

Disparities in the Deaths of Despair by Occupation, Massachusetts, 2000 to 2015

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Objective: To explore mortality rates and trends according to the occupation of workers who died from the deaths of despair (DoD). **Methods:** Death certificates for deaths due to poisonings (including opioid-related overdoses), suicides, and alcoholic liver disease occurring in Massachusetts from 2000 to 2015 were collected and coded according to the occupation of the decedent. Mortality rates and trends in mortality were calculated for each occupation. **Results:** DoDs increased by more than 50% between 2000 to 2004 and 2011 to 2015. There were substantial differences in mortality rates and trends according to occupation. Blue collar workers were at a particularly elevated risk for DoD and had elevated trends for these deaths, notably: construction and farming, fishing, and forestry workers. **Conclusions:** Interventions should be targeted to occupations with elevated mortality rates and trends. Occupational risk factors that may contribute to these disparities should be explored.

Keywords: deaths of despair, occupational health, opioids, suicide

In the United States, overall life expectancy declined annually from 2015 to 2017 with an increase occurring in 2018.^{1–3} This decline has primarily been attributed to accidental drug and alcohol poisonings (especially those related to opioids), and suicides, all of which have been increasing since at least 1999.^{4,5} The impact of deaths from these causes and also chronic liver diseases and cirrhosis has been seen most acutely among non-Hispanic whites between the ages of 45 and 54. Mortality rates among this group have been increasing since 1999, which contrasts with generally declining mortality trends observed among the same age group in other high income countries.^{6,7} Together accidental drug and alcohol poisonings, suicides, and deaths from alcoholic liver disease and cirrhosis have been deemed “deaths of despair.”⁶ It is important to note that while these changing trends in mortality for middle-aged whites are alarming, mortality among those in the middle years of life has also been increasing across all major racial and ethnic groups.⁸

With respect to drug overdoses, overprescribing of opioid painkillers and fraudulent advertising of their safety have been pointed to as triggers for the crisis.⁹ As mortality rates due to illicit opioids, such as heroin and fentanyl, have outpaced those due to prescription opioids, increasing attention has been given to the role

that social and economic factors might play in the opioid epidemic.¹⁰ Close to one-half of all suicides in the United States are among individuals without a known mental health condition; thus “upstream” social factors should be considered in suicide prevention. One study found job or financial problems preceded about 16% of the suicides examined.¹¹ Additionally, various upstream risk factors including job stress have been known to contribute to mental health problems such as anxiety and depression, which themselves are risk factors for suicide.¹² Liver cirrhosis deaths have been increasing most drastically in the midwestern and southern parts of the United States. Despite the lower absolute risk, mortality due to liver cirrhosis has been increasing much faster among those between those ages of 25 and 34, compared with older age groups.¹³

Pointing to more macro-level reasons for increases in the deaths of despair, Case and Deaton⁶ suggested that “many of the baby-boom generation are the first to find in midlife that they will not be better off than were their parents,” which may be due to the fact that the baby boom generation was in the prime working years of their lives during the Great Recession (2007 to 2009). Case and Deaton⁷ later expanded on this idea, suggesting that poorer labor market opportunities experienced by this population may have contributed to declines in real wages among this group, especially as more began working in less secure service sector jobs instead of manufacturing jobs.

Others have reported higher rates of deaths of despair among those living in rural and small to medium-sized metropolitan areas. These county-level differences may be related to economic factors, such as loss of jobs, especially in manufacturing, in rural and suburban areas.^{14,15} Stein et al¹⁴ pointed to “rural disparities in access to quality health care, higher levels of isolation, and striking differences in health behavior and attitudes, such as higher rates of smoking, sedentary activity, and stigmatization of mental illness” as contributing factors. Some of this geographic variability is also reflected in the fact that counties with reduced economic opportunities also tend to have the highest rates of opioid-related overdose deaths.¹⁶ Other studies have cast doubt on economic factors being a primary contributor to opioid and other drug deaths, suggesting instead that drug availability plays a larger role in these deaths.¹⁷ Additionally, one study found that opioid availability preceded declines in labor force participation, suggesting that it is the opioids that contributed to declines in labor force participation rather than the declines in labor force participation leading to increased opioid use.¹⁸

In contrast to the attention to these economic and social factors, the role of working conditions has received less attention, even though there are a number of mechanisms potentially linking occupational health factors to the deaths of despair.¹⁹ Studies have shown differences in the deaths of despair, as well as risk factors for these deaths, by occupation and occupational exposures. The prevalence of illicit drug use and opioid-related mortality rates are highest in blue collar workers and those working in physically demanding jobs.^{20,21} Suicide risk has also been found to vary among occupational and industry groups.²² A recent meta-analysis found that the risk of suicide was higher among lower skilled occupations.²³ Among the relatively few studies examining differences in liver cirrhosis mortality by occupation, a higher rate was reported among blue collar jobs and in jobs with easy access to alcohol.^{24,25}

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Clinical significance: This paper can help to identify occupations that may be at a particular high risk for the deaths of despair (drug overdoses, suicides, and alcoholic liver disease). Additionally, these findings may be useful for identifying occupational risk factors for these causes of death.

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Because of the possibility that occupational factors may be contributing directly or indirectly to the deaths of despair, and the potential for interventions to address these factors, this study sought to discover whether the mortality rates for the deaths of despair in Massachusetts varied among groups of workers according to their occupation. Additionally, we analyzed whether the trends in mortality rates due to the deaths of despair between 2000 and 2015 differed among occupational groups.

METHODS

Data Collection

Death certificate data for all deaths for which the cause of death was either unintentional or undetermined poisoning, suicide, or alcoholic liver disease and cirrhosis in Massachusetts (MA) from 2000 to 2015 were collected from the MA Registry of Vital Records. These deaths were identified based on the primary cause of death being categorized as one of the ICD-10 codes shown in supplementary Table 1, <http://links.lww.com/JOM/A745>, which are the same ICD-10 codes used by Case and Deaton.⁶

In addition to the detailed ICD-10 codes listing the cause of death, data about multiple causes of death were also collected. Using this information, some deaths were categorized as opioid-related if the multiple cause of death fields included codes indicating that opioids were an underlying cause (supplementary Table 1, <http://links.lww.com/JOM/A745>). This is a standard method used by the Center for Disease Control to identify opioid-related deaths.²⁶ This method for categorization means that opioid-related deaths include both unintentional and intentional poisonings (suicides) as well as a few deaths with primary codes of alcoholic liver disease and cirrhosis.

The study population was restricted to Massachusetts residents between 16 and 64 years old, when most people are engaged in paid work. Deaths were excluded if the decedent was not a MA resident, was younger than 16 or older than 64, or had information on their death certificate that indicated that they were not in paid employment or had missing occupation information. Those that were excluded because of not being in paid employment included those whose death certificate (either in the occupation or industry field) indicated that they were not working, homemakers, students, members of the military, volunteers, or retired. These exclusion criteria were decided before analysis began in order to create a sample of deaths that was consistent with the working population denominator.

Data Management and Coding

Information related to the decedent's occupation, industry, year of death, age, sex, race/ethnicity, and educational attainment was collected from death certificates. The age of the decedent was classified into five categories: 16 to 24, 25 to 34, 35 to 44, 45 to 54, and 55 to 64. Sex was recorded as a dichotomous variable: male or female. Race and ethnicity were classified into five categories: white, non-Hispanic; black, non-Hispanic; Asian, non-Hispanic; Hispanics of all races; and all others. The "other" category included a diverse group including those who fell into racial/ethnic categories other than those listed above ($n = 162$), those with multiple races listed ($n = 11$), and those whose race/ethnicity was unknown ($n = 5$). More detailed classifications of race were not possible because of limited sample sizes.

The number of years of education of the decedent was used to construct a dichotomous variable distinguishing those with 12 years of education or fewer (high school education or less) versus those with 13 or more years of education (at least some college). This categorization was performed for data from 2000 through the first half of 2014. After the first half of 2014, rather than number of years of education, the highest level of education attained was directly

reported on the death certificate. Death certificates for which educational attainment was listed as 8th grade or less; 9th grade to 12th grade, no diploma; or High School grade or GED completed were classified as having a high school education or less and death certificates for which educational attainment was listed as some college credit, but no degree; certificate; associate degree; Bachelor's degree; Master's Degree; or Doctorate or Professional Degree were classified as having some college education or more.

The occupations listed on the death certificates were coded using the National Institute for Occupational Safety and Health (NIOSH) Industry and Occupation Computerized Coding System (NIOCCS).²⁷ NIOCCS automatically codes text-based industry and occupation titles to census industry and occupation codes. The system allows computer assisted coding for industry and occupation titles that are not automatically coded. For this study, we coded occupations to major census categories. Occupation was automatically coded for 86% of the deaths. Occupations on the remaining death certificates were coded manually with computer assistance through suggestions generated by the NIOCCS system.

Denominator Data

Demographic data on the Massachusetts workforce for occupation coded to census categories, age groups, sex, race/ethnicity, and educational attainment were obtained from the American Community Survey (ACS) Public Use Micro Dataset (PUMS) files for the years 2000 to 2015. The ACS is an annual survey designed to collect demographic information representative of the population of the United States. The ACS PUMS files provide annual individual level data about U.S. residents (ACS public use microdata sample, Washington, D.C.: U.S. Census Bureau). These files were used to generate denominators for rate calculations covering MA residents employed during the survey year, stratified by occupation, age group, sex, race/ethnicity, and educational attainment.

Data Analysis

For all age, race/ethnicity, sex, educational attainment, and occupation groups, we computed the numbers and percentages of all deaths of despair accounted for by that group, and the group's average annual mortality rates due to deaths of despair with corresponding 95% confidence intervals (CIs). We also computed the number and percentage of deaths of despair and annual mortality rates with corresponding 95% CIs for each year of the study. This analysis was also done separately for opioid-related deaths, suicides, and alcoholic liver disease and cirrhosis deaths. For these three categories of deaths of, the numbers and percentages of deaths of despair accounted for by that group, and the group's average annual mortality rates, were also computed. Opioid-related deaths were comprised mostly of unintentional or undetermined poisonings, but they did include some suicides and alcoholic liver disease and cirrhosis deaths. Additionally, suicides and alcoholic liver disease and cirrhosis deaths included some opioid-related deaths, if opioids were listed as an underlying cause of death.

For each occupation category, average annual mortality rates were calculated for the first 5 years of the study (2000 to 2004) and the last 5 years (2011 to 2015). Rates with corresponding 95% CIs were calculated using the annual number of deaths within each occupation as the numerator and the annual number of workers within each category as the denominator. Rates were expressed as the number of deaths per 100,000 workers per year.

Poisson regression using generalized mixed models with a log link in SAS version 9.3 (SAS Institute, Inc., Cary, NC) was used to model trends in mortality rates. Poisson regression using generalized mixed models were used because the outcome for this analysis is a count variable (deaths). For the Poisson model, the annual number of deaths was modeled with the log of the annual number of workers treated as the offset. Trends in the mortality rate

TABLE 1. Number, Percent, and Rate of Deaths of Despair Overall and by Cause of Death, Massachusetts Residents, 16 to 64 years old, 2000 to 2015

	Total*	Opioid-Related Deaths [†]	Suicide	Alcoholic Liver Disease and Cirrhosis
N	20,046	8,583	5,411	4,364
Deaths per 100,000 workers	40.2	17.2	10.8	8.7
95% confidence interval	39.9–40.4	17.0–17.4	10.7–11.0	8.6–8.9

*The sum of the individual causes of death is less than the total because there are unintentional or undetermined poisonings for which the underlying cause was a drug or substance other than opioids that are included.

[†]Opioid-related deaths include intentional and unintentional poisonings involving opioids and some alcoholic liver disease and cirrhosis deaths in which opioid were listed as an underlying cause.

for each occupation were modeled by running separate models for each occupation with year as the independent variable. Calendar years were modeled as a continuous variable and not in 5-year age categories as was done to present the average annual mortality rates. Average annual percent changes (AAPCs) with corresponding 95% CIs were calculated for all workers and for each occupation group. To calculate these AAPCs, three separate models were run for each occupation: (1) a univariate model with only year modeled; (2) a model that included age, sex, and race-ethnicity; and (3) a model that included age, sex, race-ethnicity, and educational attainment. Both the rate and trend analyses were performed on all deaths of despair, and separately for opioid-related deaths, suicides, and alcoholic liver disease and cirrhosis deaths.

RESULTS

A total of 32,336 deaths of despair occurred in MA from 2000 to 2015. There were 25,651 deaths among MA residents between the ages of 16 and 64. From these deaths, 4083 deaths were excluded because the decedents' occupation information indicated that they were not working (1628), homemakers (1541), students (830), members of the military (71), volunteers (8), or retired (5). An additional 204 deaths were excluded because their industry information indicated that they were non-paid workers (177), members of the military (18), or retired (9). Five hundred fourteen deaths were excluded because they lacked usable occupation information. Following combination with the denominator database, 804 deaths were removed because some decedents did not have corresponding denominators. These exclusions resulted in a sample of 20,046 MA residents of working age and with usable occupation information.

Opioid-related deaths accounted for the highest number of deaths of despair (8583, 42.8%) (Table 1). The vast majority of the opioid-related deaths were unintentional or undetermined poisonings (8277, 96.4%). Few opioid-related deaths were coded as suicide (301, 3.5%) or chronic liver diseases and cirrhosis (5, less than 0.1%). As described above, the all deaths of despair category included unintentional and undetermined poisonings not due to opioids. There were a total of 10,271 unintentional or undetermined poisonings of which 1994 (19.4%) were due to either an unknown substance or a substance other than an opioid.

The average annual mortality rate for all deaths of despair in the study population during this time period was 40.2 deaths per 100,000 workers (95% CI: 39.9, 40.4). For all deaths of despair, the numbers of deaths and annual mortality rates generally increased from 2000 to 2007, plateauing until 2011, and then increasing rapidly (Fig. 1). Similar trends were observed for each of the three types of deaths of despair, although opioid-related deaths increased much more rapidly after 2011 than the other two categories (supplementary Table 2, <http://links.lww.com/JOM/A745>).

The average annual mortality rates by age group generally increased with age, with the lowest rate among those 16 to 24 years old and the highest rates among those 45 to 54 and 55 to 64 years old (supplementary Table 2, <http://links.lww.com/JOM/A745>). The specific categories of deaths varied according to age (supplementary Table 2, <http://links.lww.com/JOM/A745>). The average annual mortality rate among men was over three times higher than for women. Mortality rates from these causes among white, non-Hispanics were about 50% higher than those among Hispanics of all races and black, non-Hispanics. Asian, non-Hispanics accounted

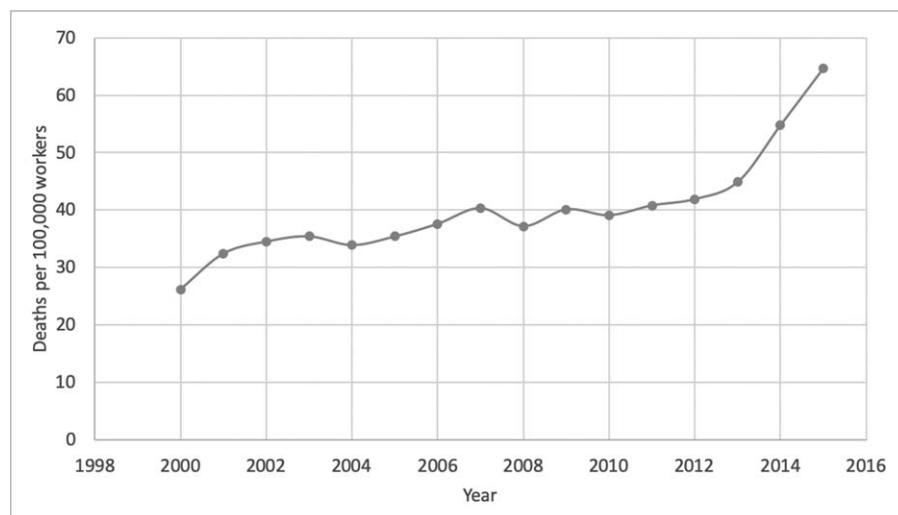
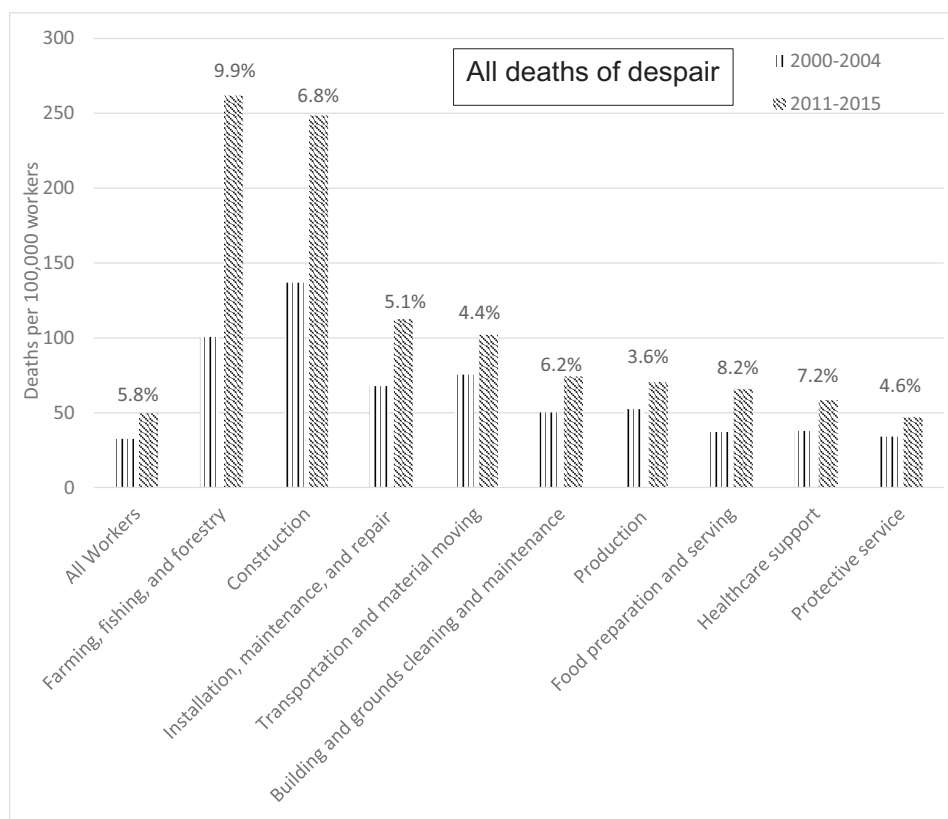
**FIGURE 1.** Mortality rate of deaths of despair over time, Massachusetts residents, 16 to 64 years old, 2000 to 2015.

FIGURE 2. Average annual mortality rates (2000 to 2004 and 2011 to 2015) and average annual percent change (AAPC, shown above bars for each occupation) in mortality rates for all deaths of despair by occupation groups with rates greater than or equal to all workers, Massachusetts residents, 16 to 64 years old, 2000 to 2015. Note: Trends control for age, sex, race/ethnicity, and education.



for less than 1% of all deaths of despair. Similar differences by sex and race/ethnicity were observed for the three categories of deaths of despair. The mortality rate among those with a high school education or less was nearly five times higher than for those with some college education or more. This disparity by educational attainment was much more pronounced for opioid-related deaths than for suicides and alcoholic liver disease and cirrhosis deaths (supplementary Table 2, <http://links.lww.com/JOM/A745>).

The average annual rate of all deaths of despair increased from 32.5 deaths per 100,000 workers in 2000 to 2004 to 49.6 in 2011 to 2015 (Fig. 2). From 2000 to 2015, the annual average percent change (AAPC) in mortality rates for all workers was 5.8%. As with the other AAPCs presented here, only the results from model 3, which adjusted for age, sex, race-ethnicity, and educational attainment, are presented. The findings from the models 1 and 2 are not markedly different from the findings from model 3. The AAPCs for all deaths of despair and the three categories of death can be found in supplementary Tables 3–6, <http://links.lww.com/JOM/A745>.

Figures 2–5 depict annual average mortality rates for the deaths of despair and the three categories of these deaths for occupations that had rates higher than the average for all workers during either the 2000 to 2004 or 2011 to 2015 time periods and also the average annual percent change in mortality rates for these occupations. For all deaths of despair and each of the three categories of deaths of despair, construction trades and farming, fishing, and forestry workers stood out as having substantially elevated rates. Among the other occupation with substantially elevated rates for all deaths of despair, installation, maintenance, and repair; transportation and material moving; building and grounds cleaning and maintenance; production; healthcare support workers also stood out as having elevated rates for all categories of

deaths of despair. Food preparation and serving workers had elevated rates for opioid-related deaths and alcohol liver disease and cirrhosis deaths and protective service workers had elevated rates for suicides and alcoholic liver disease and cirrhosis deaths.

There were several occupations that did not have elevated mortality rates in either time period for all deaths of despair, but stood out for having higher trends in one or more categories. Life, physical, and social science workers had elevated trends for both opioid-related deaths and suicides. Personal care and service and sales and related workers had elevated trends for opioid-related deaths. Management and office and administrative support workers had elevated trends for suicides (supplementary Tables 4–6, <http://links.lww.com/JOM/A745>).

DISCUSSION

The mortality rates for deaths of despair rose dramatically in Massachusetts from 2000 to 2015, more than doubling from 26.2 deaths per 100,000 workers in 2000 to 64.7 deaths per 100,000 workers in 2015. This increase has been accelerating in recent years. The epidemic of deaths of despair has not impacted all occupations equally. Occupations varied substantially in their absolute mortality rates as well as in degree of acceleration with calendar time.

This study of Massachusetts mortality data is not the first to examine the role of occupation in deaths of despair and substance use. Morano et al²¹ examined opioid-related deaths by calculating standardized proportional mortality ratios (PMRs) by occupation groups using data from 21 states between 2007 and 2012. Of the nine occupations with elevated rates in our study, five were also identified by Morano et al²¹ as being of particular concern: construction; food preparation and serving; healthcare

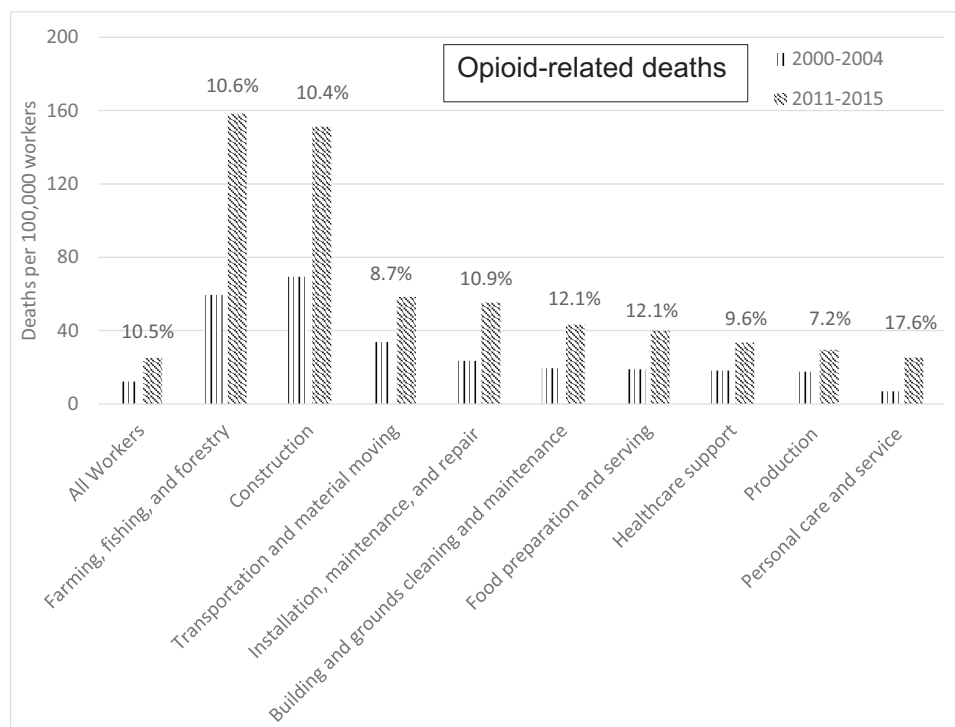


FIGURE 3. Average annual mortality rates (2000 to 2004 and 2011 to 2015) and average annual percent change (AAPC, shown above bars for each occupation) in mortality rates for opioid-related deaths by occupation groups with rates higher than or equal to that of all workers, Massachusetts residents, 16 to 64 years old, 2000 to 2015. Note: Trends control for age, sex, race/ethnicity, and education.

support; personal care and service; and installation, maintenance, and repair. One notable difference between our study and Morano et al²¹ is that they did not find elevated PMRs for farming, fishing, and forestry workers, whereas in our study this group had mortality rates over six times higher than for all workers in the

last 5 years of the study. In MA, most farming, fishing, and forestry workers are employed in commercial fishing, a sector with an elevated risk for opioid-related deaths,^{20,28} whereas nationwide the proportion of farming, fishing, and forestry workers who are fishing workers is lower.

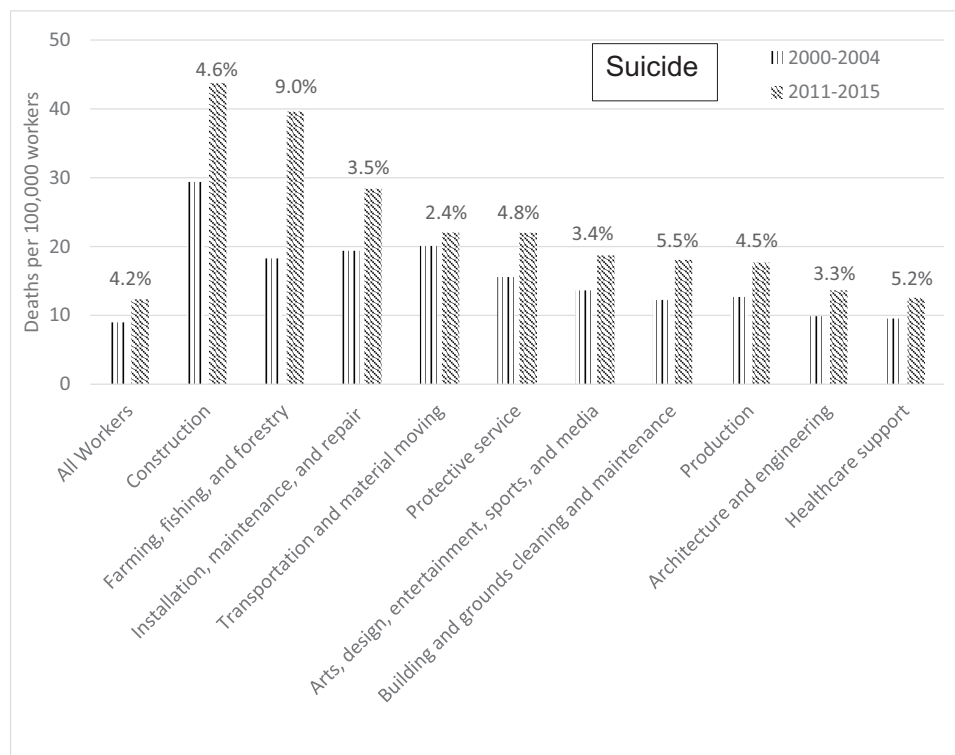
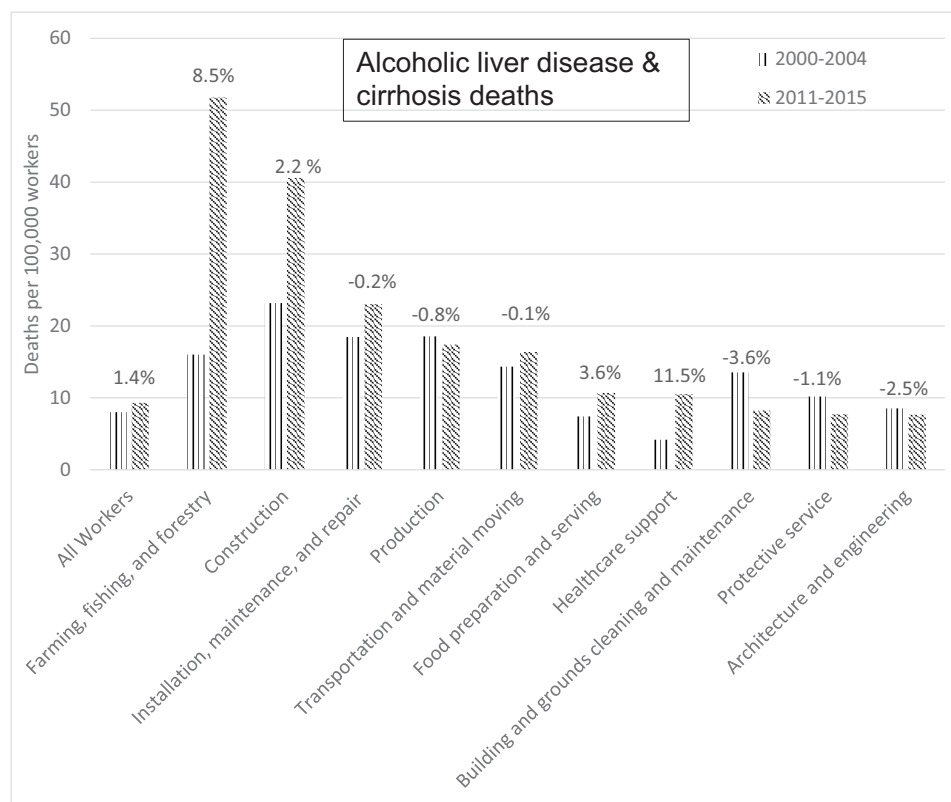


FIGURE 4. Average annual mortality rates (2000 to 2004 and 2011 to 2015) and average annual percent change (AAPC, shown above bars for each occupation) in mortality rates for suicide deaths by occupation groups with rates higher than or equal to that of all workers, Massachusetts residents, 16 to 64 years old, 2000 to 2015. Note: Trends control for age, sex, race/ethnicity, and education.

FIGURE 5. Average annual mortality rates (2000 to 2004 and 2011 to 2015) and average annual percent change (AAPC, shown above bars for each occupation) in mortality rates for alcoholic liver disease and cirrhosis deaths by occupation groups with rates higher than or equal to that of all workers, Massachusetts residents, 16 to 64 years old, 2000 to 2015. Note: Trends control for age, sex, race/ethnicity, and education.



Our findings on occupations with high suicide rates are in broad agreement with other studies.^{22,23} Milner et al²³ found that suicide tended to be elevated in elementary occupations, involving simple and routine tasks which mainly require the use of hand-held tools and often some physical effort. This category includes construction; transportation and material moving; and building and ground cleaning and maintenance workers and agriculture workers.

To the best of our knowledge, there has not been recent work examining alcoholic liver disease and cirrhosis mortality by occupation. A study of California mortality data for 1979 to 1981 reported elevated rates of alcoholic liver disease and cirrhosis mortality among waitresses; health aides, orderlies, laborers; housekeepers, janitors; bartenders; construction workers; and farm workers.²⁴

Larson et al²⁹ examined the prevalence of illicit drug use by occupational group. Six of the groups that had prevalence of illicit drug use higher than for all workers also had elevated average annual opioid-related mortality rates in our study: farming, fishing, and forestry; construction; installation, maintenance, and repair; transportation and material moving; building and grounds cleaning and maintenance; and food preparation and serving. This study covered 2002 to 2004, before opioid-related deaths had reached epidemic levels, so it is perhaps not surprising that patterns of substance abuse and of mortality do not exactly correspond. The same authors examined how heavy alcohol use differed by occupational group. Seven of the occupation groups that had prevalence of heavy alcohol use higher than for all workers also had elevated alcoholic liver disease and cirrhosis average annual mortality rates in our study: farming, fishing, and forestry; construction; installation, maintenance, and repair; production; transportation and material moving; food preparation and serving; and building and grounds cleaning and maintenance.

Construction Workers and Opioids

In Massachusetts, 2000 to 2015, construction workers stood out as having very high rates for all deaths of despair as well as elevated mortality trends for all deaths of despair with the exception of opioid-related deaths, which had an AAPC among construction workers (10.4%/yr) that, although still shockingly high, was nevertheless lower than for Massachusetts workers overall. If Massachusetts construction workers' rates from deaths of despair had not increased over the decade, but rather had remained as they were at the start of the period 1060 fewer construction workers would have died. These findings are consistent with previous work, which has demonstrated construction workers to have an elevated risk for these deaths.²⁰⁻²⁴ Some effort has been made to understand why construction workers are at an increased risk for opioid-related deaths. Construction workers have a high rate of occupational injuries³⁰ and a high prevalence of pain³¹ which may contribute to being prescribed opioids. It has also been suggested that prescribers may perceive construction workers as being less prone to addiction, which may in turn make them more likely to be prescribed opioids.³²

Among workers with injuries for which pain medication was prescribed, construction workers are more likely to be prescribed opioids, be prescribed opioids for longer time periods, and receive high doses compared with other occupations, even when controlling for a variety of covariates.³³ Additionally, opioid distributors may specifically target construction workers in their advertisement and sales strategies.³⁴ The fact that the AAPC among construction workers for opioid-related deaths was not elevated compared with other workers may be due to the fact that construction workers had high mortality rates for these deaths at the start of the period, and so the relative change in their death rates was smaller compared with other occupations, but the absolute change was still very high.

Construction workers have been reported to have a high prevalence of mental distress,³⁵ which may be a factor in their elevated rates of suicide. It has also been suggested that construction workers are less likely to seek help for mental health problems and that the transient nature of construction work does not allow some construction workers to feel that they are part of a community, which may put them at further risk for suicide.³⁶

Fishing and Opioids

In Massachusetts, farming, fishing, and forestry workers also had substantially elevated rates and trends of increasing rates for all deaths of despair and the specific categories of deaths. Seventy-five percent of the deaths among workers in this broad category were among workers engaged in fishing specifically. These findings are consistent with previous work which has demonstrated that fishing workers have elevated rates of opioid-related deaths²⁰ and agriculture workers in other states have elevated risk for suicide.²³ Like construction workers, fishing workers have a high rate of work-related injuries and musculoskeletal pain, which may contribute to their increased use of opioids.^{30,37} It has also been suggested that physical demands, high stress environments, time-pressure, and cultural attitudes to drug use in fishing may contribute to higher use of opioids.²⁸

In addition to construction and farming, fishing, and forestry workers seven other occupations stood out as having elevated mortality rates for all deaths of despair: installation, maintenance, and repair; transportation and material moving; building and grounds cleaning and maintenance; production; food preparation and serving; healthcare support; and protective services. With the exception of protective services, all of these occupations had occupational injuries and illness rates higher than for all workers in MA in 2015.³⁰ Food preparation workers had elevated rates for opioid-related deaths and alcoholic liver disease and cirrhosis, but not suicide. A number of personal factors (young age, self-selection into occupations with alcohol availability) and work-related factors (work stress, night shifts, tipped wages) among these workers have been suggested as possibly explaining the association between being a food preparation worker and substance use.³⁸ Additionally, the elevated mortality rate among protective service workers (which includes law enforcement, fire fighters, security guards, and animal control workers) was due to suicides and alcoholic liver disease and cirrhosis, but not opioid-related overdose deaths. Previous studies have found that protective service workers have higher suicide rates and alcohol use compared with other occupations.^{22,39} Elevated suicide rates among protective service workers may be due to a number of factors including sleep disturbances from shift work, occupational stress, and easier access to guns among some of these workers, especially police officers.⁴⁰

While this study is interested in uncovering the impact of factors at work on the deaths of despair, it is possible some of the relationships between occupations and these deaths may be due to economic factors, such as unemployment and not exposures faced at work directly. Previous research has suggested that increases in the deaths of despair may be due to economic changes leading to the loss of manufacturing jobs.^{7,15} In this study, production workers (who would likely be concentrated in manufacturing) had elevated rates for all of the individual categories of deaths of despair, but only slightly elevated trends for suicide. If the loss of manufacturing jobs was a primary cause of the deaths of despair, it might have been expected that their mortality rates would be increasing notably, which was not the case. These findings may be due to a few factors. First, the loss of manufacturing jobs may not in fact be a primary driver of increases in the deaths of despair. In Monnat et al,¹⁵ data were collected at the county level, which means that we do not know

whether those who were losing their manufacturing jobs in these counties were also the ones dying due to the deaths of despair. Alternatively, if the loss of jobs in manufacturing is indeed a primary contributor, then these workers may not show up in the present findings. In particular, if workers who lose their jobs in manufacturing exit the workforce and are coded as “unemployed” on the death certificate, then they would have been excluded from this study. Other workers may leave manufacturing and enter a new industry, in which case their deaths may be counted in the new occupation they assumed after leaving manufacturing. Case and Deaton⁷ suggested that manufacturing workers moving into service industries experience declines in real wages, which they hypothesize as also contributing to the deaths of despair.

Some of the differences in the rates according to occupation may be due to demographic characteristics of the workers within those occupations. We examined how differences in demographic factors related to these findings by calculating mortality ratio ratios controlling for age, sex, race/ethnicity, and sex. While some occupational differences in mortality rates might be explained by these factors, they do not appear to account for the entire relationship as indicated by mortality rate ratios still being elevated even when these factors are controlled for (supplementary Table 7, <http://links.lww.com/JOM/A745>).

This study has some limitations. First, the occupation information listed on a death certificate is the “usual” occupation in an individual’s lifetime; it may not have reflected occupation at the time of or shortly before death, and some deaths may have been among newly unemployed or retired individuals. This may have resulted in some misclassification in the numerator. Additionally, we do not know whether those who died were working at the time of death, which may have resulted in some misclassification because our denominator only included those who were employed. If workers for some occupations were more likely to list occupations that they had worked in the past, but no longer worked this will contribute to overestimate in mortality rates for the former occupations and overestimates for current occupations. Previous research has demonstrated that usual occupation is related to current occupation, however this study was not conducted using death certificates.⁴¹ Additionally, it is possible that there was some misclassification with respect to the cause of death listed on the death certificates. The biggest concern with respect to misclassification of cause of death would be suicides and poisonings. Previous research has suggested that some undetermined poisonings may in fact be intentional.⁴² Although this misclassification would not impact our opioid-related death numbers, because they include all opioid-related deaths, regardless of intent, this misclassification may lead to underestimates in the number and rates of suicides. Additionally, some previous research has included a larger pool of causes of death into their operationalization of the deaths of despair, for example chronic disease other than liver disease and cirrhosis associated with drug use and mental health and behavior symptoms associated with drug and alcohol use, like withdrawal.¹⁵ Our more narrow definition will therefore not be perfectly comparable with these previous studies. Future work should consider exploring occupational differences according to these other causes of death.

If the ongoing epidemic in deaths of despair is to be prevented, we must understand which factors are contributing both to differences in the absolute risk of mortality due to the deaths of despair according to occupation and also to differences in trends in mortality. Particular attention should be given to occupational factors that have already been found to be associated with drug use, especially opioids and alcohol, and mental health and suicide. There is a growing body of literature about the

relationship between occupational injuries and opioid use and overdose.^{20,43–47} Difficult job circumstances including job insecurity, low control, and long work hours have been identified as contributors to suicide and/or suicide ideation.^{48,49} Because this study found that trends—in addition to rates—for these deaths were increasing faster for workers in some occupational groups compared with others, additional efforts should be put into understanding how the changing nature of work may be contributing to these deaths.⁵⁰ Marked changes at the workplace including decreases in routine work, the rise of contingent work arrangements, and decreases in unionization have been occurring at the same time that we have been seeing increases in the deaths of despair.^{51,52} The potential relationships among these phenomena deserve further attention.

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