specific average education as:

$$\widehat{E}_{it} = \sum_a (W_{ai}^{2017} \times E_{ait}), \tag{B3}$$

where E_{ait} denotes average years of education for age-group *a* in education quartile *i* and year *t*, and $\widehat{E}_{it}$ indicates the corresponding overall age-adjusted average education for the quartile and year.

Online Appendix B: Supplementary Analysis [Not for publication]

This appendix presents details of additional analysis to the main results provided in the text. We first describe each set of analyses, and then present tables and figures.

Changes in educational attainment. Figure B1 presents changes in mean years of education by quartile for men and women between 2001 and 2017. Increases have been larger for women, particularly in the second-to-highest quartile, Q_3.

Robustness and Extensions. Figure B2 presents the regression estimates corresponding to equation (3) in the main text, which measures changes in log death rates by education quartile using only use the beginning and ending years of our sample period (2001-2003 and 2015-2017). Figure B6 presents regression results where quartiles are constructed separately for each race, rather than pooling all races together. The results are qualitatively similar to Figure 3 in the main text that show monotonicity in trends for women but not for men, and that the highest-educated quartile, Q_4, experienced the largest reductions. But there is also more evidence now that trends for men are related to education, even though the second and third quartiles have trends that are not statistically distinguishable.

We explore the role of geography in two ways. First, we assess whether there may be changes in the educational distribution within geographies over our sample period. Figure B11 presents a scatterplot of the share of each education quartile by Census division in 2017 (y-axis) vs. 2001 (x-axis). Each point represents a Census division-quartile pair. There is substantial variation across Census divisions, but little change over time since most points are close to the 45-degree line. This pattern suggests that there is not substantial migration linked to education that might confound comparisons across geographies over time.

Next, in Figure B12, we plot the percentage change in death rates by Census division as reported in Woolf and Schoomaker (2019) against the Census division's share of each education quartile. Each quartile is shown in a separate panel, and each point represents a Census division. If geography were a primary factor explaining the results, one would expect a negative correlation for higher education quartiles and a positive correlation for lower education quartiles. These patterns are observed for the second-lowest quartile, Q_2, and the highest quartile, Q_4. Yet there is little relationship for Q_1 or Q_3, which suggests geographic patterns are likely not the primary explanation.

Additional Details of Heterogeneity Analysis. Section 3.3 of the main text presented analysis of whether the main patterns differed within race and age groups. Here we describe our approach to assess statistical significance when examining whether lower-educated quartiles have fared better than higher-educated quartiles of the same age, race, and sex group. The regression we run, reproduced from Section 3.3 for convenience, is:

$$M_{arist} = \beta_{aris} + \delta_{aris} \times t + u_{arit} \qquad \text{(B1)}$$

To formally examine the comparisons between quartiles within each group, we conduct 1-sided tests of the null hypothesis that a lower quartile has *equal or better* mortality trends than a higher education quartile; the alternative hypothesis is that the lower quartile has *worse* trends. We use the group-specific trend estimates from equation (B1) to compare: Q_1 vs. Q_2, Q_3 and Q_4; Q_2 vs. Q_3 and Q_4; and Q_3 vs. Q_4. Standard errors and associated p-values are estimated through bootstrapping, taking 10,000 samples with replacement to calculate a distribution of trend estimates.

Our use of 1-sided tests is guided by the prevailing narrative of a widening gradient in mortality, and allows us more statistical power to reject the null when a lower-educated quartile has done *worse* than a higher one. Failing to reject the null is consistent with non-monotonic trends within a group, provided the tests have sufficient power as we discuss below.

This process results in 240 tests for each sex and functional form of mortality. For each sex, there are 6 comparisons within each of the 40 groups (10 ages x 4 races). To summarize the results of this large number of tests, we plot the distribution of their *p*-values. Presenting the distribution of *p*-values also allows for flexibility in examining robustness of the collective test results to the use of alternative significance levels. One might believe, for example, that using a conventional significance level of 0.05 is too stringent in this context and would lead us to fail to reject the null often, even if there is considerable evidence that lower quartiles have fared worse. We plot the CDF of the *p*-values, separately by sex and for logs versus levels, for the six aforementioned hypothesis tests for each group. As a benchmark, we also include a 45-degree line along with the CDFs. The 45-degree line represents the distribution of *p*-values expected under the "grand null" that lower-educated quartiles experienced no worse trends than higher-educated quartiles of the same group. By definition, if trends were randomly distributed across quartiles, 5 percent of tests would have *p*-values less than 0.05, 10 percent below 0.10, and so forth.

Figure B3 summarizes the results. Given the large average mortality declines of Q4 documented in Figure 3 of the main text, evidence against the grand null hypothesis of equal or better overall trends for lower education quartiles is fairly strong: for log death rates, about 50 percent of male and 65 percent of female tests have *p*-values below 0.05; for death rates this is true for over one third of male and one half of female tests.[1]

At the same time, evidence in support of a uniformly widening education gradient throughout all quartiles is weak. We frequently fail to detect statistically distinguishable differences when using conventional significance levels or even less stringent rejection criteria. Table B5 tabulates the fraction of tests in which the *p*-value is below critical values ranging from 0.05 to 0.5. Since the null is that less-educated quartiles have had better trends than higher-educated ones in the same age-race group, a *p*-value over 0.5 indicates this is more likely than not given the available evidence. The non-monotonicities just described occur despite the particularly favorable average mortality performance for the most-educated quartile, Q_4. To make comparisons for the lower three quartiles, we remove Q_4 and consider two tests for each group: Q_1 vs. Q_3 and Q_2 vs. Q_3. These results are summarized in Figure B4. We fail to reject the null more often for men, which is driven by the often similar experiences between Q_3 and less-educated quartiles.

A potential issue is that by splitting the sample into 10 age groups (per race) we might obtain results that are sufficiently imprecise that lower education quartiles do better than higher ones by chance or that we lack the statistical power to detect the better mortality performance of more educated groups. The individual group estimates from regressions of equation (B1) suggest that this concern is largely unfounded. One indication is that the average standard error from the trend estimates is just one-fourth to one-fifth as large as the average magnitude of the corresponding point estimate for log death rates and less than one-fifth has large for levels. The full listing of all

[1] We have conducted simulations to assess statistical power when considering log death rates versus death rates under a range of different assumptions about baseline mortality rates, true differences in trends, and random variability in the mortality process. We consistently find that we have more statistical power under a log transformation, which explains why we fail to reject more often in the latter.

trend coefficient estimates and associated standard errors is displayed in Appendix Tables B3 and B4, and provides further evidence that the standard errors are consistently small relative to the estimated trends for most groups.

Comparison to Novosad, Rafkin, and Asher (2020). Novosad et al. (2020), find that the worst mortality experiences have been concentrated among the lowest decile of whites and blacks. To compare our results, we estimate models where the bottom quartile is split into those at or below and versus above the 10th percentile. The full sample estimates in Appendix Figure B8 replicate Figure 3, after adding this decomposition of Q1, and show that the bottom 10 percent are estimated to have more favorable changes in log death rates than the 11th to 25th percentiles. These results are displayed in the two left panels and include all races. Since Novosad et al. restrict their analysis to blacks and whites, the remainder of the figure shows results for these two groups separately in the middle and right panels. The patterns indicates essentially identical trends for the bottom deciles and the remainder of the first education quartile for both whites (middle panels) and blacks (right panels).[2] Novosad et al. find the worst experiences for the least educated, and they combine the 10th to 45th percentiles. Our results suggest the rest of the bottom quartile also experience adverse mortality experiences but that, for males, these are no more unfavorable than for the second and third quartile of education.

We also note several methodological differences that may explain the somewhat different patterns we document and those of Novosad et al. They utilize the Current Population Survey (CPS), whereas we obtain overall sex-age-race populations from the more accurate SEER data and then use the ACS to estimate education shares for each group. Neither the CPS nor the ACS is fully representative at this level, but the ACS has a substantially larger sample size. For example, the CPS collects data from 100,000 residences compared to 3 million in recent years of the ACS.[3] Small sample sizes may lead to instability that produces inaccurate estimates of the changes over time in population and thus mortality rates. Also, the CPS sampling weights are based on age, race and sex but *not* education, introducing potential problems when using them to construct education-specific populations. The CPS further excludes those who are institutionalized and military persons living in group quarters, requiring Novosad et al. to make adjustments for their absence.

We explore these issues by calculating, for each group, the ratio of the population estimates obtained from the CPS alone versus those from the combined SEER and ACS data. Appendix Figure B9 plots these ratios separately for whites and blacks in 2001 and 2017. A ratio of 1.2, for example, means the CPS population estimate is 20 percent larger than that from the SEER/ACS. The ratios change substantially over time for both blacks and whites, which may explain why Novosad et al. obtain different findings than we do.

Since Novosad et al. focus exclusively on whites and blacks, we also recalculate our quartile thresholds after excluding Hispanics and other races. As shown in Appendix Figure B10, we find broadly similar patterns to our main results in Figure 3. Different results for the bottom decile may also reflect the time periods analyzed. Novosad et al. study mortality changes starting earlier in 1992, while we focus on the period since 2001, which is driven by the availability of the ACS. Finally, the results could also differ due to the bounding procedure Novosad et al. employ,

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[2] Corresponding figures for Hispanics and other nonwhites confirm that the lowest decile have more favorable experiences than the 11th through 25th percentiles.
[3] See https://www.census.gov/topics/income-poverty/poverty/guidance/data-sources/acs-vs-cps.html for more information comparing the two surveys.

which differs from our method of proportional assignment. Appendix A discusses these methodological trade-offs in greater detail.

Table B1. Number of violations of education-based monotonicity in mortality rate changes using data from first and last three years of analysis period

Group	Males		Females	
	Log Death Rate	Death Rate	Log Death Rate	Death Rate
Any Violation (max = 40)	27	30	16	24
Type of Violation				
$Q_1 < Q_2$	10	7	4	4
$Q_1 < Q_3$	17	17	3	7
$Q_1 < Q_4$	6	5	3	3
$Q_2 < Q_3$	13	15	3	5
$Q_2 < Q_4$	0	7	1	4
$Q_3 < Q_4$	22	22	10	16

Note: Table shows the number of age-race-sex groups with monotonicity violation, defined to occur when a lower education quartile has smaller mortality increase or larger decline than does a higher quartile for the same age, race and sex. This includes cases where Q_1 has a better outcome than Q_2, Q_3 or Q_4; Q_2 has a better outcome than Q_3 or Q_4; or Q_3 has a better outcome than Q_4. The numbers in the row $Q_1 < Q_2$, for example, denote the number of cases when the mortality rate rose faster or fell more slowly for the first quartile than the second quartile of the same age-race-sex group. We calculate the change from the beginning of the sample period (2001-2003) to the end of the sample period (2015-2017), averaging 3 years of data in calculating these changes to reduce noise.

Table B2. Groups with violations of education-based monotonicity in mortality trends

Males				Females			
Log Death Rate	Death Rate	Log Death Rate	Death Rate	Log Death Rate	Death Rate	Log Death Rate	Death Rate
White	25-29	White	55-59	Black	30-34	Black	25-29
White	30-34	White	65-69	Black	35-39	Black	30-34
White	35-39	White	70-74	Black	40-44	Black	35-39
White	50-54	Black	25-29	Black	45-49	Black	40-44
White	55-59	Black	30-34	Black	70-74	Black	45-49
Black	25-29	Black	35-39	Hispanic	35-39	Black	50-54
Black	30-34	Black	40-44	Hispanic	40-44	Black	55-59
Black	35-39	Black	45-49	Hispanic	45-49	Black	60-64
Black	40-44	Black	50-54	Hispanic	50-54	Black	65-69
Black	45-49	Black	55-59	Hispanic	55-59	Black	70-74
Black	50-54	Black	60-64	Hispanic	60-64	Hispanic	35-39
Black	55-59	Black	65-69	Hispanic	70-74	Hispanic	40-44
Black	65-69	Black	70-74	Other	55-59	Hispanic	45-49
Black	70-74	Hispanic	25-29	Other	60-64	Hispanic	50-54
Hispanic	25-29	Hispanic	30-34	Other	65-69	Hispanic	55-59
Hispanic	30-34	Hispanic	35-39	Other	70-74	Hispanic	60-64
Hispanic	35-39	Hispanic	40-44			Hispanic	65-69
Hispanic	40-44	Hispanic	45-49			Hispanic	70-74
Hispanic	45-49	Hispanic	50-54			Other	35-39
Hispanic	50-54	Hispanic	55-59			Other	40-44
Hispanic	55-59	Hispanic	60-64			Other	45-49
Hispanic	60-64	Hispanic	65-69			Other	55-59
Hispanic	70-74	Hispanic	70-74			Other	60-64
Other	30-34	Other	35-39			Other	65-69
Other	35-39	Other	40-44			Other	70-74
Other	50-54	Other	45-49				
Other	55-59	Other	50-54				
Other	60-64	Other	55-59				
Other	65-69	Other	60-64				
Other	70-74	Other	65-69				
		Other	70-74				

Note: Table shows the groups with a monotonicity violation, defined to occur when a lower education quartile has slower estimated mortality growth or larger decline than does a higher quartile for the same age, race and sex. This includes cases where Q_1 has a better outcome than Q_2, Q_3 or Q_4; Q_2 has a better outcome than Q_3 or Q_4; or Q_3 has a better outcome than Q_4.

Table B3. Regression Estimates of Mortality Trends by Group, Males

Race	Age	Quartile	Death Rate		Log Death Rate	
			Estimate	S.E.	Estimate	S.E.
White	25-29	1	4.43	0.92	0.018	0.003
White	25-29	2	4.18	0.72	0.021	0.003
White	25-29	3	2.78	0.36	0.022	0.003
White	25-29	4	-0.25	0.17	-0.005	0.003
White	30-34	1	7.01	1.24	0.024	0.004
White	30-34	2	5.87	1.07	0.025	0.004
White	30-34	3	3.77	0.52	0.029	0.003
White	30-34	4	0.21	0.35	0.004	0.006
White	35-39	1	4.65	1.58	0.012	0.004
White	35-39	2	3.83	1.41	0.013	0.005
White	35-39	3	2.02	0.83	0.012	0.005
White	35-39	4	-0.31	0.42	-0.004	0.005
White	40-44	1	0.60	1.45	0.001	0.003
White	40-44	2	0.03	1.14	0.000	0.003
White	40-44	3	-1.24	0.66	-0.006	0.003
White	40-44	4	-1.55	0.36	-0.014	0.003
White	45-49	1	0.61	0.89	0.001	0.001
White	45-49	2	-1.51	0.57	-0.003	0.001
White	45-49	3	-1.69	0.34	-0.005	0.001
White	45-49	4	-3.35	0.47	-0.019	0.002
White	50-54	1	6.57	1.51	0.007	0.002
White	50-54	2	2.41	0.65	0.003	0.001
White	50-54	3	1.60	0.57	0.003	0.001
White	50-54	4	-4.54	0.56	-0.016	0.002
White	55-59	1	9.46	0.95	0.007	0.001
White	55-59	2	4.71	1.36	0.004	0.001
White	55-59	3	5.52	2.19	0.007	0.003
White	55-59	4	-7.36	1.08	-0.016	0.002
White	60-64	1	3.85	1.97	0.002	0.001
White	60-64	2	-5.25	2.69	-0.003	0.002
White	60-64	3	-11.39	4.73	-0.009	0.004
White	60-64	4	-14.70	2.73	-0.020	0.003
White	65-69	1	-9.56	3.02	-0.003	0.001
White	65-69	2	-22.24	4.22	-0.010	0.002
White	65-69	3	-43.65	5.30	-0.023	0.003
White	65-69	4	-32.33	5.21	-0.028	0.004
White	70-74	1	-26.12	6.85	-0.007	0.002
White	70-74	2	-39.20	5.68	-0.012	0.002
White	70-74	3	-69.48	5.80	-0.023	0.002
White	70-74	4	-63.37	6.29	-0.032	0.002

Black	25-29	1	-6.14	2.13	-0.017	0.006
Black	25-29	2	-4.04	1.08	-0.014	0.004
Black	25-29	3	-2.17	0.69	-0.012	0.004
Black	25-29	4	-1.91	0.25	-0.025	0.003
Black	30-34	1	-1.46	2.27	-0.004	0.006
Black	30-34	2	-3.48	1.25	-0.011	0.004
Black	30-34	3	-0.74	0.53	-0.004	0.003
Black	30-34	4	-1.47	0.51	-0.016	0.005
Black	35-39	1	-5.01	2.94	-0.011	0.006
Black	35-39	2	-4.43	2.34	-0.011	0.006
Black	35-39	3	-2.16	1.07	-0.009	0.004
Black	35-39	4	-3.38	1.06	-0.026	0.007
Black	40-44	1	-10.84	2.85	-0.018	0.005
Black	40-44	2	-13.45	3.06	-0.025	0.006
Black	40-44	3	-5.60	1.72	-0.017	0.005
Black	40-44	4	-6.11	1.14	-0.033	0.005
Black	45-49	1	-22.72	3.61	-0.025	0.004
Black	45-49	2	-27.77	3.62	-0.034	0.004
Black	45-49	3	-11.89	1.71	-0.024	0.003
Black	45-49	4	-10.08	1.47	-0.035	0.004
Black	50-54	1	-28.98	4.84	-0.022	0.003
Black	50-54	2	-32.18	2.14	-0.027	0.002
Black	50-54	3	-18.29	1.93	-0.024	0.003
Black	50-54	4	-17.13	2.25	-0.036	0.004
Black	55-59	1	-26.26	4.48	-0.014	0.002
Black	55-59	2	-32.55	6.86	-0.018	0.003
Black	55-59	3	-10.70	4.65	-0.009	0.004
Black	55-59	4	-18.99	1.99	-0.025	0.002
Black	60-64	1	-6.30	4.96	-0.002	0.002
Black	60-64	2	-41.42	8.58	-0.016	0.003
Black	60-64	3	-36.03	8.03	-0.019	0.004
Black	60-64	4	-28.46	4.13	-0.023	0.003
Black	65-69	1	2.53	4.47	0.001	0.001
Black	65-69	2	-87.77	10.50	-0.025	0.003
Black	65-69	3	-87.81	13.78	-0.032	0.005
Black	65-69	4	-50.55	11.41	-0.027	0.005
Black	70-74	1	-25.59	10.97	-0.006	0.003
Black	70-74	2	-90.84	6.27	-0.019	0.001
Black	70-74	3	-161.12	24.06	-0.039	0.004
Black	70-74	4	-101.78	10.57	-0.035	0.003
Hispanic	25-29	1	0.24	0.97	0.001	0.007
Hispanic	25-29	2	-0.52	0.81	-0.005	0.007
Hispanic	25-29	3	-0.17	0.38	-0.002	0.004
Hispanic	25-29	4	-0.59	0.42	-0.014	0.010
Hispanic	30-34	1	-0.31	0.81	-0.003	0.006

Hispanic	30-34	2	-0.27	0.90	-0.002	0.007
Hispanic	30-34	3	0.69	0.41	0.008	0.005
Hispanic	30-34	4	-0.95	0.43	-0.021	0.009
Hispanic	35-39	1	-2.28	1.03	-0.014	0.006
Hispanic	35-39	2	-3.31	1.60	-0.019	0.009
Hispanic	35-39	3	-0.29	0.78	-0.002	0.007
Hispanic	35-39	4	-1.44	0.58	-0.024	0.009
Hispanic	40-44	1	-5.54	0.93	-0.024	0.004
Hispanic	40-44	2	-8.02	1.52	-0.033	0.006
Hispanic	40-44	3	-3.46	0.70	-0.021	0.004
Hispanic	40-44	4	-2.95	0.69	-0.032	0.006
Hispanic	45-49	1	-7.86	1.00	-0.023	0.003
Hispanic	45-49	2	-12.52	1.52	-0.033	0.003
Hispanic	45-49	3	-5.37	0.71	-0.021	0.003
Hispanic	45-49	4	-4.58	0.96	-0.031	0.005
Hispanic	50-54	1	-5.59	1.20	-0.011	0.002
Hispanic	50-54	2	-12.21	1.52	-0.021	0.002
Hispanic	50-54	3	-4.74	0.86	-0.012	0.002
Hispanic	50-54	4	-6.51	1.03	-0.027	0.004
Hispanic	55-59	1	-6.19	1.50	-0.008	0.002
Hispanic	55-59	2	-12.78	3.22	-0.015	0.003
Hispanic	55-59	3	-0.60	1.26	-0.001	0.002
Hispanic	55-59	4	-7.73	2.32	-0.019	0.005
Hispanic	60-64	1	-8.92	2.36	-0.008	0.002
Hispanic	60-64	2	-23.70	6.03	-0.018	0.004
Hispanic	60-64	3	-11.10	2.79	-0.012	0.003
Hispanic	60-64	4	-18.37	3.86	-0.028	0.005
Hispanic	65-69	1	-16.06	1.63	-0.010	0.001
Hispanic	65-69	2	-47.29	7.45	-0.025	0.003
Hispanic	65-69	3	-40.47	7.63	-0.027	0.004
Hispanic	65-69	4	-37.95	7.64	-0.035	0.006
Hispanic	70-74	1	-40.20	4.96	-0.017	0.002
Hispanic	70-74	2	-50.07	7.21	-0.019	0.003
Hispanic	70-74	3	-82.33	6.92	-0.034	0.002
Hispanic	70-74	4	-53.54	10.22	-0.031	0.005
Other	25-29	1	2.67	0.48	0.016	0.003
Other	25-29	2	1.53	0.39	0.012	0.003
Other	25-29	3	0.01	0.32	0.000	0.004
Other	25-29	4	-0.32	0.31	-0.009	0.009
Other	30-34	1	3.19	0.97	0.016	0.005
Other	30-34	2	0.71	0.77	0.004	0.005
Other	30-34	3	0.63	0.43	0.008	0.005
Other	30-34	4	-0.46	0.19	-0.014	0.006
Other	35-39	1	1.49	1.42	0.006	0.006
Other	35-39	2	-0.40	1.19	-0.002	0.006

Other	35-39	3	-0.15	0.46	-0.001	0.004
Other	35-39	4	-0.95	0.43	-0.021	0.009
Other	40-44	1	0.62	1.37	0.003	0.005
Other	40-44	2	-0.81	0.74	-0.003	0.003
Other	40-44	3	-2.01	0.53	-0.013	0.003
Other	40-44	4	-1.36	0.41	-0.019	0.005
Other	45-49	1	-0.35	1.48	-0.001	0.004
Other	45-49	2	-0.80	0.66	-0.002	0.002
Other	45-49	3	-0.60	0.47	-0.003	0.002
Other	45-49	4	-2.31	0.66	-0.019	0.005
Other	50-54	1	0.91	1.59	0.002	0.003
Other	50-54	2	3.92	0.92	0.008	0.002
Other	50-54	3	1.21	0.62	0.004	0.002
Other	50-54	4	-4.97	0.63	-0.024	0.003
Other	55-59	1	-4.80	1.57	-0.007	0.002
Other	55-59	2	1.74	3.13	0.003	0.004
Other	55-59	3	2.62	1.71	0.005	0.003
Other	55-59	4	-4.81	1.05	-0.014	0.003
Other	60-64	1	-8.86	4.13	-0.009	0.004
Other	60-64	2	-8.75	4.17	-0.008	0.004
Other	60-64	3	-8.12	2.75	-0.010	0.003
Other	60-64	4	-10.52	3.29	-0.018	0.005
Other	65-69	1	-23.89	4.29	-0.018	0.003
Other	65-69	2	-11.99	3.16	-0.008	0.002
Other	65-69	3	-18.04	3.34	-0.015	0.003
Other	65-69	4	-26.05	3.66	-0.028	0.004
Other	70-74	1	-35.75	5.24	-0.019	0.003
Other	70-74	2	-35.98	6.80	-0.016	0.003
Other	70-74	3	-42.21	5.08	-0.021	0.003
Other	70-74	4	-39.28	7.09	-0.026	0.004

Table B4. Regression Estimates of Mortality Trends by Group, Females

Race	Age	Quartile	Death Rate		Log Death Rate	
			Estimate	S.E.	Estimate	S.E.
White	25-29	1	4.04	0.43	0.034	0.003
White	25-29	2	1.99	0.32	0.025	0.003
White	25-29	3	0.40	0.06	0.009	0.001
White	25-29	4	-0.41	0.05	-0.018	0.002
White	30-34	1	5.81	0.67	0.036	0.003
White	30-34	2	2.93	0.45	0.028	0.003
White	30-34	3	0.72	0.15	0.012	0.002
White	30-34	4	-0.20	0.14	-0.006	0.004
White	35-39	1	5.61	0.85	0.025	0.003
White	35-39	2	2.57	0.60	0.017	0.004
White	35-39	3	0.18	0.20	0.002	0.002
White	35-39	4	-0.66	0.15	-0.014	0.003
White	40-44	1	4.96	0.65	0.017	0.002
White	40-44	2	1.91	0.46	0.009	0.002
White	40-44	3	-0.56	0.14	-0.004	0.001
White	40-44	4	-1.24	0.18	-0.016	0.002
White	45-49	1	7.11	0.60	0.018	0.002
White	45-49	2	2.98	0.17	0.010	0.001
White	45-49	3	-0.78	0.15	-0.004	0.001
White	45-49	4	-2.31	0.12	-0.019	0.001
White	50-54	1	11.95	0.38	0.021	0.001
White	50-54	2	5.31	0.32	0.012	0.001
White	50-54	3	0.89	0.39	0.003	0.001
White	50-54	4	-2.84	0.25	-0.014	0.001
White	55-59	1	8.29	1.56	0.010	0.002
White	55-59	2	2.88	1.44	0.005	0.002
White	55-59	3	-1.96	1.50	-0.004	0.003
White	55-59	4	-4.99	1.24	-0.016	0.004
White	60-64	1	-3.77	2.01	-0.003	0.002
White	60-64	2	-4.82	1.87	-0.005	0.002
White	60-64	3	-12.18	1.26	-0.015	0.001
White	60-64	4	-14.47	2.47	-0.028	0.004
White	65-69	1	-6.66	1.56	-0.004	0.001
White	65-69	2	-13.28	2.44	-0.010	0.002
White	65-69	3	-20.99	2.17	-0.016	0.001
White	65-69	4	-30.29	2.10	-0.035	0.002
White	70-74	1	-8.75	2.18	-0.003	0.001
White	70-74	2	-19.07	2.72	-0.009	0.001
White	70-74	3	-31.06	4.59	-0.014	0.002
White	70-74	4	-48.74	0.81	-0.033	0.001
Black	25-29	1	-1.10	0.52	-0.009	0.004

Black	25-29	2	-1.67	0.39	-0.017	0.004
Black	25-29	3	-1.26	0.27	-0.018	0.004
Black	25-29	4	-1.42	0.23	-0.033	0.005
Black	30-34	1	-1.56	0.53	-0.008	0.003
Black	30-34	2	-2.18	0.51	-0.016	0.004
Black	30-34	3	-1.20	0.31	-0.013	0.003
Black	30-34	4	-1.28	0.32	-0.021	0.005
Black	35-39	1	-3.68	1.06	-0.013	0.004
Black	35-39	2	-5.05	1.20	-0.024	0.005
Black	35-39	3	-2.33	0.39	-0.017	0.003
Black	35-39	4	-1.52	0.61	-0.016	0.006
Black	40-44	1	-7.26	1.19	-0.018	0.003
Black	40-44	2	-10.12	1.50	-0.031	0.004
Black	40-44	3	-5.56	0.74	-0.025	0.003
Black	40-44	4	-4.45	0.87	-0.030	0.005
Black	45-49	1	-5.84	1.49	-0.010	0.003
Black	45-49	2	-14.01	1.09	-0.029	0.002
Black	45-49	3	-10.30	0.74	-0.028	0.002
Black	45-49	4	-9.15	0.76	-0.040	0.003
Black	50-54	1	-2.59	1.82	-0.003	0.002
Black	50-54	2	-13.42	0.85	-0.019	0.001
Black	50-54	3	-13.16	0.93	-0.023	0.001
Black	50-54	4	-11.16	1.35	-0.030	0.003
Black	55-59	1	-0.39	1.67	0.000	0.002
Black	55-59	2	-15.10	3.88	-0.014	0.003
Black	55-59	3	-14.22	3.02	-0.016	0.003
Black	55-59	4	-17.68	2.73	-0.029	0.004
Black	60-64	1	-1.77	4.04	-0.001	0.003
Black	60-64	2	-28.79	5.70	-0.019	0.004
Black	60-64	3	-28.08	5.88	-0.020	0.004
Black	60-64	4	-35.77	5.39	-0.036	0.004
Black	65-69	1	-4.51	1.87	-0.003	0.001
Black	65-69	2	-58.63	5.64	-0.028	0.003
Black	65-69	3	-62.76	11.05	-0.030	0.005
Black	65-69	4	-49.63	4.53	-0.033	0.002
Black	70-74	1	-19.18	5.33	-0.008	0.002
Black	70-74	2	-61.90	4.13	-0.021	0.001
Black	70-74	3	-115.48	14.52	-0.036	0.003
Black	70-74	4	-69.93	4.33	-0.030	0.002
Hispanic	25-29	1	0.73	0.22	0.015	0.005
Hispanic	25-29	2	0.11	0.22	0.003	0.005
Hispanic	25-29	3	-0.13	0.11	-0.004	0.004
Hispanic	25-29	4	-0.43	0.10	-0.023	0.006
Hispanic	30-34	1	0.56	0.31	0.009	0.006
Hispanic	30-34	2	0.27	0.40	0.005	0.008

Hispanic	30-34	3	-0.10	0.20	-0.002	0.005
Hispanic	30-34	4	-0.17	0.24	-0.006	0.009
Hispanic	35-39	1	-0.63	0.36	-0.009	0.005
Hispanic	35-39	2	-0.94	0.62	-0.011	0.008
Hispanic	35-39	3	-0.52	0.19	-0.009	0.003
Hispanic	35-39	4	-0.53	0.27	-0.013	0.007
Hispanic	40-44	1	-1.93	0.35	-0.017	0.003
Hispanic	40-44	2	-2.27	0.68	-0.018	0.005
Hispanic	40-44	3	-1.01	0.30	-0.011	0.003
Hispanic	40-44	4	-1.83	0.46	-0.029	0.007
Hispanic	45-49	1	-2.36	0.35	-0.014	0.002
Hispanic	45-49	2	-3.32	0.60	-0.018	0.003
Hispanic	45-49	3	-1.95	0.54	-0.013	0.003
Hispanic	45-49	4	-2.36	0.48	-0.025	0.005
Hispanic	50-54	1	-2.13	0.40	-0.008	0.002
Hispanic	50-54	2	-4.79	0.95	-0.017	0.003
Hispanic	50-54	3	-3.42	0.89	-0.014	0.003
Hispanic	50-54	4	-4.11	0.73	-0.026	0.004
Hispanic	55-59	1	-4.15	1.07	-0.010	0.003
Hispanic	55-59	2	-6.79	2.13	-0.016	0.005
Hispanic	55-59	3	-4.92	1.40	-0.013	0.003
Hispanic	55-59	4	-4.86	1.72	-0.018	0.006
Hispanic	60-64	1	-7.40	1.00	-0.012	0.002
Hispanic	60-64	2	-16.73	4.23	-0.024	0.005
Hispanic	60-64	3	-11.25	3.70	-0.017	0.005
Hispanic	60-64	4	-9.57	2.20	-0.023	0.005
Hispanic	65-69	1	-12.82	1.69	-0.014	0.002
Hispanic	65-69	2	-26.32	3.72	-0.025	0.003
Hispanic	65-69	3	-28.34	6.23	-0.028	0.005
Hispanic	65-69	4	-20.24	2.59	-0.029	0.004
Hispanic	70-74	1	-27.18	2.74	-0.018	0.002
Hispanic	70-74	2	-33.84	2.77	-0.022	0.002
Hispanic	70-74	3	-61.26	10.79	-0.036	0.005
Hispanic	70-74	4	-26.77	3.87	-0.022	0.003
Other	25-29	1	2.02	0.51	0.028	0.006
Other	25-29	2	0.76	0.23	0.015	0.005
Other	25-29	3	-0.27	0.15	-0.009	0.005
Other	25-29	4	-0.53	0.22	-0.029	0.010
Other	30-34	1	2.06	0.36	0.024	0.005
Other	30-34	2	0.91	0.35	0.014	0.005
Other	30-34	3	-0.31	0.23	-0.008	0.006
Other	30-34	4	-0.40	0.19	-0.017	0.008
Other	35-39	1	1.48	0.48	0.013	0.004
Other	35-39	2	0.09	0.23	0.001	0.003
Other	35-39	3	-0.61	0.21	-0.011	0.004

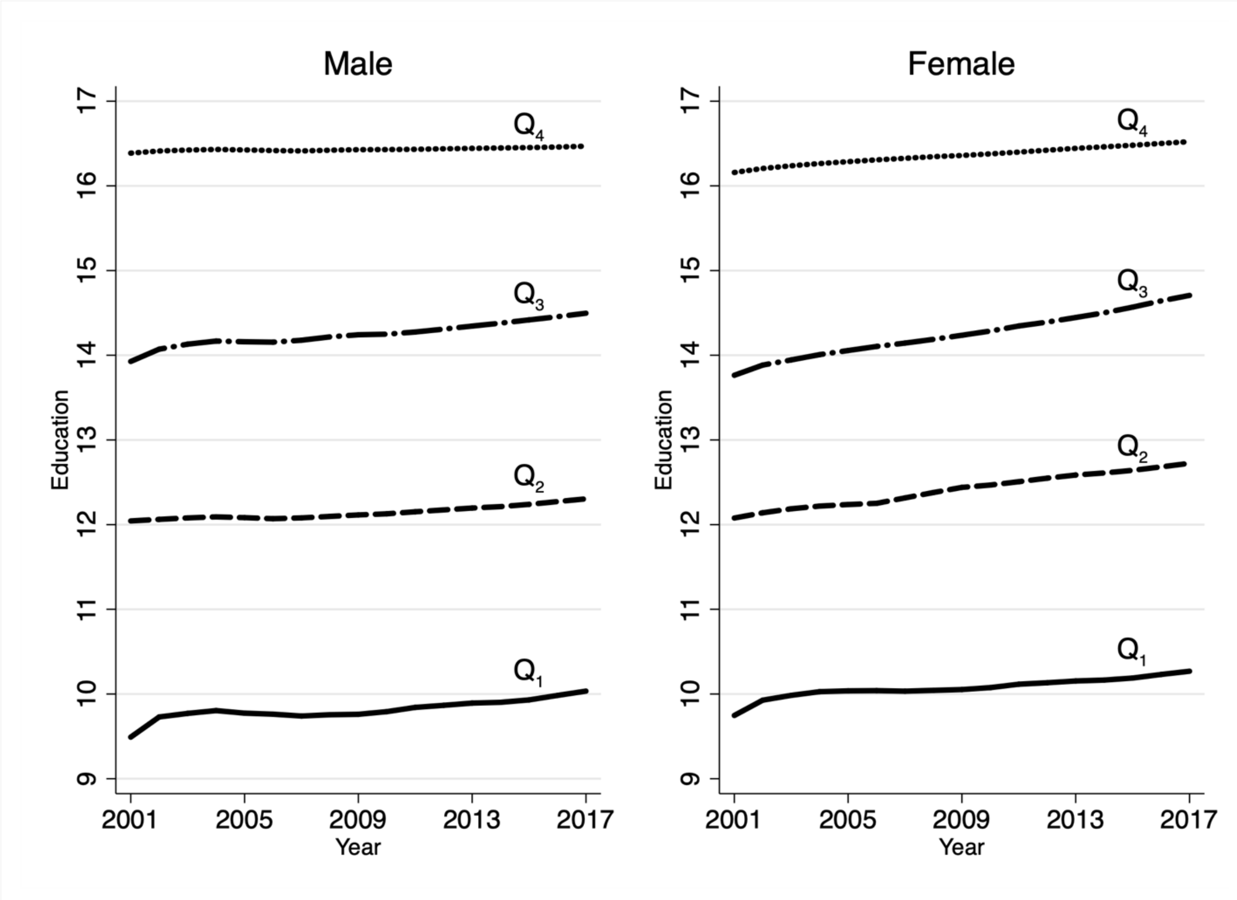
Other	35-39	4	-0.56	0.40	-0.015	0.010
Other	40-44	1	0.02	0.59	0.000	0.004
Other	40-44	2	-0.54	0.53	-0.004	0.004
Other	40-44	3	-1.42	0.33	-0.017	0.004
Other	40-44	4	-1.19	0.22	-0.023	0.004
Other	45-49	1	0.09	0.51	0.001	0.002
Other	45-49	2	-0.75	0.27	-0.004	0.001
Other	45-49	3	-1.65	0.20	-0.012	0.001
Other	45-49	4	-1.41	0.32	-0.016	0.003
Other	50-54	1	1.00	0.58	0.004	0.002
Other	50-54	2	0.24	0.87	0.001	0.003
Other	50-54	3	-1.23	0.62	-0.006	0.003
Other	50-54	4	-2.34	0.48	-0.016	0.003
Other	55-59	1	-4.77	1.35	-0.012	0.004
Other	55-59	2	-2.54	1.54	-0.006	0.004
Other	55-59	3	-2.51	1.29	-0.008	0.004
Other	55-59	4	-4.62	0.87	-0.020	0.004
Other	60-64	1	-11.26	1.65	-0.021	0.003
Other	60-64	2	-10.39	2.28	-0.017	0.004
Other	60-64	3	-11.41	1.99	-0.022	0.004
Other	60-64	4	-7.85	1.35	-0.022	0.004
Other	65-69	1	-20.39	1.71	-0.025	0.002
Other	65-69	2	-18.10	1.84	-0.020	0.002
Other	65-69	3	-26.81	3.38	-0.032	0.003
Other	65-69	4	-14.50	3.20	-0.024	0.004
Other	70-74	1	-30.87	3.99	-0.024	0.003
Other	70-74	2	-11.07	2.93	-0.008	0.002
Other	70-74	3	-39.61	2.99	-0.030	0.002
Other	70-74	4	-31.52	2.63	-0.031	0.002

Table B5. Fraction of tests with p-values less than critical value

Critical value	Log death rates		Death rates	
	Males	Females	Males	Females
Panel A. $Q_1 - Q_4$				
0.05	0.492	0.654	0.342	0.517
0.10	0.554	0.700	0.396	0.538
0.20	0.625	0.742	0.454	0.592
0.50	0.746	0.854	0.583	0.667
Panel B. $Q_1 - Q_3$				
0.05	0.300	0.663	0.287	0.613
0.10	0.325	0.675	0.363	0.613
0.20	0.350	0.712	0.400	0.637
0.50	0.463	0.800	0.463	0.663

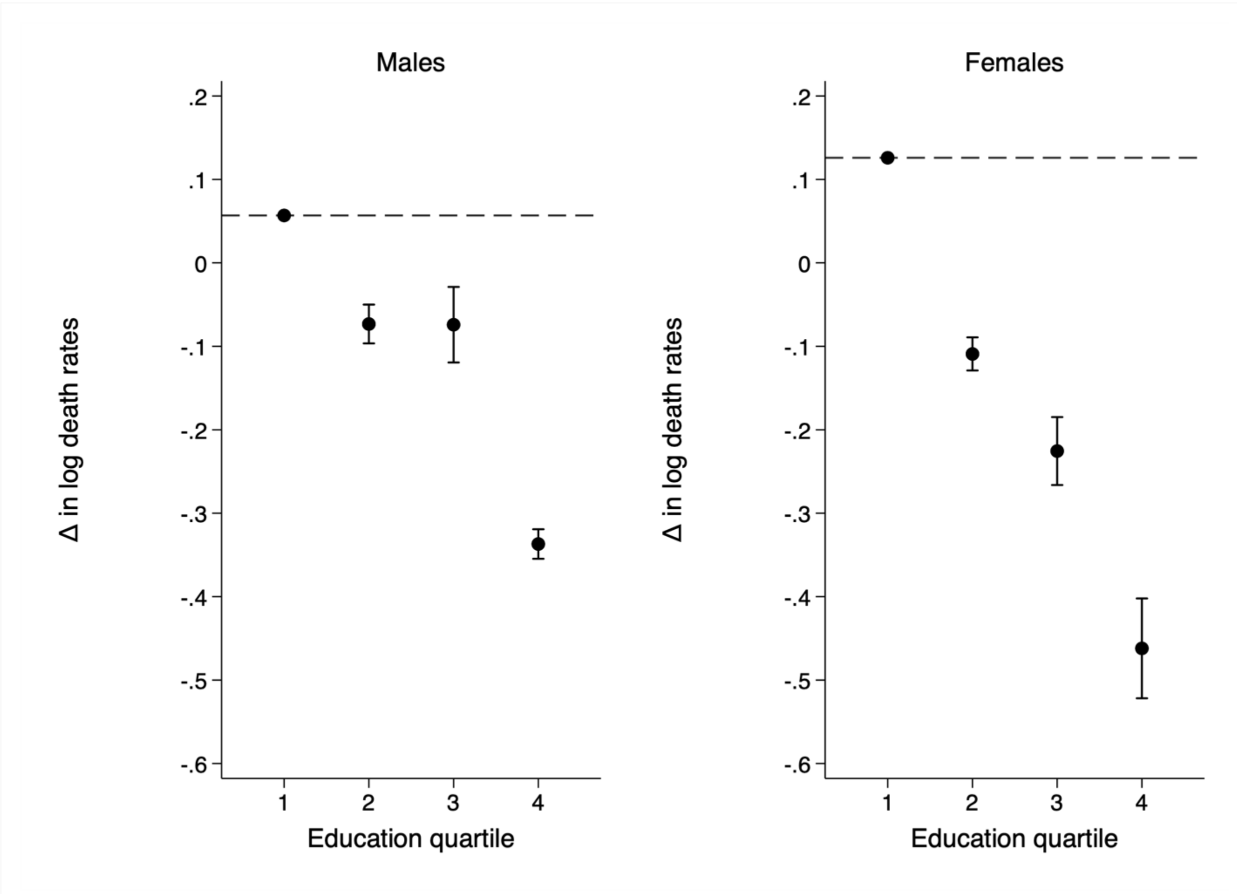
Note: Table shows the fraction the hypothesis tests of non-monotonicity in trends with p-values below different critical values. The null hypothesis is that increases in mortality among a lower-educated quartile has been no larger than increases of a higher-educated quartile within the same age/sex/race group. Panel A displays results across all quartiles, and Panel B displays results from the bottom 3 quartiles. The full distribution of p-values are presented in Appendix Figures B3 and B4. p-values are calculated via bootstrapping using 10,000 repeated samples within groups.

Figure B1. Mean years of education by quartile and sex: 25-74 year olds



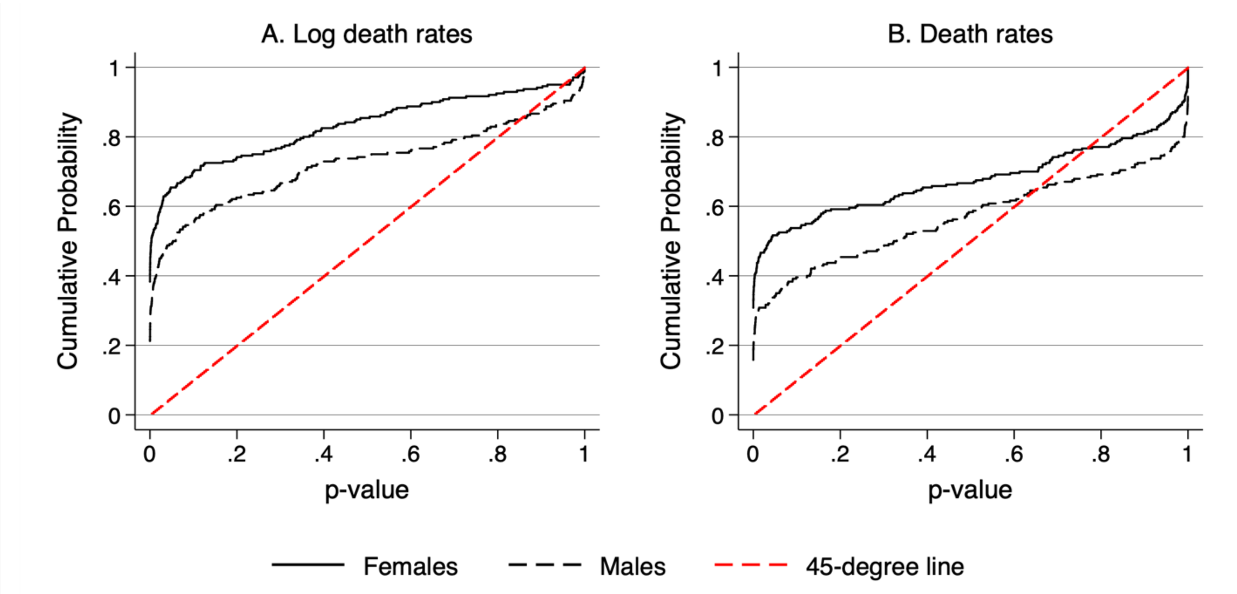
Note: Figure shows the average number of years of completed education by education quartile and sex for 25-74 year olds from 2001-2017. Education quartiles are calculated separately by sex, 5-year age group, and year using data from the ACS and SEER as described in Appendix A. The 2017 age distribution specific to each quartile and sex is used to age-standardize the mean years of education in the 25-74 year old group across time.

Figure B2. Estimated Changes in Log Death Rates by Education Quartile using Data from First and Last Three Years of Analysis Period



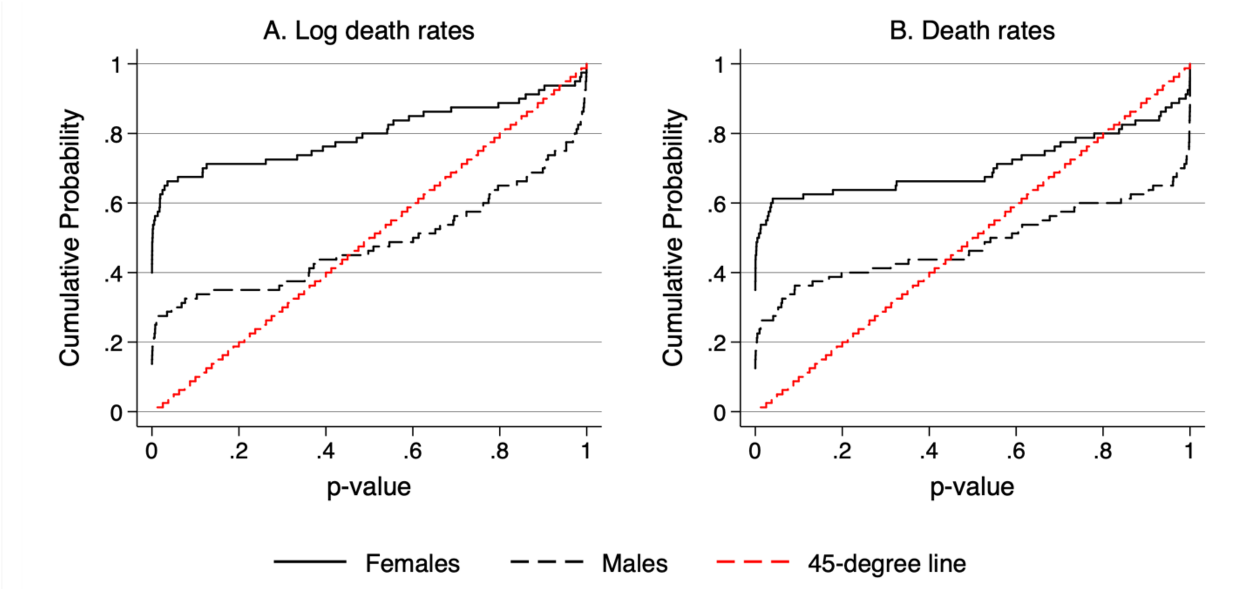
Note: Figure shows regression results from estimating equation (3) of the mean change in log death rates from the beginning to the end of the sample period. To reduce noise, we average years 2001-2003 and years 2015-2017 in calculating rates for the beginning and end, respectively. Dots represent estimates on the quartile indicators. The whiskers plot the 95% confidence interval of the difference relative to quartile 1, with the difference centered on the mean for quartiles 2, 3, and 4. If the upper-bound of the confidence interval overlaps with the horizontal dotted line, then the quartile's change is not statistically distinguishable from the change for quartile 1. Regression is weighted using the population in each group (age/sex/race/quartile cell), and standard errors are clustered at the age/race/sex level.

Figure B3. CDFs of *p*-values of tests of non-monotonicity in mortality trends



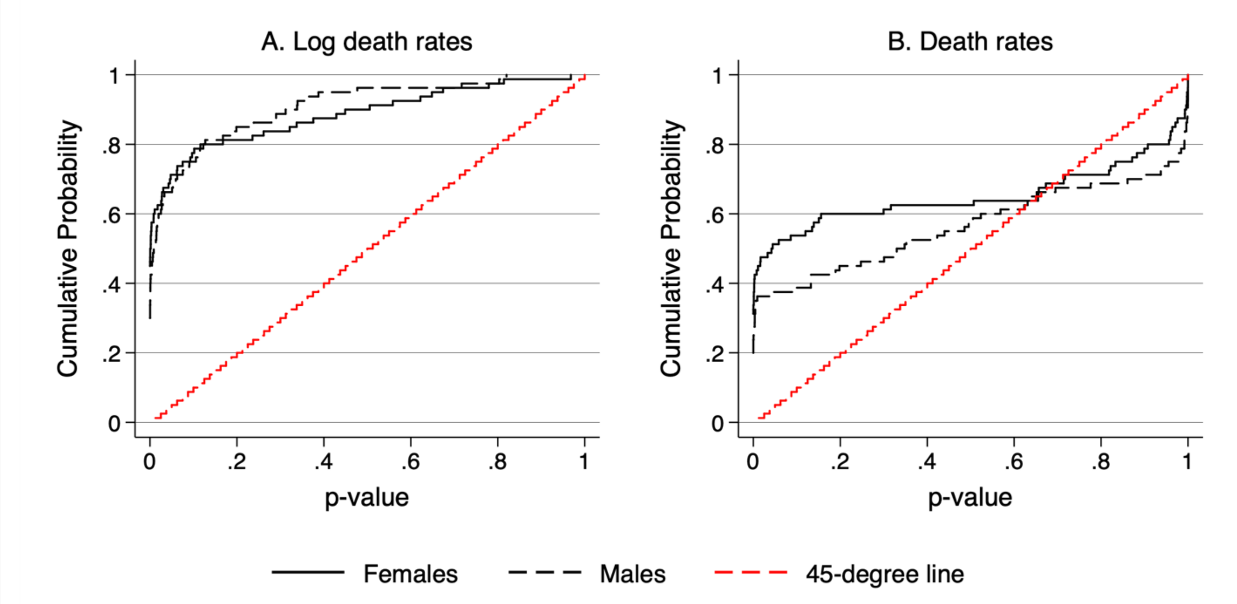
Note: Figure plots the cumulative distribution functions of the *p*-values from the hypothesis tests of non-monotonicity in trends. The null hypothesis is that increases in mortality among a lower-educated quartile has been no larger than increases of a higher-educated quartile within the same age/sex/race group. For each group, there are 6 hypothesis tests (Q_1 vs. Q_2, Q_1 vs. Q_3, Q_1 vs. Q_4, Q_2 vs. Q_3, Q_2 vs. Q_4, Q_3 vs. Q_4). Each CDF plots the results of 240 tests (40 groups x 6 tests per group). *p*-values are calculated via bootstrapping using 10,000 repeated samples within groups.

Figure B4. CDFs of *p*-values of tests of non-monotonicity in mortality trends comparing quartiles 1 and 2 to quartile 3



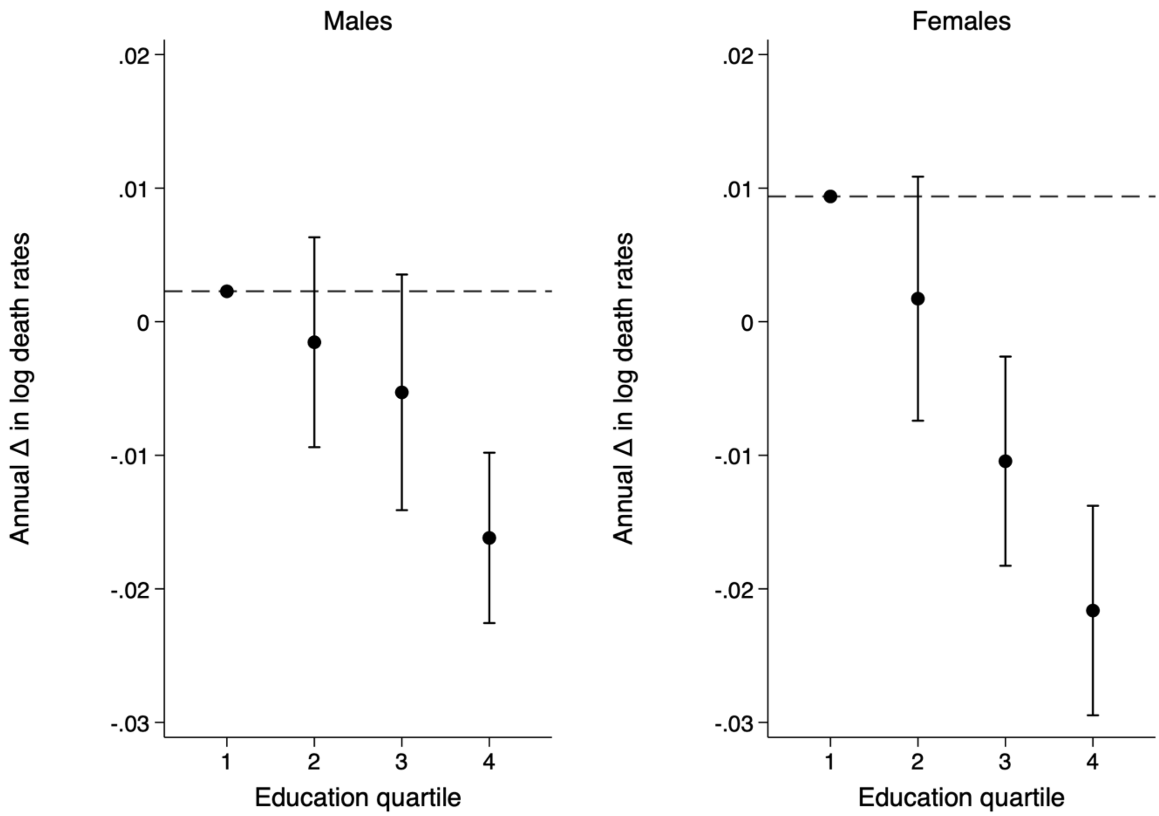
Note: Figure plots the cumulative distribution functions of the *p*-values from the hypothesis tests of non-monotonicity in trends between the bottom 3 quartiles. The null hypothesis is that increases in mortality among a lower-educated quartile has been no larger than increases of a higher-educated quartile within the same age/sex/race group. For each group, there are 2 hypothesis tests (Q_1 vs. Q_3, Q_2 vs. Q_3). Each CDF plots the results of 80 tests (40 groups x 2 tests per group). *p*-values are calculated via bootstrapping using 10,000 repeated samples within groups.

Figure B5. CDFs of *p*-values of tests of non-monotonicity in mortality trends comparing quartiles 1 and 2 to quartile 4



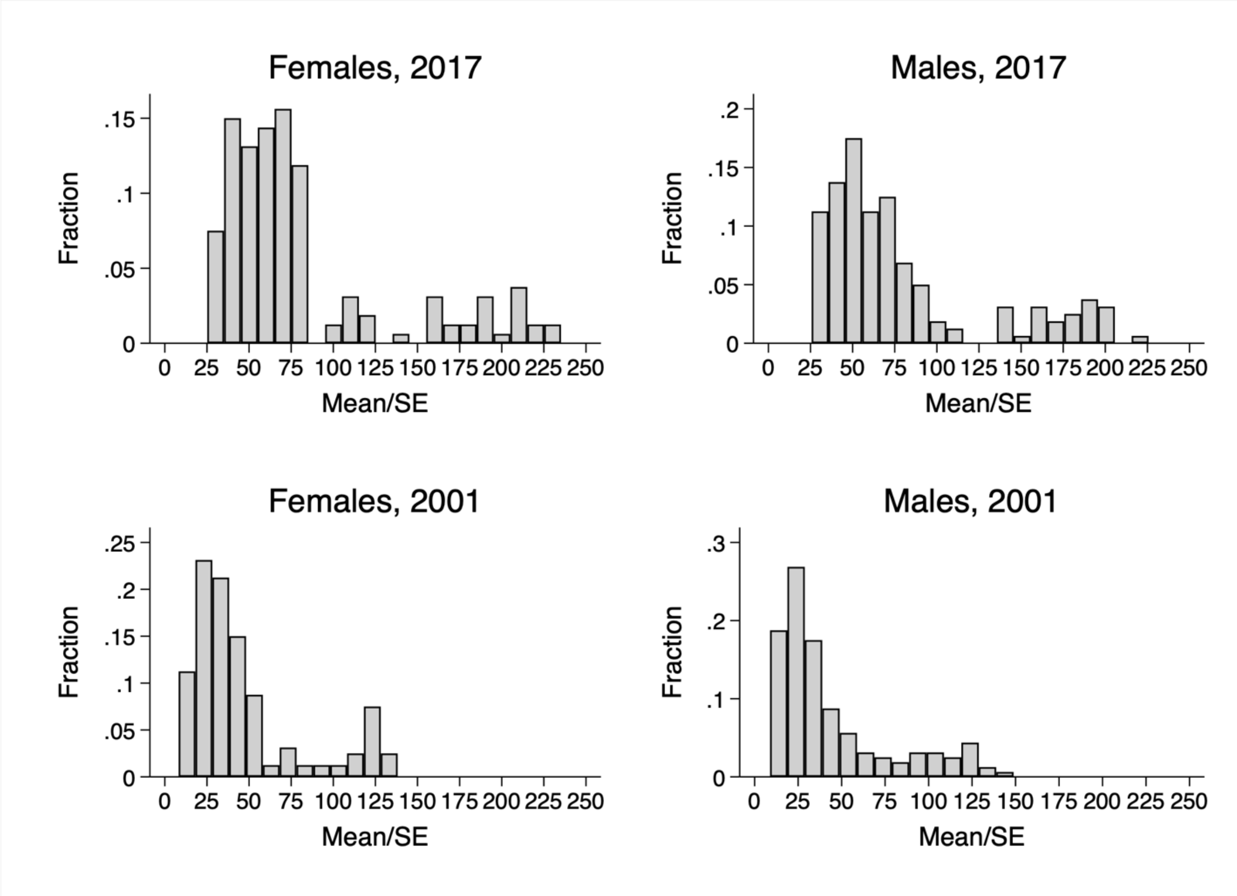
Note: Figure plots the cumulative distribution functions of the *p*-values from the hypothesis tests of non-monotonicity in trends between Q_1 or Q_2 and Q_4. The null hypothesis is that increases in mortality among a lower-educated quartile has been no larger than increases of a higher-educated quartile within the same age/sex/race group. For each group, there are 2 hypothesis tests (Q_1 vs. Q_4, Q_2 vs. Q_4). Each CDF plots the results of 80 tests (40 groups x 2 tests per group). *p*-values are calculated via bootstrapping using 10,000 repeated samples within groups.

Figure B6. Estimated Trend Differences by Race-Specific Quartile



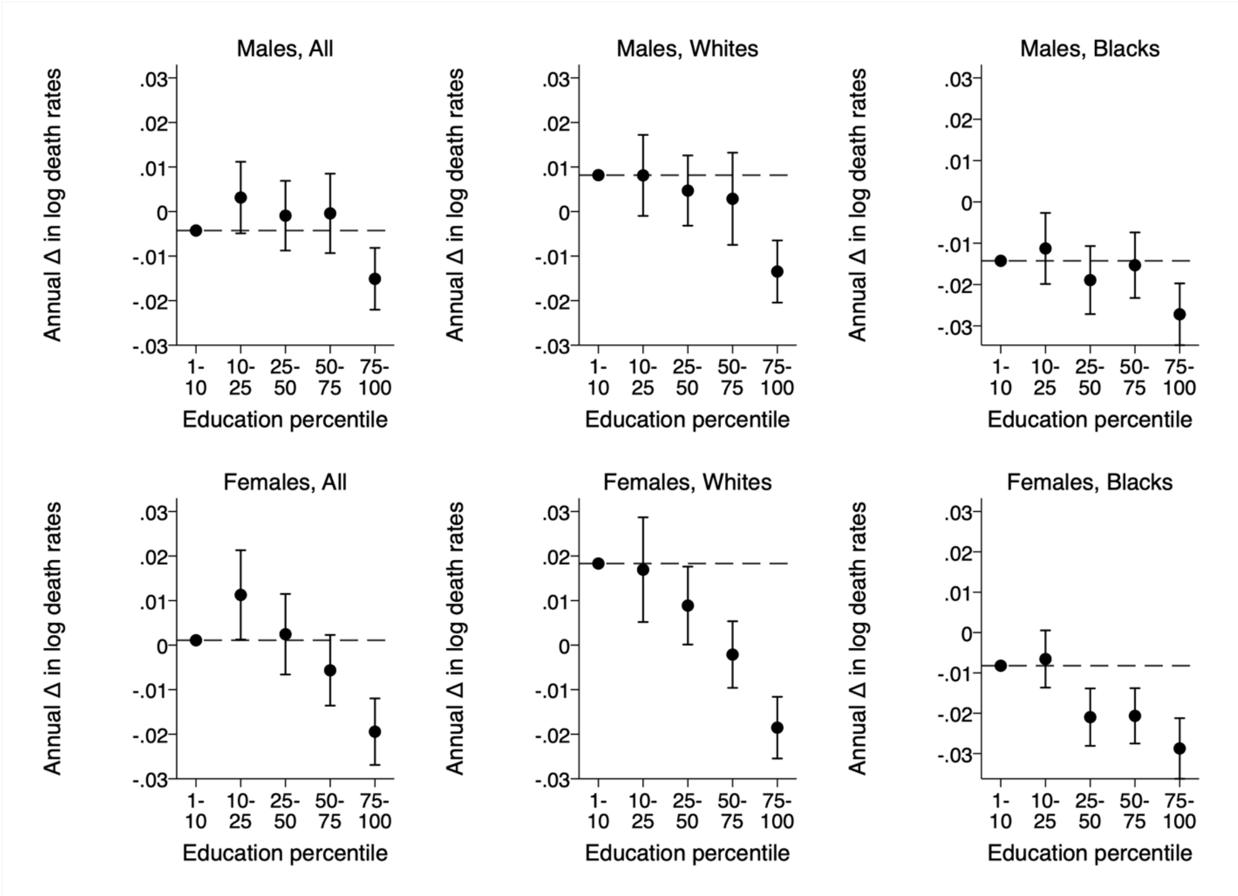
Note: Figure shows regression results from estimating equation (2) in which quartiles are calculated separately for each race. Dots represent estimates on the trend coefficient for each quartile, with those for quartiles 2, 3 and 4 calculated by adding the estimate on the corresponding regression trend interaction term to the trend estimate corresponding to quartile 1. The whiskers plot the 95% confidence interval of the difference relative to quartile 1, with the difference centered on the mean for quartiles 2, 3, and 4. If the upper-bound of the confidence interval overlaps with the horizontal dotted line, then the quartile's trend is not statistically distinguishable from the trend for quartile 1. Regression is weighted using the population in each group (age/sex/race/quartile cell), and standard errors are clustered at the group level.

Figure B7. Histograms of Mean Education Shares Relative to Standard Error by Group



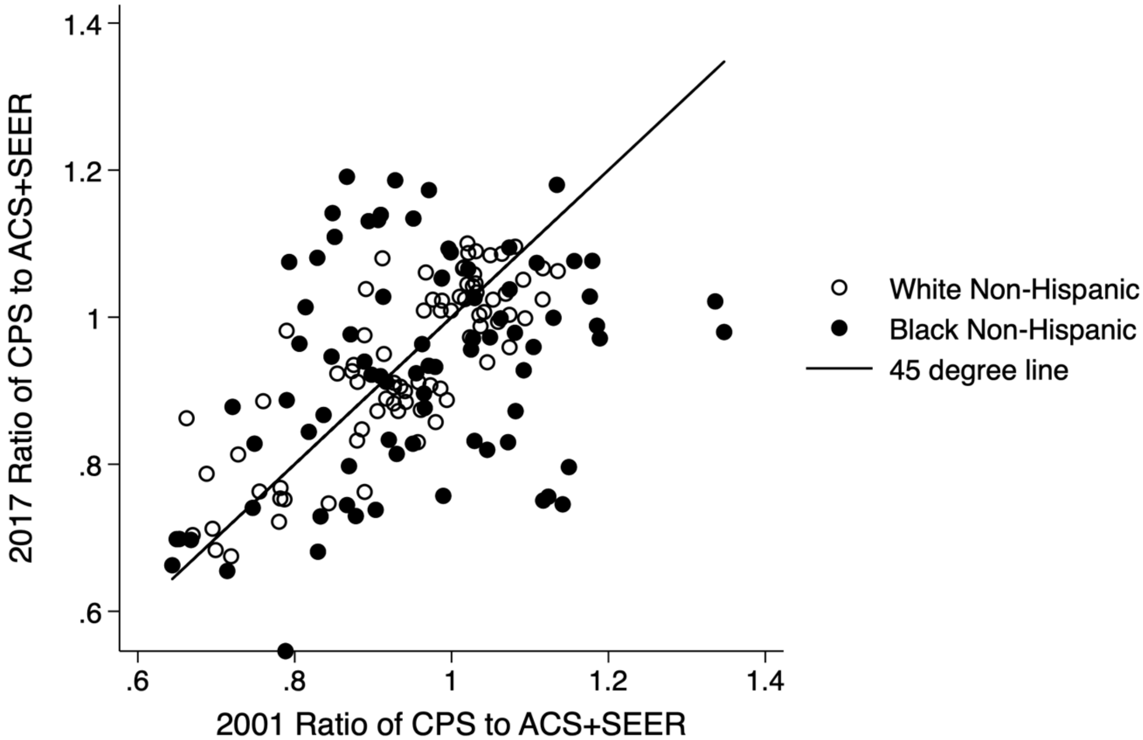
Note: Figure plots histograms of the inverse of the coefficient of variation (Mean/SE) on the education shares from the ACS for each group of race, 5-year age, and four categories of education (less than high school, high school, some college, college grad or higher), separately by sex in 2001 and 2017. Bin width equals 10. Each histogram includes 160 groups. The smallest inverse CV in 2001 is 8 for Hispanic women aged 70-74 with a college degree (mean = 6.3%, SE = 0.7%). The largest inverse CV in 2017 is 234, for white women aged 30-34 with a college degree (mean = 47.8%, SE = 0.2%).

Figure B8. Estimated Trend Differences by Alternative Percentile Groups



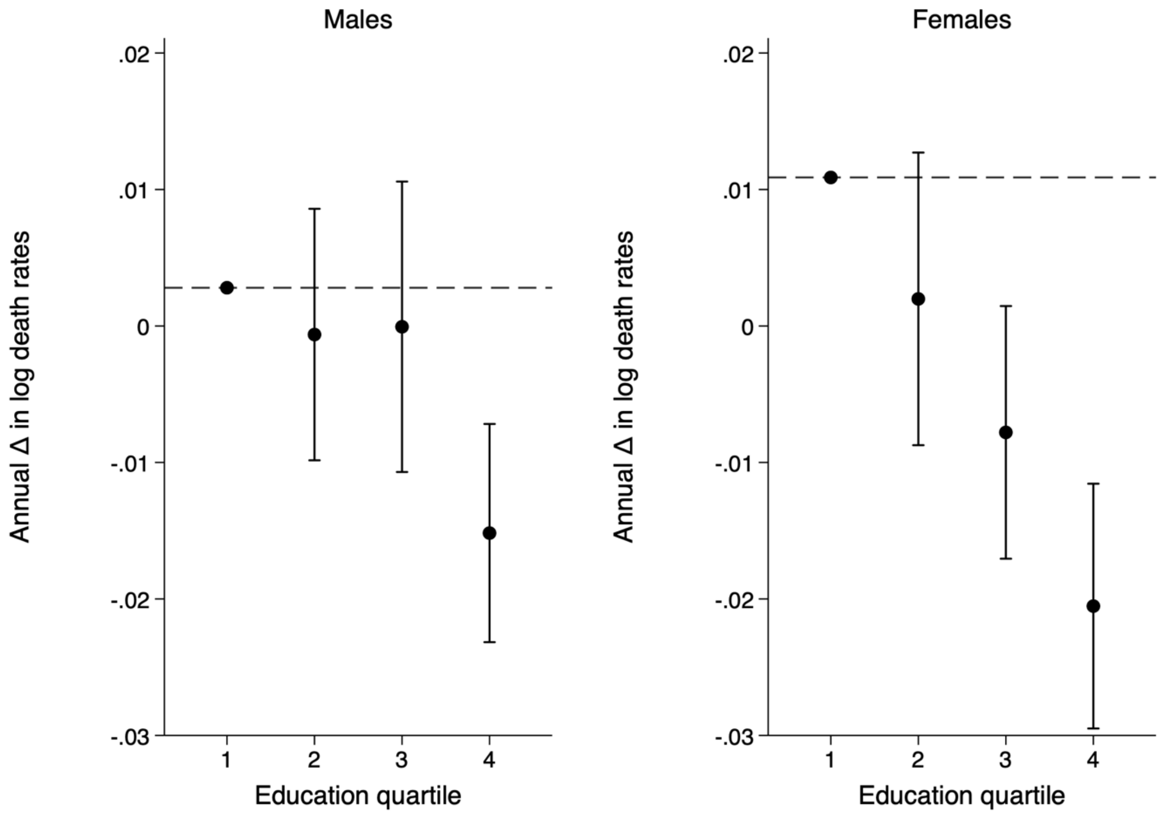
Note: Figure shows regression results from estimating equation (2) in which the bottom quartile is split between the lowest decile and the 10th to 25th percentiles. Estimates are also presented separately for whites and blacks. Dots represent estimates on the trend coefficient for each group, with those for the four highest education groups calculated by adding the estimate on the corresponding regression trend interaction term to the trend estimate corresponding to the bottom decile. The whiskers plot the 95% confidence interval of the difference relative to the bottom decile, with the difference centered on the mean for the four highest education groups. If the upper-bound of the confidence interval overlaps with the horizontal dotted line, then the quartile's trend is not statistically distinguishable from the trend for the bottom decile. Regression is weighted using the population in each group (age/sex/race/quartile cell), and standard errors are clustered at the group level.

Figure B9. Comparison of Population Estimates using CPS vs. ACS and SEER



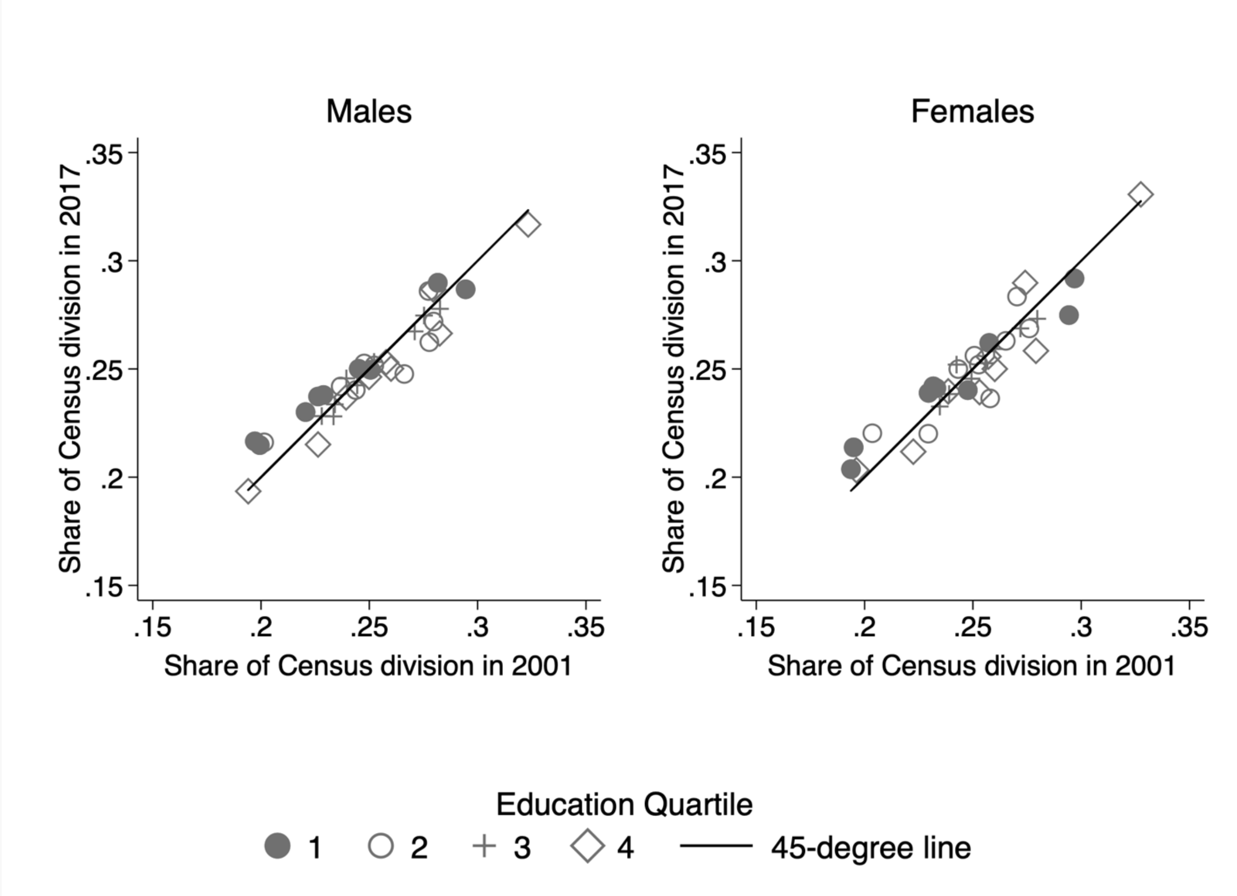
Note: Figure plots the ratio of population estimates from the CPS to those estimated from the combination of the ACS and SEER for 5-year age bands, sex, race, and four education categories (Less than high school, high school, some college, college). The *y*-axis displays the ratio using 2017 data and the *x*-axis displays the ratio using 2001 data. A ratio of 1.2 is interpreted as the population estimated from the CPS is 20 percent larger than that estimates by multiplying the SEER by the share of that demographic cell in the ACS.

Figure B10. Mortality trends by education quartile, whites and blacks only



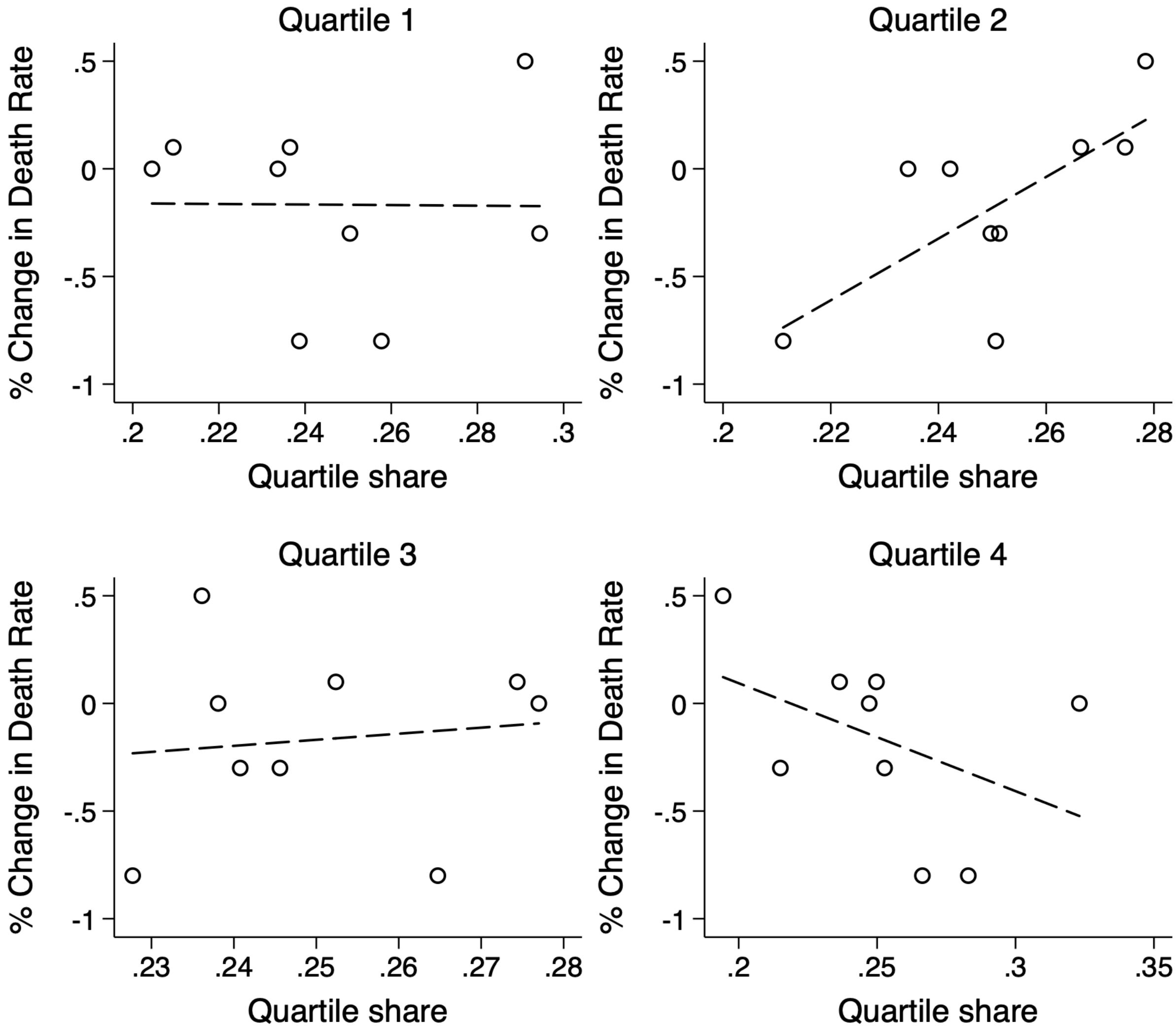
Note: Figure shows regression results from estimating equation (2) using data on whites and blacks only. Dots represent estimates on the trend coefficient for each quartile, with those for quartiles 2, 3 and 4 calculated by adding the estimate on the corresponding regression trend interaction term to the trend estimate corresponding to quartile 1. The whiskers plot the 95% confidence interval of the difference relative to quartile 1, with the difference centered on the mean for quartiles 2, 3, and 4. If the upper-bound of the confidence interval overlaps with the horizontal dotted line, then the quartile's trend is not statistically distinguishable from the trend for quartile 1. Regression is weighted using the population in each group (age/sex/race/quartile cell), and standard errors are clustered at the group level.

Figure B11. Shares of Education Quartiles within Census Divisions, 2001-2017



Note: Figure shows the fraction of education quartiles within Census divisions in 2001 and 2017, calculated separately for males and females. Each observation corresponds to a quartile within a particular Census division. The solid line denotes the 45-degree line. Points located farther from the 45-degree line indicate larger charges in the fraction of the Census division composed of that particular quartile. Points located close to the 45-degree line, indicate little change over time in the composition of quartiles within regions. We use the national thresholds for quartiles calculated using the ACS and the SEER as described in the text and used throughout the analysis.

Figure B12. Percentage Change in Death Rates vs. Quartile Shares
within Census Divisions



Note: Figures plot the relationship between the average annual percentage change in census region death rates against the average share of each education quartile. The mortality data are from Figures 9, 10, and 11 in Woolf and Schoomaker (2019), with males and females combined. The average education quartile shares within Census regions are calculated from 2001 to 2017, and also combine males and females because the shares vary little within Census divisions. We use the national thresholds for quartiles calculated using the ACS and the SEER as described in the text and used throughout the analysis. The relative change in the death rates, within Census regions, is negatively related to the share of population in Q_4 positively related to the share in Q_2. There is little relationship between mortality changes and the share within Q_1 or Q_3.

Online Appendix C: Education Quartiles vs. Categories [Not for Publication]

Our main analysis divides education groups into quartiles, so as to examine a constant proportion of the educational distribution over time. The more commonly used method is instead to use fixed educational categories. When doing so, secular increases in education will cause the proportions of the population in the categories to change, with increases in higher and decreases in less educated categories. This introduces potentially serious selection biases and a potential tradeoff between simplicity and accuracy. It is an empirical question whether the benefits of the more complicated strategy we follow are worth the additional complexity. For this reason, this appendix examines whether the results obtained substantially differ when using education quartiles rather than categories.

The four education quartiles can be roughly matched to the following four schooling categories: less than high school graduate; high school graduate but no college, some college but no degree, and college degree or more. These categories approximately correspond to the overall average educational attainment of Q_1-Q_4, although quartile-specific years of schooling vary across groups and generally increase over time.

A positive correlation between categorical and quartile-based mortality trends is obtained, as would be expected, although with considerable variation across groups. For example, the correlations are 0.90 and 0.71 when examining male logs and levels of death rates, and 0.89 and 0.72 for corresponding female outcomes. The rank correlations for males range from 0.83 to 0.88, compared to 0.84 to 0.88 for females. The categorical and quartile trend coefficients have different signs in around 16 percent of cases for men and for 19 percent of groups for women, although this mostly occurs when the absolute value of the trend coefficient is small.

To provide a better indication of the importance of the sensitivity of the results to the use of educational categories versus quartiles, Appendix Tables C1 and C2 expand on some of the prior analysis. In each case, the original estimates for quartiles are shown first, followed by the corresponding results using education categories. Using education categories often results in misclassification of both the worst and best performing groups. Between 2 and 5 of the 10 age-race-education quartiles with the largest trend increases in death or log death rates are misidentified when using corresponding education categories, with particularly poor performance (half of the 10 groups misidentified) for levels of death rate (see Table C1). In addition, the use of categories leads to a substantial overstatement of the magnitude of the rise for the worst-off groups. For instance, the death rates of white male Q_1 aged 55-59 and 30-34 were estimated to increase by 9.5 and 7.0 per 100,000 annually, the two largest increases of any of the 160 groups. By comparison, the estimated increases for same aged white males with less than high school education were 31.6 and 8.8 per 100,000 annually.

However, these estimates are erroneous, reflecting increasing negative selection into these groups as educational attainment rose over time. Similarly, the largest increases for females were the 12.0 per 100,000 annual rise in death rates estimated for 50-54 year old Q_1 whites. However, once again the growth for corresponding aged white women with less than a high school education was over two and a half times as large: 30.8 per 100,000. The estimated increase for white women aged 65-69 with less than a high school degree was 43.1 per 100,000, but the rate a decline of 6.7 per 100,000 for Q_1 white women of this age. Table C2 shows that the use of education categories, rather than quartiles, also frequently misidentifies the best performing groups, although both the magnitudes and identification of groups in the top 10 are much closer to those obtained using quartiles.

Table C1. Groups with largest mortality increases by education quartiles and categories

	Log Death Rate								Death Rate							
	Quartiles				Categories				Quartiles				Categories			
Rank	Race	Age	Educ	Coef	Race	Age	Educ	Coef	Race	Age	Educ	Coef	Race	Age	Educ	Coef
Males																
1	W	30	3	0.029	W	25	3	0.040	W	55	1	9.46	W	65	1	50.34
2	W	30	2	0.025	W	30	3	0.040	W	30	1	7.01	W	60	1	47.45
3	W	30	1	0.024	W	30	2	0.031	W	50	1	6.57	W	70	1	41.76
4	W	25	3	0.022	W	25	2	0.026	W	30	2	5.87	W	55	1	31.58
5	W	25	2	0.021	W	35	3	0.024	W	55	3	5.52	W	50	1	16.77
6	W	25	1	0.018	W	30	1	0.024	W	55	2	4.71	B	65	1	10.29
7	O	25	1	0.016	O	30	1	0.024	W	35	1	4.65	W	30	2	9.53
8	O	30	1	0.016	O	25	1	0.023	W	25	1	4.43	W	30	1	8.80
9	W	35	2	0.013	W	25	1	0.023	W	25	2	4.18	W	35	2	7.21
10	W	35	1	0.012	O	30	3	0.021	O	50	2	3.92	W	25	1	7.00
Females																
1	W	30	1	0.036	W	30	2	0.044	W	50	1	11.95	W	65	1	43.10
2	W	25	1	0.034	W	25	2	0.042	W	55	1	8.29	W	70	1	42.11
3	O	25	1	0.028	W	30	3	0.041	W	45	1	7.11	W	55	1	37.49
4	W	30	2	0.028	W	25	1	0.040	W	30	1	5.81	W	60	1	35.98
5	W	35	1	0.025	O	25	1	0.040	W	35	1	5.61	W	50	1	30.84
6	W	25	2	0.025	W	25	3	0.040	W	50	2	5.31	W	45	1	16.45
7	O	30	1	0.024	W	30	1	0.038	W	40	1	4.96	W	40	1	10.40
8	W	50	1	0.021	W	50	1	0.037	W	25	1	4.04	W	35	1	9.83
9	W	45	1	0.018	W	35	2	0.035	W	45	2	2.98	W	30	1	9.30
10	W	35	2	0.017	W	55	1	0.033	W	30	2	2.93	W	50	2	9.00

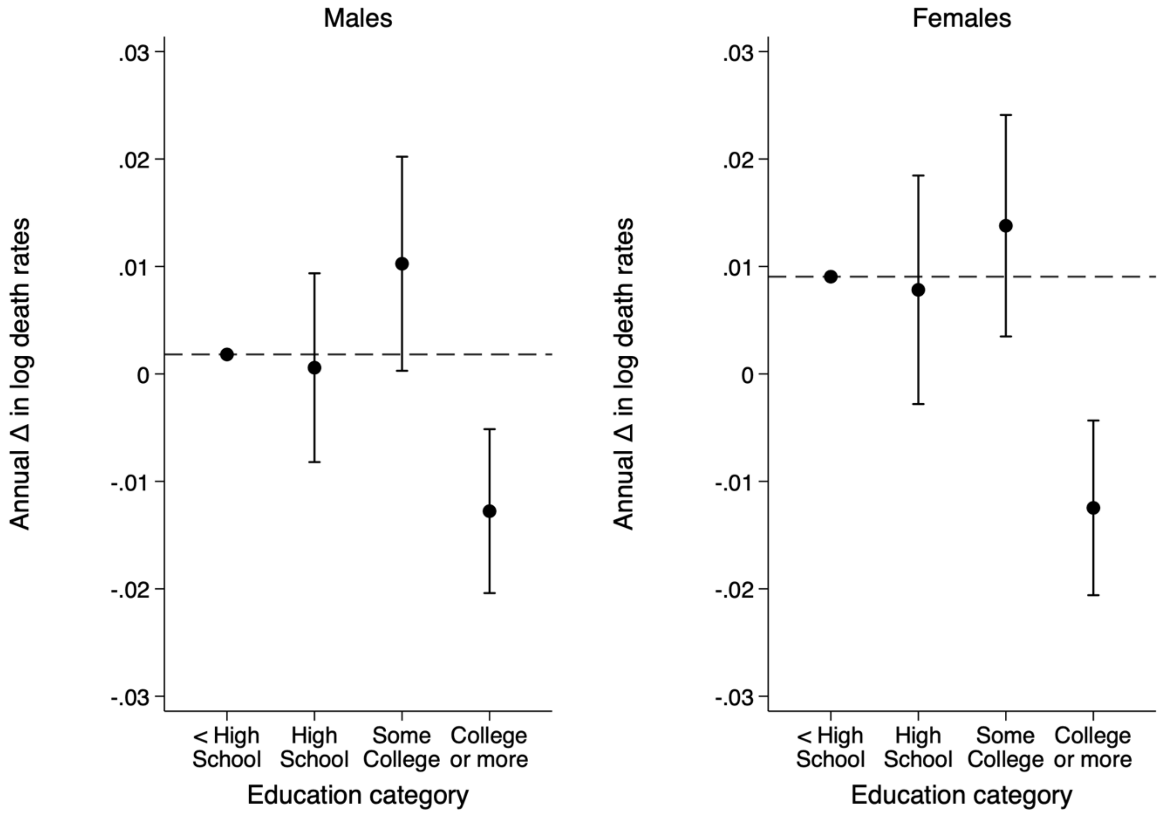
Note: This table shows the 10 groups with the largest estimated increases in logs or levels of death rates, separately by sex and whether education quartiles or categories are used in estimating equation (3). Education categories also range from one to four and refer respectively to less than high school graduate, high school graduate without college, some college but no degree, and a Bachelor's degree or more.

Table C2. Groups with largest mortality decreases by education quartiles and categories

	Log Death Rate								Death Rate							
	Quartiles				Categories				Quartiles				Categories			
Rank	Race	Age	Educ	Coef	Race	Age	Educ	Coef	Race	Age	Educ	Coef	Race	Age	Educ	Coef
Males																
160	B	70	3	-0.039	B	50	4	-0.038	B	70	3	-161.1	B	70	2	-174.2
159	B	50	4	-0.036	H	45	2	-0.036	B	70	4	-101.8	H	70	2	-105.9
158	B	70	4	-0.035	B	45	2	-0.034	B	70	2	-90.8	B	65	2	-91.0
157	B	45	4	-0.035	B	50	2	-0.034	B	65	3	-87.8	B	70	4	-90.4
156	H	65	4	-0.035	B	45	4	-0.034	B	65	2	-87.8	O	70	2	-58.3
155	B	45	2	-0.034	H	40	2	-0.033	H	70	3	-82.3	H	65	2	-53.8
154	H	70	3	-0.034	B	70	4	-0.031	W	70	3	-69.5	W	70	4	-53.7
153	B	40	4	-0.033	H	70	2	-0.030	W	70	4	-63.4	B	50	2	-50.2
152	H	45	2	-0.033	B	40	4	-0.030	H	70	4	-53.5	H	70	4	-47.1
151	H	40	2	-0.033	O	65	1	-0.030	B	65	4	-50.5	W	70	2	-46.5
Females																
160	B	45	4	-0.040	B	45	4	-0.037	B	70	3	-115.5	B	70	2	-123.4
159	B	60	4	-0.036	H	70	2	-0.036	B	70	4	-69.9	H	70	2	-75.0
158	B	70	3	-0.036	B	70	2	-0.032	B	65	3	-62.8	B	65	2	-68.6
157	H	70	3	-0.036	B	25	4	-0.030	B	70	2	-61.9	B	70	3	-43.9
156	W	65	4	-0.035	B	60	4	-0.030	H	70	3	-61.3	B	70	4	-42.2
155	B	25	4	-0.033	B	50	4	-0.030	B	65	2	-58.6	H	65	2	-34.0
154	B	65	4	-0.033	O	65	1	-0.028	B	65	4	-49.6	W	70	4	-32.7
153	W	70	4	-0.033	O	60	1	-0.027	W	70	4	-48.7	B	65	4	-32.3
152	O	65	3	-0.032	B	65	2	-0.027	O	70	3	-39.6	B	60	4	-28.7
151	O	70	4	-0.031	B	55	4	-0.027	B	60	4	-35.8	O	70	1	-28.4

Note: This table shows the 10 groups with the largest estimated decreases in log or levels of death rates, separately by sex and whether education quartiles or categories are used in estimating equation (3). Education categories also range from one to four and refer respectively to less than high school graduate, high school graduate without college, some college but no degree, and a Bachelor's degree or more.

Figure C.1 Ranked log death rate trends by education category



Note: Figure shows regression results from estimating equation (2) with categories instead of quartiles for educational attainment. Dots represent estimates on the trend coefficient for each quartile, with those for quartiles 2, 3 and 4 calculated by adding the estimate on the corresponding regression trend interaction term to the trend estimate corresponding to quartile 1. The whiskers plot the 95% confidence interval of the difference relative to less than high school education, with the difference centered on the mean for categories with higher education levels. If the upper-bound of the confidence interval overlaps with the horizontal dotted line, then the quartile's trend is not statistically distinguishable from the trend for less than high school education. Regression is weighted using the population in each group (age/sex/race/educational category cell), and standard errors are clustered at the group level.