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Racial differences in overdose events and polydrug detection in Indianapolis, Indiana

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ABSTRACT

Background: We examine racial disparities in drug overdose death rates by analyzing trends in fatal and nonfatal overdose outcomes in a large metropolitan area (Indianapolis, Indiana).

Methods: Death certificate and toxicology records for accidental drug overdose deaths from 2011 to 2018 were linked with emergency medical services (EMS) data. Bivariate comparisons examined differences in toxicology findings at the time of death as well as prior EMS events both overall and by indicator of non-fatal overdose.

Results: From 2011–2018, 2204 residents (29.4 per 100,000) died of drug overdose, 18.6% were Black (N = 410, 19.5 per 100,000) and 78.5% White (N = 1730, 35.2 per 100,000). In the year prior to death, 33.5% (N = 656) of decedents had an EMS event, 12.1% (N = 237) had an overdose event, and 9.4% (N = 185) had naloxone administered. Overdose complaint and naloxone administration were more likely to occur among White than Black patients. White decedents were more likely than Black decedents to have had naloxone administered in the year prior to death (10.1% vs. 6.8%, $\chi^2 = 4.0$, $p < .05$, Cramer's V = .05). Toxicology data illustrate changing polydrug combinations, with Black decedents more likely to test positive for fentanyl-cocaine polydrug use in recent years.

Conclusions: Recent racial disparities in overdose deaths are driven by a combination of fentanyl and cocaine, which disproportionally impacts African American drug users, but may be addressed through expanded harm reduction and community outreach services. Additionally, there is a need to assess the role of differing practices in overdose emergency service provision as a contributing factor to disparities.

1. Introduction

There have been more than a half million drug overdose deaths in the United States since 2000, with over 70,000 drug overdose deaths in 2017 alone (Seth et al., 2018). The majority of these deaths have been opioid-related; however, the role of opioids has varied dramatically across three waves of the epidemic, each resulting in increasing death rates (Ciccarone, 2017). The first wave began in the 1990s and was characterized by prescription opioid-related deaths (Cicero et al., 2014; Grau et al., 2007). Reduced availability of these prescription medications likely resulted in the second wave of the epidemic, which began in 2010 and was driven by increasing heroin use and a corresponding increase in illicit opioid deaths (Cicero et al., 2014; Rudd et al., 2014; Strickler et al., 2019). The third wave started in 2013 and has been driven by illicit fentanyl, a synthetic opioid that is 50–100 times more potent than morphine (Gladden, 2016; O'Donnell et al., 2017).

There is now growing evidence that the third wave of this epidemic is disproportionately affecting racial and ethnic minorities (Seth et al., 2018). For the purposes of our study, we define race and ethnicity as distinct constructs consistent with U.S. Census Bureau definitions (U.S. Census Bureau, 2017). To date, ethnic disparities have primarily referred to disparities between Hispanic individuals and non-Hispanic White individuals (Seth et al., 2018). Racial disparities have primarily addressed those between non-Hispanic White individuals and Black individuals. To illustrate, from 2016 to 2017, the largest relative increase in opioid-related overdoses was among the Black population. There was a 25.1% increase in all opioid-related overdoses among the Black population, while the increase in *synthetic* opioid-involved deaths for the Black population was 60.7% (Hedegaard, 2017). Current evidence suggests these trends are being driven by the growing use of fentanyl-laced cocaine among Black individuals (Jalal et al., 2018; James and Jordan, 2018), despite higher lifetime and past year cocaine

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use among White individuals (Center for Behavioral Health Statistics and Quality, 2018). Commensurate with these trends, between 2013 and 2015, the annual drug-related mortality rate increased 79% among the White population, but 107% for the Black population (Alexander et al., 2018). As rates of fatal overdose have increased so have non-fatal overdose events as measured by the use of naloxone—an opioid antagonist that reverses respiratory depression occurring during an opioid overdose—by emergency medical services (EMS). From 2012 through 2016 the rate of EMS naloxone administration events increased 75.1%; however, the proportion of events among Black patients increased by 42.7% while there was a 7.7% decrease among White patients (Cash, 2018).

Despite growing racial disparities in overdose death rates, there has been relatively little research focused on explaining this trend. Part of the difficulty in examining changes in overdose trends may be data limitations. For example, vital records data rely on the International Classification of Diseases, 10th Revision (ICD-10) codes, which often do not record the specific substances involved in a drug-related death and are limited in their ability to examine polydrug combinations (Fernandez et al., 2006; Hoppe-Roberts et al., 2000; Linakis and Frederick, 1993; Wysowski, 2007) specifically fentanyl, which has been linked to recent disparities (Katz and Goodnough, 2017; Sanger-Katz, 2018). Similarly, nationally available data on non-fatal overdoses—such as the National Emergency Medical Services Information System (NEMSIS)—are not able to be linked to fatal overdose deaths to determine whether these events preceded a fatal overdose.

Given these trends in fatal and non-fatal overdose events, as well as increased focus on emergency medical settings as a potential intervention point (Am et al., 2016; D'Onofrio et al., 2017; Saloner et al., 2018), the current study leverages a unique longitudinal dataset (2011–2018) of toxicology results collected from death investigations from a large metropolitan jurisdiction (Marion County, Indiana [Indianapolis]) that are linked to local EMS data as part of the Centers for Disease Control and Prevention (CDC), Prevention for States initiative (Lowder et al., 2018; Phalen et al., 2018; Ray et al., 2017). Indiana has been hit hard by the overdose epidemic, ranking 14th out of all of states in terms of overdose death severity, and with fatal overdose rates higher than the national average (Rudd, 2016); moreover, nearly a quarter these deaths have occurred in Marion County alone. With record linked data we conduct a retrospective analysis of EMS utilization, specifically for a nonfatal overdose in the year prior to death, to examine patterns of utilization by race and over time. We then used network analysis methods, particularly word-document networks, to explore polydrug combinations in overdose deaths by race and over time.

2. Material and methods

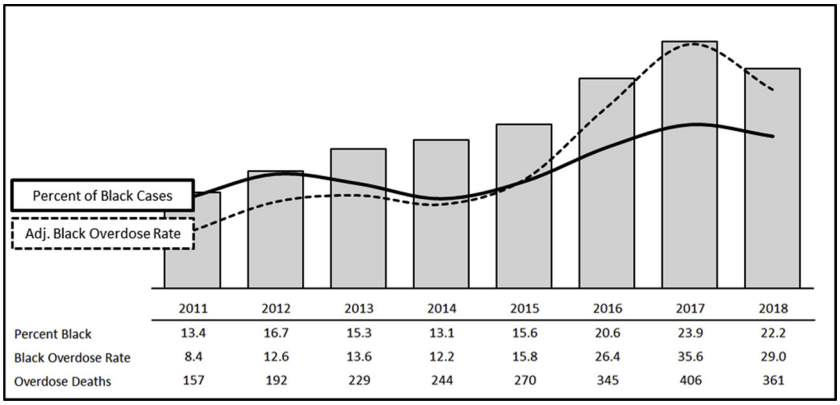
Study data come from Marion County, Indiana, the largest county in the state and home to Indiana's capital of Indianapolis. In 2015 the population in Indianapolis was estimated at 939,020 and was 57.3% White, 28.0% Black, 10.0% Hispanic or Latino, and 4.7% other racial and ethnic groups. This distribution can be compared to Indiana as a whole, where 85.5% of the population is White, 9.6% is Black, 6.6% is Hispanic or Latino, and 2.6% identifies with another racial or ethnic group ("InDepth Profile: STATS Indiana," n.d). We linked data from the Marion County Coroner's Office (MCCO) to Indianapolis Emergency Medical Services (IEMS) records. Death certificate and toxicology results from the MCCO included all suspected accidental drug overdose events (X40-X44) and are part of a larger and ongoing CDC-funded study. Death certificates provided sociodemographic information. Toxicology data provided detection (which is based on thresholds set by the testing agency) of the following substances: 6-monoacetylmorphine (heroin), fentanyl (and synthetic analogues such as carfentanyl), morphine, codeine, oxycodone, hydrocodone, oxymorphone, hydromorphone, cocaine, benzodiazepines, and methamphetamine. For EMS data, staff queried an electronic patient care record database for incidents resulting in a call for service and where the patient resided in Marion County at the time of the event. EMS records provided information on the chief complaint (i.e., overdose, other) and whether naloxone was administered to the patient, which would reflect an opioid-related overdose event.

2.1. Sample description and analysis

During the study period (2011–2018) there were a total of 2204 overdose deaths and 667,027 EMS events; 4.5% (N = 11,852) of the events were calls for an overdose, and EMS administered naloxone in 1.6% of the events (N = 4231), resulting in 277,439 unique patient records (M = 2.4 events each; SD = 5.3; Range = 1–303). EMS and MCCO data were linked using patient name (first and last) and date-of-birth. Both sources of data contained a rudimentary measure of race/ethnicity that captured broad categories: Black, White, Hispanic, Asian, American Indian, Pacific Islander, and Other. Because race was not measured separately from ethnicity, we limited our analysis to race only and coded cases where the decedent was Black or White. These categories (Black and White) represented 97.1% of overdose deaths (2140 of 2204) and 96.9% of all EMS events (646,259 of 667,027). Moreover, to explore the use of EMS services among overdose decedents by race, we examined EMS events in the year prior to death (2011 to 2018). Thus, the final sample consisted of 2140 Black and White accidental drug overdose decedents who died from 2011 through 2018. We conducted descriptive statistics on key variables and report chi-squared (χ^2) statistics to test hypotheses of differences by race. To analyze polydrug combinations in toxicology findings, we used network analysis techniques developed for analyzing relational structures in text data (Carley, 1997). We conducted the analysis in R, visualizing the frequency of co-occurrences among substances detected in the toxicology reports (Igraph-Network analysis software, 2019). Our analysis involved constructing annual word-document matrices, in our case substance-report matrices, where rows represent individual substances and columns represent individual toxicology reports. In these matrices, cell *i,j* contains a "1″ if substance *i* appeared in toxicology report *j* and zero otherwise. We then projected these substance-report matrices into substance-to-substance matrices, where rows and columns represent substances and cell *i,j* contains the number of toxicology reports where substances *i* and *j* co-occur. In the resulting visualization, the weight (thickness) of each edge (line) indicates the frequency (count) of co-occurrences between the connecting nodes (i.e. substances) in a given year. The node size indicates the frequency (count) of each specific substance. Thus, bigger nodes denote more frequent specific polydrug occurrences. Edge weights can be compared across years to examine changing frequencies of unique polydrug combinations, illustrating the growth of polydrug related deaths.

3. Results

From 2011 to 2018, 2140 patients died of a drug overdose in Marion County. The majority of deaths involved White patients (80.8%, n = 1730) versus Black patients (19.2%, n = 410). The average age of the sample was 40.2 (SD = 12.6; Range 1–89). The majority of decedents were male (65.1%, n = 1393) versus female (34.9%, n = 747). As shown in Fig. 1, the number of fatal overdoses increased from 153 deaths in 2011 to 347 in 2018 (representing rates of 17.2 and 37.8, respectively, per 100,000 county residents). Among the White population, the rate of fatal overdose grew from 21.5 per 100,000 in 2011 to 43.7 per 100,000 in 2018. Among the Black population, the overdose rate increased from 8.4 in 2011 to 29.0 in 2018. The proportion of overdose deaths involving Black patients increased from 13.4% (n = 21) in 2011 to a high of 23.9% (n = 97) in 2017. During the entire study period, 72.0% of the overdose deaths among Black decedents involved an opioid, compared to 82.7% of White decedents.



	2011	2012	2013	2014	2015	2016	2017	2018
Percent Black	13.4	16.7	15.3	13.1	15.6	20.6	23.9	22.2
Black Overdose Rate	8.4	12.6	13.6	12.2	15.8	26.4	35.6	29.0
Overdose Deaths	157	192	229	244	270	345	406	361

Fig. 1. Accidental Drug Overdose Deaths and Percent Black, 2011-2018.

3.1. Retrospective analysis of EMS events

Analysis of EMS events showed 30.0% (N = 589) of overdose deaths occurred on the same day as a decedent's last EMS event. This was the only EMS event in the year prior to death for 18.9% (N = 370) of these cases. Black decedents were more likely than White decedents to have died at the last EMS event (37.1% vs. 28.3%, $\chi^2 = 11.5$, $p < .001$, Cramer's V = .08), and to have had their only EMS event occur on the same day as death (24.4% vs. 17.5%, $\chi^2 = 9.6$, $p < .01$, Cramer's V = .07).

Excluding EMS events occurring on the same day a person died, we found 33.5% (N = 656) of decedents had an EMS event in the year prior to death. Overall, there were 1701 EMS events in the year prior to death with an average of 2.3 events (SD = 3.4; Range 1–35) per decedent. There were no differences in the average number of EMS events by race, and the most common chief complaints were poisoning/overdose (17.6%; n = 300), sick person (15.1%; n = 256), trauma/injured person (9.0%; n = 153), behavioral mental/emotional (6.4%; n = 109), and respiratory problems (5.9%; n = 101). However, among White decedents, the most common complaints were poisoning/overdose (19.4%; n = 255), sick person (14.6%; n = 191), or trauma/injured person (9.5%; n = 125) while common complaints among Black decedents were for a sick person (16.8%; n = 65), respiratory problems (13.9%; n = 54), or poisoning/overdose (11.6%; n = 45).

In the year prior to death, 12.1% (N = 237) of decedents had an overdose event based on the chief complaint and 9.4% (N = 185) had naloxone administered by EMS. Those who had an illicit opioid (fentanyl or heroin) listed on the toxicology results were more likely to have had a prior overdose response (13.9% vs. 9.3%, $\chi^2 = 9.2$, $p < .01$, Cramer's V = .07) and naloxone administered by EMS (11.4% vs. 6.3%, $\chi^2 = 14.2$ $p < .001$, Cramer's V = .08). White decedents were significantly more likely to have had naloxone administered in the year prior to death relative to Black decedents (10.1% vs. 6.8%, $\chi^2 = 4.0$, $p < .05$, Cramer's V = .05). However, having a prior non-fatal overdose was too rare an event, especially among Black decedents, to look for meaningful trends over time (e.g., in 2013 and 2016 there was only one case).

3.2. Polydrug toxicology results

Consistent with prior research (Kandel et al., 2017; Kariisa et al., 2019), we found that the majority of Marion County overdose deaths contained more than a single substance, 73.6% (N = 1720). Fig. 2 displays the prevalence of substances in overdose deaths, showing decreases in prescription opioids (oxycodone, hydrocodone, oxymorphone, and hydromorphone) and benzodiazepines as well as increases in illicit substances (heroin, fentanyl, methamphetamines, and cocaine). The most dramatic increase has been fentanyl, which was

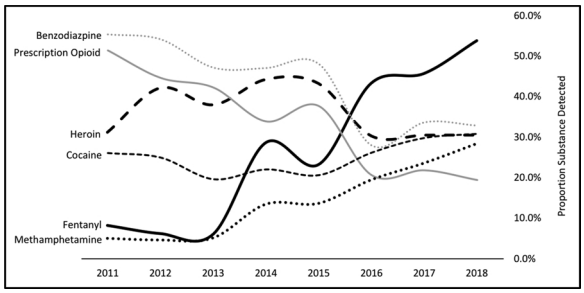


Fig. 2. Detection of Prescription and Illicit Substances in Drug Overdose Deaths, 2011-2018.

detected in 54.5% (n = 189) of overdoses in 2018, up from just 7.8% (n = 12) in 2011. Fig. 3 illustrates the polydrug combinations among overdose deaths by race. As shown in Fig. 3, from 2011 through 2015, 30.3% (n = 275) of all overdose deaths among White decedents involved both a prescription opioid and benzodiazepine compared to only 11.7% (n = 19) of Black decedents. However, as fentanyl detections began to increase in 2014, Fig. 3 shows that it was more commonly detected with cocaine in Black versus White decedents.

4. Discussion

As evidenced in national data, overdose mortality has started to disproportionately impact the Black population relative to the White population in recent years (Alexander et al., 2018; Hedegaard, 2017; Shiels et al., 2018). One potential explanation for the increase in opioid-related overdose deaths among the Black population could be disparities in the emergency medical settings, specifically the treatment of acute overdose in the emergency department and utilization of EMS (Cash, 2018; Faul et al., 2015; Mazer-Amirshahi et al., 2016; Pines et al., 2009; Singhal et al., 2016; Wilder et al., 2018). We found no differences in the likelihood of EMS use in the year prior to an overdose death by race. However, we found that Black decedents were more likely to have died on the same day as an EMS event, less likely to have an overdose event where naloxone was administered, and less likely to have been administered naloxone by EMS.

Another potential explanation for increases in fatal overdose deaths among African Americans are differences in substance use patterns (Bernstein et al., 2007; Coffin et al., 2003). Because national studies often rely on ICD codes, they are unable to examine changes in specific polydrug combinations. Our analysis of toxicology findings revealed patterns consistent with the three waves of the epidemic, showing decreases in prescription opioid-related deaths that gave rise to heroin and then fentanyl-related deaths. In visualizing polydrug combinations by race and over time, our findings are consistent with research suggesting White patients are more likely to be prescribed a

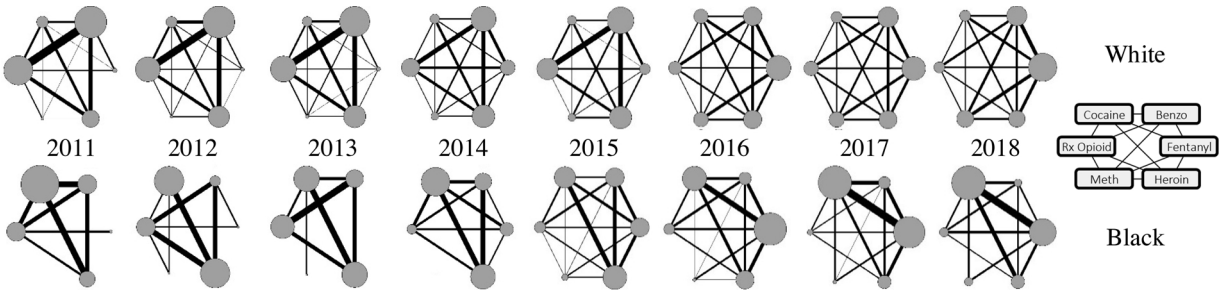


Fig. 3. Network of Substances Detected in Drug Overdose Deaths by Race, 2011-2018.

benzodiazepine, more likely to be co-prescribed opioid and benzodiazepines, and more likely to die of benzodiazepine-related poisoning (Bachhuber et al., 2016; Pletcher et al., 2008). However, our findings also suggest the third wave has disproportionately impacted racial minorities since 2014 through a combination of fentanyl and cocaine. This is consistent with evidence showing that fentanyl is being mixed into cocaine, which is contributing to overdose deaths involving these substances (Kandel et al., 2017; McCall Jones et al., 2017) as well as research showing subpopulation and racial differences in drug use patterns (Shiels et al., 2018). Moreover, this influx of fentanyl likely explains why Black patients were more likely to have died on the same day as EMS administered naloxone (Faul et al., 2017). Future research should focus on replicating the analysis presented over a broader geographic area and by different subpopulations. It will also be important to consider other antecedents to death, such as criminal justice interactions given the disproportionate representation and treatment of racial ethnic minorities in these systems (Bonczar, 2003; Carson and Sabol, 2012; Mitchell and Caudy, 2017).

Importantly, our findings demonstrate less than 10% of overdose decedents previously had naloxone administered by EMS. This trend suggests interventions based in emergency medical settings (e.g. medication assisted therapy induction or peer recovery coaches in the emergency department) or following a non-fatal overdose event (e.g. quick response teams) may impact only small portion of those at risk of death. Additionally, such interventions might disproportionately help White patients relative to Black patients. The findings from our network analysis of polydrug patterns suggests recent racial disparities in overdose deaths are largely the result of fentanyl being combined with cocaine which has disproportionately impacted African American drug users. This trend started in 2013 and coincided with the third wave of the overdose epidemic and may be the result of a supply-side poisoning (Kertesz and Gordon, 2019; Ruhm, 2019) or changes in drug seeking behavior as recent research suggests that nearly one-quarter of street-based people who use drug report a preference for fentanyl (Morales et al., 2019). Also, consistent with research on disparities in EMS responses more broadly (Merchant and Groeneveld, 2017), the potential disparities in care among Black patients from this study, specifically that Black decedents were less likely to have been administered naloxone during an overdose, is noteworthy. While we cannot determine whether this was the result of response time, assumptions about substances being used or other factors, these findings warrant additional research. Yet, given the combination of fentanyl with other illicit drugs, and the lack of prior EMS overdose events, our findings would suggest the need for expanded community-based harm reduction services as well as a broader recognition of substance use patterns that include preferences for fentanyl (Ashford et al., 2018; Atkins et al., 2019; Fraser et al., 2018). While research is limited, preliminary evidence suggests drug testing technologies (e.g., fentanyl test strips) allow drug users to understand whether the drugs they use are contaminated with lethal substances, such as fentanyl, which can allow them to adjust behaviors and prevent a potentially fatal overdose (Glick et al., 2019; Kerr, 2019; Laing et al., 2018; Sherman et al., 2018). Relatedly, public health messaging to relay information about fentanyl poisoning to targeted communities is important to increase the likelihood of drug testing technology use; given the present findings these services and campaigns should be culturally tailored to African Americans (James and Jordan, 2018).

Additionally, health care providers should be made aware of disparities in overdose emergency responses and assess the reasons why Black overdose patients are less likely to receive naloxone from EMS. Although there is limited research on racial disparities in emergency response to opioid-involved overdoses, there is now a growing body of research suggesting racial and ethnic minorities are less likely to engage in and successfully complete substance use treatment (Saloner and Cook, 2013; Wu et al., 2016). These trends in treatment utilization likely confound and exacerbate growing racial disparities in overdose deaths, underscoring the importance of addressing disparities in access to treatment more broadly.

There are several limitations to this study that should be noted. First, because study data were available for a single Midwestern geographic area, results may not generalize to other urban or rural areas in the United States. However, our use of toxicology records provides greater specificity into polydrug combinations in overdose deaths, even at the cost of reduced generalizability in comparison to national datasets, and we are not aware of any prior research leveraging toxicology records to examine racial disparities in overdose deaths. In fact, it would not be possible to conduct this study using national data as they are also limited by unspecified coding, meaning no substance was listed as a primary or contributing cause of death on the death certificate (Ruhm, 2016, 2018). While researchers have developed measures to adjust for these limitations (Ruhm, 2018) and better data collection systems are being implemented (Warner and Hedegaard, 2018), there remain gaps in our ability to examine the substances driving the overdose epidemic and how trends may vary by race. Another limitation for this study was our reliance on administrative data and our ability to link these data using name and date of birth Our administrative data only captures those overdose events recorded in EMS, so we do not know about unreported overdoses or when and how the community uses naloxone privately. Moreover, although it was noteworthy that few individuals who died in a given year had a prior non-fatal overdose with EMS, this finding limited our ability to look at trends in these events over time and by race.

Despite these limitations, our study suggests that recent increases in racial disparities may be attributable to unexpected fentanyl contamination in the cocaine supply consumed by Black drug users. Importantly, research shows not only state-level (Ruhm, 2017; Scholl, 2019) but regional and county-level differences in overdose rate (Monnat, 2018; Rossen et al., 2013, 2014; Stewart et al., 2017) and the present study offers guidance for other community or regional efforts trying to detect and prevent overdose outbreaks. More specifically that local EMS data can be used to examine trends in non-fatal overdose events prior to death but also network analysis of toxicology data from death investigations represent a means of examining polydrug overdose patterns.

5. Conclusions

This study provides a novel approach for using toxicology records that other jurisdictions can follow as well as a new approach towards examining polydrug overdoses that can be expanded to examine changes across broader geographic areas to better identify trends in the racial composition of the overdose epidemic. By integrating EMS and toxicology data in Indianapolis, Indiana we found that recent racial overdose disparities may be driven by changes in the composition of illicit drugs. This is especially important as many of the policy efforts aimed at reducing opioid-related deaths have focused on regulation through prescription drug monitoring programs or post-EMS responses; (Patrick et al., 2016) however, policies must recognize that the overdose epidemic manifests differently among subpopulations of persons who use drugs. Thus, it is important to understand the substances involved in overdose events to identify potential intervention points and to develop targeted messages and strategies for subpopulations. Strategies like empowering users to test drugs on their own are consistent with harm reduction principles that emphasize meeting users where they are rather than waiting for them to engage in a health care system (Glick et al., 2019; Sherman et al., 2018). Harm reduction strategies implemented in community settings may be a promising avenue to reduce racial disparities in overdose mortality.

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Contributors

B.R. Ray and E.M. Lowder conceptualized the study with assistance from D.P. Watson. P. Huynh cleaned, merged and managed the data and contributed to analysis. B.R. Ray and R.A. Benton analyzed the data. B.R. Ray, K. Bailey and E.M. Lowder co-wrote the article. D.P. Watson assisted in interpreting the findings. All authors have read and approved the final manuscript.

Declaration of Competing Interest

No conflict declared.

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