Original research

Maryland opioid overdose deaths from 2018 to 2022: occupational patterns and their sociodemographic variations

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ABSTRACT

Introduction We aimed to describe the occupational pattern of opioid overdose deaths in Maryland between 2018 and 2022 and determine the occupations at higher risk of opioid overdose death.

Methods The sample included undetermined or unintentional opioid overdose deaths among those aged 16 years or older in Maryland, drawn from the State Unintentional Drug Overdose Reporting System. We calculated population-based incidence overdose rates by occupation, stratified by sex and race. We further calculated the incidence rate ratios (IRRs) comparing each occupation with all other groups combined and estimated the IRRs among males versus females and non-Hispanic whites versus other racial/ethnic groups.

Results The pooled sample included 11 455 opioid overdose decedents (72% male and 55% non-Hispanic whites) of whom 80% were employed. The three occupation groups with the highest incidence rates were 'construction and extraction', 'transportation and material moving' and 'installation/maintenance and repair' with 291, 137 and 133 deaths per 100 000 workers in these respective occupational groups. Incidence rates were significantly higher in males than females in all categories except those 'Not in Labour Force' (IRR=0.51, p<0.001). Non-Hispanic whites relative to other racial/ethnic groups had a lower incidence of opioid overdose death in 'Military-Specific' occupations (IRR=0.53, p=0.031).

Conclusion Opioid overdose deaths vary by type of occupation and certain occupations are at higher risk of overdose death. The findings highlight the need for priority setting in the implementation and expansion of existing strategies to target the workers most impacted by opioid overdose.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Although there are an increasing number of studies investigating the incidence of fatal opioid overdoses by occupation, the existing literature is primarily based on data drawn exclusively from death certificates and little is known about the occupational pattern of overdose deaths in the state of Maryland.

WHAT THIS STUDY ADDS

⇒ Using the State Unintentional Drug Overdose Reporting System which is one of the most reliable databases for opioid overdose, the occupation groups with the highest incidence rates of opioid overdose death were identified.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings suggest that there is a need for further implementation/expansion of preventive and treatment programmes for opioid use disorder and its serious consequences, especially for certain occupations with a higher rate of opioid overdose death.

INTRODUCTION

Drug overdose has been increasing over the past decade in several countries, with particularly high mortality in the USA.[1 2] Among US states, Maryland ranks in the top 10 for opioid overdose deaths (36.1 per 100 000 in 2022), primarily attributed to illicitly manufactured fentanyl (33.5 per 100 000 overdose deaths in 2022).[3]

Despite a common misconception that those who use illicit drugs are unemployed, evidence shows that most of them are employed.[4] Data from the 2019 National Survey on Drug Use and Health (NSDUH) show that >69% of people reporting past 12-month use of illicit drugs were employed full- or part-time.[5] NSDUH data also show that 64.8% of people reporting past 12-month opioid use and 63.5% of people reporting past 12-month non-medical use of prescription opioids were employed.[5] The overdose death rate (92.9 per 100 000) among people of working age (ie, aged 15–64 years) is higher than for other age groups,[6] further emphasising the importance of examining occupational patterns of overdose deaths.

A growing body of literature suggests that the risk of fatal opioid overdoses varies by occupation.[7–11] Data from the Bureau of Labor Statistics' (BLS's) Census of Fatal Occupational Injuries showed an average annual increase of 24% in workplace drug overdose deaths between 2011 and 2016 in the USA with a variation by industry and the sociodemographic characteristics of the decedents.[12] Workers in occupations with high risk for physical injuries, for example, 'construction and extraction', may be at higher risk for non-medical prescription opioid use and illicit opioid use.[13] Certain occupations have been characterised as a 'pathway to opioid use

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disorder' because of their negative effects on the body.[10] People who work in physically demanding jobs experience chronic and acute musculoskeletal injuries, which may lead to pain and disability requiring prescription opioid treatment to manage pain[7 14] which predisposes them to non-medical opioid use and opioid use disorder (OUD). Research suggests that workplace injuries increase the likelihood of opioid-related morbidity by 70% within 3 years of injury.[15]

There is growing recognition of opioid-related morbidity and mortality in the workforce; however, the available literature is based on data exclusively drawn from death certificates, is primarily at the national level or is limited to workplace drug overdose deaths.[12] A few state-level studies have shown variations in the occupational pattern of overdose deaths,[7 8] but little is known about this pattern in Maryland, a state heavily impacted by the opioid epidemic. In the current study, we used recent data from Maryland's State Unintentional Drug Overdose Reporting System (SUDORS), a comprehensive dataset that draws from multiple sources beyond death certificates to ascertain opioid-related deaths (see the Methods section).[16 17]

We conducted a descriptive analysis of opioid overdose decedents in Maryland by sociodemographic characteristics and occupational status. Additionally, we examined the incidence rate of overdose in each occupation group and compared it with all other groups combined, in the total sample, as well as in the stratified sample by sex, and race/ethnicity. Findings from the current study can be used to target policy and programme interventions primarily for Maryland's worker populations that are most impacted by the opioid crisis.

METHODS

Sample

This secondary data analysis study used a pooled dataset of SUDORS data from 2018 to 2022. The datasets include decedents from Maryland whose manner of death was undetermined or unintentional. The data include all substances designated as the cause of death (COD) based on the International Classification of Diseases, Tenth Revision (ICD-10) codes X40-X44 and Y10-Y14. We limited the data to overdose decedents with opioids as a COD which includes both prescription and illicit opioids such as hydrocodone, oxycodone, oxymorphone, morphine, codeine, fentanyl, heroin and fentanyl analogues.

The SUDORS dataset is compiled from primary sources including law enforcement and medical examiner reports, and death certificates. A team of trained data abstractors review these documents and code information according to CDC guidelines,[18] which includes detailed instruction on case inclusion, data and variable requirements, and coding procedures. Abstractors cross-check fields where opioids are involved to verify ICD-10 codes and determine the COD, particularly when codes are missing or incorrect. The completeness of each record depends on the availability and accuracy of source documents, so some variables may be marked as unknown or missing if evidence is insufficient.

We used the usual occupation and industry information provided in a free text format to identify employment status and categorise the employed decedents into occupation groups. We did not use current occupation data due to significant missing information and the possibility that it may not reflect the decedents' longest-held occupation.

The occupation and industry descriptions were encoded using the 2018 Standard Occupational Classification System (SOC-2018) through the CDC's web application for the Industry and Occupation Computerized Coding System (NIOCCS) of the National Institute for Occupational Safety and Health (NIOSH).[19] Upgraded in 2021 with machine learning, NIOCCS applies sophisticated prediction models that can learn and improve from experience. Therefore, there are minimal data quality issues in the classification of occupation in the current study relative to other studies that manually categorised the occupation and industry data because it is less prone to human error in encoding descriptive information. We uploaded the de-identified occupations and industries data to the NIOCCS for coding and double-checked cases with insufficient information using the single record code system to ensure all potential codes were captured.

We used the high-level aggregated categories, recommended by the BLS[20] to classify the sample into six broad occupation categories (1) 'Management/Business/Science/Art'; (2) 'Service'; (3) 'Sales and Office'; (4) 'Natural Resources/Construction/Maintenance'; (5) 'Production/Transportation/Material Moving'; and (6) 'Military-Specific'. Additionally, we included categories of 'Unemployed'; and 'Not in Labour Force' (ie, homemakers, students, volunteers, disabled/never worked). Each one of the broad occupation categories consists of multiple major occupation groups according to SOC-2018 (online supplemental table S1). In some cases, the descriptive information was insufficient to assign a definite detailed matched code, but it was enough to determine a broad category or major occupation group. For instance, an occupation described as 'energy rater' in the 'construction' industry could match either 'construction labourers (47-2061)' or 'electricians (47-2111)'. Since both fall under the 'construction and extraction (47-000)', we categorised the decedent accordingly. Similarly, a decedent described as working as a 'housing authority' in the industry of 'Baltimore City' could be matched with several major occupations all within the broad category of 'Management/Business/Science/Arts'.

The study included sociodemographic characteristics of decedents: sex (male, female), age category in years (ie, 16–24, 25–34, 35–44, 45–54, 55–64 and ≥65), race/ethnicity (ie, non-Hispanic white, non-Hispanic black, non-Hispanic other and Hispanic), marital and relationship status (ie, married, never married/single, widowed and divorced/separated), education classified as 'less than high school', 'high school or General Education Development or GED certification' which is equivalent to a high school diploma, and 'secondary or post-secondary education', and occupational status. The non-Hispanic other race category included American Indian, Alaskan Native, Asian, Native Hawaiian, other Pacific Islander and multi-racial groups.

Statistical analysis

First, we analysed sociodemographic and occupational characteristics of opioid overdose decedents. Next, we calculated the population-based incidence rate of death for broad categories as well as for each occupation group using the population denominators for each broad category/occupation group. This was done for the total sample and stratified by sex and race/ethnicity. The incidence rate is defined as the number of decedents who died from opioid overdose in each category/occupation group divided by the population of that group each year.

The average annual population denominators for Maryland from 2018 to 2022 were obtained from the American Community Survey (https://data.census.gov/) which provides population data for broad category/occupation groups by sex and race/ethnicity. Since the denominators were available only for broad categories by race/ethnicity in 2020, we imputed the population for each occupation group in 2020 using the average from years

2018, 2019, 2021 and 2022 to be able to consistently report the incidence rates in major occupation groups by race/ethnicity.

Dummy-coded variables for each broad category/occupation group were created, and incidence rate ratios (IRRs) were computed by running multiple Poisson models comparing each broad category/occupation group to all other categories/occupation groups combined. The population who did not die due to overdose in each broad category/occupation group was considered as frequency weight in the models. The exponentiated coefficients represented IRRs of overdose mortality for each group versus all others. The analyses were conducted by sex and race/ethnicity strata. For each specific occupation, we also statistically compared incidence rates in males versus females as well as non-Hispanic whites versus other racial/ethnic groups.

RESULTS

Demographic characteristics and employment status of decedents

A total of 11 455 opioid overdose deaths occurred in Maryland from 2018 to 2022 (online supplemental table S2). The majority of decedents were male (72.4%), non-Hispanic white (54.9%), never married or single (57.1%) and had low educational attainment (ie, 52.2% had high school as their highest level of education, 22.6% did not complete high school). The mean age of decedents was 44.6 (±13.1) years ranging from 16 to 89. Of the decedents, 5.0% were younger than 25 years old, and 5.5% were older than 64; the rest of the decedents were evenly distributed in other age groups (about 22% each).

Of the total sample, 80.1% were in the labour force either in civilian or 'Military-Specific' jobs (0.4%). Among the employed decedents, 85 (0.7%) had insufficient information for occupation identification. The remaining 9.4% were either 'Unemployed' (3.7%), or 'Not in Labour Force' (5.7%) including homemakers, students, volunteers, or those who were disabled or never worked. Overall, 119 employed decedents could not be assigned to a major occupation group, though 34 had a determined broad category. About 10% of the total sample had unknown or missing occupation information.

Population-based rates by occupation

The absolute proportion of opioid overdose deaths in the pooled sample and population-based incidence rates by eight broad categories are presented in descending order in figure 1. The highest estimates for both measures were in the 'Natural Resources/Construction/Maintenance' category, which accounted for 23.9% of decedents. The next most common categories were 'Services' (19.4%) and 'Production/Transportation/Material Moving' (15.1%). The highest population-based rate of opioid overdose was for workers in 'Natural Resources/Construction/Maintenance' (230 per 100 000), followed by 'Production/Transportation/Material Moving' (124 per 100 000) and 'Service' (88 per 100 000) categories.

Figure 2 shows the absolute proportion and population-based rates of opioid overdose deaths by major occupation groups. Over one-third of the decedents were 'construction and extraction' (18.6%), 'transportation and material moving' (11.7%) and 'food preparation and services' (7.8%). The highest population-based rates of opioid overdose were 'construction and extraction' (291 per 100 000), 'transportation and material moving' (137 per 100 000), 'installation/maintenance and repair' (133 per 100 000), 'farming/fishing and forestry' (132 per 100 000) and 'food preparation and serving related' (126 per 100 000). Detailed findings are presented in online supplemental table S3.

IRRs: comparing each broad category/occupation group with all other groups combined

In analyses of broad categories, the IRR was higher than comparison group in 'Natural Resources/Construction/Maintenance' (IRR=7.21, 95% CI 6.90 to 7.54), 'Production/Transportation/Material Moving' (IRR=3.39, 95% CI 3.22 to 3.57), 'Service' (IRR=2.43, 95% CI 2.32 to 2.55) and 'Unemployed' groups (IRR=1.28, 95% CI 1.16 to 1.41) (table 1). For major occupation groups, IRRs were generally consistent with broad categories, except for a few. 'Arts/design/entertainment/sports and media' (IRR=1.16, p=0.056) and 'Sale/Office' (IRR=1.13, p=0.006) had a higher incidence rate than other groups combined, while most other groups under the corresponding broad categories had lower rates. In addition, 'protective service' had a significantly lower IRR (IRR=0.77, p=0.002) than other groups combined, as opposed to their corresponding broad category (ie, 'Service' category, IRR=2.43).

Incidence rates by sex and IRRs in male versus female

The stratified IRRs of opioid overdose death comparing each broad category/occupation group with all categories/groups

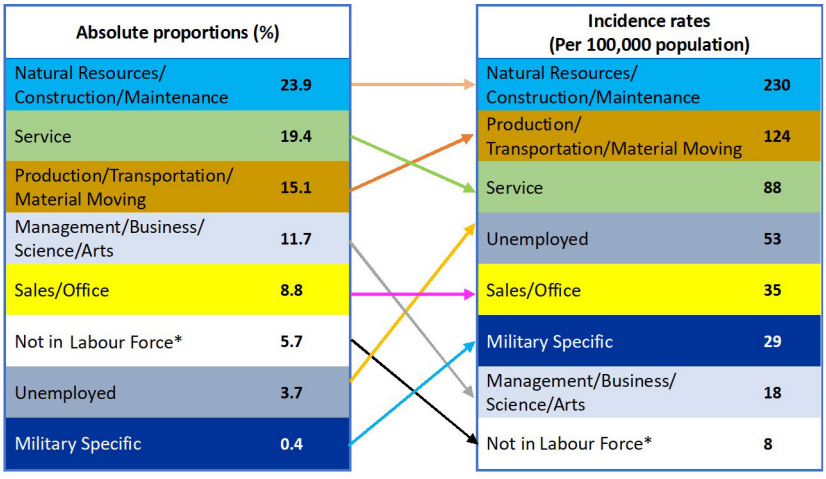

Figure 1 The ranking of the broad categories of decedents by absolute proportion and population-based rates, Maryland 2018–2022. The denominators derived from the American Community Survey for each category (https://data.census.gov/advanced). *Not in Labour Force includes homemakers, students, volunteers and disabled/never worked individuals.

Absolute proportions (%)	
1- construction & extraction	18.6
2- transportation & material moving	11.7
3- food preparation & serving related	7.8
4- Not in Labour Force*	5.7
5- building & grounds cleaning & maintenance	5.3
6- sales & related occupations	5.0
7- installation/maintenance & repair	5.0
8- office & administrative support	3.8
9- Unemployed	3.7
10- management	3.5
11- production	3.5
12- personal care & service	2.4
13- healthcare support	2.7
14- healthcare practitioners & technician	1.8
15- arts/design/entertainment/sports & media	1.5
16- business & financial operations	1.3
17- protective service	1.2
18- community & social service	0.8
19- computer & mathematical	0.7
20- architecture & engineering	0.6
21- education/training & library	0.6
22- military specific	0.4
23- farming/fishing & forestry	0.4
24- life/physical & social science	0.4
25- legal occupations	0.2

Incidence rates (Per 100,000 population)	
1- construction & extraction	291
2- transportation & material moving	137
3- installation/maintenance & repair	133
4- farming/fishing & forestry	132
5- food preparation & serving related	126
6- building & grounds cleaning & maintenance	118
7- production	93
8- healthcare support	69
9- personal care & service	65
10- Unemployed	53
11- arts/design/entertainment/sports & media	48
12- sales & related occupations	46
13- community & social service	32
14- protective service	32
15- military specific	29
16- office & administrative support	27
17- management	22
18- healthcare practitioners & technician	22
19- architecture & engineering	20
20- business & financial operations	13
21- life/physical & social science	12
22- legal occupations	9
23- computer & mathematical	8
24- Not in Labour Force*	8
25- education/training & library	6

Figure 2 The ranking of the major categories of occupations, along with those 'Unemployed' and 'Not in Labour Force' by absolute proportion and population-based rates, Maryland 2018–2022. The denominators derived from the American Community Survey for each category (https://data.census.gov/advanced). *Not in Labour Force includes homemakers, students, volunteers and disabled/never worked individuals.

combined is presented separately for males and females in online supplemental tables S4 and S5. Males in 'Sales/Office' had a significantly lower incidence compared with all other categories (online supplemental table S4), while females in the same category had a higher incidence than females in other categories (online supplemental table 5). Certain occupation groups including 'healthcare support', 'sales and related occupations', 'Military-Specific' and the broad category of 'Unemployed' showed significantly higher rates than the comparison only among females (online supplemental table S5).

Comparing males versus females, in nearly all broad categories and major occupation groups, the incidence rates were statistically higher in males than in females (table 2). The four exceptions were the broad category of 'Not in Labour Force', and occupation groups of 'healthcare support', 'protective service' and 'legal occupation'. Among those 'Not in Labour Force', males had a lower incidence of opioid overdose deaths relative to females (IRR=0.51, 95% CI 0.43 to 0.61, p<0.001). There was no significant difference between males and females who worked in 'healthcare support' (IRR=1.20, 95% CI 0.89 to 1.60, p=0.230), 'protective service' (IRR=1.43, 95% CI 0.95 to 2.16, p=0.085) and 'legal occupations' (IRR=1.67, 95% CI 0.75 to 3.71, p=0.211).

Incidence rates by race/ethnicity and IRRs in non-Hispanic white versus other racial/ethnic groups

The IRRs of opioid overdose in each broad category/occupation group in comparison with all other categories/groups are presented for non-Hispanic whites and other racial-ethnic groups, separately (online supplemental tables S6 and S7). Only among non-Hispanic whites, those who worked in the 'Military-Specific' occupations (IRR=0.48, p=0.001) had a significantly lower incidence rate of opioid overdose death than other occupation categories combined. Moreover, 'Unemployed' group had a higher incidence rate than other broad occupation categories only among non-Hispanic whites (online supplemental table S6). Compared with other major occupation groups, those in 'protective services' (IRR=0.44, p<0.001) had a significantly lower incidence rate, and 'sale and related occupation' had a

Table 1 The incidence rate ratio (IRR) of opioid overdose death in each broad category and major occupation groups, compared with all other categories/groups combined, Maryland 2018–2022

	Overdose in each broad category/major occupation group		Overdose in all other categories/groups combined		Each category/group vs others combined	
	Yes	No	Yes	No		
Broad category and major occupation groups	n	N	n	N	IRR	95% CI
Management/Business/Science/Arts	1337	7 522 805	8828	16 967 580	0.34	0.32 to 0.36*
Management	402	1 858 564	9729	22 631 852	0.50	0.46 to 0.56*
Business and financial operations	150	1 123 229	9981	23 367 187	0.31	0.27 to 0.37*
Computer and mathematical	79	935 962	10 052	23 554 454	0.20	0.16 to 0.25*
Architecture and engineering	72	357 859	10 059	24 132 557	0.48	0.38 to 0.61*
Life/physical and social science	40	321 867	10 091	24 168 549	0.30	0.22 to 0.41*
Community and social service	96	297 220	10 035	24 193 196	0.78	0.64 to 0.95**
Legal occupations	25	273 940	10 106	24 216 476	0.22	0.15 to 0.32*
Education/training and library	66	1 038 190	10 065	23 452 226	0.15	0.12 to 0.19*
Arts/design/entertainment/sports and media	167	348 497	9964	24 141 919	1.16	0.99 to 1.35
Healthcare practitioners and technicians	209	967 505	9922	23 522 911	0.51	0.45 to 0.59*
Service	2218	2 519 170	7947	21 971 215	2.43	2.32 to 2.55*
Healthcare support	304	442 319	9827	24 048 097	1.68	1.50 to 1.88*
Protective service	139	433 550	9992	24 056 866	0.77	0.65 to 0.91**
Food preparation and serving related	890	705 292	9241	23 785 124	3.25	3.03 to 3.48*
Building and grounds cleaning and maintenance	607	512 917	9524	23 977 499	2.98	2.74 to 3.23*
Personal care and service	278	425 092	9853	24 065 324	1.60	1.42 to 1.80*
Sales/Office	1012	2 866 154	9153	21 624 231	0.83	0.78 to 0.89*
Sales and related occupations	571	1 233 876	9560	23 256 540	1.13	1.03 to 1.22**
Office and administrative support	440	1 632 279	9691	22 858 137	0.64	0.58 to 0.70*
Natural Resources/Construction/Maintenance	2741	1 190 128	7424	23 300 257	7.21	6.90 to 7.54*
Farming/fishing and forestry	45	34 097	10 086	24 456 319	3.20	2.39 to 4.28*
Construction and extraction	2126	729 318	8005	23 761 098	8.63	8.23 to 9.05*
Installation/maintenance and repair	568	426 715	9563	24 063 701	3.45	3.07 to 3.64*
Production/Transportation/Material Moving	1732	1 397 490	8433	23 092 895	3.39	3.22 to 3.57*
Production	398	428 312	9733	24 062 104	2.30	2.08 to 2.54*
Transportation and material moving	1334	969 178	8797	23 521 238	3.68	3.47 to 3.89*
Military-Specific	50	172 370	10 115	24 318 015	0.70	0.53 to 0.92**
Not in Labour Force	654	8 023 723	9511	16 466 662	0.14	0.13 to 0.15*
Unemployed	421	798 545	9744	23 691 840	1.28	1.16 to 1.41*

Each broad category/major occupation group was statistically compared with all other categories/groups combined as a comparison group.
The denominators were derived from the American Community Survey for each category (https://data.census.gov/advanced).
Not in Labour Force includes homemakers, students, volunteers and disabled/never worked individuals.
*p<0.001.
**p<0.05.

higher incidence rate (IRR=1.28, p<0.001) of opioid overdose death than comparison group only among non-Hispanic whites. Whereas those in the 'art/design/entertainment/sport and media' group had a significantly higher incidence rate (IRR=1.40, p=0.010) of opioid overdose death only among other racial/ethnic groups (online supplemental table S7).

Relative to other racial-ethnic groups, non-Hispanic whites had a higher incidence of opioid overdose death in most broad categories except for 'Military-Specific' occupations (IRR=0.53, 95% CI 0.31 to 0.95). No significant racial/ethnic differences were found in the 'Production/Transportation/Material Moving' and 'Management/Business/Science/Arts' broad categories (table 3). Non-Hispanic whites generally had a higher incidence rate of opioid overdose deaths relative to other racial-ethnic groups in major occupation groups with two exceptions of 'management' (IRR=0.82, p=0.043), and 'protective services' (IRR=0.49, p<0.001) (table 3).

DISCUSSION

The goal of the current study was to present a broad view of opioid overdose deaths in Maryland by employment status and occupation group. We identified occupations that predominated among decedents and estimated population-based overdose death rates by occupations using Maryland SUDORS, a rich source of data on fatal overdoses. Our findings indicate that the vast majority of overdose decedents were employed, that certain occupations were more common among decedents, and that—within specific occupation groups—the incidence of opioid overdose death was notably higher among men and white decedents.

Most decedents were in the labour force (over 80%) with a population incidence of 59 per 100 000 workers. Employment settings present potential venues for the implementation of substance use disorder and overdose prevention strategies and behavioural health services to avoid many of these deaths. Understanding the link between employment and overdose

Table 2 Incidence rate ratio (IRR) of opioid overdose death among males versus females, by broad category and major occupation groups, Maryland 2018–2022

	Overdose in males		Overdose in females		Males vs females	
	Yes	No	Yes	No		
Broad category and major occupation groups	n	N	n	N	IRR	95% CI
Management/Business/Science/Arts	904	3 515 578	433	4 007 227	2.38	2.2 to 2.67*
Management	317	1 005 644	85	852 923	3.16	2.49 to 4.02*
Business and financial operations	97	489 552	53	633 677	2.37	1.69 to 3.31*
Computer and mathematical	69	643 909	10	292 053	3.13	1.61 to 6.07**
Architecture and engineering	–	–	–	–	3.67	1.34 to 10.05**
Life/physical and social science	–	–	–	–	3.16	1.51 to 6.64**
Community and social service	57	96 527	39	200 693	3.04	2.02 to 4.56*
Legal occupations	15	129 750	10	144 190	1.67	0.75 to 3.71
Education/training and library	28	275 434	38	762 756	2.04	1.25 to 3.32**
Arts/design/entertainment/sports and media	126	177 247	41	171 250	2.97	2.09 to 4.22*
Healthcare practitioners and technicians	71	235 419	138	732 086	1.60	1.20 to 2.13**
Services	1294	1 104 051	924	1 415 119	1.79	1.65 to 1.95*
Healthcare support	55	68 959	249	373 360	1.20	0.89 to 1.60
Protective service	110	314 663	29	118 887	1.43	0.95 to 2.16
Food preparation and serving related	537	321 136	353	384 156	1.82	1.60 to 2.08*
Building and grounds cleaning and maintenance	452	294 332	155	218 585	2.16	1.80 to 2.60*
Personal care and service	140	104 961	138	320 131	3.09	2.44 to 3.91*
Sales/Office	487	1 036 327	525	1 829 827	1.64	1.45 to 1.85*
Sales and related occupations	316	609 446	255	624 430	1.27	1.08 to 1.50**
Office and administrative support	170	426 882	270	1 205 397	1.78	1.47 to 2.15*
Natural Resources/Construction/Maintenance	2702	1 134 198	39	55 930	3.41	2.49 to 4.68*
Farming/fishing and forestry	–	–	–	–	4.87	1.74 to 13.60**
Construction and extraction	2103	703 774	23	25 544	3.31	2.20 to 4.99*
Installation/maintenance and repair	556	407 329	12	19 386	2.20	1.24 to 3.90**
Production/Transportation/Material Moving	1537	1 069 777	195	327 713	2.41	2.08 to 2.80*
Production	349	301 143	49	127 169	3.01	2.23 to 4.05*
Transportation and material moving	1188	768 634	146	200 544	2.12	1.79 to 2.52*
Military-Specific	–	–	–	–	4.13	1.29 to 13.26**
Not in Labour Force	174	3 337 504	480	4 686 219	0.51	0.43 to 0.61*
Unemployed	261	403 034	160	395 511	1.60	1.31 to 1.95*

Males in each broad category/major occupation group were statistically compared with females in the same category/group.
The denominators were derived from the American Community Survey for each category (https://data.census.gov/advanced).
Due to confidentiality circumstances, the data was suppressed (indicated by an en dash) if the cell had fewer than 10 cases or provided information to calculate another suppressed cell.
Not in Labour Force includes homemakers, students, volunteers and disabled/never worked individuals.
*p<0.001.
**p<0.05.

mortality can help policymakers develop effective preventive programmes.[10 21–26] Working under serious stress, job insecurity, financial issues caused by absenteeism, chronic and acute musculoskeletal injuries due to physically demanding jobs that lead to excessive use of prescription opioids, and limited access to proper healthcare due to lack or inadequate health insurance among underprivileged workers could make the medically or psychologically challenged workers susceptible to developing a full-blown psychiatric condition including substance use disorders and drug overdose.[10 21–26] The findings of this study suggest a need for effective regulatory oversight to strengthen employer policies, develop improved work practices within high-risk industries, and expand healthcare benefits to support treatment and rehabilitation options for OUD.

This study also found that overdose death rates varied by occupation group. The 'Natural Resources/Construction/Maintenance' category stands out as the occupation category with the largest number of opioid overdose decedents and as the occupation category with the highest population-based opioid overdose death rate. All three occupation groups under this category (ie, 'farming/fishing and forestry', 'construction and extraction' and 'installation/maintenance and repair' groups) were at a higher opioid overdose incidence rate. This finding is consistent with previous research demonstrating that workers in construction and similar jobs have a higher risk of opioid overdose.[8 9 12 13 27] The relatively high rate of injuries and intensive physically demanding work in the 'construction and extraction' group may increase the odds of using pain-relieving medications and may lead to an increased risk of overdose.[28–31] Many workers in this occupational group are also paid based on their performance which could further increase the work stress and make them further susceptible to work-related injuries.[13 32 33] Those in this occupational group are also less likely to have health insurance than other occupations; therefore, there is potentially a greater unmet need for treatment.[7 34]

Table 3 The incidence rate ratio (IRR) of opioid overdose deaths non-Hispanic whites compared with other racial-ethnic groups, by broad category and major occupation group, Maryland 2018–2022

	Overdose in Non-Hispanic whites		Overdose in other racial-ethnic groups		Males vs females	
	Yes	No	Yes	No		
Broad occupation category and major occupation groups	n	N	n	N	IRR	95% CI
Management/Business/Science/Arts	776	4 282 815	561	3 239 990	1.05	0.94 to 1.17
Management	225	1 132 174	177	726 393	0.82	0.67 to 0.99**
Business and financial operations	100	599 754	50	523 475	1.74	1.24 to 2.45**
Computer and mathematical	53	468 715	26	467 247	2.03	1.27 to 3.25**
Architecture and engineering	49	229 202	23	128 657	1.20	0.73 to 1.96
Life/physical and social science	30	183 523	10	138 344	2.26	1.11 to 4.63**
Community and social service	42	140 587	54	156 633	0.87	0.58 to 1.30
Legal occupations	–	–	–	–	1.07	0.47 to 2.43
Education/training and library	34	618 820	32	419 370	0.72	0.44 to 1.17
Arts/design/entertainment/sports and media	107	225 498	60	122 999	0.97	0.70 to 1.33
Healthcare practitioners and technicians	116	497 614	93	469 891	1.18	0.90 to 1.55
Services	1114	931 407	1104	1 587 763	1.72	1.58 to 1.87*
Healthcare support	128	118 159	176	324 160	1.99	1.59 to 2.50*
Protective service	39	191 199	100	242 351	0.49	0.34 to 0.72*
Food preparation and serving related	531	290 571	359	414 721	2.11	1.84 to 2.41*
Building and grounds cleaning and maintenance	264	141 565	343	371 352	2.02	1.72 to 2.37*
Personal care and service	152	184 615	126	240 477	1.57	1.24 to 1.99*
Sales/Office	635	1 457 502	377	1 408 652	1.63	1.43 to 1.85*
Sales and related occupations	380	660 852	191	573 024	1.72	1.45 to 2.05*
Office and administrative support	254	788 068	186	844 211	1.46	1.21 to 1.77*
Natural Resources/Construction/Maintenance	1816	572 174	925	617 954	2.12	1.96 to 2.29*
Farming/fishing and forestry	34	21 651	11	12 446	1.78	0.90 to 3.50
Construction and extraction	1403	310 244	723	419 074	2.61	2.39 to 2.86*
Installation/maintenance and repair	379	231 064	189	195 651	1.70	1.43 to 2.02*
Production/Transportation/Material Moving	708	563 206	1024	834 284	1.02	0.93 to 1.13
Production	225	208 231	173	220 081	1.37	1.13 to 1.68**
Transportation and material moving	483	352 074	851	616 104	0.99	0.89 to 1.11
Military-Specific	23	105 270	27	67 100	0.54	0.31 to 0.95**
Not in Labour Force	446	4 362 020	208	3 661 703	1.80	1.53 to 2.12*
Unemployed	228	291 731	193	506 814	2.05	1.69 to 2.49*

Non-Hispanic whites in each occupation were statistically compared with other race/ethnic groups in the same broad category/major occupation group.
Other racial-ethnic groups primarily include non-Hispanic black, Hispanics and other non-Hispanics (ie, American Indian/Alaskan Native, Asian, Native Hawaiian/other Pacific Islander and multi-racial).
The denominators were derived from the American Community Survey for each category (https://data.census.gov/advanced) in each year except for the year 2020 in which the population was only available for broad categories by race. The population in each major category for the year 2020 was estimated using the average population number in other years.
Due to confidentiality circumstances, the data was suppressed (indicated by an en dash) if the cell had fewer than 10 cases or provided information to calculate another suppressed cell.
Not in Labour Force includes homemakers, students, volunteers and disabled/never worked individuals.
*p<0.001.
**p<0.05.

Apart from the 'construction and extraction' group, occupations with high population-based incidence rates were 'transportation and material moving', 'installation/maintenance and repair', 'farming/fishing and forestry' and 'food preparation and serving related'. This finding is also consistent with previous studies from other states.[9 13 27] For instance, a higher rate of overdose death in the 'farming/fishing and forestry' group was reported in Massachusetts, which has a high number of commercial fishing workers.[7 35] Fulmer *et al* reported a greater mortality rate of opioid overdose in commercial fishermen compared with non-fishermen living in the same ports in Massachusetts from 2000 to 2014.[35] The gender composition of some occupations may also contribute to a higher rate of substance use disorders in those occupations.[36 37] For instance, most of the occupation groups at a higher risk of opioid overdose deaths are overwhelmingly dominated by young male workers who are at a higher risk of substance use disorders.[36]

In all occupation groups, overdose decedents were predominantly male, except in a few groups (ie, 'healthcare support', 'legal occupation' and 'protective services') in which there was no significant difference between males and females. This finding is consistent with prior studies which also showed an elevated risk of overdose among females in 'healthcare support'.[7]

In terms of interaction between race/ethnicity and type of occupation, the incidence of opioid overdose death rate was higher among non-Hispanic whites relative to other race/ethnicity in almost all of the occupational categories with few exceptions. We observed a lower incidence of overdose deaths among

non-Hispanic whites than other races/ethnicities among those in 'Military-Specific' occupations and there was no significant difference between the two racial/ethnic groups among those in the 'Production/Transportation/Material Moving' category. In general, sex and race variations in our study are consistent with average national estimates indicating that non-Hispanic white male workers have the highest overdose death rates.[9]

Our results should be interpreted in light of several limitations. First, despite all the efforts made to classify the decedents into one of the occupational groups, there was no information available to assign approximately 10% of the decedents to occupational groups. However, the percentage of un-codable occupations in the SUDORS data was lower than in a prior study conducted on multi-state data derived from the National Violent Death Reporting System in 2016.[38] Second, we were unable to conduct sensitivity analyses using current occupation information due to a large proportion of missing data for the decedents' current occupations. It is possible that decedents were unemployed or employed in a different job at the time of death, while their longest-held occupation was something else. However, previous studies indicate that there is a high concordance between current occupation and usual occupation descriptions recorded on death certificates.[39 40] Third, due to the unavailability of denominators by race and ethnicity for major occupation groups in the year 2020, we had to impute the population in each major occupation group in the year 2020 using the average population number from other years. Fourth, the occupation and industry information in the death certificates was entered by non-occupational medicine providers and did not include a comprehensive occupational history of the decedents. Therefore, misclassification of occupation groups is inevitable. However, by using the computerised coding system (NIOCCS), we reduced the probability of additional human errors in the classification of occupation groups compared with prior studies where occupations were manually categorised. Fifth, there may be discrepancies between the number of opioid overdose deaths reported in the Maryland SUDORS data and the figures from CDC WONDER (https://wonder.cdc.gov/). These differences can be attributed to variations in data scope, verification methods, timeliness and data quality, though they are not substantial.

CONCLUSION

Our findings have implications for policymakers and other related stakeholders to identify occupations at higher risk of opioid overdose death and to advocate for the development of opioid overdose prevention measures or expansion of existing programmes in the state of Maryland. Additional research is necessary to understand the occupational circumstances or other related factors such as the unmet need for treatment of substance use disorders or inadequate naloxone administration contributing to opioid overdose deaths in certain occupational groups with the highest incidence of opioid overdose death. A comparative study replicating the analyses in other states using the SUDORS data is also recommended.

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