

Divergence Between Individual- and Neighborhood-Level Fatal Overdose Burden: A Population-Based Statewide Study

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ABSTRACT

OBJECTIVES: To compare the characteristics of *individual* overdose decedents in Rhode Island, 2016–2020 to the *neighborhoods* where fatal overdoses occurred over the same time period.

METHODS: We conducted a retrospective analysis of fatal overdoses occurring between January 1, 2016 and June 30, 2020. Using individual- and neighborhood-level data, we conducted descriptive analyses to explore the characteristics of individuals and neighborhoods most affected by overdose.

RESULTS: Most overdose decedents during the study period were non-Hispanic White. Across increasingly more White and non-Hispanic neighborhoods, rates of fatal overdose per 100,000 person-years decreased. An opposite pattern was observed across quintiles of average neighborhood poverty.

CONCLUSIONS: Rates of fatal overdose were higher in less White, more Hispanic, and poorer neighborhoods, suggesting modest divergence between the characteristics of individuals and the neighborhoods most severely affected. These impacts may not be uniform across space and may accrue differentially to more disadvantaged and racially/ethnically diverse neighborhoods.

KEYWORDS: overdose, substance use, descriptive epidemiology, neighborhood characteristics, opioids

INTRODUCTION

Preventing fatal overdose has been a critical public health priority for many years, made even more urgent by the unprecedented spike in overdose deaths recorded in 2020. Since 1999, more than 800,000 people in the United States have died due to overdose,¹ with provisional estimates pointing to 93,000 deaths in 2020 alone.² The overdose crisis is a major public health event impacting every state in the country and has been compounded by the COVID-19 pandemic.³ For obvious reasons, overdose prevention efforts tend to prioritize individuals who use drugs. At the same time, the overdose crisis is also a population-level public health emergency, and its impacts on entire communities have been less extensively explored in the public health literature.

Here, we sought to identify the communities most heavily impacted by persistent overdose activity, and explore the divergence between the individuals and communities most affected by fatal overdose in Rhode Island using descriptive epidemiological methods. Rhode Island is a compelling case study for many reasons. Like much of the United States, Rhode Island communities are highly segregated by race/ethnicity. Mirroring national trends, overdose deaths in the state increased nearly 25% from 2019–2020.⁴ The majority of overdose decedents in the state are non-Hispanic White, but rates of fatal overdose are higher among Black Rhode Island residents than their White counterparts (53.9 vs. 36.0 per 100,000 person-years).^{5,6}

An ample “neighborhood effects” literature seeks to situate overdose in a community context by isolating and evaluating the effects of, e.g., neighborhood income⁷ or socioeconomic disadvantage,^{8–10} income inequality,¹¹ policing intensity,⁷ residential racial segregation,¹² and racial/ethnic composition¹³ on individual or neighborhood-level aggregated overdose risk. Fewer analyses have explored the potential divergence between the characteristics of individuals and the communities or neighborhoods most impacted by fatal overdose.^{14–16} Fatal overdoses tend to exhibit persistent spatial clustering,^{17,18} and persistently high rates of overdose at the community level may have variable and adverse effects on members of a neighborhood or a community, including those who are not directly affected by overdose. While we did not investigate the effects of high levels of fatal overdose on community or individual health, identifying the most heavily impacted neighborhoods could help prioritize interventions to mitigate the potential for such adverse effects.

The objective of this descriptive, exploratory analysis was to compare the characteristics of individual overdose decedents in Rhode Island, 2016–2020 (specifically, race/ethnicity and usual occupation) to the racial/ethnic and socio-demographic characteristics of the neighborhoods in which fatal overdoses occurred over the same time period. Such a comparison has the potential to shed light on the neighborhood-level correlates of high levels of overdose, to sketch a more complete picture of the total impact of the overdose crisis on Rhode Island residents and their communities, and ultimately as a first step towards informing population-level intervention strategies that take community impacts into account.

METHODS

We conducted a descriptive, retrospective analysis of fatal overdoses occurring between January 1, 2016 and June 30, 2020 in the state of Rhode Island. The units of analysis for this study were individual overdose decedents as well as census block groups (roughly corresponding to and hereafter referred to interchangeably as neighborhoods) within Rhode Island where fatal overdoses occurred during the study period. Census block groups are contiguous statistical divisions of census tracts containing 600–3000 people.

Data sources

Data were obtained from multiple sources as part of the Preventing Overdose Using Data and Information from the Environment (PROVIDENT) study.¹⁹ As all data analyzed as part of PROVIDENT are collected through ongoing public health surveillance activities and the use of protected health information involves no more than a minimal risk to the privacy of individuals, the institutional review board (IRB) of record approved a waiver of research participants' authorization for use/disclosure of information about them for research purposes, in accordance with 45 CFR § 164.512(i)(2)(iv).

We leveraged two components of the PROVIDENT data for this analysis. First, neighborhood of injury (i.e., neighborhood of fatal overdose), and residence, race/ethnicity, and usual occupation for each unintentional (any drug) overdose decedent were obtained from the State Unintentional Drug Overdose Reporting System (SUDORS). SUDORS is a component of the Enhanced State Opioid Overdose Surveillance program of the Centers for Disease Control and Prevention (CDC) intended to improve timeliness of fatal overdose reporting.²⁰ The neighborhoods of injury (i.e., where a given overdose occurred) and decedent residence both are included in SUDORS data; for the purposes of this analysis, we used injury location when available. For the 93 (6.60%) of records for which neighborhood of injury was missing, we used decedent residence. In Rhode Island between 01/01/16 and 07/31/2020, the majority of overdose deaths (70%) occurred in the private locations, likely the home.²¹ Race/ethnicity data, abstracted from death certificates, are reported in SUDORS. Usual occupation is abstracted from information on the death certificate and refers to the work a person usually does (not necessarily their occupation at time of death);²² we coded usual occupation into standard occupational classifications according to the Bureau of Labor Statistics Standard Occupational Classification System.

Second, neighborhood-level characteristics (percent White, not Hispanic/Latino, of civilians employed in construction, natural resources, and management (CNRM) occupations, and of families with income below the federal poverty limit [FPL]) were obtained from the American Community Survey (ACS) 5-year estimates (2012–2016 5-year estimates for 2016, 2013–2017 5-year estimates for 2017, and so on).

Finally, we used 2018 ACS 5-year population estimates to calculate fatal overdose rates by census block group. The 2018 estimates correspond roughly to the midpoint of the study period.²⁸ We excluded 6 of the 815 census block groups in Rhode Island with zero population for a total of 809 census block groups in the analytic sample. In a secondary analysis, we also restricted the analytic sample to neighborhoods with more than 600 residents. Neighborhoods with fewer than 600 residents tend to correspond to special land use block groups (e.g., the block group containing Rhode Island T.F. Green International Airport) and may have disproportionately high rates of fatal overdose due to low population. We excluded 61 neighborhoods with ≤ 600 residents and repeated the above analyses on the resulting analytic sample of 748 census block groups.

STATISTICAL ANALYSIS

We first generated descriptive statistics for individual overdose decedents. We similarly generated descriptive statistics for neighborhoods. To do this, we averaged each ACS-derived neighborhood-level variable of interest across the study period, then examined the overall characteristics of each census block group included in the analysis.

Next, we calculated the fatal overdose rate per 100,000 person-years for each census block group over the study period and examined the median and interquartile range (IQR) of this fatal overdose rate across quintiles of each neighborhood-level variable. Calculation of the rate allowed for more direct comparison of fatal overdose burden across census block groups with different populations.

Finally, to examine possible divergence between the characteristics of individual overdose decedents and the neighborhoods where fatal overdoses take place in more detail, we identified a subset of individual overdose decedents with discordant locations of injury and residence – i.e., individuals for whom the neighborhood of injury (overdose) did not match the neighborhood of residence. We compared the neighborhood characteristics corresponding to the neighborhoods of injury and residence for those in this discordant subset whose state of residence was Rhode Island and also estimated the median distance as-the-crow-flies between centroids (geographic centers) of these discordant neighborhoods.

RESULTS

Among the 1408 overdose decedents during the study period, the average age was 43 (standard deviation = 12), with a range of 17 to 88. Comparing the age distribution of overdose decedents to the age distribution across neighborhoods in Rhode Island, nearly 75% of overdose decedents were 25–54 years old at time of death, while the median proportion of residents in this age group across Rhode Island neighborhoods

is approximately 35% (Table 1). Nearly 75% of overdose decedents were male, compared to a median proportion of male residents across Rhode Island neighborhoods of 43%. The majority of overdose decedents were White (64%) and non-Hispanic (88%). Compared to neighborhood composition, overdose decedents were less White (the median proportion of White residents across all neighborhoods was 79%)

Table 1. Characteristics of individual decedents and census block groups, Rhode Island, United States, 01/01/2016–06/30/2020.

	Individual decedents (N = 1408)	Census block groups (N = 809)	Populated Census block groups ^a (N = 748)
	%	Median (IQR) % among census block groups ^b	
Age			
< 18	< 1	2.73 (3.10)	2.87 (2.97)
18–24	5.50	6.99 (5.34)	7.15 (5.29)
25–34	25.20	11.61 (8.00)	11.58 (7.66)
35–44	25.00	10.17 (5.44)	10.28 (5.21)
45–54	23.70	12.68 (5.61)	12.68 (5.42)
≥55	20.50	27.63 (14.56)	27.18 (14.22)
Sex			
Male	73.10	42.99 (5.55)	42.92 (5.50)
Female	26.90	45.90 (5.55)	45.97 (5.50)
Race			
White	64.10	78.62 (21.03)	78.65 (20.69)
Black	5.30	2.18 (8.46)	2.12 (8.33)
Other	18.30	7.21 (12.83)	7.23 (12.70)
Missing	< 1		—
Hispanic/Latino of any race ^c	11.90	4.85 (14.64)	4.82 (14.00)
Ethnicity			
Hispanic	11.90	4.85 (14.64)	4.82 (14.00)
Non-Hispanic	88.07	84.04 (14.64)	84.07 (14.00)
Standard occupational classification			
CNRM ^b	24.50	5.38 (5.75)	5.50 (5.68)
Poverty			
Household income below FPL ^b	—	4.51 (12.87)	4.64 (12.83)

^a Populated census block groups are those with ≥ 600 population.

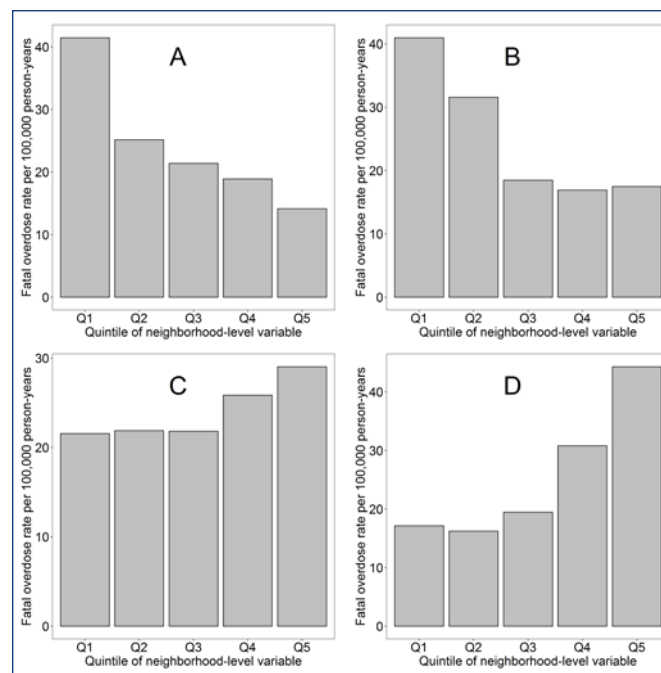
^b These columns present the median percentage of each relevant population characteristic, along with its IQR (interquartile range), across all census block groups included in the analysis. For example, the median percentage of male residents across all 809 census block groups is 42.99%. Abbreviations: CNRM: Construction, natural resources, and maintenance (includes construction and extraction, farming, fishing, and forestry and installation, maintenance, and repair occupations); FPL: federal poverty limit.

^c Race and ethnicity are reported separately in this table. Hispanic/Latino ethnicity of any race is presented along with race variables to accord with the presentation and proportions available in the individual-level SUDORS (State Unintentional Drug Overdose Reporting System) data.

and similarly non-Hispanic (the median proportion of non-Hispanic residents all neighborhoods was 84%). Notably, Black residents are overrepresented among overdose decedents relative to the median proportion of Black residents across neighborhoods (5.3% compared to just over 2%, respectively). Nearly 25% of overdose decedents during this period were employed in a CNRM occupation, though the median proportion of civilians employed in CNRM in Rhode Island neighborhoods is just over 5%. Finally, although SUDORS data do not contain individual-level income information, other research has reported a large proportion of overdose decedents (25% in 2019 and 38% in 2020) live below the federal poverty limit³ compared to a median of just under 5% across Rhode Island neighborhoods.

Examining all neighborhoods in the state, a marked gradient is evident in neighborhood-level rates of fatal overdose (per 100,000 person-years, see Figure 1). Across increasing quintiles of average neighborhood racial/ethnic composition (percent White and percent non-Hispanic), fatal overdose rates decreased – that is, neighborhoods with higher proportions of White and non-Hispanic residents experienced lower rates of fatal overdose during the study period. For

Figure 1. Rate of fatal overdose per 100,000 person-years across quintiles of neighborhood characteristics, a Rhode Island census block groups, 01/01/2016–06/30/2020 (N = 809).



^a Neighborhood characteristics are operationalized as follows. **Panel A:** race, median percent White; **Panel B:** ethnicity, median percent non-Hispanic; **Panel C:** occupation; median percent of civilians employed in construction, natural resources, and maintenance (CNRM) occupations; **Panel D:** poverty; median percent of households with incomes below the federal poverty limit (FPL). Quintiles are of each neighborhood-level variable, ranging from lowest (1) to highest (5). For example, Q1 corresponds to the neighborhoods with the lowest proportions of White residents, non-Hispanic residents, residents employed in CNRM occupations, and residents living below the FPL.

example, the least White neighborhoods (first quintile) had a median (IQR) fatal overdose rate per 100,000 person-years of 41.5 (50.3), compared to 14.1 (35.9) in the most White neighborhoods (fifth quintile). Neighborhoods with the lowest proportions of households with incomes below the FPL had lower fatal overdose rates than neighborhoods with the highest proportions of such households: 17.2 (36.8) in the first quintile, compared to 44.3 (49.7) in the fifth quintile. The findings regarding proportion of civilians employed in CNRM occupations are more equivocal; from the first to the fifth quintiles, the rate of fatal overdose increases slightly, but the most marked change is from the third to the fifth quintile. Results after restricting the sample of census block groups to those populated census block groups with more than 600 residents had almost no effect on these estimates and general patterns (data not shown).

An analysis of the 218 overdose decedents with discordant locations of injury and residence (at the census block group level, across all 809 census block groups in Rhode Island) further revealed modest divergence between the characteristics of individuals and neighborhoods most affected by fatal overdose (Table 2). Compared to the neighborhoods of residence in this subset, the neighborhoods of injury (i.e., where the fatal overdose took place) were moderately less White and less non-Hispanic (78.6% vs. 71.5% and 83.7% vs. 78.3%, respectively). Interestingly, neighborhoods of injury had a markedly higher proportion of households with incomes below the FPL (8.2% vs. 5.5%). The median (IQR) distance between centroids of these discordant neighborhoods of residence and injury was 6868 (3069–15219) meters or approximately 4.3 (1.9–9.5) miles (data not shown).

Table 2. Characteristics of neighborhoods of injury and neighborhoods of residence among the subset of 218 overdose decedents with discordant neighborhoods of residence and injury, Rhode Island, 01/01/2016–06/30/2020.

Median (IQR) ^a	Neighborhood of injury N = 218	Neighborhood of residence N = 218
Percent White	71.5 (33.4)	78.6 (25.4)
Percent non-Hispanic	78.3 (29.5)	83.7 (18.4)
Percent of civilians employed in CNRM ^a	6.0 (7.4)	6.5 (4.9)
Percent of households with incomes < FPL ^a	8.1 (19.0)	5.5 (13.5)

^a Abbreviations. IQR: interquartile range CNRM: construction, natural resources, and maintenance; FPL: federal poverty limit.

DISCUSSION

This analysis identified features of the neighborhoods most severely affected by persistently high rates of fatal overdose in Rhode Island between 2016 and 2020. Specifically, rates of fatal overdose were higher in less White, more Hispanic, and poorer neighborhoods in across the state. Our work also confirmed previous findings regarding characteristics of individual overdose decedents in Rhode Island.^{6,21,22} Most overdose decedents over the study period were non-Hispanic White, and CNRM occupations are the most heavily represented among overdose decedents.

Overall, this work points to modest divergence between the characteristics of individuals and neighborhoods most severely affected by overdose in Rhode Island. Most overdose decedents in Rhode Island are non-Hispanic White, but the neighborhoods in Rhode Island most affected by fatal overdose are not those with the highest proportions of non-Hispanic White people; in fact, our findings suggest the opposite. Neighborhoods with the most families in extreme poverty (measured as proportion of households with incomes below the FPL) also have the highest rates of fatal overdose. In many ways, this is an expected finding; poverty is heavily racialized in the US, and both poverty and racism are spatialized (e.g., racial residential segregation, concentrated disadvantage, and environmental injustice), with wide variation in neighborhood infrastructure.

Labor and occupation are also racialized in the United States. However, while there is a pronounced occupational gradient at the individual level, we did not observe large differences in fatal overdose rates by neighborhood occupational composition. There may be several reasons for this. First, White people are overrepresented in CNRM occupations relative to their share of the state's population,²⁵ such that neighborhood-level occupational composition may be an indirect and imperfect proxy for neighborhood-level racial composition. Second, there may be occupational dynamics at play that are not fully captured by looking simply at the neighborhood-level proportion of civilians employed in CNRM occupations. Finally, occupation may be less strongly spatially patterned than race/ethnicity or poverty, or may exhibit less pronounced spatial patterning statewide.

Broadly, we found that community-level indices of social disadvantage track higher rates of fatal overdose during the study period. The divergence between the characteristics of the individuals and the characteristics of the neighborhoods most affected by fatal overdose may point to additional community-level interventions to complement existing individually-focused outreach and overdose prevention programs. In addition to reaching people who use drugs directly, optimizing the allocation of harm reduction resources to communities most impacted by fatal overdose could have important public health benefits. Our findings also support the approach to community-level intervention spearheaded by the Rhode Island Department of Health (RIDOH) with

the creation of Health Equity Zones across the state. For example, through the Health Equity Zones, RIDOH provide technical assistance, surveillance information, and evaluation supports as local coalitions develop community-level overdose response plans.²³

This study has several important limitations which should inform interpretation of the results. First, we conducted a descriptive cross-sectional (albeit multi-year) study. Therefore, we are limited in the conclusions we can draw. We were not attentive to causal structures and did not attempt to adjust for confounders or apply any statistical methodology to make causal inferences from the data. Second, we examined only fatal overdose as an endpoint. It is possible that examining nonfatal overdose (EMS runs for suspected overdose) would have yielded different patterns of community impact. Third, Rhode Island is a small, primarily urban state; our findings may not generalize beyond this specific context. Finally, and relatedly, Rhode Island has a high proportion of overdose decedents who overdose in their home neighborhood, and those individuals who overdose in a neighborhood different than their neighborhood of residence may be different from others in meaningful ways. While our analysis of the subset of individuals with discordant neighborhoods of residence and injury revealed that the neighborhoods of injury were moderately less White, more Hispanic, and poorer than the neighborhoods of residence, this finding should be interpreted cautiously as this subset is small and potentially unrepresentative of overdose decedents more generally. One recent study conducted in Cook County, Illinois, found evidence that overdose decedents tended to travel to more racially segregated and poorer neighborhoods to procure drugs than their neighborhood of residence.²⁴ A similar phenomenon may explain our findings, though we caution that the observed discrepancies between locations of injury and residence were small, suggesting that this effect (if present) is less pronounced in Rhode Island. The median distance between centroids of these discordant neighborhoods of residence and location was approximately 4.3 miles; this may represent more or less distance depending on context (for example, 4.3 miles may represent adjacent neighborhoods in rural areas but non-adjacent neighborhoods in more dense and compact urban areas).

Our findings suggest that the community-level impacts of fatal overdose may not be uniform across space and in fact may accrue differentially to more disadvantaged and racially/ethnically diverse neighborhoods. Communities with high rates of overdose should have the resources they need to respond to overdoses in an evidence-based way, and additional research is needed to determine the direct and indirect neighborhood-level effects of persistently high overdose rates on community health outcomes. Specifically, future work should engage a diverse body of stakeholders (e.g., community members, policymakers, friends and family members affected by overdose) as well as existing data sources to elucidate these effects.

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