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Racial disparities in alcohol-related liver disease mortality in a 75 year follow-up study of Michigan autoworkers

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ABSTRACT

Background: Suicide, drug overdose, and alcohol-related liver disease (ALD) mortality have been rising in the United States. While suicide and overdose have received a great deal of attention, far less public health concern has focused on chronic ALD. To address this gap, we examine ALD mortality rates, by race, in a cohort of autoworkers to describe trends over the past 75 years, from the peak in automobile manufacturing employment through its decline.

Methods: Based on the United Autoworkers-General Motors (UAW-GM) cohort we estimated temporal trends in age-adjusted ALD mortality rates from 1941 through 2015 at three automobile manufacturing plants in Michigan. We compared these rates to county, state, and U.S. rates, directly standardized to the 2000 U.S. census, to assess the roles of race and employment on ALD mortality.

Results: The overall age-adjusted ALD mortality rate among 41,097 male autoworkers peaked at 46.1 per 100,000 in the 1970s, followed by a gradual decline and a recent rise. Rates were slightly higher for black than white men until early 2000s, when rates increased only for white men. ALD mortality rates in the study cohort tracked national, state, and county rates for white men until the most recent time period, but were lower throughout the study period for black men, especially in the 1970s and 1980s.

Conclusions: Employment in automobile manufacturing may have offered some protection against death from ALD for black men, and loss of those manufacturing jobs may have impacted white men without a college degree more in recent decades.

1. Introduction

During the early 2000s, the United States experienced a stagnation in life expectancy, followed by a decline in 2015 (Harper et al., 2021). This decline was attributed to an increase in deaths among middle-aged white communities without a college degree due to suicide, drug overdose (opioids in particular) and alcohol-related liver disease (ALD) mortality, collectively known as 'deaths of despair' (Case & Deaton, 2017). This narrative has eclipsed attention to the rising rates in black and Latinx populations decades earlier (Muennig et al., 2018).

There is a growing literature on rising rates of acute deaths of despair, particularly the opioid epidemic (Classen & Dunn, 2012; Jalal et al., 2018, p. 361; Murthy, 2016), but little focus on chronic alcohol-related liver disease (ALD) mortality. Alcohol-related liver disease is a major cause of death in the United States; mortality rates have increased by 50 % since 1999 (White et al., 2020). In 2017, liver cirrhosis was the 11th leading cause of death overall, and accounted for 4.1 % of all deaths during midlife, 45–64 year olds (Heron, 2019).

The most prevalent types of alcohol-related liver disease are fatty liver, hepatitis, and hepatic cirrhosis (Mann et al., 2003). ALD is caused by excessive alcohol consumption over many years; as the duration of excessive consumption increases, individuals can progress from fatty liver to hepatitis to liver cirrhosis. Approximately 10–15 % of alcoholics develop liver cirrhosis, which is the most serious form of ALD and results from the accumulation of scar tissue in the liver, leading to potentially fatal complications and renal failure (Mann et al., 2003; Tapper & Parikh, 2018). Once ALD progresses to cirrhosis, it becomes irreversible. The five-year survival probability is 35–90 %, depending on the severity

Abbreviations: alcohol-related liver disease (ALD), United Autoworkers-General Motors (UAW-GM).

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of the condition and abstinence from drinking. Women in the U.S. consume less alcohol than men and have lower rates of cirrhosis mortality (Mann et al., 2003); women account for less than 25 % of all alcohol-related mortality since 2000 (White et al., 2020). During the 1970s and 1980s, black men in the U.S. had substantially higher cirrhosis mortality rates than white men (Yoon & Yi, 2012). After a long period of decline starting in the late 1970s, cirrhosis mortality has increased by 65 % since 1999 (Mann et al., 2003; Tapper & Parikh, 2018).

Deterioration of job opportunities, particularly for those without a college degree, has been hypothesized as a cause of the rise in deaths of despair (Case & Deaton, 2017), but causation is difficult to establish (Catalano et al., 2011). Here we take advantage of an existing cohort of autoworkers to describe long-term trends in ALD mortality, by race, during the period of decline in the U.S. automobile manufacturing industry. After dominating the manufacturing industry for 50 years, the "Big Three" Detroit-based automakers lost 40 percent of their market share from the 1950s through 2008 (Klier, 2009). Between 2000 and 2008, the U.S. auto industry shed approximately 166,000 jobs in Michigan alone (Klier, 2009). Job security for those without a college degree has faded along with the loss of manufacturing jobs in the U.S..

This study characterizes the burden of ALD mortality in the United Autoworkers-General Motors (UAW-GM) cohort (E. A. Eisen et al., 1992). Given the industry's significant population of black employees, we have a unique opportunity to assess potential racial health disparities in ALD mortality between black and white autoworkers (Chapman, 2008; Logan & Temin, 2020). We estimated temporal age-adjusted ALD mortality rates in the cohort stratified by race and plant location. We also compared these estimates to ALD mortality rates in the U.S., Michigan, and the three counties where the plants were located.

2. Methods

2.1. Study population

The UAW-GM cohort study has been described in detail elsewhere (Costello et al., 2020; E. A. Eisen et al., 1992). Briefly, the cohort consists of 46,294 hourly workers, at three automobile manufacturing plants in Michigan, with at least three years of employment. This analysis was restricted to 41,097 men; women were excluded from the analysis due to the small number of ALD deaths (N = 20). Plant 1 was located in Detroit and employed most of the black workers in the cohort. Plant 2 was in the nearby township of Ypsilanti. Plant 3 was in Saginaw, a small city known as "mid-Michigan" that suffered high unemployment in the late 1900s. Birthdate, sex, race, and work history through 1994 were obtained from company records. A total of 9252 (22.5 %) subjects were still employed on December 31, 1994. We do not know the exact work termination dates for these subjects, but due to plant closures, we know they left work by the end of follow-up in 2015 (Jordan, 2013; Strohl, 2013; Walsh, 2011).

Vital status and underlying cause of death were extracted from state vital records, union records, and the National Death Index (NDI Plus). Subjects who worked at more than one plant during their employment were assigned to the plant where they had worked longest. A total of 8202 (20 %) subjects had missing race data. Race was not regularly recorded at the plants until the electronic employment record system was introduced in the late 1970s (E. A. Eisen et al., 1992).In this context, we use the term 'race' as it appears in GM work records. However, we acknowledge that race has no inherent biological meaning and was historically designed to segregate individuals based on their skin color. We are specifically interested in understanding how structural and interpersonal racism may have influenced ALD mortality across different 'racial' groups over time.

2.2. Follow-up time

Follow-up began three years after subjects' date of hire, the date subjects reached 35 years of age (because the outcome was rare at younger ages), or in 1941 (the first year the Social Security Administration records provided vital status information), whichever occurred later. Subjects stopped accumulating person-time at their year of death, the end of follow-up on December 31, 2015, or the year they reached age 100, whichever came first. Eighty-four subjects with unknown dates of death were censored at age 100.

2.3. Outcome assessment

The National Death Index provides cause of death recorded using the International Classification of Disease codes, which are occasionally updated; the 10th edition was current at the end of follow-up in 2015. International Classification of Disease-10 (ICD-10) codes for alcohol-related liver disease mortality were obtained from Case and Deaton (2015), and equivalent ICD-9 and ICD-8 codes (in use during the earlier periods of follow-up) were obtained using an ICD code conversion tool. The ICD-10 codes used for the analysis were K70 and K73–K74. The ICD-9 codes used were 571.0, 571.2, 571.4–571.6, and 571.9. The ICD-8 codes used were 571x. Additional details on the ICD codes used are available in Appendix A.

2.4. Statistical analyses

We estimated ALD mortality rates from 1941 through 2015 and stratified the cohort by black and white race and plant location. We estimated temporal changes over five calendar periods (1941–1969, 1970–1979, 1980–1989, 1990–1999 and 2000–2015). The 95 % confidence intervals for mortality rates were calculated using the gamma distribution for Poisson counts. Age adjustment was performed via direct standardization based on the 2000 census of the U.S. population (Meyer, 2001).

As a comparison group, we calculated age-adjusted ALD mortality rates in men over age 35 in the general population in the U.S., Michigan, and the three counties where the cohort plants were located (Wayne (Plant 1), Washtenaw (Plant 2) and Saginaw (Plant 3)) using the CDC's Wide-ranging Online Data for Epidemiologic Research (WONDER) database. We calculated annual rates from 1968 through 2015 and over four calendar-year categories (1970–1978, 1980–1989, 1990–1998 and 2000–2015). We also estimated temporal changes in national, state, and county ALD mortality rates stratified by black and white race. Age adjustment was again performed via direct standardization based on the 2000 census of the U.S. population.

Multiple Imputation for race: In this analysis, missing race was multiply imputed as black or white and rates reported as the mean age-adjusted rates across 50 imputed datasets. The variance of the multiply-imputed rate was estimated applying an ANOVA style decomposition (Murray, 2018; Rubin, 2004). Each imputation was the result of posterior sampling under non-informative priors for logistic regression parameters associated with year of birth, year of hire, year of leaving work, plant, sex, and whether the individual died of ALD.

All analyses were conducted with R version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria). Bayesian model fitting for imputation of missing race was conducted using the R2jags package version 0.6-1 linked to JAGS version 4.3.0 (Plummer & others, 2003; Yajima, 2020). The study was approved by the Committee for the Protection of Human Subjects at the University of California, Berkeley.

3. Results

The basic demographic characteristics of the UAW-GM cohort are presented in Table 1 along with demographics of those 442 who died from ALD (1.8 % of the deceased). Subjects in Plant 1 were

Table 1
Summary of the UAW-GM cohort.

	Full cohort		ALD death	
N (person-years)	41 097	(1 310 161)	442	(9550)
Race, *n* (%)				
black	6388	(16 %)	69	(16 %)
white	26 507	(64 %)	248	(56 %)
unknown	8202	(20 %)	125	(28 %)
Plant[a], *n* (%)				
Plant 1 (Detroit)	15 604	(38 %)	210	(48 %)
Plant 2 (Ypsilanti)	13 973	(34 %)	147	(33 %)
Plant 3 (Saginaw)	11 129	(27 %)	85	(19 %)
Deceased by end of follow-up	25 086	(61 %)	442	(100 %)
	Median	(Q1, Q3)	Median	(Q1, Q3)
Years of follow-up	39.6	(33.09, 47.32)	28.21	(20.92, 36.13)
Year of birth	1931	(1914, 1947)	1926	(1913, 1941)
Year of hire	1959	(1948, 1969)	1953	(1946, 1967)
Age at hire	25	(21, 33)	25	(21, 34)
Year of leaving work[b]	1980	(1963, 1994)	1973	(1957, 1989)
Age at leaving work[b]	48	(37, 58)	47	(37, 57)
Years of employment[b]	16.7	(8.1, 27.8)	15.6	(8.1, 25.8)
Year of death among deceased	1991	(1977, 2003)	1986	(1973, 2000)
Age at death among deceased	71	(61, 80)	60	(52, 67)

Notes: Statistics shown are median (first quartile, third quartile), unless otherwise indicated.

[a] Some subjects worked at several sites; plant indicates the site of longest work record time.

[b] 9252 subjects were excluded from these summary statistics because they had incomplete employment records.

overrepresented in ALD deaths, as were subjects with unknown race. Subjects who died of ALD were born five years earlier than the overall cohort.

The age-adjusted ALD mortality rates are presented by calendar period and over the entire follow-up period, with national and Michigan state rates for contrast (Fig. 1). The overall age-adjusted mortality rate in the cohort was 31.5 per 100,000 person-years (95 % CI: 28.6, 34.7). The rate peaked in the 1970s at 46.1 per 100,000 person-years (95 % CI: 36.3, 57.6) and then gradually declined, before rising again slightly after 2000 to 34.9 per 100,000 person-years (95 % CI: 26.0, 45.9). The U.S. rates followed a similar pattern, peaking in the 1970s, at 45.7 per 100,000 population, steadily declining and then increasing slightly

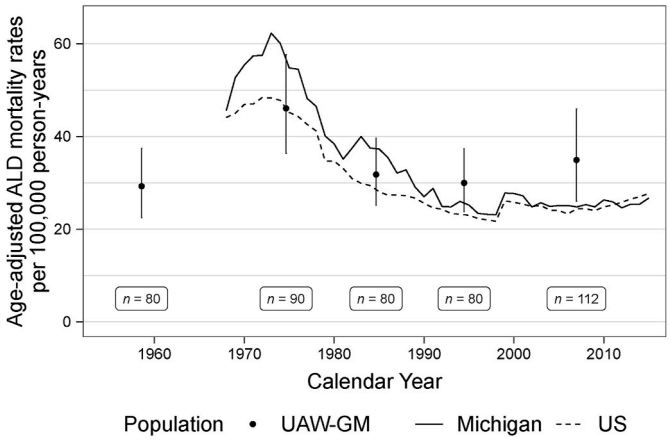

Fig. 1. Age-adjusted Alcohol-related Liver Disease (ALD) mortality rates among men in the UAW-GM cohort, Michigan, and the US between 1941 through 2015. n represents the number of ALD mortality cases per calendar time in the UAW-GM cohort.

around 2000. ALD mortality rates were higher in Michigan than either the national or UAW-GM rates in the 1970s. Michigan rates peaked at 55.2 per 100,000 and then steeply declined until the 1990s followed by a plateau. After 2000, the rates were higher for autoworkers than for Michigan or the US. This recent excess in ALD mortality was also observed relative to county rates for Plant 2 (Appendix B, Figure B.1).

The estimated age-adjusted ALD mortality rates for the UAW-GM cohort, U.S., and Michigan, are shown by calendar period, stratified by race, in Fig. 2. The overall mortality rate in the cohort was modestly higher for black than white autoworkers, 35.4 (95 % CI: 28.0, 44.1) and 30.6 (95 % CI: 27.4, 34.0), respectively. The U.S. and Michigan rates were comparable to UAW-GM rates for white men, except for after 2000, when UAW-GM rates rose above both U.S. and Michigan rates. In contrast, national and state-wide rates were substantially higher than UAW-GM rates for black men in the 1970s and remained higher in Michigan through the 1980s. For black men in the 1970s, the UAW-GM rate was 40.5 per 100,000 person-years (95 % CI: 23.5, 65.2), while the general population rates were 70.5 and 109.9 per 100,000 population in the U.S. and Michigan, respectively. (See Tables B.5, B.7, and B.9 in Appendix B).

Plant 1 (Detroit) employed most of the black workers (68 %) and the estimated age-adjusted ALD mortality rates are shown, stratified by race, for that plant in Fig. 3. Over the entire follow-up period, the rates were slightly higher in black than white men in Plant 1, at 39.5 (95 % CI: 33.1, 46.6) and 34.7 (95 % CI: 26.4, 44.9) per 100,000 person-years, respectively. Temporal trends also differed by race. Annual rates peaked for black men in the 1970s, gradually declined throughout the 1980s and 1990s, and then dropped sharply to 15.2 per 100,000 person-years (95 % CI: 6.8, 29.2) after 2000. In contrast, rates for white men also peaked in the 1970s followed by declines in the 1980s and 1990s, but then increased after 2000 to 51.1 per 100,000 person-years (95 % CI: 20.1, 106.7). In Wayne County, ALD rates roughly mirrored UAW-GM rates in white men but were consistently higher than UAW-GM rates in black men, with racial and geographic disparities attenuating after 2000.

4. Discussion

Among a large cohort of U.S. autoworkers, we found that from 1941 through 2015, the overall age-adjusted ALD mortality tracked national and state rates until the early 2000s, when it exceeded both the U.S. and Michigan rates. The variation in overall UAW-GM ALD mortality rates over time peaked in the 1970s and then increased again after 2000 following a 20-year decline (Case & Deaton, 2015; Mann et al., 2003). However, the picture differed after stratifying by race. Rates were slightly higher for black than white men from the 1970s through the late 1990s, though after 2000 the age-adjusted rates increased only for white men. We found that UAW-GM rates mirrored U.S., Michigan, and Wayne County rates until the early 2000s in white men, but were substantially lower for black autoworkers, especially in the 1970s and 1980s. Relative to Michigan and Wayne County, the lower death rates from ALD in black autoworkers persisted throughout the later 1900s. Since we adjusted the ALD mortality rates by age, factors other than age must have contributed to the observed rates over time. We discuss some of these factors below.

Our finding that ALD mortality rates rose in white male autoworkers after 2000 aligns with findings from Case and Deaton, who reported elevated ALD mortality rates, along with suicide and fatal overdose, in Non-Latinx white people with less than a Bachelor's degree since 1999 (Case & Deaton, 2015, 2017). They attributed this rise to cumulative disadvantage – in social connection and health outcomes – triggered by worsening labor market opportunities, particularly for those with low levels of education. The UAW-GM cohort presents a striking case study of this hypothesis. The US Bureau of Labor Statistics estimates that 80–90 % of U.S. autoworkers have less than a Bachelor's degree, and 15–20 % have less than a high school diploma (U.S. Bureau of Labor Statistics, 2019). In the 1950s, lucrative contracts negotiated by the

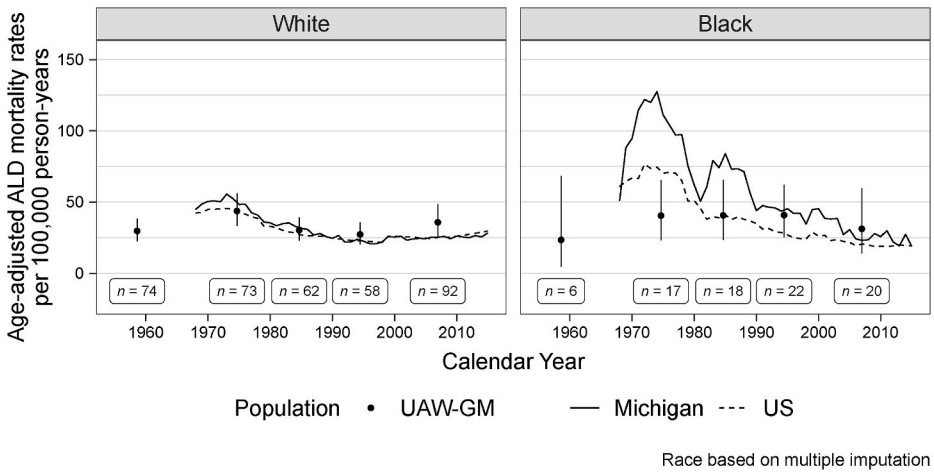

Fig. 2. Age-adjusted Alcohol-related Liver Disease (ALD) mortality rates in men stratified by race in the UAW-GM cohort, Michigan, and the U.S. from 1941 through 2015 (with unknown race multiply-imputed).

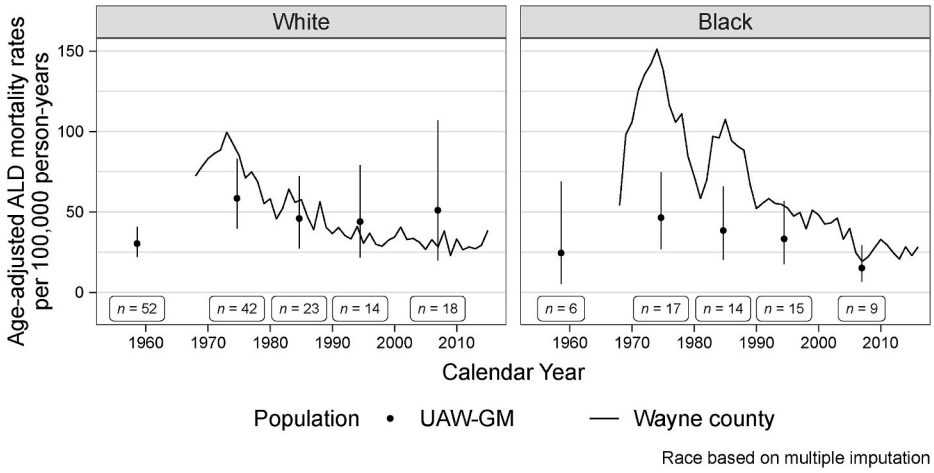

Fig. 3. Age-adjusted Alcohol-related Liver Disease (ALD) mortality rates in men in plant 1 stratified by race in the UAW-GM cohort and Wayne County between 1941 through 2015 (with unknown race multiply imputed).

United Automobile Workers (UAW) resulted in higher wages and improved benefits for autoworkers (The New York Times, 2015). After sustained growth for a decade, globalization, climbing oil prices, and foreign-produced automobiles led GM to begin reducing costs.

In the 1970s, as the U.S. automobile manufacturing industry started losing market share, wages did not keep up with increased cost of living for autoworkers (Klier, 2009; The New York Times, 2015). In addition, the "Big Three" Detroit-based automakers started eliminating jobs; by the end of the study period all three of the study plants were closed (Jordan, 2013; Strohl, 2013; Walsh, 2011). As a result, automobile manufacturing lost its status as a lucrative blue-collar profession, with autoworkers bearing the brunt of this decline. The physical demands of automobile manufacturing may have led to injuries and chronic pain, presenting fertile ground for opioid misuse, and perhaps, alcoholism (Oswald & Wand, 2004; Charniga, 2019). We recently estimated a 16-fold hazard rate of suicide and drug overdose after leaving work in this cohort (E. A. Eisen et al., 2020). This progressive deterioration of job opportunity and security, chronic alcohol abuse, as well as increasing use of opioids in automobile manufacturing workers may have all contributed to the recent rise of deaths of despair in white men in UAW-GM.

On the other hand, national and state-wide data show that the burden of ALD mortality was substantially higher for black compared to white men, especially in 1970s and 1980s, while rates were substantially lower for black autoworkers compared to black men in the general population. This racial disparity in the national alcohol-related mortality rates - more apparent in Wayne county (Detroit), with its history of racial conflict and policies harming the black community - may be attributed to the lifelong effects of structural, institutional, and interpersonal racism on substance use disorders in communities of color (Fine, 2007). During the first wave of the Great Migration (1910–1930), over 100,000 black Americans settled in Detroit (an increase in the black population of 2000 %), many motivated by work opportunities in the automobile manufacturing industry, one of the biggest employers of black Americans at the time (Chapman, 2008). This demographic shift, as well as another doubling of the black population of Detroit associated with the second wave of the Great Migration (1940–1950), contributed to increased racial tension in the city motivated by white residents' fear of reduced job opportunities, culminating in the Detroit race riots of 1943 and 1967, and white flight to the suburbs in the 1950s and 1960s (Boustan, 2010; Darden & Thomas, 2013). At the time, the automobile manufacturing industry provided middle class wages that were largely unavailable to the broader black community. This income stability may have been protective against ALD mortality in black autoworkers at the time.

Another possible explanation for the protective effect of employment we observed for black autoworkers is the healthy worker effect and its two components, healthy hire and healthy worker survivor effect (E.

Eisen et al., 2006). When comparing an occupational cohort to the general population, mortality rates are likely biased downward, towards the null and beyond, because healthier individuals are more likely to be hired. Eligibility for the UAW-GM cohort required at least three years of employment and this eligibility criterion may have introduced healthy worker survivor bias by screening out the less healthy subjects, such as those suffering from alcoholism. In addition to the healthy worker effect, it might also be that disparities between black and white autoworkers relative to their respective general population counterparts could be explained by differences in the relative educational attainment of black versus white autoworkers. For example, data from the American Community Survey indicate that in Michigan, black autoworkers earned more than the average black man, while white autoworkers earned 10 % less than the average white man. Additionally in recent decades, lack of a college education has become a strong risk factor for deaths of despair (Crum et al., 1993). While the automobile manufacturing industry was one of the largest employers of black men at the time, discriminatory hiring practices may have led to a larger proportion of college-educated black than white employees relative to their respective populations. However, we had no access to data on educational attainment of UAW-GM employees to examine this explanation.

4.1. Strengths

This is the first study to describe ALD mortality rates in an occupational cohort in the U.S.. The 75-year follow-up allowed us to examine temporal changes in ALD mortality rates for workers at this iconic company during a period of industrial expansion and contraction. Moreover, the substantial number of black autoworkers allowed us to examine trends in ALD mortality rates by race. Nation-wide, state-wide, and county-wide rates provide a historical context for the experience of these autoworkers.

4.2. Limitations

To address missing race for a large proportion of the cohort we applied multiple imputation. Results were generally consistent using either recorded or imputed race (Appendix B, Figures B.2 and B.3).

4.3. Conclusions

This study provides a unique window on ALD mortality, industrial decline, race, and deaths of despair. The disparity between ALD mortality rates in black and white autoworkers since 2000 may be explained by Case and Deaton's hypothesis: the decline in job opportunities for those without a college degree may have affected white more than black autoworkers due to ongoing structural racism. Since the 1970s, standards of living have steadily decreased for white communities without a Bachelor's degree. However, black communities across all levels of educational attainment were, and still are, suffering from lower incomes, lower standards of living, and lower life expectancy than white communities (Alang, 2019; Hswen et al., 2020). These historical inequities have meant that, even for black and white workers earning the same income, black workers and their families have been unable to establish the stability of intergenerational wealth or develop the social capital that white families were able to access. The increase in deaths of despair we see in white communities today may be the result of dashed expectations of what life could or 'should' be like, i.e., the consistent improvements of the standard of living enjoyed by parents and grandparents suddenly falling short of reality for white communities. Because of long-standing, structural impediments to improvements to quality of life, black communities may have not shared these expectations. In turn, these communities may have had higher resilience in the face of reduced job opportunities following the collapse of the U.S. automobile manufacturing industry (Assari & Lankarani, 2016; Keyes, 2009).

Funding

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Statement of ethics approval

The study was approved by the Committee for the Protection of Human Subjects at the University of California, Berkeley [2013-11-5825]. Participant consent was not required for publication.

Author contributions

FA made substantial contributions to the data analysis, interpretation of findings, and manuscript preparation. KTC made substantial contributions to the data analysis. LL made substantial contributions to the interpretation of findings and manuscript preparation. SC made substantial contributions to the interpretation of findings. SP made substantial contributions to the data analysis and interpretation of findings. EAE made substantial contributions to the conception of the work, acquisition of data, design of the work, interpretation of findings and manuscript preparation.

Declaration of competing interest

The authors declare no competing interests.

Appendix A. Detailed ICD Codes for ALD Mortality Used in the Analyses

The ICD-8 codes used for the analyses were 571.0 for alcoholic cirrhosis of liver, 571.8 for other specified cirrhosis of liver, and 571.9 for unspecified cirrhosis of liver.

The ICD-9 codes used for the analyses were 571.0 for alcohol fatty liver, 571.2 for alcoholic cirrhosis of liver, 571.4 for chronic hepatitis, 571.5 for cirrhosis of liver without mention of alcohol, 571.6 for biliary cirrhosis, and 571.9 for unspecified chronic liver disease without mention of alcohol.

The ICD-10 codes used for the analyses were K70 for alcoholic liver disease (K70.0 for alcoholic fatty liver, K70.1 for alcoholic hepatitis, K70.2 for alcoholic fibrosis and sclerosis of the liver, K70.3 for alcoholic cirrhosis of the liver, K70.4 for alcoholic hepatic failure, and K70.9 for unspecified alcoholic liver disease), K73 for chronic hepatitis, not elsewhere classified (K73.0 for chronic persistent hepatitis, not elsewhere classified, K73.1 for chronic lobular hepatitis, not elsewhere classified, K73.2 for chronic active hepatitis, not elsewhere classified, K73.8 for other chronic hepatitis, not elsewhere classified, and K73.9 for chronic hepatitis, unspecified), and K74 for fibrosis and cirrhosis of liver (K74.0 for hepatic fibrosis, K74.1 for hepatic sclerosis, K74.2 for hepatic fibrosis with hepatic sclerosis, K74.3 for primary biliary cirrhosis, K74.4 for secondary biliary cirrhosis, K74.5 for biliary cirrhosis, unspecified, and K74.6 for other and unspecified cirrhosis of liver).

Appendix B. Supplemental Tables and Figures

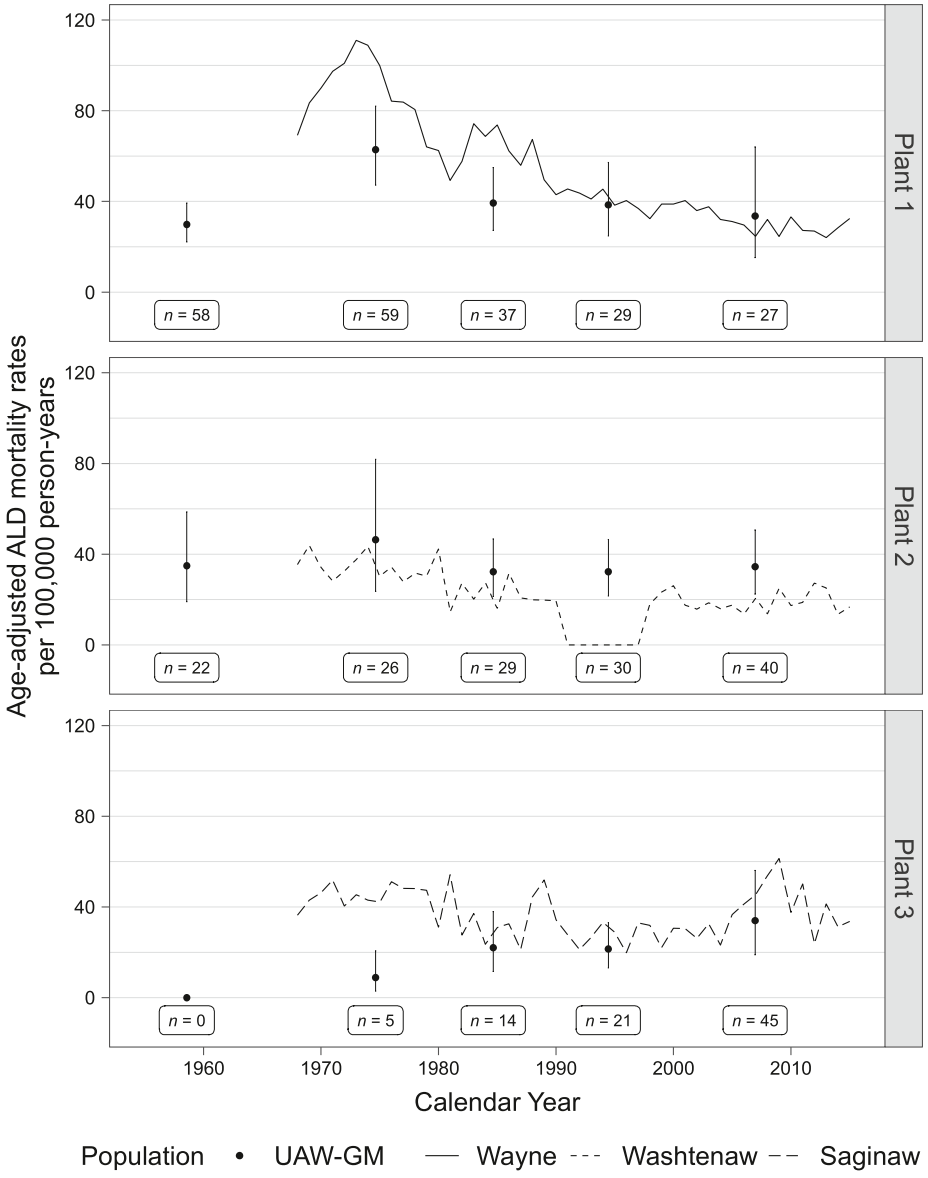

Fig. B.1. Age-adjusted ALD mortality rates in men by plant in the UAW-GM cohort and Wayne, Washtenaw, and Saginaw Counties between 1941 through 2015. n represents the number of ALD mortality cases per calendar time in the UAW-GM cohort.

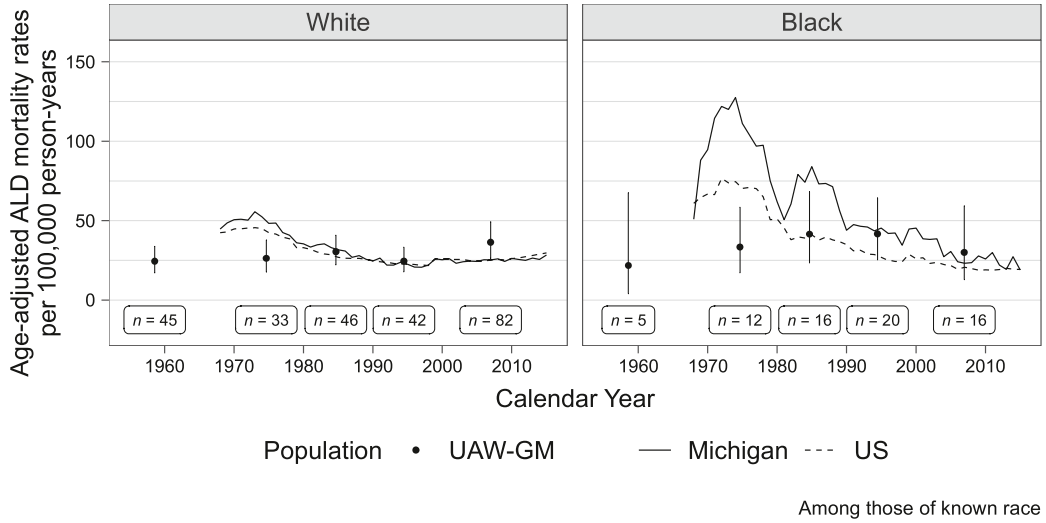

Fig. B.2. Age-adjusted ALD mortality rates in men by known race in the UAW-GM cohort, Michigan, and the U.S. between 1941 through 2015. n represents the number of ALD mortality cases per calendar time in the UAW-GM cohort.

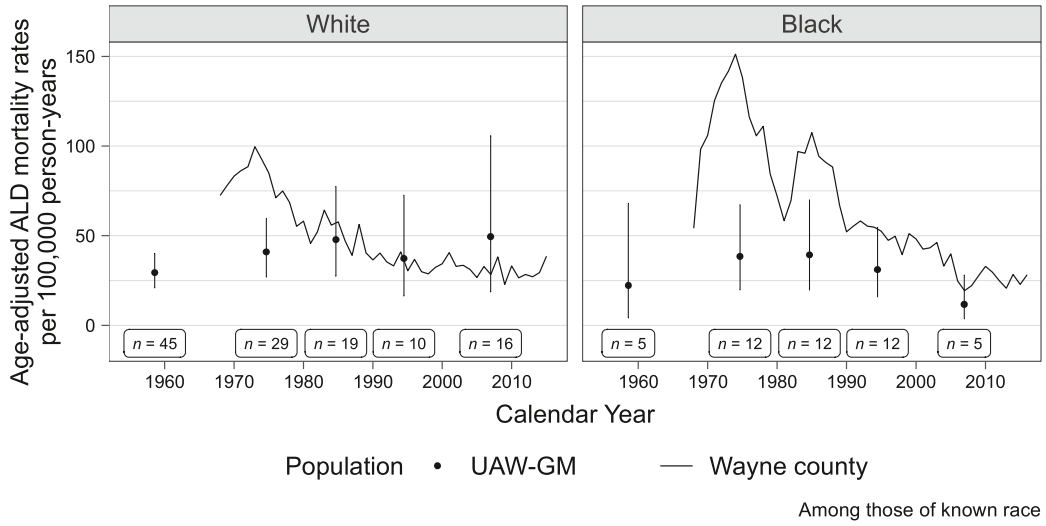

Fig. B.3. Age-adjusted ALD mortality rates in men in Plant 1 by known race in the UAW-GM cohort and Wayne County between 1941 through 2015. n represents the number of ALD mortality cases per calendar time in the UAW-GM cohort.

Table B.1
Overall ALD mortality rate among men in UAW-GM.

Calendar period	ALD deaths	Person years	Age-adjusted rate per 100,000 (95 % CI)
1941 to 1969	80	310 330	29.3 (22.5, 37.5)
1970 to 1979	90	192 400	46.1 (36.3, 57.6)
1980 to 1989	80	237 371	31.8 (25.2, 39.7)
1990 to 1999	80	255 962	30.0 (23.7, 37.4)
2000 to 2015	112	314 099	34.9 (26.0, 45.9)
All calendar periods	442	1 310 161	31.50 (28.6, 34.7)

Table B.2
Age-adjusted ALD mortality rate among men in the US.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	179 457	369 438 987	45.7 (45.5, 45.9)
1980 to 1989	145 022	479 776 726	29.4 (29.3, 29.6)
1990 to 1998	120 760	531 555 317	23.3 (23.2, 23.4)
2000 to 2015	315 611	1 200 544 017	25.3 (25.2, 25.4)

Table B.3
Age-adjusted ALD mortality rate among men in Michigan.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	8828	15 149 051	55.2 (54.0, 56.3)
1980 to 1989	6613	18 171 245	35.5 (34.6, 36.4)
1990 to 1998	4762	19 490 112	25.1 (24.4, 25.8)
2000 to 2015	10 953	40 546 671	25.7 (25.2, 26.2)

Table B.4
Age-adjusted ALD mortality rate among white men in UAW-GM (with multiply-imputed race).

Calendar period	ALD deaths	Person years	Age-adjusted rate per 100,000 (95 % CI)
1941 to 1969	74	274 643	29.7 (22.6, 38.3)
1970 to 1979	73	158 446	43.7 (33.5, 56.0)
1980 to 1989	62	191 195	30.3 (23.3, 38.9)
1990 to 1999	58	205 128	27.3 (20.7, 35.4)
2000 to 2015	92	252 993	35.8 (25.8, 48.4)
All calendar periods	359	1 082 405	30.6 (27.4, 34.0)

Table B.5
Age-adjusted ALD mortality rate among black men in UAW-GM (with multiply-imputed race).

Calendar period	ALD deaths	Person years	Age-adjusted rate per 100,000 (95 % CI)
1941 to 1969	6	35 687	23.5 (4.9, 68.1)
1970 to 1979	17	33 954	40.5 (23.3, 65.2)
1980 to 1989	18	46 175	40.7 (23.5, 65.4)
1990 to 1999	22	50 835	40.8 (25.6, 61.8)
2000 to 2015	20	61 105	31.3 (14.3, 59.4)
All calendar periods	83	227 756	35.4 (28.0, 44.1)

Table B.6
Age-adjusted ALD mortality rate among white men in the US.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	152 972	331 559 885	43.0 (42.8, 43.3)
1980 to 1989	124 736	424 065 622	28.3 (28.2, 28.5)
1990 to 1998	104 334	460 409 812	23.0 (22.8, 23.1)
2000 to 2015	277 752	1 002 478 960	26.3 (26.2, 26.4)

Table B.7
Age-adjusted ALD mortality rate among black men in the US.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	24 257	32 964 596	70.5 (69.6, 71.4)
1980 to 1989	18 046	43 783 718	40.4 (39.8, 41.0)
1990 to 1998	13 889	51 632 403	28.1 (27.6, 28.6)
2000 to 2015	27 580	130 415 334	21.0 (20.7, 21.3)

Table B.8
Age-adjusted ALD mortality rate among white men in Michigan.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	7036	13 565 629	48.8 (47.6, 50.0)
1980 to 1989	5202	16 048 755	31.4 (30.6, 32.3)
1990 to 1998	3760	16 990 596	22.7 (22.0, 23.5)
2000 to 2015	9338	34 728 672	25.4 (24.9, 26.0)

Table B.9
Age-adjusted ALD mortality rate among black men in Michigan.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	1755	1 499 552	109.9 (104.6, 115.1)
1980 to 1989	1362	1 929 422	68.6 (64.9, 72.3)
1990 to 1998	947	2 190 697	43.4 (40.6, 46.1)
2000 to 2015	1424	4 723 400	28.6 (27.1, 30.1)

Table B.10
Age-adjusted rate among white men in Plant 1 (with multiply-imputed race).

Calendar period	ALD deaths	Person years	Age-adjusted rate per 100,000 (95 % CI)
1941 to 1969	52	164 073	30.4 (22.2, 40.6)
1970 to 1979	42	55 446	58.5 (39.9, 82.7)
1980 to 1989	23	44 990	45.9 (27.6, 71.8)
1990 to 1999	14	34 411	44.0 (21.9, 78.8)
2000 to 2015	18	33 129	51.1 (20.1, 106.7)
All calendar periods	149	332 050	39.5 (33.1, 46.6)

Table B.11
Age-adjusted rate among black men in Plant 1 in UAW-GM (with multiply-imputed race).

Calendar period	ALD deaths	Person years	Age-adjusted rate per 100,000 (95 % CI)
1941 to 1969	6	34 128	24.5 (5.5, 68.8)
1970 to 1979	17	30 830	46.5 (27.1, 74.3)
1980 to 1989	14	36 298	38.5 (20.6, 65.5)
1990 to 1999	15	33 370	33.3 (17.9, 56.5)
2000 to 2015	9	35 437	15.2 (6.8, 29.2)
All calendar periods	61	170 064	34.7 (26.4, 44.9)

Table B.12
Age-adjusted ALD mortality rate among white men in Wayne County.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	3010	3 272 485	83.7 (80.6, 86.8)
1980 to 1989	1616	2 897 204	51.7 (49.1, 54.3)
1990 to 1998	889	2 570 151	34.8 (32.5, 37.1)
2000 to 2015	1451	4 392 065	31.5 (29.9, 33.2)

Table B.13
Age-adjusted ALD mortality rate among black men in Wayne County.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	1491	1 110 261	125.9 (119.4, 132.5)
1980 to 1989	1164	1 339 303	84.2 (79.3, 89.2)
1990 to 1998	732	1 408 935	51.6 (47.8, 55.4)
2000 to 2015	878	2 582 491	31.8 (29.6, 33.9)

Table B.14
Age-adjusted ALD mortality rate among men in Plant 1 in UAW-GM.

Calendar period	ALD deaths	Person years	Age-adjusted rate per 100,000 (95 % CI)
1941 to 1969	58	198 201	29.9 (22.2, 39.4)
1970 to 1979	59	86 277	62.8 (47.1, 82.1)
1980 to 1989	37	81 289	39.4 (27.3, 55.0)
1990 to 1999	29	67 782	38.5 (24.7, 57.2)
2000 to 2015	27	68 566	33.6 (15.3, 64.0)
All calendar periods	210	502 114	38.2 (33.1, 44.0)

Table B.15
Age-adjusted ALD mortality rate among men in Plant 2 in UAW-GM.

Calendar period	ALD deaths	Person years	Age-adjusted rate per 100,000 (95 % CI)
1941 to 1969	22	83 791	34.9 (19.0, 58.7)
1970 to 1979	26	62 801	46.4 (23.6, 81.9)
1980 to 1989	29	77 547	32.3 (21.4, 46.8)
1990 to 1999	30	93 805	32.3 (21.6, 46.5)
2000 to 2015	40	119 411	34.5 (22.4, 50.8)
All calendar periods	147	437 354	31.6 (26.6, 37.4)

Table B.16
Age-adjusted ALD mortality rate among men in Plant 3 in UAW-GM.

Calendar period	ALD deaths	Person years	Age-adjusted rate per 100,000 (95 % CI)
1941 to 1969	0	28 337	–
1970 to 1979	5	43 322	8.9 (2.9, 20.7)
1980 to 1989	14	78 535	22.0 (11.6, 38.0)
1990 to 1999	21	94 376	21.5 (13.1, 33.1)
2000 to 2015	45	126 122	34.0 (19.0, 56.1)
All calendar periods	85	370 693	22.5 (17.7, 28.3)

Table B.17
Age-adjusted ALD mortality rate among men in Wayne County.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	4513	4 410 129	95.5 (92.6, 98.4)
1980 to 1989	2790	4 280 735	62.2 (59.8, 64.6)
1990 to 1998	1637	4 042 321	40.8 (38.8, 42.8)
2000 to 2015	2357	7 185 184	31.3 (30.0, 32.5)

Table B.18
Age-adjusted ALD mortality rate among men in Washtenaw County.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	106	321 459	33.3 (26.6, 39.9)
1980 to 1989	81	387 767	–
1990 to 1998	69	527 765	15.2 (11.7, 19.4)
2000 to 2015	242	1 225 296	19.0 (16.6, 21.5)

Table B.19
Age-adjusted ALD mortality rate among men in Saginaw County.

Calendar period	ALD deaths	Population	Age-adjusted rate per 100,000 (95 % CI)
1970 to 1978	173	255 082	46.2 (39.2, 53.3)
1980 to 1989	152	420 000	35.6 (29.8, 41.4)
1990 to 1998	120	426 916	28.5 (23.3, 33.7)
2000 to 2015	328	817 846	37.5 (33.3, 41.6)

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