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Increased overdose mortality during the first week of the month: Revisiting the "check effect" through a spatial lens

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Abstract

Background: The timing of social service benefit issuance is thought to be associated with increased drug overdose fatalities. However, the extent to which this excess mortality is concentrated in communities with higher levels of benefit receipt has not been studied. We sought to examine if benefit receipt at the neighborhood level was associated with spatiotemporal patterns of overdose fatalities.

Methods: We conducted a retrospective review of all accidental overdose deaths recorded in Rhode Island from 2014 to 2016 (n = 838). Overdose incident locations were geocoded to the census block group level. Clusters of census block groups with excess overdose mortality at the beginning of a month were identified using spatial scan methods. Logistic regression models were fit to identify characteristics associated with the inclusion of a census block group within a cluster.

Results: Increased rates of overdose fatalities at the beginning of a month were observed relative to the end of a preceding month (Ratio: 1.17; 95% CI: 1.04, 1.38). The proportions of residents

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Contributors

Mr. Goedel and Dr. Marshall conceived and designed the study. Ms. Viner-Brown provided access to the data source. Mr. Goedel conducted the data analysis, generated the figures, and wrote a first draft of the manuscript with input from Dr. Marshall. Drs. Green and Rich assisted in interpretation and presentation of the results. All authors revised or reviewed the manuscript critically and approved the final version. Dr. Marshall takes final responsibility for the accuracy of the results and overall fidelity of the manuscript.

Data statement

Due to the sensitive nature of the data collected from medical examiner records, the raw data used in the study cannot be made available for public health.

Conflicts of interest

The authors declare no conflicts of interest.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2018.12.024.

receiving cash public assistance or Supplemental Security Income were not associated with excess mortality at the beginning of a month; however, the proportion of residents living in unaffordable housing was (OR: 1.42; 95% CI: 1.05, 1.91).

Conclusion: Despite previous research on benefit check issuance and overdose, welfare receipt was not associated with excess overdose mortality at the beginning of a month at the neighborhood level. Future research on housing cost burden and its influence on overdose death risk at the individual level is needed.

Keywords

Opioids; Overdose; Social service benefits; Clustering; Spatial epidemiology; GIS

1. Introduction

Deaths attributable to accidental drug overdose, particularly those involving opioids, have reached epidemic levels in the United States and Canada. Since the turn of the century, overdose mortality rates have more than tripled in the United States. In 2000, the age-adjusted drug overdose death rate was 6.2 per 100,000 persons and this has since increased to 19.8 per 100,000 persons in 2016 (Rudd et al., 2016; Seth et al., 2018). The burden of the current drug overdose epidemic is greatly elevated in New England, where Rhode Island experienced the tenth highest rate of drug overdose death among all states in 2016 (Seth et al., 2018).

Although several studies have identified variations in overdose mortality rates across states and from year-to-year (Calcaterra et al., 2013), fewer studies have examined spatiotemporal variation in overdose deaths within states (Bohnert et al., 2014; Cerda et al., 2013; Rossen et al., 2013, 2014). For many causes of death, there are regular changes and seasonality in mortality rates, with systematically recurring periods of increased and decreased risk. For example, deaths attributable to influenza are highest in the colder winter months (Durand et al., 2015), and deaths from motor vehicle accidents are often most common on long holiday weekends (Anowar et al., 2013). Some of these changes are linked to fluctuations in natural processes (in the case of influenza), while others are linked to sociocultural factors that influence behavior (in the case of motor vehicle accidents).

Deaths from substance use and other external causes, such as suicide and homicide, are often more likely to occur during the first week of the month than during the last week of the preceding month (Otterstatter et al., 2016; Phillips et al., 1999; Riddell and Riddell, 2006; Verheul et al., 1997). The beginning of the month is often associated with several stressful events, such as evictions from rental properties and the payment of rent, mortgage, and bills. Furthermore, in many jurisdictions across the United States and Canada, income assistance payments from social service programs are disbursed on a monthly basis, often during the first week of the month (Social Security Administration, 2016). Emerging research has investigated the association between the timing of income assistance payments and substance use and related harms, showing an increase in adverse outcomes and health service utilization on or immediately after checks have been issued (Krebs et al., 2016; Otterstatter et al., 2016; Zlotorzynska et al., 2014).

Although rates of substance use do not vary among those who receive social service benefits and those who do not (Rosen, 2011), previous research has noted that peaks in intensity of substance use among recipients are synchronized with check issuance (Brunette et al., 1991; Krebs et al., 2016). It has been suggested that a sudden increase in cash may act as a conditioned cue for drug consumption (Epstein et al., 2009; O'Brien et al., 1992). In issuing checks to all recipients at the same time, the potential adverse effects associated with increased intensity of substance use may be magnified at the population level, leading to the so-called "check effect" (Rosen, 2011).

Despite this growing literature, no studies have assessed spatiotemporal patterning in the distribution of overdose fatalities by time of month, thereby limiting our understanding of whether these check effects are limited in their impact to specific communities with high levels of social assistance receipt. Should the excess overdose fatalities occurring at the beginning of a month be due to social service check issuance, overdose fatalities occurring within the first days of a month should cluster in communities where high proportions of residents receive public assistance. In the current study, we sought to investigate the effect of check issuance timing on overdose patterns in Rhode Island and examined the spatiotemporal patterning of overdose deaths occurring within the first week of a month. Given previous research on check issuance and drug overdose (Krebs et al., 2016; Otterstatter et al., 2016; Rosen, 2011; Zlotorzynska et al., 2014), we hypothesized that: (a) there would be a higher number of overdose fatalities occurring with the first seven days of a month relative to the last seven days of a preceding month; and (b), that excess overdose fatalities occurring in the first seven days of a month would cluster in geographic areas with a higher proportion of residents receiving public assistance benefits.

2. Material and methods

We conducted a retrospective review of accidental drug overdose fatalities occurring in Rhode Island between January 1, 2014 and December 31, 2016, as part of ongoing overdose surveillance activities (Marshall et al., 2017a,2017b). Methods for case review and data abstraction have been described previously in detail (Marshall et al., 2017a,2017b). In brief, in accordance with state policies (Rhode Island Department of Health, 2015), cases were considered to confirmed accidental drug overdose fatalities if: (a) the death was pronounced in Rhode Island; (b) the final manner of death was deemed an accident by the medical examiner; and (c) a drug is listed on the death certificate as the primary cause of death or a significant contributing factor. Each case was reviewed independently by a minimum of two trained research assistants; discrepancies were resolved by consensus. Data regarding demographic characteristics of the decedent, toxicological analyses, the date of death, the exact address at which the overdose occurred, and the circumstances of the overdose were abstracted from medical examiner files. In addition, the address at which the overdose occurred was classified into one of several categories, such as the decedent's own residence, the residence of another individual, or a public space, allowing for a determination of whether the decedent resided at the overdose location. This study was deemed exempt from institutional review board review as the analysis was conducted on behalf of public health and did not involve living subjects.

The study population included all accidental overdose fatalities (n = 866) recorded in Rhode Island between January 1, 2014 and December 31, 2016. A small proportion of overdose fatalities (n = 26, 3.2%) were excluded, some due to missing information regarding the location of overdose (n = 5; 0.8%) and others due to the fact that although the death was pronounced in Rhode Island, they occurred in neighborhood states (n = 21; 2.4%). This reduced the analytical sample to 840 overdose fatalities.

Each fatal overdose was classified based on time of month as either occurring within the first seven days of a month, during the last seven days of a month, or any other time during a month. The change in the number of deaths before and after the first of the month was measured by calculating the ratio of the number of deaths within first seven days of the month to the number occurring within the last seven days of the preceding month (Phillips et al., 1999). This window was chosen based on prior literature (Catalano et al., 2000; Otterstatter et al., 2016; Phillips et al., 1999; Shaner et al., 1995), although others have used other windows, including five days (Dobkin and Puller, 2007). As a sensitivity analysis, we also conducted our analyses using a five-day window. Next, all overdose events were then geocoded in ArcGIS Version 10.3 based on the address at which the overdose occurred to one of 812 census block groups in Rhode Island. A census block group is a geographical unit used by the United States Census Bureau that typically has a population of 600 to 3000 people (United States Census Bureau, 2012). It is the smallest geographic unit for which the Census Bureau published demographic and socioeconomic information (United States Census Bureau, 2012). As the boundaries of census block groups are somewhat artificial and can be subject to the modifiable areal unit problem (Dark and Bram, 2007), presenting the exact locations of fatalities would have been preferable. However, due to confidentiality concerns surrounding overdose fatalities, this was not possible. As such, census block groups were used as the unit of analysis as they are the smallest unit available. Their boundaries are designed to be stable over time and are considered a preferred unit for geographic analyses compared to non-population-based spatial units, such as ZIP code tabulation areas.

In spatial epidemiology, clusters are broadly defined as geographic areas in which the prevalence of disease is disproportionately higher compared to neighboring areas. For this study, we used a spatial scan statistic (Kulldorff, 1997, 1999) to test for census block group-level clustering of overdose fatalities in the beginning of a month using SaTScan (Version 9.9.4). Random datasets of overdose fatalities were generated following a Poisson distribution using Monte Carlo simulations under the null hypothesis that the expected counts of overdose fatalities in each census block group were proportional to the population of the census block group. Potential clusters were identified by a circular window that scans each census block group centroid, maximizing the disproportion in the prevalence of fatal overdoses between the inside of the window and the outside of the window. Potential cluster size was defined by the percent of the population used in the analyses, with the lower limit automatically set to 0% and the upper limit set to 50%. This upper limit was selected as it allowed for the largest applicable cluster size, as a higher percentage would identify areas with lower rates outside the spatial scan window rather than areas with higher rates inside the window. Setting the upper limit to 50% allowed the program to search for both small and large clusters without pre-selection bias. A maximum likelihood ratio was calculated

for each potential cluster and the likelihood ratios of observed events are tested against the distribution of values from the simulated events. This method accounts for uneven geographic population distribution between the census block groups and does not assume *a priori* cluster size. Monte Carlo testing was used to determine statistical significance. All clusters were visualized in ArcGIS (Version 10.3). The sample used to identify clusters was restricted to decedents who experienced an overdose at their own residence in a sensitivity analysis to examine the robustness of the study findings when scanning for clusters among individuals who were confirmed to reside in the census tract that they experienced an overdose in.

After clusters of overdoses occurring during the first week of the month were determined, logistic regression models were used to analyze demographic variables associated with a census block group being in a cluster using 5-year estimates derived from the 2012–2016 cycles of the American Community Survey (United States Census Bureau, 2017). In the regression model, public assistance receipt (measured as the percentage of people receiving cash public assistance in each census block group) was treated as the main exposure of interest. All other covariates were treated as potential confounders, including a measure for age distribution (operationalized as percentage of residents aged 18 to 24), measures of racial composition (percent of residents identify as White, African American or Black, and Hispanic or Latino), poverty (percent of residents living below the poverty line), labor force participation (percent of residents active in the labor force), educational attainment (percent of residents earning at least a high school diploma or equivalent certification), health insurance coverage (percent of residents with coverage from at least one health insurance plan), disability status (percent of residents reported to have hearing, visual, cognitive, ambulatory, self-care, or independent living disabilities), and housing cost burden (percentage of households whose monthly housing costs were more than 30% of their household income). Statistical analyses were conducted in R Studio (Version 1.1.383).

3. Results

There were 840 eligible fatal overdose events recorded within Rhode Island between January 1, 2014 and December 31, 2016, corresponding to an annualized rate of fatal overdose of 26.5 overdose fatalities per 100,000 persons. The median age at death was 43.0 years old (interquartile range [IQR]: 31.0–52.0); about one in two decedents was younger than 45 years old at death (55.5%). The majority of decedents were male (72.1%). Most overdoses involved an opioid (83.3%). Among those involving an opioid (n = 698), 57.7% involved fentanyl and 37.5% involved heroin or morphine (the primary metabolite of heroin). Among all opioid-involved fatalities, 32.1% also involved cocaine, 26.1% also involved alcohol, and 13.5% also involved a benzodiazepine. Of all overdose fatalities, 74.9% occurred at the decedent's own residence. Of those who experienced an overdose in a place other than their own residence (n = 210), 45.2% experienced an overdose in the city/town they resided in, 31.0% experienced an overdose in the residence of another individual who resided in another city/town, and 17.1% experienced an overdose in a public place (e.g., car, hotel/motel, park) outside of the city/town they resided in.

Over the three-year study period, there were a total of 225 overdose fatalities occurred during the first seven days of a month compared to 193 overdose fatalities in the last seven days in a preceding month (Fig. 1), for a Rate Ratio of 1.17 (1.04–1.38). Increases were evident for a range of demographic characteristics and substances (Table 1), including in deaths among those aged between 35 and 44 years at death (R: 1.19; 95% CI: 1.09, 1.29) and those aged between 45 and 54 years at death (R: 1.42; 95% CI: 1.33, 1.52), females (R: 1.18; 95% CI: 1.10, 1.25), involving any opioid (R: 1.06; 95% CI: 1.01, 1.10) and involving fentanyl (R: 1.11; 95% CI: 1.05, 1.17). An inverse association was observed for deaths among those younger than 34 years (R: 0.79; 95% CI: 0.72, 0.85). A total of 190 overdose deaths occurred in the week following the first week of the month and 161 overdose deaths occurred in the week preceding the last week of the month.

A spatial scan of the overdose fatalities occurring within the first seven days of a month detected two significant clusters (Fig. 2). The first cluster included 15 overdose fatalities among a population of 19,099 residents across 18 census block groups, representing an annualized rate of fatal overdose of 26.2 per 100,000 persons (4 overdose deaths expected, or 7.0 per 100,000 persons). The second cluster included 21 overdose fatalities among a population of 35,525 residents in 24 census block groups, representing an annualized rate of fatal overdose of 19.7 per 100,000 persons (7 overdose deaths expected, or 6.6 per 10,000 persons). In total, these two clusters include only 5.2% of the population of the state but included 16.7% of the fatal overdose events occurring within the first seven days of a month.

Descriptive statistics regarding neighborhood-level social and structural characteristics of census block groups included within these clusters and those outside of these clusters are provided in Table 2. At the bivariate level, census block groups included within these clusters had, on average, higher percentages of Black/African American (non-Hispanic/Latino) residents, residents living below the federal poverty line, residents living with a disability, residents receiving cash public assistance, residents receiving Supplemental Security Income (SSI), and deemed burdened by their housing costs. In addition, these census block groups had, on average, lower percentages of residents participating in the labor force, residents with high school diplomas, and residents with health insurance coverage.

Multivariable analyses of neighborhood-level characteristics and census block groups within a cluster of overdoses occurring during the first week of the month are presented in Table 3. Census block groups with excess overdose-related fatalities during the first seven days of a month had higher percentages of Black/African American (non-Hispanic/Latino) residents (adjusted odds ratio [AOR]: 1.42; 95% CI: 1.02–1.98), residents living below the federal poverty line (AOR: 1.51; 95% CI: 1.14, 1.99), and residents deemed burdened by their housing costs (AOR: 1.42; 95% CI: 1.05, 1.91) compared to census block groups outside of these two clusters. Percent of residents receiving public assistance was not independently associated with membership in a cluster of excess overdoses at the beginning of a month (AOR: 0.73, 95% CI: 0.36, 1.38) nor was the percent of residents receiving SSI (AOR: 1.04; 95% CI: 0.67, 162). In a sensitivity analysis with a five-day window, we found no significant increase in overdose fatalities in the first five days of a month relative to the last five days

of a month (R: 1.16; 95% CI: 0.94, 1.42) (Supplemental Table 1). Given that this association was non-significant, the spatial scan was not repeated with this time period.

3.1. Sensitivity analysis

In a spatial scan in the restricted sample of individuals who experienced an overdose at their own residence (n = 628), three clusters of overdose deaths were detected in the first week of a month. Two of these clusters were similar to those found in a spatial scan among the full sample but were slightly larger and a third unique cluster was identified (Supplemental Fig. 1). In identifying correlates of clustering in this restricted sample (Supplemental Table 2), the percentage of residents living below the federal poverty line (AOR: 1.42; 95% CI: 1.14, 1.78) and the percentage of residents deemed burdened by their housing costs (AOR: 1.28; 95% CI: 1.02–1.59) were similarly significantly and positively associated with a census block group being located in a cluster. Similarly, the percent of residents receiving SSI was not associated with cluster member (AOR: 1.04; 95% CI: 0.72–1.50). In this analysis, census block groups located within clusters had higher percentages of residents participating in the labor force (AOR: 1.51; 95% CI: 1.15, 2.02) and residents with disabilities (AOR: 1.95% CI: 1.38–2.76) and lower percentages of residents who completed high school (AOR: 0.74; 95% CI: 0.58–0.96) and who received public assistance (AOR: 0.43; 95% CI: 0.22–0.77).

4. Discussion

In this retrospective, population-based study of overdose fatalities in Rhode Island, we observed an eight percent increase in fatal overdose events during the first day days of a month compared to the last seven days of a previous month. Across a three-year period from 2014 to 2016, these increases were evident across a range of individual-level overdose decedent characteristics (e.g., decedent age, sex, and substances involved). Given previous research suggesting a link between social service benefit check issuance and increased rates of overdose fatalities (Krebs et al., 2016; Otterstatter et al., 2016; Rosen, 2011; Zlotorzynska et al., 2014), we hypothesized that this excess mortality within the first seven days of a month would be concentrated within communities with high rates of cash public assistance participation. Although we found that census block groups in clusters indicating excess fatalities in the first seven days of a month did have higher rates of public assistance receipt (5.8% compared to 3.1% of residents on average) and SSI receipt (14.6% compared to 6.9% of residents on average) in bivariable levels, these associations did not persist in multivariable models. Among all deaths, census block group membership in one of these clusters was not independently associated with the proportion of residents in that census block group receiving cash public assistance or SSI benefits. Higher proportions of residences receiving cash public assistance were associated with lower odds of cluster membership when examining clusters among a restricted sample of decedents who experience an overdose in their own homes.

Higher levels of housing cost burden (i.e., a higher proportion of residents paying 30% or more of their household income towards rent, mortgage, or other housing costs) were independently associated with census block group membership in clusters with excess overdose fatalities occurring in the first seven days of a month in both the full and restricted

samples. Several factors may explain this relationship, which require further investigations. First, high housing-related costs have been linked to a broad range of poor health outcomes, including psychological distress (Bentley et al., 2012, 2011; Mason et al., 2013). Since 2008, a national housing bubble and lax lending standards produced high levels of both foreclosure and household debt (Joint Center for Housing Studies of Harvard University, 2008, 2009), while declining real wages for the lowest earners, combined with increasing housing costs, has led to an insufficient supply of affordable rental housing units (Joint Center for Housing Studies of Harvard University, 2008, 2009). From 2011–2016, the number of households living in unaffordable housing increased by 5.5%–38.7 million (United States Census Bureau, 2017) Therefore, high housing costs may cause high levels of stress and emotional strain that can be heightened given people's emotional attachment to their homes (Fullilove, 2004; Hiscock et al., 2001; Kearns et al., 2000), which may in turn caused increased substance use. Second, in addition to these mechanisms, stress associated with rent and mortgage payments due at the beginning of a month, as well as the threat of eviction, may result in higher intensity of substance use leading up to these deadlines. In communities with high proportions of the population living in poverty, these individual-level effects may be magnified at then neighborhood level, resulting in clustering of drug-related harms in housing cost-burdened communities. Although our findings cannot necessarily be generalized to the individual level, the results of this study suggest that previously observed associations between receipt of social assistance and increased risk of overdose at the beginning of the month may be confounded by high housing costs, the threat of eviction, and other housing-related stresses that peak during the first of the month. Future mixed-methods research is needed to elucidate the causal mechanisms that may link housing cost burden and other financial stressors with excess overdose risk at the individual level.

These findings are not without limitation. First, the sensitive nature of information pertaining to drug overdose fatalities requires a level of confidentiality that prevented us from using a more precise measure of geographic location in our analyses. As such, the results of these analyses may have been influenced by the aggregation of data into census block groups (Dark and Bram, 2007). Second, these analyses are at the neighborhood level and, without information on social service benefit receipt among decedents, we are unable to extrapolate these findings to the individual-level and we cannot determine if individuals who receive social service benefits are over- or under-represented in overdose fatalities occurring in the first seven days of a month. Similarly, no information is available at the parcel level on the incident location, including whether the decedent was resident of the location, the household income relative to overall housing costs, and whether the home had been subject to foreclosure proceedings in a period prior to death. Third, although our retrospective review includes all drug overdose fatalities recorded within Rhode Island between 2014 and 2016, these data are not intended to represent all deaths among the overall population in the states, as deaths of Rhode Island residents proclaimed in other states would not be included in this sample, whereas deaths of residents of other states proclaimed in Rhode Island are included in this sample. The results were not robust to a shorter window period. This may be a result of type II error (given the smaller number of deaths observed during this window). Larger studies conducted in other settings should confirm these findings.

Future research is needed to further explore the complex relationships between economic factors (e.g., social service benefit receipt, housing cost burden) and fatal overdose. To our knowledge, the current analysis presents a novel association between neighborhood-level housing cost burden and excess risk for fatal overdoses at the beginning of the month. Given that inferences cannot be made about the association of housing cost burden with overdose at the individual level, future studies should assess these factors and their associations with individual-level risk of fatal and non-fatal overdose. It is possible that mounting stress associated with periods leading up to rent or mortgage periods or in the periods following the beginning of foreclosure proceedings may be associated with higher intensity of substance use and, therefore, higher risk of overdose. Given that the excess mortality was observed for some substances (e.g., cocaine, fentanyl, benzodiazepines) and not others, it is also possible that some of these associations may be explained by supply-side factors (e.g., changes in drug potency or adulterants present in illicit drug supplies) over time. Further research is needed to determine whether and how a combination of supply- and demand-side factors increase overdose deaths at the beginning of the month.

Although the effect size is small (i.e., an 8% increase in fatal drug overdoses in the first week of a month relative to the last week of a month), this effect is similar in magnitude to that observed in other settings (Zlotorzynska et al., 2014). Nonetheless, these results have important implications for policy and practice. First, given an increase in drug overdose deaths in the first week of a month, acute responses to overdose events, such as street outreach, naloxone distribution, and peer recovery support services can be scaled up with a targeted focus on areas where overdose fatalities have clustered. Second, given that the clustering of excess overdose mortality in communities where housing-related costs represent a major financial burden, structural interventions can be implemented to reduce the potential psychosocial distress associated with the need to make payments for rent or mortgages and subsequently reduce the risk of eviction.

5. Conclusions

Among this sample of decedents in Rhode Island, increases in overdose fatalities were observed in the first seven days of a month relative to the last seven days of a month. Overdose fatalities occurring within the first seven days of a month clustered in specific locations within the state. However, despite previous research on social service benefit check issuance and increases in overdose mortality at the beginning of a month, there was no significant association between the proportion of residents receiving cash public assistance and cluster locations. Increasing proportions of residents within a neighborhood living in unaffordable housing was associated with cluster location, highlighting a need for future research on housing cost burden and its influence as a risk factor for fatal overdose at the individual level.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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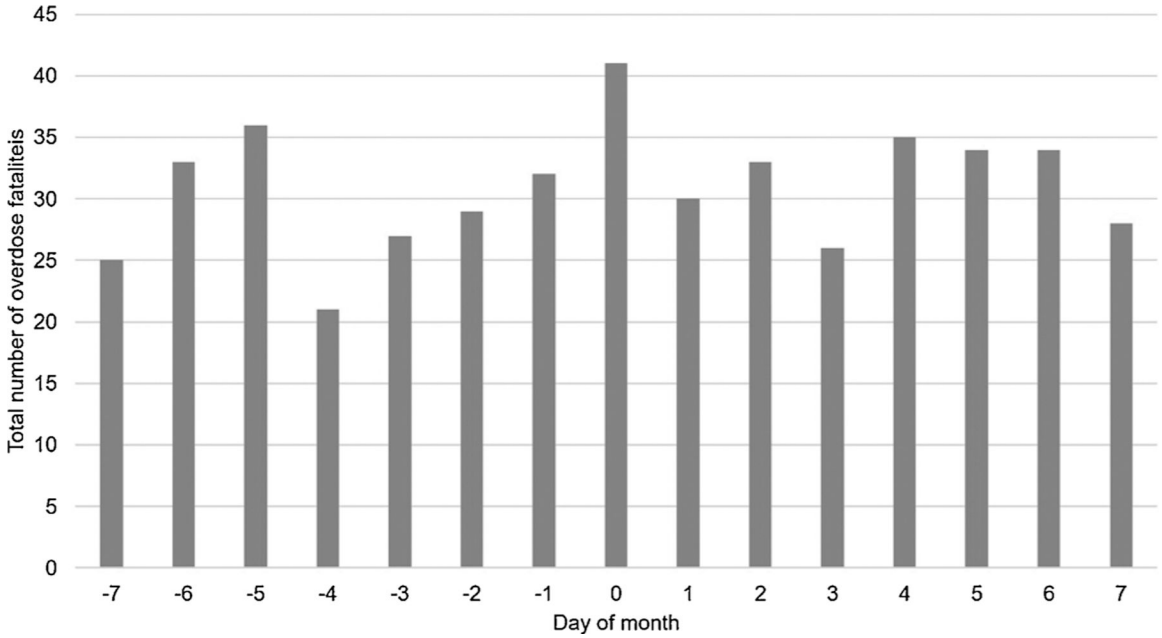

Fig. 1.
Number of overdose fatalities by day of the month, Rhode Island.2014–2016.

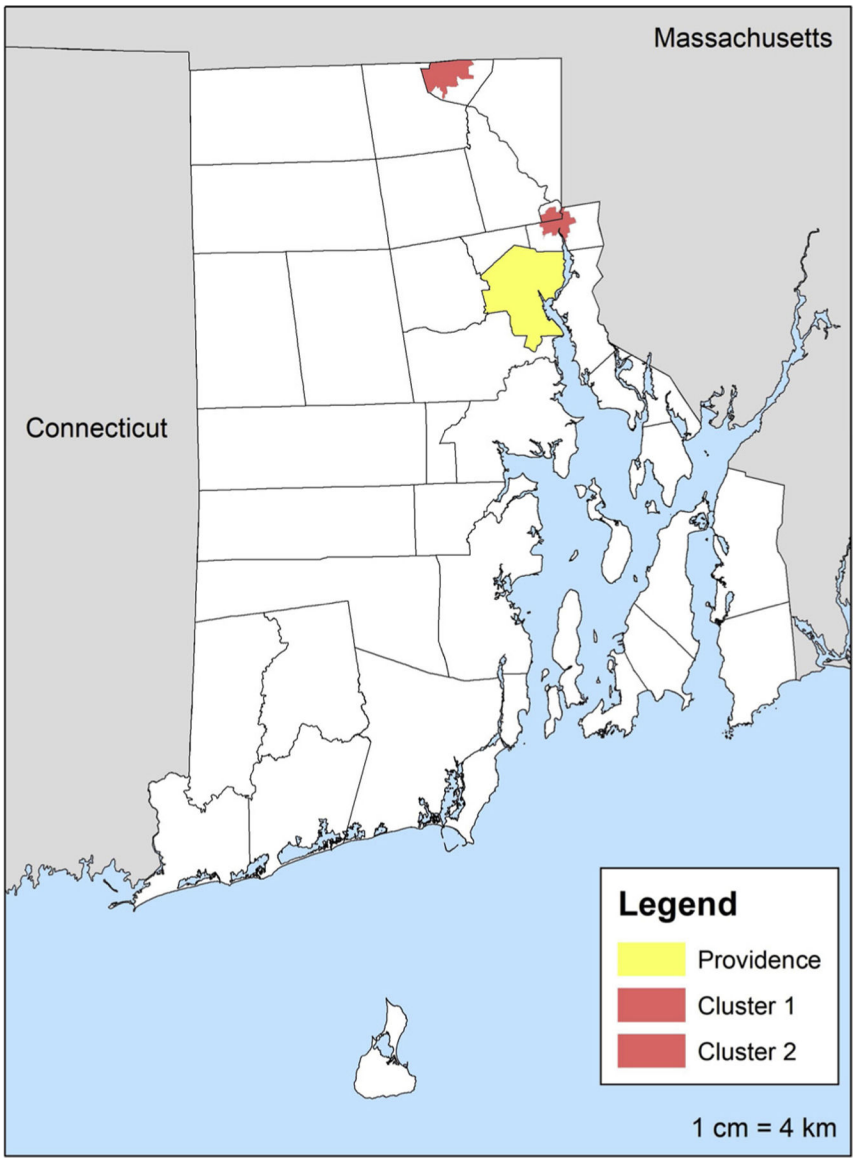

Fig. 2.

Clusters of excess overdose fatalities within the first week of a month in Rhode Island. Note: Day 0 represents the first day of a month.

Table 1

Increases in overdose fatalities in Rhode Island (2014–2016) in the beginning of a month relative to the end of a month, stratified by decedent age and sex and substances deemed to be involved in death.

	Total Overdoses	Overdoses:First 7 Days	Overdoses:Last 7 Days	Ratio (95% CI)
Overall	840	225	193	1.17 (1.04–1.38)
Age				
18 to 24 years old	67	17	17	1.00 (0.85, 1.15)
25 to 34 years old	228	42	58	0.72 (0.65, 0.80)
35 to 44 years old	162	50	42	1.19 (1.09, 1.29)
45 to 54 years old	222	59	50	1.42 (1.33, 1.52)
55 years and older	159	47	33	1.42 (0.94, 1.30)
Sex				
Male	604	155	149	1.04 (0.99, 1.09)
Female	234	60	51	1.18 (1.10, 1.25)
Substances Involved [a]				
Alcohol	230	54	57	0.95 (0.87, 1.03)
Cocaine	299	77	69	1.12 (1.05, 1.18)
Heroin	262	65	66	0.98 (0.91, 1.06)
Fentanyl	403	104	94	1.11 (1.05, 1.17)
Benzodiazepines	104	30	22	1.36 (1.25, 1.48)
Prescription Opioids	234	56	55	1.02 (0.74, 1.41)
Any Opioid	698	179	169	1.06 (1.01, 1.10)

[b] Includes buprenorphine, codeine, dihydrocodeine, hydrocodone, hydromorphone, methadone, oxycodone, oxymorphone, and tramadol.

[a] Multiple substances could have been involved in a single overdose. As such, the number of deaths summed across each of the substances involved may add up to more than the total number of deaths.

Table 2

Differences in neighborhood-level social and structural characteristics between within-cluster and out-of-cluster census block groups for overdoses occurring during the first week of the month, Rhode Island (2014–2016)

	Within Cluster Mean (Standard Deviation)	Outside Cluster Mean (Standard Deviation)	*p* value
% 18 to 24 years old	9.8 (4.0)	10.1 (11.6)	.754
% Male	50.2 (5.6)	48.3 (6.3)	.060
% Black (Non-Hispanic)	14.0 (9.6)	5.2 (8.2)	< .001
% Poverty	31.8 (12.7)	13.3 (13.5)	< .001
% Labor Force Participation	60.5 (12.0)	65.7 (10.7)	.002
% High School Completion	73.1 (13.4)	87.1 (11.3)	< .001
% Health Insurance	86.1 (5.8)	91.7 (7.1)	< .001
% Disability	17.6 (9.4)	10.8 (7.6)	< .001
% Cash Public Assistance Receipt	5.8 (5.3)	3.1 (4.4)	< .001
% Supplemental Security Income (SSI) Receipt	14.6 (9.4)	6.9 (7.4)	< .001
% Housing Cost Burdened	49.7 (10.3)	40.0 (13.0)	< .001

Table 3

Multivariable logistic regression analyses of factors associated with a census block group being included within a cluster of excess overdoses occurring during the first week of the month, Rhode Island (2014–2016).

Neighborhood Characteristic	Adjusted Odds Ratio (95% Confidence Interval)
% 18 to 24 years old	0.65 (0.36, 1.18)
% Male	1.28 (0.78, 2.08)
% Black (Non-Hispanic)	1.42 (1.02, 1.98)
% Poverty	1.51 (1.14, 1.99)
% Labor Force Participation	1.18 (0.82, 1.71)
% High School Completion	0.76 (0.55, 1.04)
% Health Insurance	0.96 (0.62, 1.49)
% Disability	1.53 (0.97, 2.41)
% Public Assistance Receipt	0.72 (0.36, 1.42)
% Supplemental Security Income (SSI) Receipt	1.04 (0.67, 1.62)
% Housing Cost Burdened	1.42 (1.05, 1.91)

Note: All odds ratios are expressed per 10-unit increase in each of the continuous covariates.