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Worker exit and suicide and overdose mortality in a cohort of male non-metal mine workers

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ABSTRACT

Background: Suicides, overdoses, and drug-related liver diseases (deaths of despair) are greatly elevated in the mining and extraction industries compared to other industries. To better understand the drivers of these deaths, we examined suicide or overdose mortality in relation to age at worker exit among a retrospective cohort of 11,009 male mine workers from the Diesel Exhaust in Miners Study II.

Methods: We calculated age-adjusted mortality rates (1947–2015) and estimated hazard ratios (HRs) and 95% Confidence Intervals (CI) for suicide or overdose death in relation to age at worker exit (leaving work). The mining industry curtailed its workforce in the early 1980s due to economic downturn; therefore, separate models were fit for worker exit pre- and post-1980.

Results: Suicide deaths peaked between 1980 and 1989 at 67.2 per 100,000, more than double the rate in the general population. The hazard rate for suicide or overdose was 2.56 times higher for inactive versus actively employed workers (95% CI: 1.88, 3.50). Based on 187 suicides or overdoses, associations between younger age at worker exit and suicide or overdose death were null or protective before 1980. However post-1980, those who exited between ages 30–39 years had an elevated risk of death HR = 1.33, 95% CI (0.70, 2.53) and those who exited before age 30 had a HR for suicide or overdose of 1.57 (0.83, 2.96) compared to those who exited work after age 55.

Conclusion: Worker exit may contribute to the elevated mortality from suicide or overdose among male mine workers, particularly among younger age groups.

1. Introduction

In the United States (US), increasing mortality among working-age (i.e., 25–64 years) adults contributed to a striking decline in US life expectancy from 2015 to 2017 (Murphy et al., 2018). This decline is largely attributed to rapidly increasing death rates from drug and alcohol poisonings, alcoholic liver disease, and suicides (Case and Deaton, 2015; Dowell et al., 2017; Hedegaard et al., 2021). Coined "deaths of despair" by Case and Deaton (Case and Deaton, 2015), these deaths are observed particularly among middle-aged non-Hispanic white men with less than a high school education (Case and Deaton, 2017). Research has increasingly linked construction, mining and extraction with elevated rates of suicide and overdose relative to other occupations and the general population (Harduar Morano et al., 2018; Peek-Asa et al., 2021; Peterson et al., 2020). In 2016, the suicide rate among males in the mining, quarrying, and extraction industries was 54.2 (95% Confidence Interval (CI): 44.0–64.3) per 100,000 persons (Peterson et al., 2020), making it the highest among all industries and more than double the general US male population rate of 21.4 (Hedegaard et al., 2018). Given that over 650,000 people were employed in the US mining and extraction industries as of 2018 (*Employment and wages in mining industries*, 2018), these estimates highlight the significant public health burden posed by suicide and overdose within the industry.

Since 2015, mortality rates due to illicit opioids, such as fentanyl, have outpaced those attributed to prescription opioids (Dai et al., 2019), bringing more attention to the role of declining socioeconomic

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conditions and increasing drug use disorders (van Draanen et al., 2020). A growing body of literature has revealed associations between economic distress and poor mental health and substance use. Of note, economic changes and industrial restructuring are inherently spatial and US regions focused on mining and extraction have been plagued by several unemployment downturns and wage stagnations in recent decades (Monnat, 2018). These macro-level labor market stressors often exacerbate the impacts that job loss already has on mental health (Milner et al., 2018) and consequently, they impose community-level traumas through lower rates of health care usage and social cohesion, and higher rates of substance use and physical injury (Monnat, 2018, 2019). Indeed, in a study of economic recession, job or financial issues preceded 13% of the suicides examined (Coope et al., 2015), while a systematic review found that, for nearly all 48 studies, a period of recession preceded increases in suicide mortality rates (Guerra and Eboreime, 2021). Although job loss and insecurity can worsen mental health, this economic research underscores the significance of structural contexts in amplifying the risk of suicide or overdose beyond the impact of job loss alone, urging ongoing consideration of these broader factors.

Life course and economics scholars stress the importance of considering both the timing of job loss within the social, political, and economic environment and within a person's life (Gray and Dagg, 2019). Several shocks to the US economy occurred in the early 1980s, when two recessions hit in three years, and the manufacturing and mining industries never quite recovered production levels (Brandon, 2012; Plunkert, 1990). Employment in the overall mining industry dropped nearly 25%, and declined by 7% in non-metal mining specifically (Brandon, 2012; Plunkert, 1990). These boom-and-bust cycles, typical of extraction industries, are known to have adverse health effects (Boslett and Hill, 2022). This literature on the importance of place and local economic conditions on mortality and mental health (Finkelstein et al., 2021) forms the basis of our investigation of mining deaths in the context of the macroeconomic environment.

In this analysis of the Diesel Exhaust in Miners Study II (DEMS II), we compare age-adjusted suicide and overdose rates between men in the mining industry and the general US male population. To better understand the potential impact of leaving work on suicide and overdose mortality among miners, we also investigated the role of age at worker exit. To examine whether the precipitous decline in the non-metal mining industry that occurred post-1980 modified the association between age at worker exit and suicide or overdose, we further stratified our analysis into pre- and post-1980 periods.

2. Materials and methods

2.1. Study population

The DEMS and DEMS II cohorts have been described previously (Koutros et al., 2023). Briefly, DEMS was conducted jointly by the National Institute of Occupational Safety and Health (NIOSH) and the National Cancer Institute (NCI) to study lung cancer in eight non-metal US mining facilities located in in Missouri (1 limestone mine), New Mexico (3 potash mines), Ohio (1 salt mine), and Wyoming (3 trona mines). DEMS II was also conducted by NCI and comprises the same 12, 315 non-metal mine workers, but extends mortality follow-up from 1997 to 2015. Exposure histories were documented through 1999. All workers were employed at the study mines for at least one year after the introduction of diesel equipment, which ranged from 1947 to 1967 across the eight mines. Workers were followed for mortality from their hire date or the start of dieselization, whichever occurred later, through 2015.

We restricted to a sub-cohort of 11,009 male mine workers of either White or unknown race/ethnicity. Due to the small numbers of suicides and overdoses as well as the documented burden of suicide among male miners (Peterson et al., 2020), we excluded 498 females and 808 additional workers with race/ethnicity in the "other" category.

2.2. Outcome

We defined two outcomes: suicide mortality and overdose mortality. Overdose mortality was defined as a death due to accidental poisoning, late effects accidental poisoning, and alcohol poisoning (Case and Deaton, 2015). Vital status of each subject was ascertained through 12/31/2015 by linkage with National Death Index (NDI) and Social Security Administration mortality files. Cause of death information was obtained from NDI Plus, or pre-1979, from death certificates coded by a certified nosologist. We identified suicide mortality using codes from the International Classification of Diseases (ICD) (Table S1). Cases were defined using underlying cause of death and the first two other contributing causes of death; therefore, a subject could be classified with more than one cause of death. In this study, if a death was due to both suicide and overdose, we classified the case a suicide death (n = 28).

2.3. Exposure

Our primary exposure was age at worker exit. Date of worker exit was obtained via employment records. Age at worker exit was calculated as the difference between an employee's birth date and their job end date. The definition of worker exit excluded those who died while employed and who died within one day of exiting work. To distinguish retirement from early exit, we categorized age at exit into four groups (<30, 30–39, 40–54, and ≥ 55 years). We defined exit at ages ≥ 55 as retirement-age exit. This is the reference group since the exit likely voluntary (Brandon, 2012). We hypothesize that early-age exit workers who left work when they were <55 years (the 75th percentile of the age at worker exit) were less likely to have left voluntarily and may have an increased risk of suicide or overdose mortality.

2.4. Confounders

Individual characteristics, including age, sex, race/ethnicity, hire date, work location (surface, underground), mine type (i.e., salt, trona, potash, limestone), and date of worker exit were obtained from employment records. Race/ethnicity was limited to "White" including non-Hispanic White or Hispanic, and "unknown". Workers on the surface for their entire work history were classified as "surface only". Those who worked underground at any time during their work history after dieselization were classified as "ever-underground" (Ferguson et al., 2020). Follow-up time for each miner was characterized as actively employed or inactive after termination. A directed acyclic graph (Fig. 1) illustrates the anticipated relationships between age at worker exit (exposure), suicide or overdose mortality (outcome), and measured and unmeasured confounders.

2.5. Statistical analysis

We estimated age-adjusted suicide mortality and overdose mortality rates, respectively, in the DEMS II cohort from 1947 to 2015 by decade among workers 24–65 years. Due to small numbers of suicide and overdose, we combined the early calendar periods (i.e., 1947–1979 for suicides). We calculated 95% confidence intervals for mortality rates using the gamma distribution for Poisson counts. Age-adjustment was performed via direct standardization based on the 2000 census of the US male population. For comparison, we calculated age-adjusted suicide and overdose mortality rates, respectively, in men of working age (24–65 years) in the general US male population overall and among states with DEMS II mining sites (Missouri, New Mexico, Ohio, and Wyoming) using the Centers for Disease Control and Prevention's (CDC) Wide-ranging Online Data for Epidemiologic Research (WONDER) database (https://wonder.cdc.gov/mortSQL.html). Through WONDER, we calculated annual rates over calendar year categories from 1968 to 2015. The year 1968 was the earliest available in the WONDER database. As with the DEMS II cohort rates, these annual WONDER rates

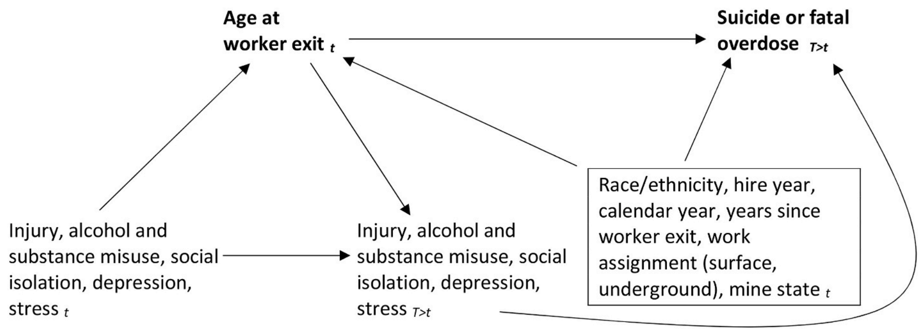

Fig. 1. Directed acyclic graph representing our working assumptions about the causal relationships between age at worker exit, suicide or overdose, and a simplified set of confounders (a box is drawn around the measured confounders). Effect modification by the economic environment (pre-1980 vs post-1980) is not shown.

were age-standardized to the US male 2000 population.

First, adjusted hazard ratios (HR) for suicide or overdose were estimated in relation to employment status (inactive vs actively employed) in a Cox proportional hazards model based on those with complete work records, using age as the time scale. We similarly assessed cumulative time inactive. To estimate the impact of age at worker exit, we fit Cox models with follow-up starting the year of exit and time since worker exit as the scale. Individuals still employed when work records ended (i.e., 1997) or who died at work were excluded.

We a priori conceptualized the economic environment as a potential effect modifier (Attia et al., 2022; Brandon, 2012; Plunkert, 1990). Mine type, year of hire, and calendar year were included in the Cox models to adjust for confounding. A sensitivity analysis for the primary results included race/ethnicity as an additional confounder. Race/ethnicity was excluded from the primary analysis because of the lack of detail available for 57% of the cohort (the unknown category). Time-varying confounders affected by prior exposure, such as injury and stress prior to leaving work, are unmeasured.

To assess effect measure modification by socioeconomic period, we stratified our models to compare worker exit between periods of mining industry growth (pre-1980) and industry downturn, with major lay-offs and facility closures (post-1980) (Brandon, 2012; Plunkert, 1990). For each period, we fit separate models assessing the impact of age at worker exit on suicide or overdose. To determine whether HRs between those exiting work pre- and post-1980 were significantly different, we calculated the ratio of the HRs and the p-values for interaction (Altman and Bland, 2003; Knol and VanderWeele, 2012). As a secondary analysis, we used Cox models with time since worker exit as the scale to examine suicide and suicide or overdose in relation to the decade of worker exit.

The baseline hazards of all Cox models were stratified by state of employment (Missouri, New Mexico, Ohio, or Wyoming) which was equivalent to mine type (limestone, potash, salt, and trona, respectively) (Ferguson et al., 2020).

Cox modeling was performed in Stata version 16, 2019 (Stata Corp LLC, College Station, TX, USA). This study was approved by the Office for the Protection of Human Subjects at the University of California, Berkeley (2013-02-4994). The DEMS II dataset was obtained under data-transfer agreement with the National Cancer Institute. Personal identifiers were removed from the data, and the study was approved by the Human Subjects Review Boards at the University of California, Berkeley and the National Cancer Institute.

3. Results

Among the entire cohort of 12,315 workers, 84% worked in Wyoming trona mines or New Mexico potash mines, reaching peaks pre-1980 of ~3000 and 1500 employees, respectively (Fig. S1). Shortly thereafter, large decreases in employment occurred, especially in Wyoming, which dropped by 27% from 1980 to 1985. See Fig. S2 for a timeline of exiting workers by state.

Among the 11,009 men, there were 4559 deaths by the end of follow-up, including 262 deaths due to suicide (n = 178) or overdose (n = 84) (Table 1). Those who died via suicide were born earlier and worked longer than those who died via overdose. Among the 241 suicides or overdoses with known exit status at the time of death, 82% occurred after worker exit (Table 2).

Age-adjusted mortality rates per 100,000 person-years for suicide (Fig. 2) among the DEMS II male cohort are consistently higher than the US male population overall and the DEMS II mining states. Over the entire follow-up period, the DEMS II age-adjusted suicide mortality rate was 42.4 (95% CI: 35.2–50.5). Over time, the suicide rate increased from 29.3 (1940–1979) to a peak of 67.2 in the decade 1980–1989 before dropping in the next decades to 47.6. This pattern was reflected by the age-adjusted rates for suicide among mine workers at the most populous sites, Wyoming, and New Mexico (Table S2). DEMS II cohort rates for overdose remained above the general populations until 2000 and the peak occurred in the 1990s at 49.1 (95% CI: 31.8–72.7) (Fig. S3). When suicide was combined with overdose (n = 202 among workers 25–64 years), the age-adjusted mortality rate over the entire follow-up period was 65.2 (95% CI: 56.2–75.1).

The adjusted HR was elevated at 2.56 (95% CI: 1.88–3.50) for inactive compared to active workers. Additionally, suicide and overdose risk was most elevated at 1.45 for those with 1–2 years of inactive time compared to zero (95% CI: 0.85–2.48) (Table S3). Table 3 presents results from Cox models restricted to those who exited work and whose employment follow-up was complete (n cases = 187). HRs comparing each age group at worker exit to the reference group of those exiting work at 55 years or older (retirement-age exit), were null (Table 3). Follow-up was then stratified by age at worker exit pre- and post-1980 to examine effect measure modification by the socioeconomic environment. Results are generally null or protective for all age groups among those exiting pre-1980. However, post-1980, results for age at worker exit are monotonic with effect estimates increasing with decreasing age at exit. Results rose to a HR of 1.57 (95% CI: 0.83–2.96) comparing those exiting work before 30 years of age to those exiting near retirement (≥ 55 years). The ratio of HRs consistently indicated greater risk of death for those exiting post-1980 compared to pre-1980, in each age category (Table 3). Similar results are shown in Table S4 with additional adjustment for race/ethnicity.

As a secondary analysis, we examined associations between calendar period and suicide or overdose and suicide only (Table S5). Using 1947–1969 as the reference, suicide or overdose mortality rates by decade of worker exit rose to a statistically significant peak HR of 2.38 (n = 66; 95% CI: 1.28–4.43) in the 1980s before dropping to a lower but still elevated HR of 1.98 (95% CI: 0.90–4.38) in the 1990s (Table S4). Examining suicide only, our results were elevated when comparing each decade to the reference, although the confidence intervals were wider and included the null.

Table 1
Demographic characteristics by cause of death, among males in the Diesel Exhaust in Miners Study II (DEMS II) cohort 1947–2015. [a]

Characteristic	Cohort (N = 11,009)		Suicide or Overdose (N = 262)		Overdose Only (N = 84)		Suicide (N = 178)	
	N (%)	Median (P25–P75)	N (%)	Median (P25–P75)	N (%)	Median (P25–P75)	N (%)	Median (P25–P75)
Race/ethnicity								
White	4736 (43.0)		137 (52.3)		35 (41.7)		102 (57.3)	
Unknown	6273 (57.0)		125 (47.7)		49 (58.3)		76 (42.7)	
Location								
Ever-underground	7435 (68.0)		190 (72.5)		63 (75.0)		127 (71.3)	
Surface-only	3574 (32.5)		72 (27.5)		21 (25.0)		51 (28.7)	
Duration of Employment (years) [b]		7.6 (3.0–19.1)		7.7 (2.9–18.7)		6.3 (3.3–14.3)		9.7 (2.8–19.9)
Birth Year		1946 (1931–1954)		1948 (1933–1954)		1951 (1941–1956)		1946 (1931–1954)
Death Year		1999 (1987–2008)		1992 (1984–2000)		1993 (1985–1996)		1991 (1983–2002)
Age at Hire (years)		26.0 (21.7–34.1)		25.2 (21.6–30.9)		24.3 (21.1–29.3)		26 (22.0–31.2)
Age at worker exit [b]		37.9 (28.3, 56.0)		34.2 (27.3, 48.1)		31.6 (25.8, 41.4)		35.6 (28.6, 50.8)
Age at Death (years) [c]		68.9 (58.9–78.9)		47.4 (36.5–58.5)		44.6 (36.5–54.4)		48.4 (36.8–61.6)

Abbreviations: IQR = interquartile range.
[a] Deaths are coded from the underlying cause of death and top two contributing causes of death. A person can have multiple causes of death. "Overdose only" are cases of overdose not defined as also due to suicide, those such cases were categorized as suicide.
[b] Among those who left work or died at work.
[c] Among those who died, n = 4559.

Table 2
Deaths by Suicide or Overdose by Cohort Follow-up in the Diesel Exhaust in Miners Study II (DEMS II) cohort 1947–2015.

Causes of Death	Cohort (N = 11,009)	While Employed (N = 188)	After Worker Exit (N = 7846)	Exit Status Unknown [b] (N = 2900)
Suicide or Overdose	262	43 (16.4%)	198 (75.6%)	21 (8.0%)
Overdose only [a]	84	16 (19.0%)	64 (76.2%)	4 (4.7 %)
Suicide	178	27 (15.2%)	134 (75.3%)	17 (9.6%)

[a] Deaths are coded from the underlying cause of death and top two contributing causes of death. A person can have multiple causes of death. "Overdose only" are cases of overdose not defined as also due to suicide, those such cases were categorized as suicide.
[b] Work records ended before exit status at the time of death could be determined.

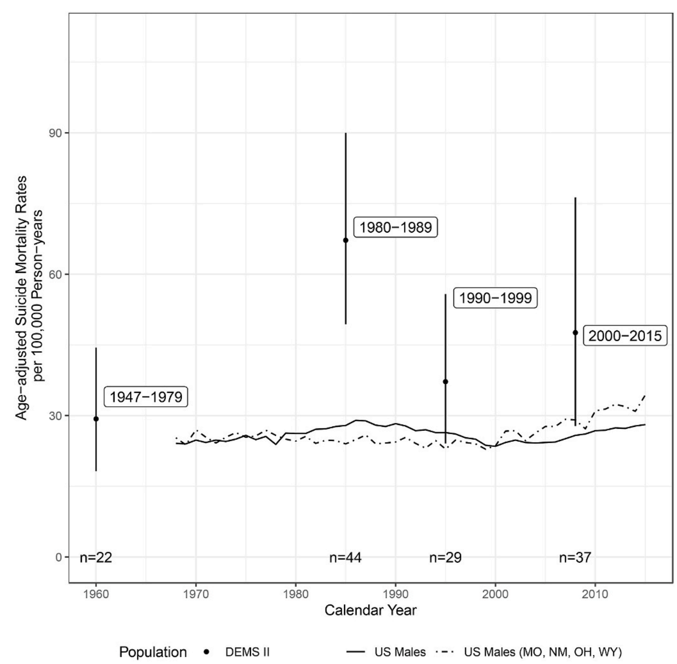

Fig. 2. Age-adjusted suicide mortality rates among men in the DEMS II cohort (1947–2015), the United States (US) overall, and the US states Missouri, New Mexico, Ohio, and Wyoming (1968–2015). Age-adjusted DEMS II cohort suicide mortality rate point estimates are represented by the solid dot with 95% confidence intervals being the surrounding vertical lines. Age-adjusted suicide mortality rates for the US are represented by the solid line and for the select US states by the dashed line.

4. Discussion

Suicide rates among DEMS II male mine workers were consistently higher than US males nationally or statewide from 1980 to 2015. The DEMS II rates were similar to that reported in 2016 from US mining, quarrying, and extraction industries, indicating that suicide remains a long-standing public health crisis in these industries (Peterson et al., 2020). In addition, fatal overdose rates in DEMS II were generally elevated relative to national and statewide rates. When we investigated the impact of worker exit on the risk of suicide or overdose, we found that exit at younger ages was associated with greater risk. This relationship between exit age and suicide was likely modified by the economic environment. We observed null effects pre-1980; however, post-1980, when the mining industry was struggling to recover from economic declines and facility downsizing (Brandon, 2012; Plunkert, 1990), age-stratified risks rose monotonically to a HR of 1.57 for those exiting younger than 30 years.

The profound psychiatric consequences of economic instability have been particularly observed among younger individuals who often work at lower wages and possess less experience and skill (Bell and Blanchflower, 2011). Job losses due to international trade have highly localized impacts, with layoffs, unemployment, and lower wages concentrated in specific labor markets (Autor et al., 2016). Region-specific industries are particularly exposed (Ellison et al., 2010). The loss of such jobs may pose problems for people of young ages given that prolonged youth unemployment may lead to reduced self-efficacy, feelings of hopelessness, and negative impacts on future plans – risk factors for deaths of despair (*Special Issue on the Impact of the Global Economic Crisis on Youth*, 2010). In short, trade-related jobs can be extremely valuable (Davis and

Table 3
Adjusted hazard ratio (HR) estimates for suicide or overdose after worker exit by age at worker exit (N = 7731).

Age at worker exit	Entire Cohort [a]			Worker Exit before 1980			Worker Exit After 1980			Ratio of HRs [b]	Test of Inter-action [c]
	N Cases = 187			N cases = 97			N Cases = 90				
	N cases	HR	(95% CI)	N cases	HR	(95% CI)	N cases	HR	(95% CI)		
55 years or older	35	1.00	–	18	1.00	–	17	1.00	–		
40–54 years	32	0.88	0.53, 1.45	17	0.56	0.28, 1.12	15	1.19	0.58, 2.43	2.13 [0.79, 5.70]	0.13
30–39 years	52	0.91	0.58, 1.43	26	0.51	0.27, 0.98	26	1.33	0.70, 2.53	2.61 [1.09, 6.26]	0.03
<30 years	68	0.86	0.55, 1.34	36	0.41	0.22, 0.76	32	1.57	0.83, 2.96	3.77 [1.63, 8.98]	<0.01

Cox models used time since worker exit as the scale, stratified the baseline hazard by mine state of employment (Missouri, New Mexico, Ohio, or Wyoming), and adjusted for 5-year calendar interval, and work location (surface, underground).

[a] Population is restricted to persons who exited work. Excludes person whose employment follow-up is censored and persons who died at work and those who died within one day of exiting work.

[b] The Ratio of the hazard ratio can be used to understand if the hazard ratio for suicide or overdose for a given age at worker exit category (e.g. 40–54 vs the reference of 55 years or older) is different based on if the worker exited before or after 1980 (the two stratified estimates). A RHR >1 means the HR among workers exiting after 1980 is larger than the HR for workers exiting before 1980, for a given age at worker exit category.

[c] Two-sided p-value to compare estimates on a log scale and the reported p-value from these stratified hazard ratio estimates is equivalent to the p-value obtained from one model with an interaction for socioeconomic period. The p-values are evaluated at the 5% level of significance.

Harrigan, 2011). However, even when new employment is found after job loss, as the age at job loss decreases, the resulting dislocation and economic shock may lead to an increased risk of suicide and overdose.

The current research on work-related psychosocial factors is limited, especially in large-scale prospective cohort studies (Kim and von dem Knesebeck, 2016). Further understanding how occupational conditions affect suicidal behavior is important, as a large proportion of all suicidal ideation, attempts, and deaths occur among working-age individuals, with especially high risk among those in construction and extraction (Han et al., 2016). Stressors, including job insecurity, are assumed to contribute to an increased risk of mental health problems due to wear on body regulation functions and/or increases in risky behaviors (Kim and von dem Knesebeck, 2016). Due in part to recent economic recessions, advancements in technology, labor market deregulation and offshoring manufacturing, US job insecurity has risen (Johnston et al., 2020). Although we were unable to measure stress or risky health behaviors as mediators, we assessed potential effect measure modification via the broader economic environment (i.e., period of increased layoffs).

Implementation of suicide and fatal overdose prevention programs in the mining industry could provide counseling and education to workers and increase awareness in this high-risk occupation. The 2012 revised National Strategy for Suicide Prevention encourages community-based settings, such as workplaces, to implement wellness and suicidality prevention programs (Office of the Surgeon & National Action Alliance for Suicide, 2012). Importantly, age differences were identified in suicide literacy in the construction (King et al., 2019) and energy (Ross et al., 2020) sectors. Younger workers reported a lack of awareness of the warning signs of suicidal ideation; however, they were also more likely to consider mental health a workplace health and safety issue. Therefore, the effectiveness of a workplace suicide awareness program may be highest if it is implemented soon after workers are hired.

The World Health Organization suggests a comprehensive workplace approach by raising suicide literacy, preventing and reducing job stress, early detection of mental health difficulties, and early intervention through employee health and assistance programs (Tiesman et al., 2015). Such workplace suicide prevention programs have demonstrated efficacy and could be highly beneficial for workers of any age. For example, a large law enforcement cohort study found a 79% decrease in suicides in the 12 years since the implementation of a suicide prevention program (Mishara and Martin, 2012). Although little is known regarding the details of and exposure to suicide and overdose awareness programs in the US mining industry, the results of this study suggest there are opportunities to implement or improve these programs, identify workplace factors that induce strain and contribute to psychological distress in employees, and restructure safety policies and practices to include mental health.

Our study has important strengths, including a large occupational cohort with nearly 70 years of follow-up. Limitations include the lack of information about the specific reasons for worker exit or any employment information beyond 1999. Suicide and overdose mortality are outcomes resulting from a complex confluence of socioeconomic, social, and individual factors. The interpretation of our results is constrained by lack of information on injury, alcohol and substance misuse, social isolation, and depression or anxiety prior to leaving work. Finally, the lack of available information on race/ethnicity limited our ability to explore how the impact of age at worker exit on suicide or overdose may differ by membership in a socially racialized and/or marginalized group.

5. Conclusions

The capacity of policy makers to identify mining-related mental health issues is limited by an absence of empirical investigation. Building on a scarcity of research, we found an association between job loss at younger ages and suicide or overdose death among male mine workers. In particular, risk was elevated post-1980, a period of decline in US mining when worker exit was likely related to facility downsizing and closure. Our findings support the need for counseling and educational awareness programs for suicide prevention in the mining industry. Such efforts should incorporate the impact of economic circumstances on suicide risk. Based on our retrospective cohort analysis, we expect that future economic recessions may have similar impacts on US mine workers if effective mental health awareness programs are not established and maintained. Finally, we recommend more comprehensive research on the impacts of workplace practices and policies such as shiftwork, contract work, salaries, and safety protocol on mine worker health. A view that covers these structural aspects of the workplace will ensure more effective development of targeted education and interventions to promote mental health in mining.

CRediT authorship contribution statement

Hilary L. Colbeth: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Jacqueline M. Ferguson:** Writing – review & editing, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Sally Picciotto:** Writing – review & editing. **Stella Koutros:** Writing – review & editing. **Debra T. Silverman:** Writing – review & editing, Funding acquisition, Data curation, Conceptualization. **Ellen A. Eisen:** Writing – review & editing, Methodology, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmmh.2024.100336.

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