Title
Integrating Data Science and Ethnography for Critically Applied Rapid Surveillance of Emerging Health Inequalities

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Integrating Data Science and Ethnography for Critically Applied Rapid Surveillance of Emerging Health Inequalities

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Bioinformatics

by

Joseph Friedman

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ABSTRACT OF THE DISSERTATION

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for Critically Applied Rapid Surveillance of

Emerging Health Inequalities

by

Joseph Friedman

Doctor of Philosophy in Bioinformatics

University of California, Los Angeles, 2022

Professor Alex A.T. Bui, Co-Chair

Professor Philippe I. Bourgois, Co-Chair

Public health surveillance is a basic function of an effective modern state. Yet this surveillance is a deeply political phenomenon; the specifics of which data are collected, about whom, and the speed and format of how they are aggregated and disseminated are shaped by social and political priorities. Surveillance, then, can serve as a powerful tool for tracking social inequalities, or alternatively, a mechanism by which they remain invisible. Here, using a series of case studies, I develop and implement a model of public health surveillance that is rapid,

critically-applied, mixed-methods in nature, and especially focused on the measurement of emerging or shifting health inequalities. A key aim is the advancement of new techniques to fill data gaps, especially by drawing on mixed methods research. While public health surveillance has traditionally been nearly synonymous with quantitative methods, here I seek to combine data science approaches with qualitative social science techniques, especially ethnography. A nuanced data science approach especially drawing on novel data sources, can offer robust prediction in a real-time fashion, which can further yield detailed insights about emerging health disparities. Similarly, ethnography represents a manner of accessing common-sense, on-the-ground logics around social dynamics and health disparities that can often be surprisingly difficult to characterize with traditional survey methodologies and other quantitative approaches. This model of public health surveillance is also critically-applied, meaning grounded in social theory (but not fully subservient to it) and ultimately oriented towards affecting real change. In this fashion, critically-applied surveillance work can be thought of as a first step in assessing, interrogating, and challenging the structural violence that pervades modern societies. In sum, in the 14 case studies contained within this body of work, I develop and implement a critically-applied and inequalities-oriented, heavily mixed-methods approach to public health surveillance, which can be employed widely to improve inequality monitoring across many areas of public health and clinical practice. This model is applied here especially to the study of shifting trends in the North American overdose crisis, studying clandestine, illicit, and complex dynamics that are difficult to assess with traditional approaches.

The dissertation of Joseph Friedman is approved.

Helena Hansen

Joel T. Braslow

David L. Schriger

Philippe I. Bourgois, Committee Co-Chair

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University of California, Los Angeles

2022

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Chapter two is a modified version of: *Friedman J, Karandinos G, Hart LK, Castrillo FM, Graetz N, Bourgois P. Structural vulnerability to narcotics-driven firearm violence: An ethnographic and epidemiological study of Philadelphia's Puerto Rican inner-city. Benoit C, ed. PLoS ONE. 2019;14(11):e0225376. doi:10.1371/journal.pone.0225376.* Philippe Bourgois was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter three is a modified version of: *Friedman J, Syvertsen JL, Bourgois P, Bui A, Beletsky L, Pollini R. Intersectional structural vulnerability to abusive policing among people who inject drugs: A mixed methods assessment in california's central valley. International Journal of Drug*

Policy. 2021;87:102981. doi:10.1016/j.drugpo.2020.102981. Robin Pollini was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter four is a modified version of*: Friedman, J., Bourgois, P., Godvin, M., Chavez, A., Pacheco, L., Segovia, L. A., Beletsky, L., & Arredondo, J. (2022). The introduction of fentanyl on the US–Mexico border: An ethnographic account triangulated with drug checking data from Tijuana. International Journal of Drug Policy, 104, 103678. https://doi.org/10.1016/j.drugpo.2022.103678.* Philippe Bourgois was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter five is a modified version of: *Friedman, J., Calderón-Villarreal, A., Adame, R. C., Abramovitz, D., Rafful, C., Rangel, G., Vera, A., Strathdee, S. A., & Bourgois, P. (2022). An Ethnographic Assessment of COVID-19–Related Changes to the Risk Environment for People Who Use Drugs in Tijuana, Mexico. American Journal of Public Health, 112(S2), S199–S205. https://doi.org/10.2105/AJPH.2022.306796.* Philippe Bourgois and Steffanie Strathdee were the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter six is a modified version of: *Friedman, J., Montero, F., Bourgois, P., Wahbi, R., Dye, D., Goodman-Meza, D., & Shover, C. (2022). Xylazine spreads across the US: A growing component of the increasingly synthetic and polysubstance overdose crisis. Drug and Alcohol Dependence, 233, 109380. https://doi.org/10.1016/j.drugalcdep.2022.109380*. Philippe Bourgois and Chelsea Shover were the principal investigators of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter seven is a modified version of: *Friedman, J., Calderón-Villarreal, A., Bojorquez, I., Vera Hernández, C., Schriger, D. L., & Tovar Hirashima, E. (2020). Excess Out-of-Hospital Mortality and Declining Oxygen Saturation: The Sentinel Role of Emergency Medical Services Data in the COVID-19 Crisis in Tijuana, Mexico. Annals of Emergency Medicine, 76(4), 413–426. https://doi.org/10.1016/j.annemergmed.2020.07.035* Eva Tovar was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter eight is a modified version of: *Friedman, J., Mann, N. C., Hansen, H., Bourgois, P., Braslow, J., Bui, A. A. T., Beletsky, L., & Schriger, D. L. (2021). Racial/Ethnic, Social, and Geographic Trends in Overdose-Associated Cardiac Arrests Observed by US Emergency Medical Services During the COVID-19 Pandemic. JAMA Psychiatry, 78(8), 886–895. https://doi.org/10.1001/jamapsychiatry.2021.0967.* Joseph Friedman was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter nine is a modified version of: *Friedman J, Akre S. COVID-19 and the Drug Overdose Crisis: Uncovering the Deadliest Months in the United States, January–July 2020. Am J Public Health. Published online April 15, 2021:e1-e8. doi:10.2105/AJPH.2021.306256.* Joseph Friedman was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

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Joseph Friedman was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter eleven is a modified version of: *Friedman J, Hansen H, Bluthenthal RN, Harawa N, Jordan A, Beletsky L. Growing racial/ethnic disparities in overdose mortality before and during the COVID-19 pandemic in California. Preventive medicine. 2021;153:106845.* Joseph Friedman was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter twelve is a modified version of: *Friedman J, Hansen H. Evaluation of Increases in Drug Overdose Mortality Rates in the US by Race and Ethnicity Before and During the COVID-19 Pandemic. JAMA Psychiatry. Published online March 2, 2022. doi:10.1001/jamapsychiatry.2022.0004.* Joseph Friedman was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter thirteen is a modified version of: *Friedman J, Godvin M, Shover CL, Gone JP, Hansen H, Schriger DL. Trends in Drug Overdose Deaths Among US Adolescents, January 2010 to June 2021. JAMA. 2022;327(14):1398. doi:10.1001/jama.2022.2847.* Joseph Friedman was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter fourteen is a modified version of: *Friedman J, Hansen H. Far From a "White Problem": Responding to the Overdose Crisis as a Racial Justice Issue. Am J Public Health. 2022;112(S1):S30-S32. doi:10.2105/AJPH.2021.306698.* Helena Hansen was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Chapter fifteen is a modified version of: *Friedman J, Hansen H, Gone, J. Deaths of Despair and Indigenous Data Genocide: the Pandemic as a Turning Point. Under peer review.* Joseph Friedman was the principal investigator of this study. Joseph Friedman wrote the first draft of the article. All authors contributed to analysis and writing.

Vita – Joseph Friedman

Education

2014-17	MPH	Global Health -- Metrics and Evaluation	University of Washington
2010-14	B.A.	Anthropology Major, Spanish Minor, Pre-Med	University of Vermont

Selected Honors and Awards

2019	Grant for Emerging Researchers/Clinicians	IDSA
2017	David Geffen Medical Scholarship	UCLA
2014	Fulbright Graduate Study Award (Declined)	FULBRIGHT- COMEXUS
2014	George Henry Perkins Award for Outstanding Senior	UVM Anthropology
2014	Summa Cum Laude	UVM
2014	Phi Beta Kappa	UVM

Selected Academic and Work Experience

2021-XX	Member of WHO Technical Advisory Group on Estimation of Excess Mortality
2020-XX	Co-Creator: covidcompare.io
2019-XX	Peer reviewer: for Lancet Public Health, BMJ, WHO Bulletin, Journal of Substance Abuse Treatment, Annals of Emergency Medicine, Frontiers of Public Health, Stat, Annals of Epidemiology, PLOS Global Health, BMC Medicine.
2018-19	Advisor, Los Angeles Global Health Conference, UCLA
2018-19	Coordinator, Global Health Interest Group, UCLA
2018-19	Coordinator, Wilderness Medicine Interest Group, UCLA
2017-18	Co-Director, Los Angeles Global Health Conference, UCLA
2014-17	Post-Bachelor Fellow, Institute for Health Metrics and Evaluation, UW
2016-17	Co-Instructor, UCONJ 624: Community Organizing + Health Equity, UW

Selected Peer-Reviewed Publications

For the complete list see: (https://scholar.google.com/citations?hl=en&user=Vkr2uEwAAAAJ)

2022 **Friedman J**, Godvin M, Shover CL, Gone JP, Hansen H, Schriger DL. Trends in Drug Overdose Deaths Among US Adolescents, January 2010 to June 2021. JAMA. 2022;327(14):1398. doi:10.1001/jama.2022.2847

2022 Flor LS**, Friedman J**, Spencer CN, et al. Quantifying the effects of the COVID-19 pandemic on gender equality on health, social, and economic indicators: a comprehensive review of data from March, 2020, to September, 2021. The Lancet. Published online March 2, 2022. doi:10.1016/S0140-6736(22)00008-3

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2021	**Friedman J,** Liu P, Troeger CE, et al. Predictive performance of international COVID-19 mortality forecasting models. Nat Commun. 2021;12(1):2609. doi:10.1038/s41467-021-22457-w
2020	**Friedman J,** Beletsky L, Schriger DL. Overdose-Related Cardiac Arrests Observed by Emergency Medical Services During the US COVID-19 Epidemic. JAMA Psychiatry. Published online December 3, 2020. doi:10.1001/jamapsychiatry.2020.4218
2020	**Friedman J**, Syvertsen JL, Bourgois P, Bui A, Beletsky L, Pollini R. Intersectional structural vulnerability to abusive policing among people who inject drugs: A mixed methods assessment in California's central valley. International Journal of Drug Policy. 2021;87:102981. doi:10.1016/j.drugpo.2020.102981
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2020	**Friedman J,** York H, Graetz N, et al. Measuring and forecasting progress towards the education-related SDG targets. Nature. 2020;580(7805):636-639. doi:10.1038/s41586-020-2198-8
2019	**Friedman J**, Kim D, Schneberk T, Bourgois P, Shin M, Celious A, et al. Assessment of Racial/Ethnic and Income Disparities in the Prescription of Opioids and Other Controlled Medications in California. *JAMA Internal Medicine*. 2019.

Selected Popular Press Articles

2022	Xylazine, a Dangerous Veterinary Tranquilizer, Is Showing Us the Future of the Overdose Crisis. TIME. https://time.com/6164652/xylazine-overdose-crisis/
2022	COVID-19 Led to Worse Social and Economic Consequences for Women. ThinkGlobalHealth. https://www.thinkglobalhealth.org/article/covid-19-led-worse-social-and-economic-consequences-women
2022	Op-Ed: Surging overdose deaths are a tragic racial justice issue. LA Times. https://www.latimes.com/opinion/story/2021-11-23/overdoses-u-s-black-white-native-americans
2021	Gender Equality in the Global Return to School. ThinkGlobalHealth. https://www.thinkglobalhealth.org/article/gender-equality-global-return-school
2021	Op-Ed: An overdose epidemic is raging alongside the coronavirus pandemic. LA Times. https://www.latimes.com/opinion/story/2021-01-05/overdose-epidemic-fentanyl-treatment-buprenorphine-methadone

Selected Presentations

2022	Far From a 'White Problem' : Addressing the Surging Overdose Crisis as a Racial Justice Issue	OUPCC 2022, Toronto
2022	The Fourth Wave of the US Overdose Crisis.	Harm Reduction Los Angeles, Invited Oral.
2021	Tracking rising racial/ethnic disparities in overdose mortality: Leveraging multiple data streams and now-casting for real-time disparities-oriented surveillance	Podium Presentation at APHA 2022.

Chapter 1: Introduction – Towards a Rapid, Critically-Applied, Mixed-Methods Surveillance of Health Inequalities

Public health surveillance is a basic function of an effective modern state. Through censuses, surveys, and data registries, the state invests resources in surveilling the bodies of the people residing within it. Although substantial potential for subversive or exploitative uses of these data exist, on the whole, the state must know the basic health status of its population in order to fill its basic responsibilities of advancing quality of life. This work therefore takes as a starting assumption that some degree of public health surveillance is a necessary public good. Of course, the devil is in the details. Public health surveillance is a deeply political phenomenon. Throughout this dissertation and body of work, I will argue that public health surveillance is not a neutral activity. Rather, the specifics of which data are collected, about whom, and the speed and format of how they are aggregated and disseminated are shaped by social and political priorities. A core tenet of this work is that the rapid surveillance of health inequalities can serve as a powerful force towards their amelioration. Herein, I therefore argue for a model of public health surveillance that is rapid, critically-applied, mixed-methods in nature, and especially focused on the measurement of emerging or shifting inequalities.

Focused on Shifting Inequalities

Many of the most pressing health disparities currently are markedly difficult to measure and track accurately and quickly. COVID-19 has clearly illustrated this in several new ways. For example, as will be covered extensively in the proceeding chapters, overdose deaths spiked during the pandemic[1–3]. Although this was common knowledge among frontline harm reduction organizations[4], quantitative data showing the same phenomenon were not available for many months[5]. Even worse, right across the border in Mexico, similar spikes likely occurred yet overdose surveillance data are entirely missing in this context. Therefore, quantitative information robustly tracking shifts in overdose deaths during COVID-19 may never become available, creating a total lack of data about a pressing health issue[6]. Similar lags can be found in numerous circumstances across public health and global health applications. They are often especially relevant to the measurement of social disparities in health. For example, early in the pandemic great efforts were made to make COVID-19 death data available on an ongoing daily fashion[7,8]. However, results disaggregated by race and ethnicity, as well as other social factors, were not made available on a timely basis[9]. Only after a great deal of social pressure and lawsuits forced the issue were great pains taken by federal agencies to produce accurate data by race and ethnicity and release them quickly. Similar situations can be seen in many public health applications, and there is a need for new methods to account for sparse data on key social health issues.

Mixed Methods

In this work, a key aim is the advancement of new techniques to fill data gaps – especially where they relate to emerging health disparities – by drawing on mixed methods research. While public health surveillance has traditionally been nearly synonymous with quantitative methods, here I seek to combine data science approaches with qualitative social science techniques, especially ethnography. As will be illustrated below, each of these techniques offers various advantages for the detection and description of social inequalities in data poor environments. It is often the case that a nuanced data science approach can offer robust prediction in a real-time fashion, which can further yield detailed insights about emerging health disparities. Similarly, ethnography represents a manner of accessing common-sense, on-the-ground logics around social dynamics and health disparities that can often be surprisingly difficult to characterize with traditional survey methodologies and other quantitative approaches[10–14]. By combining these methodologies, this work aims to leverage the traditional methods from numerous fields, beginning each analytical task with the problem or outcome of interest. In this fashion, the best set of methods can be applied for each question at hand.

Critically Applied

If we accept that public health surveillance is both affected by political processes and has the power to affect political distributions of resources, then we can conclude that it should be *critically applied* if it is to reliably assist in reducing health inequalities[13]. Surveillance, then, cannot simply neutrally report differences in negative health outcomes as if they were a natural state of affairs. Instead, it must challenge power relations, and actively interrogating the status quo, in pursuit of the ideal that, in a perfect society, social group status would not be a definitive driver of one's health, wellness, or access to resources.

Similarly, critically-applied public health surveillance must be grounded in social theory, but not fully subservient to it. Unlike traditional social scientific research—which aims centrally to contribute to theory—critically applied public health research must aim to affect real change. Theory must be advanced as a vehicle to improving the field and its impact but should not be considered an end-goal of solitary importance.

In this fashion, critically-applied surveillance work can be thought of as a first step in assessing, interrogating, and challenging the *structural violence* that pervades modern societies. Structural violence refers to the social and economic structures and power systems that put people in harms way in a drastically differential pattern based on birth circumstances and social group membership[15–17]. A critically-applied public health surveillance, then assesses inequalities between groups and along these lines of social and economic power as unnatural, preventable, and modifiable consequences of unequal systems that represent urgent public health challenges.

In sum, in the chapters of this dissertation and body of work, I develop and implement a critically-applied and inequalities-oriented, heavily mixed-methods approach to public health surveillance, which can be employed widely to improve inequality monitoring across many areas of public health and clinical practice. Each of the subsequent 14 chapters of this dissertation develops a distinct aspect of this form of public health surveillance, leveraging distinct combinations of mixed methods, novel data science techniques, and social epidemiological study of shifting inequalities. Topically, the chapters are focused especially on people who use drugs, and other vulnerable populations, in a North American context. Many discuss rapid shifts in health trends related to a) the onset of the COVID-19 pandemic and b) sharp increases in overdose deaths relating to the increasing toxification of the illicit drug supply in North America. All chapters relate to tracking health inequalities among vulnerable populations, leveraging new methods and/or insights from social science:

- Chapter 2 provides the first 'deep mixed methods' case study—blending longitudinal ethnography and data science—to study violence stemming from prohibition drug markets in Philadelphia and characterize how Puerto Rican communities have been the most affected. As a clandestine subject, drug market violence is difficult to study, yet long-term ethnography and geo-located police incident data provide valuable insights in this data sparse context.
- Chapter 3 provides the second deep mixed methods case study, focused on documenting police violence against people who inject drugs—an extremely stigmatized and difficult-to-track phenomenon—in California's Central Valley. Again ethnography is

employed for an initial assessment, yet in this case study, it is also coupled with more traditional long-form qualitative interviewing. Preliminary insights from the qualitative phase of work were used to design a participant-driven-sampled quantitative survey—a powerful method for generating quantitative data among marginalized groups.

- Chapter 4 is the third deep mixed methods case study, focused on the arrival and spread of illicit fentanyls through the drug supply of Tijuana, Mexico. This is a data sparse context, as the overdose mortality records typically used to monitor similar trends in the US are not reliably available in Tijuana. However, ethnography coupled with drug checking data was employed to provide a rich characterization.
- Chapter 5 tracks the social and economic consequences of COVID-19 for vulnerable people who use drugs in Tijuana, Mexico. Census or traditional survey data regarding this (mostly unhoused) population are difficult to find, especially on the rapid timeframe needed to track pandemic-related consequences. This fourth deep mixed methods case study tracks these shifts using longitudinal ethnography and a rapidly deployed survey targeting a cohort of people who use drugs in Tijuana.
- Chapter 6 surveils the emergency of xylazine—a veterinary sedative not fit for human consumption—in the illicit drug supply of the US. Xylazine is not tracked nationally by the CDC, but became very notable in the ethnographic field site in Philadelphia surveilled by a team of drug market ethnographers. Ethnographic insights about this public health threat were used to design a national data search in medical examiner and coroner's records, yielding the first analysis showing the national spread of xylazine.
- Chapter 7 is the first of three 'out-of-the-box' data science case studies, leveraging non-traditional data sources to improve the speed and granularity (especially with regards to social inequalities) of surveillance of rapid shifts occurring during the COVID-19

pandemic. This case study focuses on tracking out-of-hospital deaths seen by emergency medical services in Tijuana, Mexico—where formal excess mortality data were highly delayed, and lacking social indicators for assessing inequalities. However EMS data provided an alternative source of information to track rapid shifts and unequal geospatial and social patterns of individuals dying out-of-the-hospital at record numbers.

- Chapter 8, the second out-of-the-box data science case study, leverages EMS records to track racial, ethnic, social, and geographic trends in spiking overdose deaths during the COVID-19 pandemic. This case study filled a critical gap in inequalities-oriented surveillance, as overdose deaths were known to be spiking, but the degree of social inequalities could not be assessed using traditional records from the CDC.
- Chapter 9, the third out-of-the-box data science case study, critiqued the format of provisional overdose trends made available by the CDC. Data were made available in rolling 12-month averages, which we showed masked critical state-level inequalities in overdose spikes. We used an algorithm and several data sources to reverse-engineer the original values and make them publicly available as a surveillance resource.
- Chapter 10 begins the section of chapters on the social epidemiology of drug overdose deaths, specifically the shifting profile of racial and ethnic inequalities. This chapter describes how the emergence of illicit fentanyls has disproportionately impacted Black and Native communities at the state and national level, between 2010 and 2019.
- Chapter 11 examines rising racial and ethnic disparities in overdose occurring during California during the COVID-19 pandemic. We find that California is ahead of the national average in terms of racial disparities in overdose.

- Chapter 12 analyzes the first national data made available describing overdose trends by race and ethnicity during the COVID-19 pandemic, finding sharp inequalities for Black and Native communities.
- Chapter 13 examines shifts in overdose deaths among adolescents, finding that illicit fentanyls started to affect this age group in the 2020-2021 period for the first time in recorded data. Latinx and native teens were disproportionately affected.
- Chapter 14 synthesizes much of the evidence presented in chapters 10-12 with social science theory, and argues that drug overdose must be treated as an urgent racial justice issue by the public health community.
- Chapter 15 critiques the wider framing of the 'Deaths of Despair' framework, of which drug overdose is the largest component. Specifically, the pervasiveness of exclusion of data representing Native communities is discussed as a key form of inequality.

Chapter 1 References

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Chapter 2: Structural vulnerability to narcotics-driven firearm violence: An ethnographic and epidemiological study of Philadelphia's Puerto Rican inner-city

A modified version of this chapter appeared as a research article in PLOS ONE:

Friedman J, Karandinos G, Hart LK, Castrillo FM, Graetz N, Bourgois P. Structural vulnerability to narcotics-driven firearm violence: An ethnographic and epidemiological study of Philadelphia's Puerto Rican inner-city. Benoit C, ed. PLoS ONE. 2019;14(11):e0225376. doi:10.1371/journal.pone.0225376

This chapter—the first case study of the dissertation in mixing data science and ethnography – interrogates the phenomenon of firearm violence stemming from drug markets, specifically in the context of the majority Puerto Rican part of inner-city Philadelphia. This is a very difficult-to-study phenomenon, given its illegal, clandestine, and dangerous nature, yet a matter of great public health consequence. It is therefore a well-suited topic for a longitudinal ethnographic approach, which was employed by an ethnographic team embedded in Philadelphia for over a decade. These initial insights were then mixed with a quantitative analysis of geolocated police incident data. Quantitative records are used to test a number of ethnographically-derived hypotheses. This case study is emblematic of the rich mixed methods characterization possible of clandestine public trends when combining data science and ethnography.

Introduction

It wasn't even supposed to happen like that. I was gonna smack him...but he kept talking. I wasn't even gonna shoot him, but it just happened too fast man. I don't know... This the dumbest thing I ever did in my life. I just don't want to go back to the same nut shit when I get home. Philly is like the fuckin' devil. I need to figure out a game plan to keep me away from the streets. I need to have a job before I get out of here. And I don't know how that's goin' to work. I ain't never had no job before."

> -18-year-old Leo, recently sentenced to 10 years in prison for shooting another young man in a narcotics-related disagreement, just months after he first gains lucrative employment in the narcotics economy of inner-city Philadelphia.

In 2007, our ethnographic team set out to study urban poverty in a majority Puerto-Rican neighborhood in North Philadelphia. We immersed ourselves for six years in Philadelphia's sprawling open-air narcotics market located in the heart of the city's Puerto Rican area. We rented an apartment on a block surrounded by multiple heroin and cocaine sales points, and two members of our team (George Karandinos and Fernando Montero) lived there full-time, directly observing the sale of massive retail quantities of heroin and cocaine and participating in the routine activities of daily life in the neighborhood. Fig 2.1, part A shows the field site in North Philadelphia.

One of the most immediately salient features of the neighborhood was the pervasiveness of violence. As we tape-recorded interviews with residents, seeking to understand their lives, the sound of gunshots regularly punctuated the flow of conversation. On nearly every block in the area, at least one homicide occurred during the years we studied this neighborhood (Fig 2.1, part B). In this small, approximately 10 square block area, it was rare for a month to pass without a homicide (Fig 2.1, part C), and at least half a dozen armed assaults and robberies. The sound of gunshots on the blocks surrounding us became a fact of everyday life.

This level of persistent violence is not unique to inner-city Puerto Rican Philadelphia. The United States is broadly facing a continuing crisis of gun violence, and economically marginalized inner-city communities of color are among the most affected by homicide [1–6] even as national levels of homicide decreased during our fieldwork years. Levels of interpersonal violence are higher in the US than in any other developed nation, and guns are implicated in a disproportionate percent of the associated mortality, morbidity, and costs to society [7–9]. There is a growing academic and political understanding that this crisis must be approached in a systemic, public-health oriented fashion [10]. The traditional response focusing on modifying individual factors—such as mental health interventions or personal gun safety practices—has done little to curb violence, failing to address the deep roots of the crisis and its maladministration by law enforcement, the courts, and corrections [2]. It is becoming increasingly clear that to successfully reduce firearm violence, public health interventions must engage with the complex social factors and structural drivers that undergird it. A number of programs have been able to make inroads with violence reduction among inner-city populations in a cost-effective manner through community and hospital-based interventions [11–15]. Despite these sporadic efforts, firearm homicide remains pervasive across inner-city America, with casualties largely falling along lines of race and class. This reflects the deeply entrenched systemic nature of firearm violence in inner-city America which overwhelming claims the lives of the most structurally vulnerable members of society [16].

Early in the course of our fieldwork we realized that much of the burden of the gun violence occurring around us was not random or totally senseless. It was often tied directly to interpersonal power dynamics, petty insults, and narcotics business negotiations regarding unpaid debts, the enforcement of monopoly control, or the theft of drugs. The killings that periodically took place, therefore, could not be averted with simple programs seeking to encourage teens to think twice before purchasing an illicit firearm or manage their anger more responsibly. Violence in our neighborhood was a constant anxiety because of the economic and political forces that converted this economically-abandoned industrial neighborhood into a hub of competing open-air narcotics sales points.

Our neighbors were rendered vulnerable to violence by structural forces [16–19], such as their low educational levels, marginalization from legal employment opportunities, easy access to wholesale supplies of heroin and cocaine, easy access to licensed and unlicensed firearms, and alienation from social services. Framed in classic public health terminology, each of these circumstances could be considered a social determinant of health—a social factor, out of the individual's immediate control that modifies their personal risk for adverse health outcomes, such as addiction or death by homicide [20]. Employing the concept of structural vulnerability, however, we can go beyond isolated risk factors to assess how each person's risk relates to their specific position in the social and economic hierarchies of their local environment [21]. Structural vulnerability is driven by power relations, large-scale social and economic forces that marginalize certain individuals and cause and exacerbate, their illnesses. Beyond just macro-level economic disparities, structural vulnerability also engenders an understanding of how local cultural and social dynamics often mediate or exacerbate personal risk of illness. For example, in our field site we saw how community dynamics and cultural patterns regulate and place limits on the violence occurring in the community. Therefore, any intervention seeking to address violence in inner-city Puerto Rican Philadelphia must be both structurally and culturally competent—it must understand the specific position of community members relative to social factors and structural drivers—if it is to be effective in truly reducing the level of mortality.

In this study, we seek to characterize the structural vulnerability of the Puerto Rican community in Philadelphia to gun violence, using a mixed-methods approach. We build on our team's previous collaborative efforts to put ethnographic observations from the inner-city into direct conversation with epidemiological data [22–24], and aim to present an assessment of firearm violence in these communities that is quantitatively rigorous with regard to the larger picture while also conveying the lived experience of the human suffering reflected in the macro statistics.

Methods

We used an exploratory sequential [25] mixed methods [26,27] study design. In this approach, the first stage entailed an exploratory, ethnographic process by which the ethnographic team deeply acquainted themselves with the field site and the relevant social dynamics. In the second stage, ethnographic data were analyzed using formal qualitative methods. Qualitative conclusions were then used to generate hypotheses about macro-level dynamics that could be tested quantitatively. Epidemiological methods were then applied to quantitative data, in order to assess the hypothesis that had been initially generated ethnographically. Iteratively, qualitative and quantitative results were compared, and placed into dialogue with each other, to produce final conclusions.

Ethnographic methods

The members of the ethnographic team (FM,GK,LH,PB) immersed themselves for six years in the heart of Philadelphia's sprawling open-air narcotics markets located in the core of the city's Puerto Rican area, from Fall 2007 through Summer 2013 with strategic follow-up work through Spring 2019 [24,28]. We rented an apartment in the field site in a decaying subdivided row home where GK and FM lived full-time and LH and PB visited regularly, sometimes staying the night, enabling us to participate in the local social scene as neighbors. With IRB approval, we conducted interviews in a conversational format while accompanying respondents in their daily lives and activities. Through the standard anthropological methods of participant-observation and immersion in the social environment, we were able to document hard-to-observe, stigmatized, and illegal activities [29]. Our long-term immersion reduced social desirability bias and also enabled us to compare the reported practices of respondents with direct observation of their activities and emotions. Over the course of these years we developed genuine close friendships with many of our respondents, which we still enjoy. These warm relationships facilitate long-term follow-up with hard-to-reach criminal justice- and substance use disorder-impacted, vulnerable populations [24,29,30].We watched young neighbors come of age and climb the ranks of the narcotics economy, accompanied them through the criminal justice system, visited them in jail, and corresponded with them in prison [31].

These ethnographic experiences yielded over 1300 pages of field notes, and nearly 2000 pages of transcripts from hundreds of interviews with dozens of respondents, hundreds of photographs, and dozens of hours of video. Our final qualitative database consisted of 3,189 pages of fieldnotes and transcriptions of interviews, representing 471 separate files, which often includes data from multiple participants and overlapping interviews. Our data included detailed documentation of both firearm and barehanded violence, police corruption and brutality, the logistics of narcotics sales, friend and family relationships, and interactions between members of our neighborhood with state institutions, especially schools, clinics, courts and carceral facilities. All names describing research participants in this work are pseudonyms. We obtained verbal informed consent because for ethnographic data, the benefits to protecting confidentiality by documenting it with a signature are outweighed by the risk that a hard copy paper signature represents as the most directly-identifying legal marker of the participant. Verbal informed consent was also obtained from parents or guardians for unemancipated minors as well as from the minors themselves. For additional methodological details we refer to more extensive, previously published discussions of our ethnographic methodology [23,24,28,29,32,33].

All ethnographic data was loaded into the NVivo qualitative analysis platform and coded for themes and characters. Analysis was done iteratively, with preliminary rounds beginning while the fieldwork was still being conducted, which was used to prompt follow-up assessments and refine research questions. Self-reports of behavior were triangulated against qualitative observations of practices occurring in real time in the natural environment. As we began the preliminary analysis, we also further explored the generalizability of our observations in the later stages of our fieldwork. This was accomplished by strategically following up with individuals who had made statements or exhibited behaviors counter to the dominant ideas in the community about research questions. Through long term documentation, we were able to assess whether these "exceptions prove the rule" or if they represented a significant divergence from our findings that required us to shift our analysis. Ultimately, what we present here is a reflection of the dominant social dynamics and views in each neighborhood—those that might have the most impact on the macro-level statistical trends we observe. Final rounds of qualitative analysis occurred until "saturation" had been achieved, at which point the qualitative analysis yielded several quantitative hypotheses about the racial/ethnic and social dynamics of firearm violence in Philadelphia.

We tested statistically our main hypothesis that, even controlling for poverty levels, poor majority-Puerto Rican neighborhoods in Philadelphia experience higher levels of violence and narcotics traffic than white or black areas. We also sought to confirm our qualitative understandings of unique properties of the field site, in terms of sociodemographic trends including the degree of marginalization, as well as the uniqueness levels of narcotics and violence-related crime experienced in our community. Quantitative data were sought, where possible, to confirm or refute the understandings we had built ethnographically.

Quantitative methods

Data describing levels of narcotics- and violence-related crime was obtained from files made publicly-available by the Philadelphia police department [34]. The database describes nearly 3 million geo-coded and time-stamped incidents that occurred from 2006 to 2017, from which we selected the approximately 200,000 observations describing crime incidents in the "Aggravated Assault Firearm", "Narcotic / Drug Law Violations", "Weapon Violations", or "Homicide – Criminal" categories. We used the latitude and longitude of each event to assign it to a census tract. We obtained census tract level information representing ethnic, racial, and poverty data for the pooled 2012-2016 period from the American Communities Survey (ACS) [35]. We identified the majority social group in each census tract from these files, as either "black", "white", "Puerto Rican", or "Non-Puerto Rican Hispanic". We used "non-Hispanic White" status as "white" in this study. Data were mapped using a census-tract shapefile made available by the city of Philadelphia[36].

We explored the relationship between neighborhood ethnic composition, levels of violence and narcotics-related incidents, and poverty, using mapping, plotting, and Poisson regression. To test if rates of violence and narcotics are higher in Puerto Rican areas, controlling for poverty, we use Poisson regression to estimate the relationship shown in Eq 1.1

$$Crime_{T,G} = +\beta_1 \cdot I_{Wh} + \beta_2 \cdot I_{PR} + \beta_3 \cdot I_{Bl} + \beta_4 \cdot Pov \cdot I_{Wh} + \beta_5 \cdot Pov \cdot I_{PR} + \beta_6 \cdot Pov \cdot I_{Bl} \quad \textbf{(1.1)}$$

Where $Crime_{T,G}$ represents the tract-level counts of violence- or narcotics-related crime of type T for tracts of majority social group G occurring between 2006 and 2017, Pov represents the percent of the population living under the poverty line during the 2012 to 2016 period, and I_{Wh}, I_{PR}, and I_{Bl} are binary indicators for majority-white, Puerto Rican, and black neighborhoods respectively. This model estimates separately the poverty-crime gradient for each social group with distinct slopes and intercepts. The small number of majority non-Puerto Rican Hispanic neighborhoods were not included in this analysis due to insufficient sample size. We also excluded 4 majority-white census tracts that appear to have high levels of poverty because they are almost entirely composed of relatively high socio-economic status college students. This regression was repeated separately for each T type of crime including "Aggravated Assault Firearm", "Weapon Violations", "Homicide – Criminal," and "Narcotic/Drug Law Violations."

In order to test our hypothesis that the most impoverished Puerto Rican neighborhoods have higher levels of violence and narcotics traffic relative to majority-black or majority-white areas, even controlling for poverty, we predicted $Crime_{T,G}$ values for each social group and crime outcome modeled where Pov= 60%, which is similar to the neighborhood in which we conducted field research. We then calculated the ratio between the estimated counts of violence and narcotics related crime for each social group (e.g. the ratio of majority-Puerto Rican to majority-black rates of homicides at 60% poverty) and calculated the 95% prediction interval for each ratio. We modeled total counts of narcotics or violence related crime, without using an offset, in order to measure neighborhood-level effects. Given the dynamics of narcotics-related violence, the individuals who are perpetrating or suffering from violence in a given location often don't live in that census tract. By using total counts, we measure the cumulative exposure to violence experienced by people living in a certain census tract with a given set of social characteristics. All analyses were conducted using R version 3.5.1 [37]. All data used in this analysis are publicly available [34,35].

In the last stage of analysis, the qualitative and quantitative results were synthesized to produce final conclusions. This entailed the comparison of qualitative results and qualitatively-generated hypotheses with quantitative data and results. Whenever possible, qualitative and quantitative data describing similar phenomena were placed in close proximity to one another; e.g. maps describing socioeconomic deprivation placed adjacent to ethnographic descriptions of the same phenomena. Final conclusions were drawn after considering all data, and via numerous rounds of consensus-driven feedback from the ethnographic and quantitative analysis teams.

Results and discussion

Life in the deindustrialized and hyper-segregated inner-city

Leo, the young man featured in the opening lines of this article, was born into the poorest corner of Philadelphia's Puerto Rican inner-city, once the core of Philadelphia's 19th century industrial sector. His grandparents came to the mainland United States, alongside millions of other Puerto Ricans in the 1950s and 1960s, seeking factory employment. Unfortunately, Puerto Ricans began migrating to Philadelphia just as the manufacturing industry started shrinking in size. By the 1980s the neighborhood was characterized by abandoned factories, empty row homes, vacant lots, and piles of rubble [4]. Philadelphia has not recovered from deindustrialization, and it remains the poorest of the largest ten American cities [28]. It experienced the classic US pattern of "white flight" to the suburbs, with the creation of hyper-segregated, poor, racialized ghettos with high vacancy rates in its former factory neighborhoods. This infrastructural decay represents a perfect environment for harboring difficult-to-police drug markets, sex work, drug consumption shooting galleries, and homeless squats [16]. Fig 2.2 demonstrates the marked segregation along racial lines in Philadelphia, as well as the correlation with poverty, narcotics, and firearm and violence rates (see S1 Fig 2.for a continuous color scale). The majority-Puerto Rican section is wedged between hyper-segregated white and black neighborhoods and is traversed by a subway system and two major interstate highways, facilitating access for multi-racial urban and suburban customers from the wider region, including New Jersey, Delaware, Pennsylvania, and Maryland [24,38].

The Puerto Rican inner-city has economically fared worse than the city average, experiencing extreme levels of private and public sector disinvestment, worsened by neoliberal policies that slashed the social safety net system [39]. As a result, deeply entrenched poverty has prevailed. According to ACS data ~60% of households in the neighborhood had incomes under the poverty line between 2012 and 2016 (Fig 2.2). During our fieldwork there were virtually no legal businesses in the neighborhood offering meaningful employment opportunities. Quite literally in the shadow of abandoned factories, the narcotics economy rose up to fill the employment vacuum (Fig 2.3).

The narcotics economy in Puerto Rican Philadelphia

For Leo, a low-income male high school dropout, the narcotics economy represented the only "equal opportunity" employer available to him. An enterprising young man, Leo was motivated to succeed. He had no local examples of successful male role-models in his social network who achieved economic stability and social mobility without participating in the retail sale of narcotics. Furthermore, all of Leo's immediate family and almost all of the young males in his extended social network were either employed selling heroin and cocaine, incarcerated, or prematurely deceased. A few older males and recent immigrants from Puerto Rico in the neighborhood did manage to find work in downtown office complexes as janitors, or commuted to jobs in suburban warehouses, golf courses, or slaughterhouses. There they competed with undocumented Dominican, Mexican and Central American day laborers for minimum wage employment, with almost no prospects for upward mobility or promotion. Leo did, in fact, briefly seek similar employment as a janitor, and even asked several members of the ethnographic team to serve as references for his application. However, he quickly abandoned this pursuit after several applications submitted for minimum-wage positions resulted in zero calls or interviews. In contrast, several young men whom Leo admired, including his older brother Tito with whom he was very close, had achieved meteoric success in the narcotics economy. Leo had seen these men earn many thousands of dollars per week, as well as command the respect and admiration of their peers, by taking over boss-level roles in the neighborhood business of peddling narcotics.

In this context, Leo made the decision to enter the narcotics economy, like so many other young men in the area before him. He started out at the lowest ranks of "hustler" making hand-to-hand retail sales. His employer was Raffy, the neighborhood *bichote*, who "owned" the block. *Bichote*—a term for "drug boss"—is a Spanglish double entendre of the phrase "big shot," and Puerto Rican slang for a large phallus. Whenever *bichotes* arrive on a block they become the central organizing point of power, influence, cash flow, risk and above all employment.

To stay alive, maintain control of their territory, and remain free from incarceration, *bichotes* must walk a tightrope between respect and fear. Raffy's survival was predicated on his ability to command fear, so as to prevent dozens of other ambitious young men from taking over his corner by force. Fear, however, is not enough to protect a bichote from being reported to the police in the long-term. He had to earn the respect of the neighbors by cultivating a reputation for generosity and a charismatic ability to keep the neighborhood safe from criminals and interlopers. As we have described in other publications, a *bichote* who is seen as overly greedy or too permissive of interpersonal violence or aggressive behavior towards women on the block could expect to be ousted by neighbors repeatedly calling the police with precise information about the location of his caches of drugs, guns and money [28]. For *bichotes* who can navigate these dynamics—keeping potential usurpers at bay and the neighborhood residents happy, or at least begrudgingly tolerant–the payout was enormous. During a single twelve-hour sales shift, ten to fifteen thousand dollars of cash in ten-dollar bills would routinely change hands on a single drug corner in this desperately poor inner-city neighborhood. We saw drug bosses rapidly accumulate hundreds of thousands in tax-free cash income, buy multiple fancy cars and invest in local rental properties. We saw the "American Dream" of many others, however, crash and burn in a fusillade of bullets or in court fees, civil assets forfeiture cases and/or behind bars.

Bichotes run their neighborhood narcotics business much like other retail endeavors, with a hierarchy of customer-facing and administrative roles. They hire managers, called "caseworkers", to run 8- or 12-hour sales shifts at a specific "*punto*" (sales point), and "runners" who move drug supplies and cash between the sales points and safe houses. Caseworkers are responsible for hiring and managing "*joseadores*" (Spanglish for "hustlers") who make the hand-to-hand sales to clients of packets of heroin and cocaine in $5- and $10-dollar ink-stamped and scotch tape sealed packets. There is highly differential risk at each level of this retail narcotics hierarchy that reflects risk-taking and responsibility. The hustlers are the most visible and along with the clients, they face the highest risk of arrest and chronic incarceration. There is a near constant police presence in the neighborhood, and drug busts are extremely common. Yet the police often fail to conduct the more complex surveillance work needed to identify caseworkers, runners and bichotes. Instead they arrest whichever customers and hustlers happen to be present at the moment of their raid. Fig 2.4 highlights how each month there are approximately 200 drug arrests—about 7 per day—in our relatively small field site, to say nothing of the many raids that do not result in arrests.

Each higher level of management in the narcotics hierarchy earns a greater portion of the profits and is also increasingly insulated from the ever-present risk of arrest. *Bichotes* ultimately earn a lion's share of the profit and most spend minimal time at the sales points, lest they attract too much police attention. In this way, the neighborhood sales point represents a self-contained instance of exploitative capitalism—the lowest-level employees experience the most risk while the business owners accumulate windfall profits, all situated in the poorest and most infrastructurally devastated corner of inner-city Philadelphia.

In tenth grade, Leo started out working at the lowest levels of the narcotics economy, selling packets of heroin and cocaine and dodging police raids, for several years. His big break came, ominously, when his older brother Tito was arrested for the accidental killing of his business partner, after having lasted only lasted 3 months as a bichote. Tito rose to the position by skillfully negotiating the rights to a corner from the wife of its previous owner -- who had suddenly been shot dead by the brother of his caseworker whom he had failed to bail out of jail. The wife of the deceased *bichote* trusted Tito who had been a schoolmate of hers and a runner for her late husband. She offered to let him run the block for the exceptionally low rent of $500 per week (the block we lived on often rented for $5000 per week) because she was scared her husband's cousins might steal it from her. Tito happily agreed and established a partnership with a friend who owned a .357 Magnum pistol --to guard against retaliation by the murdered *bichote's* cousins. After three months of successful earnings, Tito accidently shot his partner dead while posing for selfies in the midst of a drunken celebration. Tito was charged with homicide and faced a 17- to 34-year sentence. As a result, Tito's younger brother Leo inherited the *bichote* title on the block. He eagerly rose to the challenge, despite the inauspicious circumstances of his promotion, and he was determined to "do it right" and delegate all the risk to his caseworker and hustlers.

The role of gun violence in the maintenance of order in the narcotics economy

Tito's choice of business partner—a young man who owned an imposing automatic handgun—is indicative of the importance for a *bichote* of maintaining the perception of a capacity for violence. In our field site the sale of cocaine and heroin represents an extremely lucrative market located in a deeply impoverished area. In a single day, hundreds of thousands of dollars of untraceable cash routinely flow through a neighborhood where the majority of residents live well below the poverty line. In this context, Tito, and Leo after him, needed to be able to perform violence at a moment's notice to protect their reputations and maintain monopoly control of profits. In a clandestine market there is no legal recourse should product or profit be stolen by an employee or a competitor. Order, therefore, generally is maintained with violence or the threat of violence, both within and between *bichote*-led retail businesses. Ultimately it was this need to maintain control that tragically resulted in the near-loss of life of Leo's employee, and caused Leo to lose 10 years of his life behind bars with no access to drug treatment or vocational, educational or mental health services.

As a precocious 18-year-old teenager who had stepped up to fill his brother's shoes as a *bichote*, Leo had been routinely bullied, threatened, and disrespected by his jealous and slightly older employees whom he had hired to work for him. We visited Leo in jail where he anxiously reflected on why he had pulled the trigger:

> *Oh man, I got into some dumb shit. Real stupid! It was all over some nut-ass shit. I had this young bol [man], Adrian, out there hustling for me and I went around the corner to advertise my stamp [shout out his heroin's brand name to passersby]. When I go back, the work [cache of drugs] ain't there, so I'm like, "Adrian, damn, you're the only person sittin' here, like, what's up? Where the work go?"*
>
> *[Imitating ostentatious innocence] "Oh, I didn't touch nothin'"... this-an' that. Then he wanted to get all hype, so he called his peoples--all of his cousins. So I go back to my crib and I grab the strap [gun] and I come back. [Head in his hands his voice cracking] I don't know, everything was just moving so fast, like. I ain't really know what to do. I was gonna smack the shit out of him with the jawn [indefinite pronoun, in this case meaning the handle of his gun]. But he kept talking. I raised my hand at him but he*

> *dipped back. And all his peoples was standin' there, I was thinkin' in my head, like [setting his face into a threatening frown], "Damn, if one of his peoples got a gun..." And Adrian like [taunting voice]. "You a nut-ass nigga! You ain't gonna be treating me like a nut'... This-an'-that..."*
>
> *I'm like, "What!" And I pulled the jawn [gun] out. But he was just like, "Nigga you not gonna do shit." And he came at me. So I shot him, but just once so he could get away from me. That the first time I ever shot somebody. And I thought I was gonna be like hesitant. But I didn't even hesitate. It was just like a spur of the moment thing.*
>
> *Afterwards, from my crib I had called one of his peoples. He told me they found the dope and I told him, "Look, when Adrian get better, we could rumble [fist fight]." But they told me Adrian was like almost dying in the hospital 'cause the bullet almost hit his main artery. I'm thinking in the back of my head, "Damn, I didn't want all that to happen... I just did some dumb shit." Next thing I know, the police come running up in my crib. "Where the gun at?" And started rippin' the house apart.*

All Leo had wanted to do was threaten his employee into returning his $500 stash of heroin, but the desire to maintain the appearance of control over his business, and the very realistic fear that any of his employee's family members might also have a gun, led him to use lethal force instead of a simple fist fight or pistol whipping as he had intended. This was just one of many fatalities or near-fatalities that we documented as rival individuals vied for control of the lucrative sales points on almost all the blocks surrounding us. We documented nearly a dozen *bichote* transitions during our time at the field site. These shifts in local power were often precipitated by the killing of a *bichote* for a perceived offense, or his or her incarceration. Each time bichote stability was upended in this manner, a violent scramble for power ensued, often among multiple aspiring rivals.

This central role of violence in the narcotics economy has resulted in the exposure of local residents to a high prevalence of violent events. Fig 2.4 shows the spatiotemporal pattern of crime-related incidents according to the Philadelphia police department. From 2006 to 2017, in our small, ten square block field site there was a monthly average of 9 aggravated assaults with a firearm, and 7 weapons violations. It should be noted that these likely represent only a fraction of the true burden of violence in this community, as many incidents go unreported.

In addition to the intentional and functional violence that surrounds power struggles for the narcotics market in inner-city Philadelphia, the prevalence of narcotics traffic, guns, and cycles of violence led to a number of unintentional deaths or close calls for residents of the area who had nothing to do with narcotics. For example, in one instance of retaliation-gone-wrong, numerous shots were fired, in the middle of the day, through the front door and into the living room of a peaceful family of undocumented Central American migrants. Luckily no one was harmed because the whole family was out working at legal jobs in downtown restaurants as dishwashers. Their door had been mistaken for that of their next-door neighbor, a young man who had recently accepted a plea deal that was interpreted as proof that he had "snitched" on his *bichote* employer. Though unharmed, the family packed up and left the neighborhood the next day, presumably terrified of future violence or deportation stemming from the incident. During our time in the field site we witnessed many such instances of accidental violence affecting residents who were not directly involved in the narcotics trade, and not all ended as favorably. In one incident that was frequently recalled on our block, one of our neighbor's high school-aged sons was killed in crossfire during a mid-day shootout stemming from a drug dispute. He had been frantically trying to usher the children playing on the block out of harm's way when a stray bullet caught him in his neck.

Violence is also central to the policing strategy employed by the Philadelphia police department. During our fieldwork Philadelphia newspaper reports—including one Pulitzer Prize winning investigation— documented several dozen police brutality and corruption scandals [40,41]. Early in our fieldwork, a member of our ethnographic team recording interviews with sellers (PB) was knocked to the ground during a routine police raid, handcuffed facedown on the pavement, and then kicked with such force that several of his ribs were cracked. He was then arrested on false narcotics possession charges. Whites present in the neighborhood were profiled by the police as addicted customers and the white members of the ethnographic team were regularly harassed, detained, and insulted by the police as they walked home to the block from the subway.

More commonly, the victims of police brutality were the Puerto Rican neighborhood residents. The following fieldnote describes George's observations of an instance in which police—responding to a call about a drug-related shoot-out—brutally assaulted a young Puerto Rican male bystander, while failing to apprehend anyone involved in the shooting:

> *Sitting on the stoop I notice an immobile young man lying limply at the feet of the police with his hands cuffed behind his back. They ignore him while they search the vicinity. A police flashlight illuminates the blood-stained concrete near the youth, and I see that he is lying with his neck at an odd angle; his face totally covered in blood. He doesn't move for several minutes, and I wonder if he is conscious.*
>
> *One of my neighbors tells me that there has just been a shootout which I had mistaken for fireworks: "Four black guys got out and went to their trunk, pulled out guns and cocked them and then walked down the block. I went inside, and then I heard the shots." Another neighbor adds that the young man lying on the concrete had run from the police, even though he didn't have anything to do with the shoot-out. "He tripped and dove halfway under a car. The police caught him, and kicked him in the face, hard, pulled him out, and beat him to a pulp right on the street."*
>
> *Someone suggests that he might've had "work" [drugs] on him, prompting him to flee, even though "the cops weren't gonna do shit to him if he had just stood around, but he panicked." I suggest that they probably didn't find anything on him since they were looking for so long. Someone else informs us that he only ran because he was on probation and was afraid they would think he had something to do with the shooting.*
>
> *Instead of calling an ambulance, the officers roughly bundle the handcuffed young man into the back of a police car, half-carrying him since he can barely walk. They slam the door shut without securing him to his seat and without saying a thing to us, they speed off leaving a puddle of coagulating blood on the street and the stench of burnt rubber from their tires. Everyone standing around agrees it was "fucked up" that the cops beat someone so savagely "when he hadn't done anything." Someone suggests we should call a lawyer, and another suggests calling "the supervisor" of the officers to report an incident of brutality. "Fuck that," someone says dismissively, "there was a white shirt [captain] out here when it happened. No point in complaining to the perpetrators!" A couple of kids come by to take pictures of the pool of blood,*

furious that their friend had been brutalized so badly by the police. I just watch in shock.

We witnessed several other such instances of egregious violence directed towards neighborhood individuals by police. These incidents alienated residents from the police, adding yet another layer of victimization to a community already plagued by violence from within [28,32]. Importantly, violence perpetrated by police against neighborhood residents is unlikely to be represented in the statistics we present here, or in public health databases generally [42].

When young men involved in the narcotics economy eventually found themselves incarcerated, the performance of violence again emerged as vitally necessary for survival in the overcrowded and terrifying world of the Philadelphia County Jail. For example, Leo's older brother Tito who was arrested after accidently killing his business partner, was brought into the jail visiting room when we came to visit:

This unit is crazy man. A lot of people don't know what's going on yet with their case. They stressin'. They have that uncertainty. They don't know if they are going to go home soon, or if they aren't ever goin' home. Plus, we in close custody. They got us on lockdown half the time because of some shanking [stabbing]. There aint' shit to do. You just sit in your cell all day bored and frustrated. That's half the reason there so many problems. We might kill each other over 10 minutes on the phone. Or hot water in the shower, or whatever.

Out in the street I knew how to resolve a situation, you could talk to someone out there and maybe it didn't have to come to any violence. In here there is no choice. You can't just let them treat you like a bitch 'cause then everyone be sayin', 'He a pussy. He ain't gonna do anything.' And walk up in your cell, "Look nigga gimme all that, or I'm'a fuck you up." I done seen it too many times man. No one is going to talk about me like that. All I have in here... [choking back tears] is my pride. I'm not letting nobody take that away from me!

I just got in a fight with some black bol and look, the motherfucker bit me! We had words earlier at the phones, and he kept runnin' his mouth. But I let it go. I wanted to be peaceful, you know, I have a lot on my mind. I have to go to court tomorrow. But nigga came into my cell and [making a punching motion] snuck me in the back of the head. Then stood there lookin' at me like I wasn't gonna' do nothin'. Like I'm a pussy.

I guess 'cause I'm small and I'm Puerto Rican, and I came in here quiet, minding my business, people think they can fuck with you. That's what I get for trying to keep to myself. I know if I came in here like a savage then he wouldn't done that.

It was a matter of common sense that cultivating a reputation for violence was essential to avoid being victimized while incarcerated. Young men entering prison would often aggressively attack anyone who seemed to vaguely threaten or disrespect them, in order to avoid being targeted for subsequent rape or murder. This mechanism of self-protection also had the unintended effect of trapping incarcerated men into ever-extending prison sentences with add-on charges for violence committed while incarcerated, as well as trauma-inducing punitive isolation lockdowns that further increased their desperation and rage. Carceral experiences of violence and trauma further cemented the propensity for violence as a core element of a man's identity. It increased the chances that once released he would respond to challenges with hyper-aggressive displays of violence that ultimately feed back into ongoing cycles of mortality and morbidity in the neighborhood.

In the midst of power structures that privilege the perpetration of violence for economic and social success and protection, the easy access to automatic weapons raised the stakes of each instance of violence and increased the total mortality levels. During our jail visits, Leo reflected on how he had obtained the gun that he had used to shoot his employee, and the role of easily accessible guns in his life:

I bought the jawn [weapon] off one of my homies. It was a big-ass chrome forty [.40 mm]. I put $300 and my bol Freddo put $300. We was sharin' it. It was real cheap 'cause somebody probably already done did something with it.

I'm a gun freak, I love them too much. They just come to me. Like, [Imitating a sales pitch] 'Yo, I got a shotgun $100. Real cheap! ...' [Voice filling with energy] 'a nine [9mm]... a forty...' And, I'm like, '[Eyes lighting up] I need that!' I don't know why. I got to leave them alone... I had so many guns in the house, I'm surprised that my mom didn't just get rid of me [tears welling up and putting his head in his hands].

In a cultural and economic context that places substantial emphasis on the perception of a capacity for violence, and with ineffective gun control laws in place, it is unsurprising that gun fetishism emerges around increasingly powerful automatic and semiautomatic weapons. As we saw with the story of Leo's near-killing of his employee, the ubiquity of powerful firearms and fear of retaliation encourages the pre-emptive use of lethal force, even when lesser measures could suffice: "I was thinkin' in my head, like, 'Damn! If one of his peoples got a gun…'

The production of violence as a structural and cultural phenomenon

The economic, structural drivers of violence are of paramount importance in understanding the bloodshed we witnessed in our field site. Poverty and lack of formal employment ultimately play a central role in the production of the narcotics economy, as well as the violence that accompanies it in the context of prohibition. Nevertheless, this macro level line of reasoning does not account for the greatly elevated levels of narcotics traffic in low-income majority-Puerto Rican areas relative to majority-black neighborhoods with similar levels of poverty. Based on our observations, both highly-impoverished black and Puerto Rican neighborhoods had narcotics retail businesses operating on their corners. Nevertheless, the scope of sales at black areas paled in comparison in terms of volume and organization to their Puerto Rican counterparts (S1 Fig). The following fieldnote illustrates the pace of open-air sales witnessed each time we walked to our apartment from the nearest subway stop [24]:

> *Before I have walked halfway down the subway platform stairs I am hailed with, "Works [syringes]! Works! Sub [Suboxone pills], sub, sub!" As I step onto the sidewalk an emaciated white injector offers to take me to a corner "that's poppin' today." He assures me that he was given a sample less than an hour ago ". . . it's a 10 [highest quality rating]." I have learned to shake my head, mumbling, "I'm good," and continue rapidly down the sidewalk. I find myself in the midst of a stream of mostly white injectors in various states of emaciation and ill-health. They are fanning out from the*

subway entrance. hurrying through the labyrinth of surrounding narrow one-wayside streets

A twenty-something-year-old young white man in a Penn State sweatshirt with his baseball cap tilted backwards is walking just a little too fast and too eagerly next to me. He could look like he just walked off a college campus but is 20- or 30-pounds under-weight. He raises two fingers of his right hand in what I mistake to be a victory sign and peels off across the street towards a Puerto Rican teenager who is crouching by the tire of an SUV and pulls out two packets of heroin for him from underneath the chassis. They make a quick one-handed exchange. Spinning around, he thrusts his hand down the back of his pants, stashing the heroin in his rear before heading straight back to the subway.

Ahead of me there are two couples, both consisting of a young, skinny, scantily dressed woman walking more confidently than their older boyfriends. But most of the injectors around me who are on their way to buy heroin are single men walking alone or in duos, sometimes trios, in temporary nervous alliances for protection and information about "what's best today." Others are scanning about looking for an acquaintance to guide them to "the best dope" in return for a tip or a taste. A burly, white middle-aged man in paint-splattered pants presumably taking a user's break from a contractor's job, or else still buff from weightlifting during a recent bout of incarceration, asks me, "Is Godfather open today? Have you tried it?" I shrug my shoulders and look away, but another younger more emaciated white 30 something-year-old man with a big friendly smile, overhears the question and shuffles over, his foot wrapped in a filthy bandage, "I had some. Godfather's poppin' today." In the same breath, the painter anxiously snaps back, "How long ago?"

The flow of addicts, many of whom look like the walking wounded, has now reached the next corner and we are greeted by two physically-fit, clear-eyed Puerto Rican teenagers dressed in the latest hip-hop style, shouting "DOA [brand name] DOA!" and "powder [cocaine], powder, powder, powder. . . What you need?" followed by a fainter chorus of "works, works, works" coming from a set of older, broken-down-looking whites who are standing almost deferentially further away against an abandoned rowhome. They are clearly subordinated to the younger Puerto Rican heroin and cocaine street sellers. These choruses repeat themselves half a dozen more times on just about every block, sometimes again halfway through the block through which I walk until I reach our apartment. On our block, the brand name has been "Dead End" for the past three months.

Most corners in the 300+ square blocks surrounding us had a near constant stream of customers moving through the area, mostly white outsiders. In comparison, the African American sections of North Philadelphia appeared to have a much lower volume of customers, and most were African American residents of the same neighborhood. Given that there were both black and Puerto Rican areas with similarly high levels of poverty and chronic unemployment (Fig 2.2), a simple economic argument linking poverty to narcotics sales is insufficient to explain the exceptional level of sales to white outsiders in poor Puerto Rican neighborhoods.

As we came to understand, the concentration of the retail narcotics market in our field site needs to be understood in the context of a deeply racially divided city with long standing tensions between black and white communities. At the time of our fieldwork, the vast majority of customers seeking heroin in Philadelphia were white, reflecting the opioid epidemic of the time that was mostly concentrated in low-income white populations [43,44]. These white customers were much less likely to enter black neighborhoods to buy heroin for several reasons. Phenotypically they stood out much more in a racially-segregated black area and they were easily and immediately profiled as addicted customers by police, exposing them to arrest or harassment. Black-white animosities also increased the possibility of being heckled or mugged when seeking drugs in black neighborhoods. As one African-American dealer put it to us, while we stood observing the frenzied slew of customers flowing through a Puerto Rican block:

> *It don't work this way in South Philly [a predominantly African-American Area]. Everybody be out for they self. Papis [local racist term for Puerto Ricans] are smart, they get that white money. All of it! And the white junkies keep coming back with more! If these people walked onto my block with cash in their hands, someone would take their money. Matter of fact [laughing] I might.*

This contrasted sharply to the attitudes of Puerto Rican residents, who tended to view the emaciated white clients with some sympathy and even occasionally with admiration for their light complexions. Philadelphia has a long and fraught history of racial segregation and race riots. In a particularly iconic example that is still a political flash point in the city, a mere 20 years before we began our fieldwork, the virtually all-white Philadelphia police force firebombed an all-black residential neighborhood in the name of fighting the black power movement, destroying 61 homes and killing 11 people [45,46]. In this context of extreme racial tension, Puerto

Rican neighborhoods have served as a neutral meeting ground where white clients could more comfortably navigate through the inner-city to procure heroin.

Our ethnographically-derived understanding of the hyperbolic nature of drug sales in our field site can be confirmed by looking at police records showing an extreme concentration of arrests for narcotics in impoverished majority Puerto Rican areas. As Fig 2.5 indicates, across the board higher levels of poverty are correlated with higher levels of narcotics arrests, yet this gradient is much steeper for Puerto Rican areas relative to their black or white counterparts. As is clearly indicated by Fig 2.5, the most impoverished Puerto Rican neighborhoods have hyperbolic levels of drug arrests compared to the poorest black or white areas. The fitted lines on Fig 2.5 also show the predicted results of a statistical analysis of the poverty-narcotics gradient, separately by majority social group. In Fig 2.6, we predicted the expected rate of narcotics incidents for a poverty rate of 60%, similar to our field site (Fig 2.6), and compare the ratios of these predictions for each racial group. This allows us to control for poverty and show the association between race and levels of violence- and narcotics-related crime. The predicted values of narcotics-related crime for highly-impoverished, majority-Puerto Rican neighborhoods were significantly elevated compared to that of majority-black and white areas, with ratios of 4.2 (95% CI: 4.1-4.3) and 6.1 (5.8-6.4) respectively (Fig 2.6). This indicates that at a poverty level of 60%, majority Puerto Rican areas were predicted to have over 6 times more narcotics crime relative to majority white areas. The relationship between poverty and violence has also been well documented. It has become relatively commonsense that in the United States, higher poverty rates are correlated with a greater burden of interpersonal violence. Based on our observations that violence in our field site stems directly from the narcotics economy, we hypothesized that the poverty-violence relationship would be steeper for the most-impoverished Puerto Rican areas. Even controlling for the deeply entrenched poverty, we would expect that they have excessive levels of violence due to their key position in housing the retail narcotics markets of the city.

A quantitative examination of police crime data suggests that this hypothesis has merit for several categories of violence. As shown in Fig 2.5, there is a clear poverty-violence gradient seen for all social groups. Nevertheless, it is clear that the most impoverished Puerto Rican areas are the most burdened by violence of any part of the city, when considering homicides, assaults with a firearm, or weapons violations. Nevertheless, it is important to consider that our field site also represents the most impoverished corner of Philadelphia, and therefore we used a statistical analysis to assess if the level of violence exceeds what would be expected based purely on the level of poverty alone. That is to say, that the poverty-violence gradient is steeper at the most low-income end of the spectrum for majority Puerto Rican areas relative to majority black or white areas, and the observed differences are not due to chance alone.

Poisson regression results confirm our descriptive observations of the quantitative data. Poverty is significantly associated with homicides, assaults with a firearm, and weapons violations, for all groups. Furthermore, Fig 2.6 indicates that at a 60% poverty level, majority-Puerto Rican status is associated with significantly elevated levels of violence, for each category of violent crime examined. At lower levels of poverty sharp disparities can be observed for majority-black neighborhoods, which often have several times the level of violence compared to their equally impoverished majority-white counterparts. Nevertheless, the highly impoverished majority Puerto Rican areas clearly represent the most burdened part of the city in terms of poverty and also violence- and narcotics-related crime.

These trends are also reflected in the per-capita murder rates observed across the 2006 to 2017 period. The city-wide murder rate was 20.0 per 100,000 persons per year, compared to

5.8 for majority-white areas, 30.8 for majority-black areas, 39.0 for majority-Puerto Rican areas, and 62.0 for the core narcotics area that was our field site, identified in Fig 2.1.

Conclusions

Documenting and humanizing inner-city violence with mixed methods research

In this mixed methods study, we document racial and economic disparities in exposure to violence in inner-city Philadelphia. The maps contained in this study paint a troubling, yet all-too-common picture, of a hyper-segregated city in which poverty and violence levels correlate strongly with race/ethnicity [16,24,24]. Our especially-poor inner-city field site had a per capita murder rate over ten times higher than the average for majority-white areas, and three times the average for the city.

Clearly, economic factors play a key role in driving the violence we witnessed. Young men such as Leo and Tito have little opportunity for social mobility outside of the narcotics economy, and role models for other paths are essentially non-existent. The extreme poverty in Puerto Rican inner-city Philadelphia stems from its rapid deindustrialization, the history of colonial domination of the island of Puerto Rico, and the increasing disinvestment of the public and private sectors in inner cities [4,18,28]. This poverty has only been exacerbated by recent cuts to welfare and social services that render subsistence survival at the lowest economic rungs even more difficult [39]. The narcotics economy has arisen to fill the void, providing employment and a chance at social mobility, but at a steep cost in risk for violence and incarceration.

The logic of prohibition for a highly-sought-after product such as heroin or cocaine today (or alcohol in its time) inevitably creates a lucrative black market that is protected by violence, and systematically inflates levels of crime in society [47]. In the punitive political context of the War on Drugs, and the hyper-incarceration of non-white individuals involved in the narcotics economy, young men in our neighborhood had little chance to escape incarceration, injury, and/or, at the extreme, death by homicide [48]. In this way, powerful economic and social structures directed young men of color through a series of decisions and punitive institutions involving a high risk of victimization and/or perpetration of lethal violence.

Clearly, the bloodshed we observed as a daily phenomenon in our field site must be understood as "structural violence" [17]. Our friends were rendered "structurally vulnerable" to violence from the social and economic forces that create average levels of violence many dozens of times higher in poor non-white neighborhoods compared to affluent white areas just a few miles away [16]. These "social determinants" play an outsized role in shaping the economic and health outcomes available to residents of our field site [20,49]. Nevertheless, through contextualizing these disparities in a mixed-methods assessment of both structural and cultural factors, we see that to understand patterns of violence we need to employ an intersectional analysis involving not only economic drivers but also racial dynamics, spatial segregation patterns, and the individual-level experiences of these forces [50].

A simplistic structural assessment of poverty is insufficient to explain the group-specific vulnerabilities to violence we documented in Philadelphia. Even controlling for poverty, the homicide rate in our field site was nearly three times higher than a hypothetical similarly-impoverished white area (which, it is important to note, does not actually exist). The exceptional vitality of the retail narcotics trade and the violence it spawns in Philadelphia's majority-Puerto Rican neighborhoods reflect the unique social role of these interstitial areas sandwiched between poor white and black neighborhoods that converts them into a neutral racial meeting ground in hyper-segregated Philadelphia. The predominantly white, indigent customer base is much more likely to seek heroin and cocaine in phenotypically more diverse

Puerto Rican neighborhoods, rather than black neighborhoods where they are more conspicuous to law enforcement, and more likely to be assaulted in the context of deep racial animosities. Gun violence consequently cannot be understood simplistically as the direct result of poverty and racism alone. Instead, the nuances of the particular racial and economic history at hand must be appreciated to understand, and subsequently ameliorate racial/ethnic disparities in exposure to violence. For this reason, it is paramount that firearm violence prevention programs take both a cultural and structural approach to ameliorating the epidemic of gun violence faced in the United States.

We provide a nuanced analysis of the particular vulnerability of Puerto Rican communities in Philadelphia, which has not been thoroughly documented in the epidemiological literature. This represents just one small corner of America's epidemic of firearm and interpersonal violence, yet it has implications for socially-patterned violence in inner-city areas throughout the country. There are other pockets of culturally patterned violence with very different mechanisms, such as firearm suicide among low-income white males in the Southern US and especially in rural communities [51]. This highlights the need for further contextualization of epidemiological data describing gun violence with close examination of the particular cultural and structural mechanisms that are relevant for each hot-spot of bloodshed.

Limitations

As all quantitative studies, this analysis is limited by its data source. The use of police data to study violence in our inner-city field site could be seen as ironic, given the disruptive and often violent nature of the police interactions we witnessed on a regular basis and the racially selective enforcement of the War on Drugs. Yet it is most indicative of the unfortunate reality that the only public institution that reliably interfaces with this community, and has granular data related to its victimization, is the Philadelphia Police Department. Our results must therefore be considered in the context of the limitations of these data. It is certain that police data undercount the prevalence of both violence and narcotics, and potentially in irregular ways that could bias the results. Nevertheless, the large magnitude of the disparities presented here make it unlikely that any bias in the data could reverse them, especially given their consistency with our ethnographic observations. Nevertheless, it is possible that a bias in the police force against Puerto Rican neighborhoods could lead to greater police attention in those areas, subsequently overrepresenting violence or drug crime in those areas. Furthermore, the white/non-white disparities observed here may be magnified by racial biases held by police officers, wherein drug trafficking in white areas receives less attention that its equivalent in non-white areas.

It should also be noted that our quantitative analysis is ecological, we are describing neighborhood level associations at the census tract level. There are minority individuals in each tract who do not pertain to the majority social group whose identity defines the major dynamics of the neighborhood. Nevertheless, it is these neighborhood-level effects we are most interested in capturing in this study, and the extreme degree of racial segregation in Philadelphia limits the complications of relying on neighborhood-level variables to describe social groups. We also use pooled data representing 2012 through 2016 for sociodemographic indices, which represents a moving average that does not reflect any single point in time during this window. For limitations related to ethnographic data collection we will refer to more extensive, previously published discussions of our ethnographic methodology [24,28,29,32]. Our work is most representative of the time period during which the intensive fieldwork was conducted (2007 through 2013), although our periodic return visits to the field site indicate that the dynamics described here remain largely predominant.

Implementing structural solutions to structural issues

Gun control represents the most obvious key strategy to control the generalized crisis of firearm violence throughout the United States. Easy access to discounted "used" automatic and semi-automatic guns raises the already high stakes of struggles for power in the crowded and profitable inner-city narcotics market. In many instances we saw accidental and intentional fatalities in our field site that would likely not have occurred if the bar for attaining a weapon in the United States were substantially higher. Nevertheless, it is difficult to imagine how moderate gun control measures could make a meaningful impact on the pattern of violence we observed in our field site in Philadelphia. The inner-city is already awash in legally and illegally obtained firearms, and it is difficult to conceive of a politically-viable intervention that could rapidly empty the streets of these weapons.

The logic of participation in the narcotics economy, and the violence that surrounds it, cannot be overcome without structural interventions that address the deeper roots of American violence. Importantly, the policies of hyper-incarceration oriented around the War on Drugs have been profoundly counterproductive. They criminalize the residents of our field site while doing virtually nothing to assure their physical safety. Indeed, we observed that despite near-certainty of incarceration, young men continued to fill the lowest ranks of the retail narcotics market and readily served as foot soldiers defending the profits of their bosses, in hopes that others would someday do the same for them. Indeed, our observations suggest that hyper-incarceration actually fuels violence, as one of the most common destabilizing forces throwing a neighborhood into a bloody fight for control was the imprisonment of a *bichote.*

The election of Larry Krasner as Philadelphia's District Attorney in 2018 marked a dramatic retreat from the hyper-punitive approach characterizing the past half century of US criminal justice policy. Krasner ran on a platform of "ending mass incarceration." In just his first year in office, the city saw a 30% reduction in the jail population, as well as reduced parole and probation sentencing, and the elimination of cash bail for many non-violent crimes. At the time of this writing, Philadelphia was considering fully decriminalizing possession of all narcotics [52–54].

It can be argued that decriminalization possibly followed by legalization of narcotics would provide the only definitive solution to ending the highly profitable market that drives the astronomical rates of violence we observed in our field site. As long as prohibition exists, so will artificially-high profits that can only be defended with extra-legal violence. Similarly, the brutality, racial profiling and corruption of the police in the context of the War on Drugs alienate inner-city residents, pushing youth who have been victimized to pursue violent revenge rather than seek justice through the criminal justice system. Although the specifics of the casualties observed across the US and Latin America depend highly on the particularities of the social and economic circumstances, as long as narcotics represent a clandestine and profitable market it is likely that their presence will generate violence [47]. Beyond Philadelphia, prohibition has filled the streets of the United States and Latin America with powerful criminal organizations that terrorize populations and corrupt democracies in predatory pursuit of profits [47]. Various approaches to deconstructing this logic of prohibition have been proposed. In Europe, heroin prescription programs have had impressive success [29,55]. By offering individuals suffering from addiction a source of contaminant-free heroin, injected by a nurse in a safe facility, they have been able to dramatically reduce the social and health impacts of addiction—especially overdose. They also importantly remove customers and the profit motive from the narcotics economy, thereby representing a unique opportunity to decrease narcotics-associated violence. Instead of finding themselves forced into entry-level sales to support their habits, individuals are stabilized with less-damaging, contaminant-free heroin and rendered free to pursue other aspects of their lives. In this context, many find the stability they need to leave narcotics behind.

Outright legalization has also been enacted in limited settings—e.g. marijuana in the United States—and might represent a radical blow to organized criminal international syndicates. If narcotics were sold in safer forms by governments, without advertising, and coupled with accessible treatment and medical care, it would reduce the profit motive from the narcotics-driven violence that remains at crisis-levels all over the Americas. Nevertheless, as evidenced by the recent US opioid epidemic, widespread access to narcotics also has profound risks at the population level [43]. In either case, if the main source of economic survival is to be successfully taken from our inner-city field site, it must be replaced with other options for social mobility. A Marshall Plan-level of formal job creation, expansion of educational opportunities, and infrastructure investment—bolstered by gun control, narcotics decriminalization/legalization, and rehabilitative criminal justice reform—represent the scale and type of violence interventions capable of driving structural long-term change.

> *There's old-ass people in here with white hairs. And them niggas ain't changed. You really gotta be strong to change. And I ain't gonna lie to you, I get sucked into doing dumb stuff.*
> *'Cause it's like a chain reaction. You come home [from prison] and you go back right to the same thing. This lifestyle is just so addictive --especially when you got a block [are a bichote]. You just wake up and you got money. You walk around the block and your workers passin' you some money. Next thing you know, "Yo, I'm done, come pick this money up."*
>
> *It's so easy. But it don't lead nowhere. Next thing you know you wind up killin' somebody 'cause he tried to kill you and you in this situation [shaking his shackles] ready to do more time. That's why I know I ain't gonna change if I come back to Philly. I just wanna leave Philly. I just really wanna get up and go. If I'm gonna go for the better, then good. If I'm gonna go for the worse, then it is what it is. I just wanna leave though. There ain't shit down here, man. Everything is nutty out here. It's like, it's impossible to make something, you know what I'm saying, if you wanna sell drugs you ain't gonna make it nowhere selling drugs. I rather take my chances somewhere else.*

So, I know if I leave I'm gonna go somewhere brand new. I ain't gonna know nobody. I ain't gonna sell drugs. I'll just go and be like, fuck it, let me get a job and go to school. I need to figure out a game plan to keep me away from the streets. I need to have a job before I get out of here. And I don't know how that's goin' to work. I ain't never had no job before.

> -Leo, at the outset of a ten-year prison sentence, reflecting on his hopes to escape the cycles of incarceration and violence inherent to his upbringing in the narcotics economy of inner-city Puerto Rican Philadelphia.

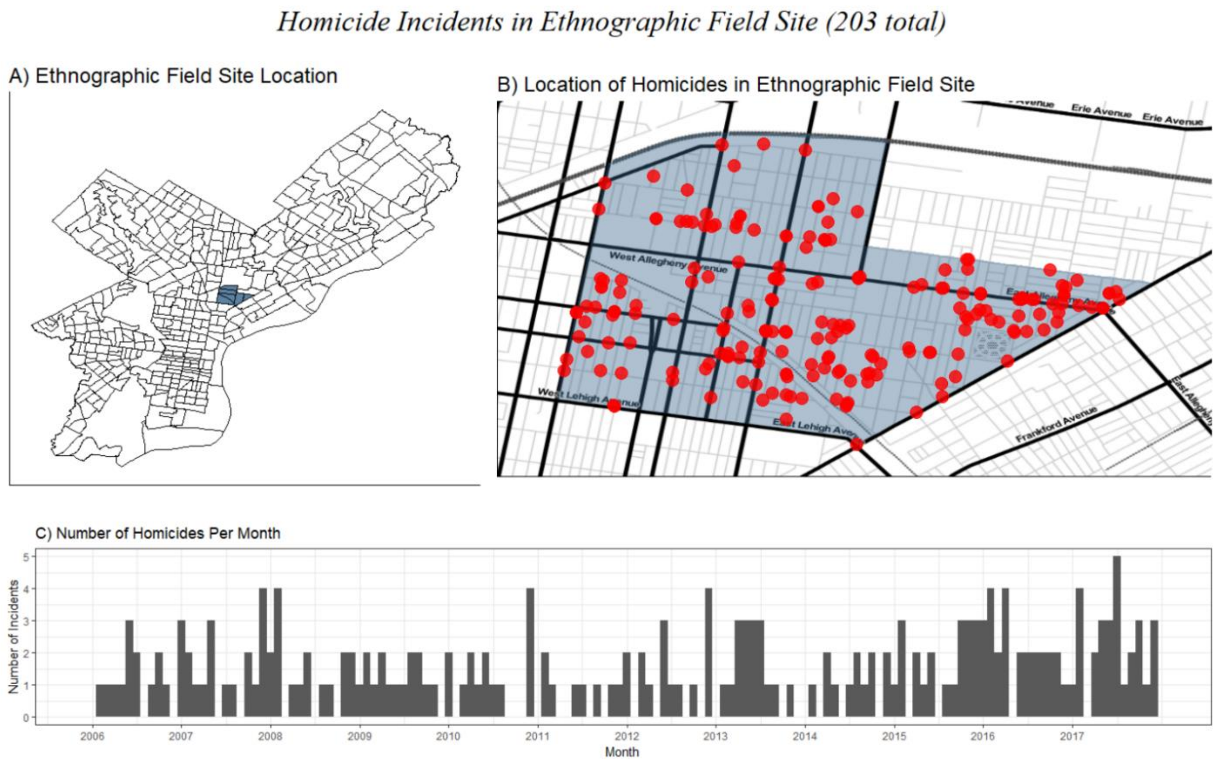

Fig 2.1. Homicides in ethnographic field site from 2006-2017 (203 total).

A) Location of ethnographic field site in North Philadelphia. B) Location of each homicide incident occurring in the ethnographic site during this time. C) Monthly trends in the number of homicides occurring in the field site.

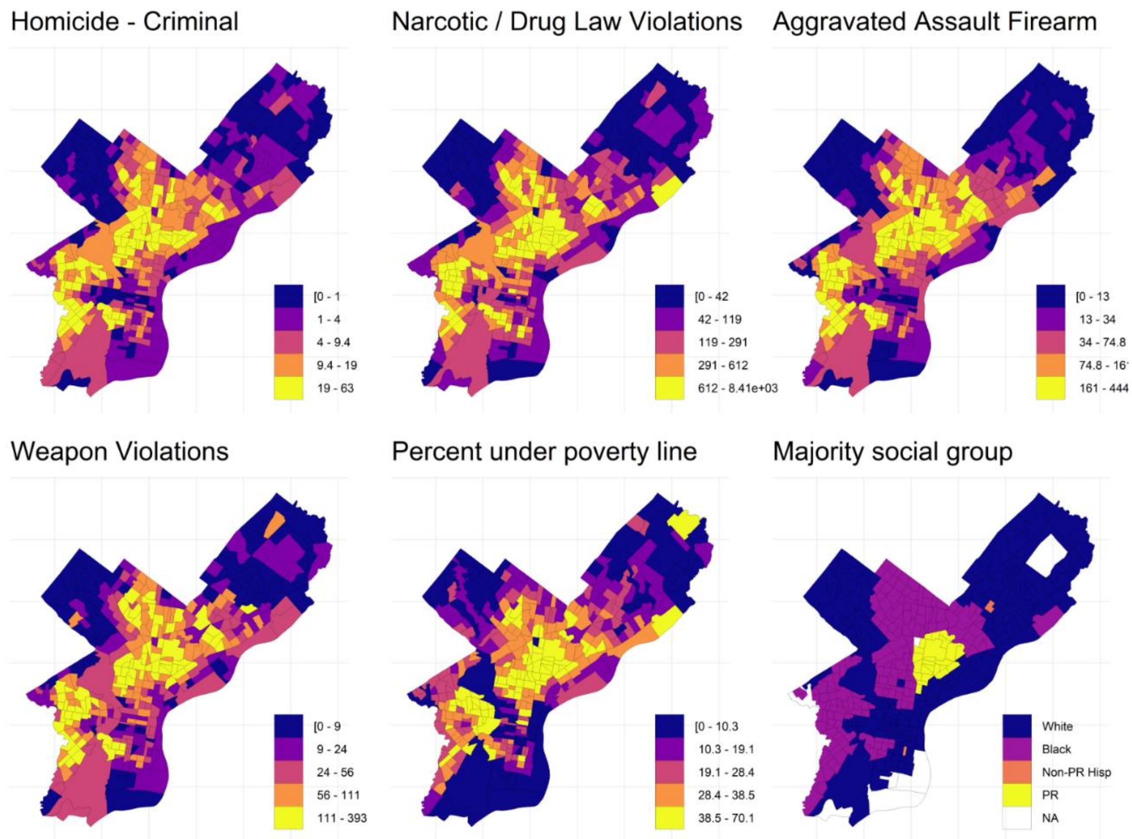

Fig 2.2. Census tract level counts of crime-related incidents.

Based on data from the Philadelphia police department, as well as the percent of individuals living under the poverty line and the majority social group from 2012 to 2016 American Community Survey data.

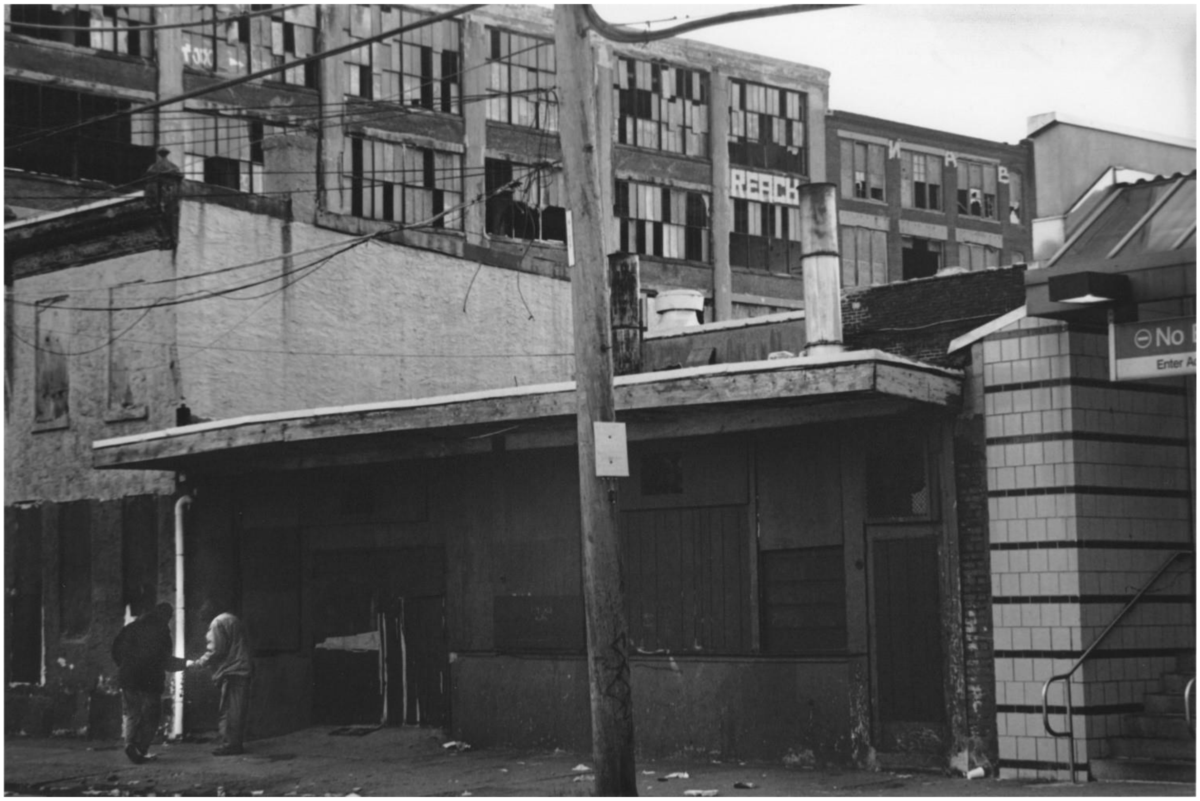

Fig 2.3. A narcotics transaction in the ethnographic field site in Puerto Rican Inner-City Philadelphia.

Hit hard by deindustrialization and disinvestment from the inner-city, young men born in this neighborhood often find themselves working in the lowest-level of the retail narcotics economy, selling heroin and cocaine in the shadow of the factories that used to employ their new immigrant grandparents. Photo by George Karandinos.

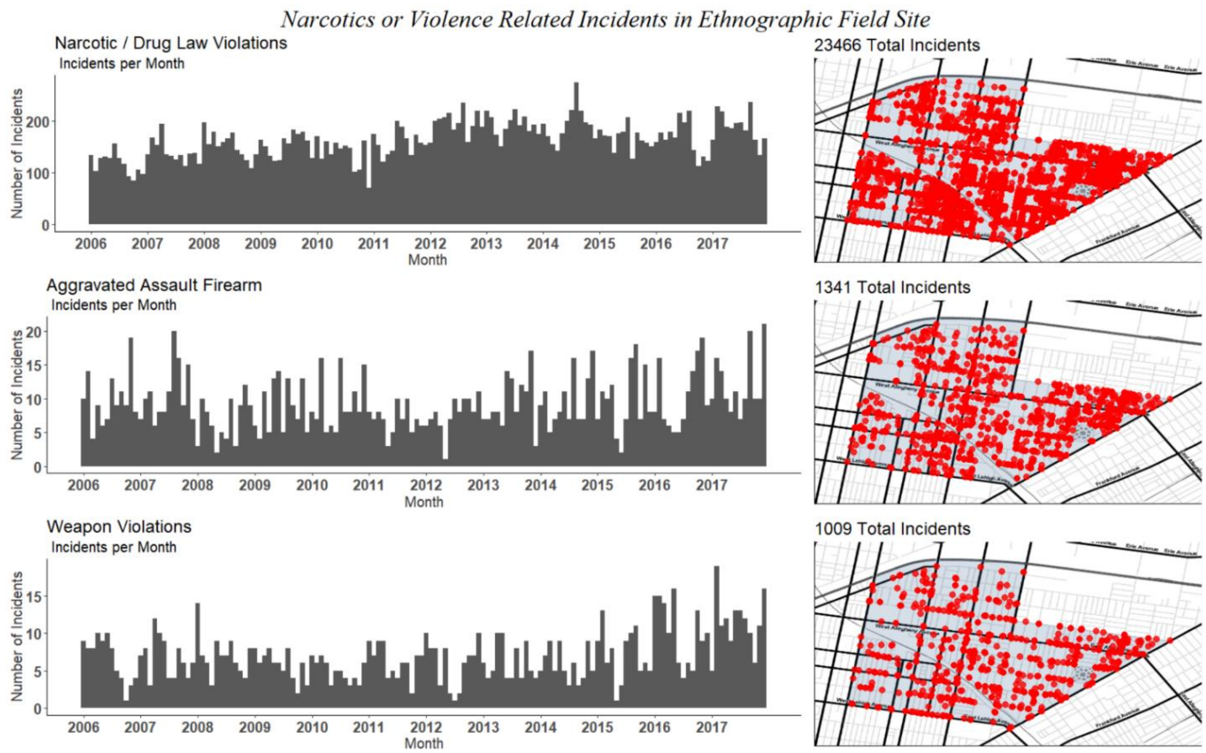

Fig 2.4. Crime-related incidents in the ethnographic field site from 2006-2017 by type of incident.

Shown by monthly incidence (left) and spatial distribution (right).

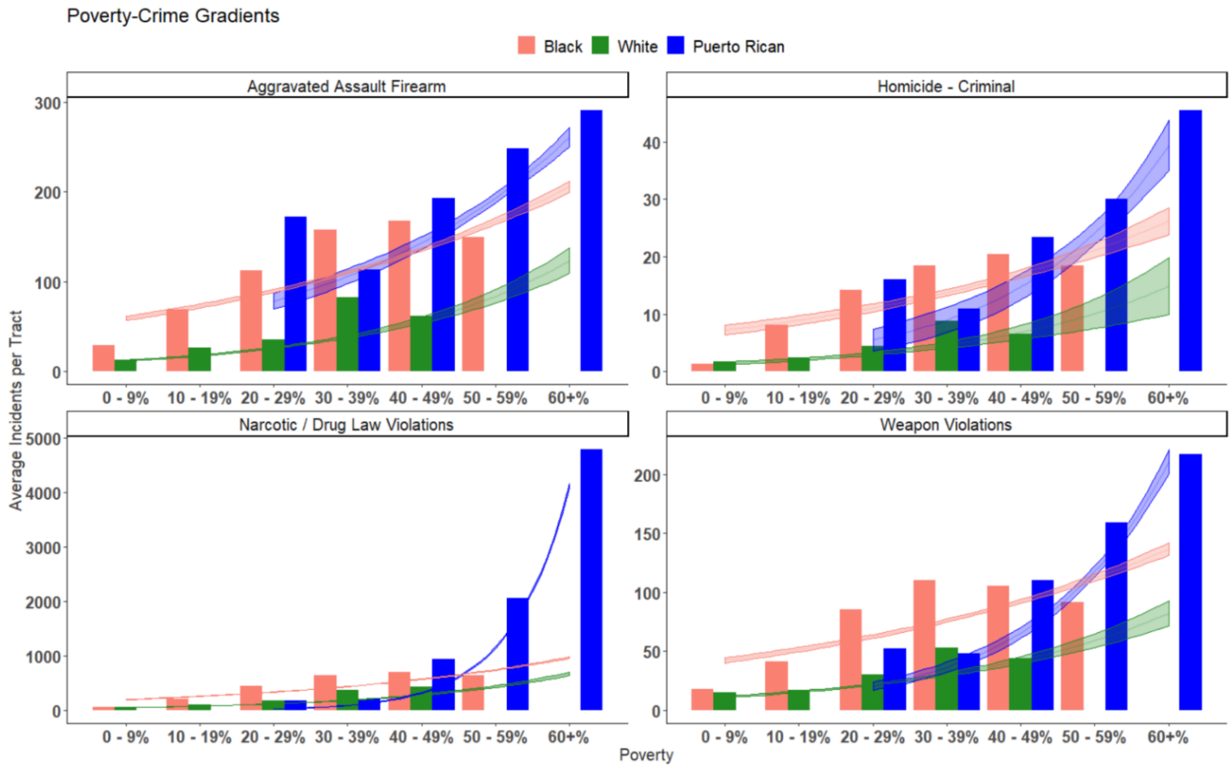

Fig 2.5. Poverty-Crime Gradients by Racial Group.

Bars represent the average number of crime-related incidents per census tract, from 2006 to 2017, by percent of the population living in poverty, separate for majority-Puerto Rican, -black, and-white areas. The fitted lines represent model predictions from the Poisson regression, with 95% confidence intervals.

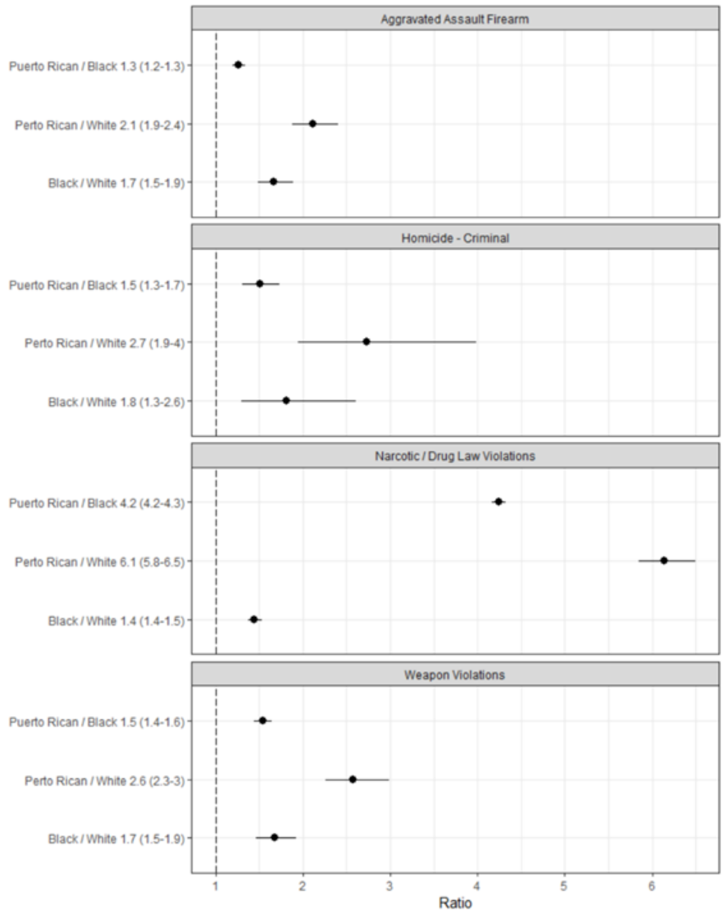

Fig 2.6. Racial Disparity among maximally impoverished neighborhoods.

The ratio, with 95% confidence interval, between social groups of predicted levels of violence- or narcotics-related crime from 2006 to 2017, for a poverty level of 60%, similar to our field site in the most impoverished corner of inner-city, Puerto Rican Philadelphia. For example, a ratio of 6.1 between whites and Puerto Ricans for narcotics related crime indicates that majority Puerto Rican areas were predicted to have over 6 times more narcotics crime relative to majority white areas, at a poverty level of 60%.

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Chapter 3: Intersectional structural vulnerability to abusive policing among people who inject drugs: A mixed methods assessment in California's Central Valley

A modified version of this chapter appeared as a research article in the International Journal of Drug Policy:

Friedman J, Syvertsen JL, Bourgois P, Bui A, Beletsky L, Pollini R. Intersectional structural vulnerability to abusive policing among people who inject drugs: A mixed methods assessment in california's central valley. International Journal of Drug Policy. 2021;87:102981. doi:10.1016/j.drugpo.2020.102981

This mixed methods case study characterizes the difficult-to-document phenomenon of police violence against people who inject drugs. This is a critical topic for public health surveillance as police violence has been shown to be heavily under-reported in traditional data sources, and generating data among people who inject drugs is notoriously difficult. However, we were able to provide a rich characterization with a multi-phased mixed methods approach. The first phase leverages ethnographic and long-form qualitative interview data. Preliminary findings were used to design a respondent-driven sampled quantitative survey, which also represents a highly effective method for generating data about clandestine topics with difficult-to-reach populations.

Introduction

Encounters with police have been identified as a key structural determinant of health for people who inject drugs (PWID) [1,2]. Increased policing has been the dominant response to substance use and addiction in the United States over the past half-century. In material terms, spending on policing and incarceration consumes the vast majority of drug policy expenditures globally [3]. Nevertheless, evidence suggests that much of this spending on policing does not have positive public health impact [4]. Rather, police contact has been associated in numerous settings with increased risky injection practices, a greater burden of infectious disease, and risk of overdose death for PWID [3,5–11]. In some cases, these health harms stem from legislative frameworks that conflict with evidence-based practices to minimize health risk. For example, policies that criminalize the possession, and disincentivize the use of sterile syringes [2,5]. However, extrajudicial police actions—such as unauthorized confiscation of unused syringes, routine harassment, or physical or sexual violence—have increasingly been identified as factors driving infectious disease risk and other health harms for PWID [12–14].

Police misconduct involving PWID has been reported widely across numerous contexts within the United States and globally [14–23]. In one study using data from New York City in the year 2000, 65% of PWID reported ever experiencing or directly witnessing physical violence, and 33% experienced or directly witnessed sexual violence from police [14]. In the same study, 63% of PWID reported psychological violence such as name-calling, unprompted physical threats, forced strip-searches in public, or being forced to remain in uncomfortable positions for long periods of time. In Bangkok, Thailand a study in 2010 found that 38% of PWID reporting ever being beaten by police [18]. A similar 2012 study in Tijuana, Mexico found that 21% of PWID had been physically assaulted by police in the past six months [17]. Data from five cities in Ukraine in 2015 showed that 64% of PWID had been physically assaulted by police [20]. In the Philippines, police murder has become an officially endorsed part of state sponsored violence against PWID, and is also linked to corruption in the police force [19,24]. Research from Baltimore, New York, Mexico, Nigeria, and elsewhere indicate that police may frequently confiscate or destroy injection equipment, often with no associated arrest, regardless of if it is justified by the prevailing legislative framework [1,14,22,25]. Nevertheless, high rates of police violence and victimization have not been observed universally. For example, a cohort-based study in Vancouver, Canada, found that the percent of PWID reporting direct police violence in 2014 was only 3%, though this had fallen substantially from 14% in 2004 [21]. Rates of abusive policing, therefore, seem to vary locally, and are likely linked to the historical factors, legislative frameworks, and local police cultures of each area [26,27].

In this article we assess how PWID experiences with abusive or violent policing relate to *intersectional structural vulnerability*. The framework of structural vulnerability highlights how each individual's risk of a deleterious health outcome—such as experiencing police brutality—is related to their position in the wider social and economic hierarchies of their local environment [28,29]. Indeed, numerous studies have identified that abusive policing more commonly affects people with specific structural vulnerabilities. For example, people of color widely report higher rates of violent police encounters across the United States, among the general population, and PWID [15,30]. It has also been reported in numerous contexts globally that women, especially those who have ever traded sex for money or drugs, are at much higher risk of sexual violence or coercion from police [16,20,31,32]. In Tijuana, Mexico, deported status is a predictor of experiencing police bribery or extortion compared to PWID who have not been deported [33]. Less is known, however, about the *intersectional* nature of these vulnerabilities. Intersectional theory proposes that numerous, overlapping and inter-related vulnerabilities intersect to place certain groups at a higher risk of health harm [34–36]. We therefore bring the framework of *structural vulnerability*—developed by public health/clinical researchers working in the social sciences—together with *intersectionality theory*, developed in Critical Legal Studies in dialogue with Cultural, Ethnic, Sexuality and Gender Studies [2,28,37].

Our mixed methods approach of *intersectional structural vulnerability* allows for the detection of clusters of high-risk individuals and highlights how structural factors can drive health harms in a differential, complex, and nonlinear fashion for different groups based on their particular constellation of vulnerabilities. Although intersectional theory has proven relevant to numerous contexts and health outcomes, it has not, to our knowledge, been assessed in detail for its relation to abusive or violent policing among PWID. In this study, we therefore develop a mixed methods framework for operationalizing intersectionality, and bring it into discourse with current understanding of how structural vulnerability drives rates of police violence and misconduct towards PWID. This approach of intersectional structural vulnerability is oriented towards assessing how multiple overlapping and interrelated demographic, personal identity, occupational and social prestige characteristics interface in nonlinear ways. Ultimately this can help us identify specific upstream policies and local interventions to ameliorate the negative health outcomes experienced by the most vulnerable clusters of individuals.

Additionally, there is a notable lack of data describing experiences with abusive policing among PWID in rural/suburban areas of the United States, despite their increasing importance for the mitigation of the growing overdose crisis. In the past decade, the demographic composition of the population that injects opioids and other drugs in the United States has shifted increasingly towards rural and suburban areas [38–41]. Overdose mortality has followed, and is now concentrated in low-income, majority-white, and rural areas [42–44]. Rural and suburban areas, therefore, represent the front lines for preventing health harms related to injection drug use, including those influenced by policing. Nevertheless, data describing the policing practices of PWID is almost exclusively drawn from large metropolitan areas, where most research about injection drug use has been focused [43].

As a largely rural/suburban and more politically conservative part of California, with high rates of injection drug use and overdose, the Central Valley can offer unique insight into the role of policing as a structural determinant of health for PWID. Nevertheless, to our knowledge no other data exist describing rates of abusive policing among PWID in the Central Valley. The region is a large, mostly agriculturally oriented section of inland California. Fresno and Bakersfield, the two metropolitan areas highlighted in this study, are main urban hubs, and have historically had among the highest rates of injection drug use in the country [45]. In 2015, the age-adjusted overall overdose death rate for Kern and Fresno counties, home to Fresno and Bakersfield, respectively were 24.9 and 14.9, significantly higher than the 11.0 seen for California as a whole [46,47]. Furthermore, the Central Valley represents an apt location to study the importance of intersectional structural vulnerability, as a highly ethnically and socioeconomically diverse areas with substantial social disparities [48].

Methods

This exploratory, sequential [49], mixed methods analysis [50,51] was part of a wider data study among PWID in the Central Valley, focusing on injection drug use, and related health harm [52,53]. It began with ethnographic fieldwork in in Fresno and Kern counties. Fieldwork was targeted to harm reduction spaces as well as other organizations that were attempting to address similar issues, such as churches and health clinics. These experiences led to interviews with PWID, as well as people who provide health or harm reduction services, within which policing, and police-related abuse, emerged as a key factor affecting the health and wellbeing of PWID. A subsequent survey of PWID therefore included a module focused on policing, which was designed and implemented based on insights gleaned from analysis of the qualitative data. Quantitative and qualitative findings were placed into dialogue and jointly considered to yield final conclusions.

Documenting abusive policing of PWID presents numerous methodological challenges [54]. Reliably measuring extralegal or abusive practices by law enforcement officers using administrative databases or official statistics is often impossible [55]. Here we draw on self-reported experiences among PWID and employed several methods that have been shown to work well for documenting social and medical phenomena among difficult-to-reach populations: interviews driven by targeted and snowball sampling, and quantitative surveys collected using respondent driven sampling (RDS). The study was approved by the ethics review committee at the Pacific Institute for Research and Evaluation. Informed consent was obtained for all interview and survey interactions.

Qualitative Interviews

The processes used to generate the qualitative interview data used in this study have been described more extensively elsewhere [52,53]. Through ethnographic fieldwork we recruited n=8 key informants who offer health or harm reduction services to PWID in Kern or Fresno counties. We also used targeted and snowball sampling to recruit n=46 people age 18 or older who reported injection drug use in the past year. Recruitment was initiated through contacts at harm reduction and other health programs, as well as on the street in areas known to be frequented by PWID, and sustained through snowball sampling. We purposefully designed a sample that was diverse in gender, heroin vs methamphetamine use, and urban vs rural residency to capture a range of experiences. Interviews were conducted between March and December 2015, and typically lasted 60-90 minutes. Interviews were digitally recorded, summarized, and coded for numerous themes, including interactions with police. Findings from the coded interviews were used to guide the construction of a quantitative survey instrument, with diverse domains including questions related to police encounters.

Quantitative Survey

Given that research about PWID in the Central Valley has been limited, and injection drug use remains highly stigmatized, we drew on RDS, a chain referral sampling method well-adapted to reaching "hidden populations" [56]. We recruited participants who were at least 18 years old and who reported injecting drugs at least twice within the previous 30-day period. They were offered dual incentives: $30 USD for completing the survey and $5 USD for recruiting eligible peers, for up to 3 referrals. We strategically selected 11 'seed' individuals to initiate the chain referral process to promote sample diversity. As emergent themes between Fresno and Kern countries were judged to be suitably similar, survey sampling consolidated was consolidated to Fresno and the surrounding area, and occurred from April to September 2016.

Outcome measures of interest included lifetime risk of self-reported physical assault by police, verbal abuse by police, sexual violence or exploitation by police (including attempted or completed sexual assault or sexual proposition), the confiscation of unused syringes, the confiscation of any syringes (used or unused), and the number of times stopped but not arrested (a marker of routine police harassment [1]. These variables were identified as relevant dimensions of abusive policing through analysis of the qualitative interview data. Some of these outcomes are unequivocally extrajudicial and health-damaging, such as sexual assault. However, others exist in legal grey areas, and have health harms that are more contextually dependent, such as routinized harassment or the confiscation of unused syringes.

Vulnerability factors (used as explanatory/independent variables) were chosen on the basis of the initial qualitative analysis, and included: gender, race, level of educational attainment, current housing status, currently residing in a rural location, and having ever engaged in sex work. Most outcome variables were modeled as binary outcomes using logistic regression. Regression coefficients were exponentiated to yield adjusted odds ratios. Number of times stopped but not arrested was modelled as a continuous outcome (as nearly all participants had at least one encounter, it could not be modeled as dichotomous), using a quasi-Poisson model, and exponentiated coefficients yielded adjusted odds ratios. All explanatory variables were measured as dichotomous exposures. Race was dichotomized as non-Hispanic white vs. person of color. Educational attainment was dichotomized as having successfully completing secondary education, not including a GED. Rurality was defined as residing in a zip code with less than 2,000 people per square mile, according to American Community Survey 2018 5-year estimates [57].

Intersectional Quantitative Analysis

We first assessed the independent effects of each predictor on each outcome, using bivariate and multivariate regression analysis. One regression was run per outcome using all predictors. Unweighted regression analysis was used given recent findings that it has better performance in a respondent driven sample context [58]. We also used exploratory, descriptive data visualization to search for clusters of intersectional vulnerability. We visualized the overlapping distributions of the six vulnerability factors using a modified UpSet plot framework, a tool from intersectional set theory [59]. In the UpSet plot, each observed constellation of vulnerability factors is assessed as one cluster, or analytic group. For each cluster, we visualized the magnitude of each of the six outcome measures, rescaled as a 0 to 100 scale of intensity. A composite score was also created for each cluster as the average intensity across all six outcomes.

Results

The respondent-driven survey sample consisted of 494 PWID, 60.5% of whom were male, with a mean age of 44.2 years (Table 3. 1). 87.0% of the sample had injected heroin and 76.6% injected methamphetamine in the past month. Sociodemographic data, vulnerability factors, and police interaction outcomes are provided in Table 3. 1. The qualitative sample consisted of 8 key informants, and 46 PWID, with a demographic composition relatively similar to the survey data; these interview participants had an average age of 38.7 years (range 20-65 years), 65% were male, and 37% Hispanic (see prior publications for more details) [52,53].

"Looking Like a Drug User" – Cycles of Police Harassment Mediated by Vulnerability

"It's like you feel caged. They always pull up on you, you know, it could be 4 or 5 of us standing there, and they'd pull up on you and say, "Is any of y'all on probation, parole or got a warrant? And doesn't matter what you say, they want to run your name just to see. That ain't cool. And, because they might see 3 Blacks, or 2 Mexicans in a group, they automatically assume that of the 5 cats on that corner, at least one or two of them are on probation or parole. And they're going to run everyone's name. And if they see you've got any warrants, or if they see anything, they are taking you away. And you were just sitting there minding your business, haven't done anything. It's just like a witch hunt type thing." – Eddy, M, 55, Black, Non-Hispanic, Fresno County

This account highlights the most prevalent theme emerging from interviews with PWID about their interactions with the police in the Central Valley—nearly every respondent felt that police attention towards PWID reached the level of harassment and could be highly disruptive to the daily life of the people who were its target. Participants describe how police routinely pass through so-called "known drug use areas"—which are generally low-income neighborhoods—and summarily stop any individual or group that was deemed to be "suspicious." During these encounters, the "running of names"—checking individual names against a database of active warrants for arrest—was a central theme. Survey results confirmed a high density of no-arrest police stops among PWID. The average person in our sample reported being stopped but not arrested 24.4 times and 96.1% of participants had been stopped at least once (Table 3. 1).

Social presentation, identity, and vulnerability were described as mediating these cycles. Numerous participants discussed strategies they employed to escape this kind of police attention. Nevertheless, in many instances these tactics could only work for so long. One interview participant recounted her experience becoming a "known entity" to the police:

"For the longest time I had the police fooled that I was not an IV drug user. I usually don't look

that raggedy. Normally I'm pretty well put together. I'm educated. I'm not stupid. I can communicate. I'm articulate. I can pull it off, you know, I cover my tracks. So when I first started going to jail the cops would be like, "You just don't seem like you should be here," and I'd be like, "I know I shouldn't." It took me being involved in a lot of shit…but then the cops saw me around a lot of 'the wrong' places, and then they were just like, 'Bitch you're not fooling us anymore.' And after that, it sucked, you know, it was plain ass harassment. And anybody that would be with me would get it too. People would be walking with me, people that don't use drugs, that the cops had never even seen before, and they would run them. They'd run their name, just to see what they had. The reason they gave was because of 'the company they're keeping'. And they were referring to me. It was harassment." -Karla, 35, F, Mexican American, Kern County

This informant identified her educational background and social presence as protective factors that buffered her from negative police attention for some time. Ultimately, though, she was "marked" by police for targeted attention.

These cycles of police attention were often intimately linked to the probation system. In many instances, as described above, police would summarily ask individuals if they were on probation, in order to increase their powers to conduct legal searches. Furthermore, many participants described receiving targeted police attention once they were in the probation system. Often these encounters were described as even more disruptive to their lives, because they would occur not only in the street, but in their homes and places of work, which were known to probation officers and police:

"Whenever I was stopped by a police officer or a probation officer, I mean these people literally had so much control over me that no matter where I was or who I was with, they had a right to stop me, search through my purse, read through my journals. They could strip me down naked and put their hands on my body. They could even stick a mirror up my ass crack if they wanted to and I had to let them because if I didn't then I was going to go to jail and I was going to risk police brutality and that sort of thing. I couldn't stand it anymore. I was tired of that and literally living in a small town, the probation and parole officers, they are very, very into their jobs over there. They are real go-getters. I was literally being stopped by law enforcement at least twice a week, and sitting on the sidewalk while some asshole with a badge poured my purse out all over the sidewalk. It was constant. They were coming to my job. They would come to my friends' houses looking for me. I mean it was like borderline harassment. My boss actually asked me to talk to them about showing up at my job like that, because a lot of our clients were elderly people, and we've got these probation officers with guns and tasers and pepper spray and bulletproof vests on. They're coming in and they're pulling out an employee,

and it was bad for business." -Rebecca, 25, F, Native American, Non-Hispanic, Kern County

This passage highlights how police attention, and harassment, can extend far beyond criminal justice implications, and affect housing, finances, transportation, work, and other dimensions of life. Additionally, this woman identified living in a rural area as a risk factor for negative police attention, because it increased the degree of familiarity with the police, as compared to more anonymous, larger metropolitan areas. She also recounted that in her case, the "small town" police she encountered were much more aggressive than their counterparts in big cities.

In each of the three passages above, specific elements of personal identity or appearance were identified as vulnerability factors, which could increase or mediate police harassment in contextually variable ways. There was wide consensus that this burden of police attention was not experienced equally. Race, ethnicity, gender, homelessness, personal grooming, level of education, intelligence, and living in a rural area were all identified by participants as factors that could influence police interaction frequency or intensity. These factors were often collectively articulated through the frame of "looking like a drug user," i.e., to what degree the person in question resemble the stereotypical presentation of what a PWID "should look like" in the minds of police. Although many factors—especially race, class, and housing status—were linked clearly by interview participants to their ability to avoid "looking like a drug user", it was described as an overall complicated and emergent phenomenon. Furthermore, interview participants conveyed the general sense that individual social capital or charisma could supersede the importance of these factors in specific cases. For instance, one participant explained that she was able to avoid many negative effects of police attention, despite her status as someone experiencing homelessness:

"Once they talk to me, and see that I am educated, and that I don't look like I'm on drugs, they're a lot nicer. Unfortunately, the people that are in trans-generational poverty, or whatever it may be, they're not so lucky. The cops aren't so kind. I was getting, I don't want to say harassed, but "hey you're sleeping here, what are you doing? We're curious, why are you here?" The rangers at the park, they pretty much all got to know me, and I had them stop and say, "hey, we just want to know your story, why are you here? You kind of don't fit in with all these people, you don't look like you're on drugs, and you're clean, and you're homeless, so what's the deal?" But if you are in active addiction, and you look the part, then yeah, you're going to be treated differently." -Sarah, 40, F, White, Non-Hispanic, Kern County

In this case, the participant identified her education and appearance as factors protecting her from police harassment, despite her status as homeless and injecting drugs. She compared her social capita to that of individuals experiencing transgenerational poverty to explain her relative state of privilege.

Physical Violence

Physical violence by police was also commonly reported by PWID (42.2% of survey respondents). Most typically, violence from police was described as stemming from larger rituals of harassment, in cases where the officer perceived a transgression against their authority, or threat to their safety:

I was on my way to court, 'cuz I had a Prop 36 [drug possession] case to deal with. I had stopped and got something to eat. I did a shot. I'd kicked my shoes off because it was summer, I was driving with socks. Traffic was bumper to bumper, and this lady stopped right in front of me and I wanted to hit my brakes and it slipped off and I swerved and I just barely bumped her car. She called 911 and this older sheriff came, and he told me that my license had been suspended for a possession of weed ticket, a $50 fine, that I hadn't taken care of. I told him I had to be at court, and he said, "Well, we'll see if we can get this cleared up with her insurance first, and then I'll let you off with just a warning for having your driver's license suspended. I'll let you park your car, and somebody can pick you up to take you to court." He was okay with it, the older sheriff guy. But then, as I'm sitting there waiting for my information to come back, this Bakersfield PD cruiser pulls up, and some youngster right out of academy hops out. He took one look at me and he stereotyped me, and he started pushing my buttons, disrespecting me by the way he was talking to me, and I'm looking at my watch thinking, "Well, I got about 20 minutes before I'm going to get a failure to appear, and there goes my bail. I'm going back to jail," and he just kept on me, and kept on harassing me. I told him, "You know, I gave you no reason to talk to me that way. I asked you not to disrespect me like that," and he just kept on. Finally, he tells me, "Get up, stupid. Put your hands behind your back and stand up against the car," and I looked at him and I said, "Excuse me?" and he slammed me into the car and cuffed me up. I spit in his face, so he beat me up. When he arrested me, he didn't call an *ambulance or anything. He dragged me. I couldn't walk, and he dragged me to the car. Then they hog-tied me, put me in the cold tank, kicked me four or five more times, cut the zip ties off me, and I stayed in there for about 22 hours before they even booked me in. I got failure to appear, so I went back to jail for 22 days. I lost everything after that. They impounded my car. I lost the place where I was living. -Kevin, M, 55, White, Non-Hispanic, Kern County*

This incident highlights the discretionary power held by individual officers, who can often unilaterally escalate cycles of harassment and violence, in cases where other officers may not have elected to do so. In this case, the younger officer was described as initiating the aggression by "slamming" the participant into his car. This kind of routine physicality was commonly reported to be used in conducting searches or arrests. It was understood, however, that any perceived response of physicality, or lack of respect for absolute police authority, could be met with numerous methods of retaliation, including physical violence or pre-booking incarceration for an extended period.

The most commonly discussed inciting event that would trigger police violence towards PWID was the discovery of a syringe while conducting a search, especially if police feared a needle stick incident:

"A cop does not want to find a syringe on you. I've had it happen, and it got me beat up, I had a syringe in my pocket. They wake me up while I'm sleeping in my truck, and he asked me if I have anything on me, and I don't, I don't even know what's going on. So I'm telling him "No man. What's the ..." You know? And he reaches into my pocket, and what does he find? Right, the syringe. So he thinks he's getting stuck, so what's he want to do? He wants to hit on me for a little bit. You know? I think I've been beat up by the cops more than I've been beat up by anybody else out here."-Tom, 30, M, White, Non-Hispanic, Fresno County

"If you do you have a syringe you better tell them because they don't want to get poked on. And let's say you think they're not going to get poked, but if they find it on you, that's when the shit starts. They don't like that." -Enrique, 60, M, Mexican American, Kern County

Although, at the time of data collection, syringe possession was a legal grey area in California, the possession of unused syringes obtained from an "authorized source" was generally legal [53]. Nevertheless, fear of conflict with police over syringes was a commonly discussed theme in regard to why people preferred not to carry syringes with them, opting to leave them "stashed" in various spots around their neighborhood, or to borrow them from friends when not at home. Syringe confiscation was also common among survey respondents, with 38.5% of PWID reporting the confiscation of new/unused syringes (Table 3. 1).

Although there was a general consensus that most of the violence police enacted against PWID was not legal or justified, there was also a widespread impression that offending officers would be all but sure to be treated with impunity:

"See Fresno police got a bad reputation man, as they're vigilantes. They're not police, you know what I mean. They'll gun you down. They don't take no chances, because of the gang problems that's reaching out here. You got a lot of shootings. So, there's this mentality that Dyer the chief of police, he puts in their head. Shoot first ask questions later. That's why they always getting in trouble. That's why every time when you here Dyer say, "Well my officer, he felt threatened. And he had no choice but to use excessive force." I call him King Damage Control because every time they get in trouble or do something, he comes in there and makes it right. And it's not always right. The police ain't always right. But he's going to make them right every time." -Robert, M, 55, Black, Non-Hispanic, Fresno County

Sexual Violence and Exploitation

Sexual violence or exploitation were reported by 9.1% of survey respondents. During qualitative interviews, these forms of violence were discussed most frequently by men and women who had traded sex for drugs or money. Victimization by police was described as an occupational hazard of engaging in sex work, associated with specific officers who displayed patterns of repeated predatory behavior:

Most of 'em, when they know you, they know you, and they'll mess with you. But they're just doing their job. There's some out there, though, that come on to the girls. Just recently my friend told me, "Girl, that cop was asking about you." You know, 'cause he passes his number out. I actually even had it before, and I tossed it. Cuz he always passes it out, 'cause he likes us, he wants to date us. You know what I'm saying? He wants to date us, so ...He's married. There's a lot of them out there like that though. Now that I think about it, there's more than what the system knows about. They're supposed to be doing their job. I had one the last place I worked, this was like 7 years ago, everybody knew him, knew what he was about. He would take you out to the country in the car, and you would have to pay him to get out. Like to break you out, you would have to break him off, and if you didn't, he was forcing himself on females.

Lots of the male cops used to go after prostitutes so they could fuck them and stuff. I had one pick me up, and he'd talk dirty all the times he took me in. And I was also trying to talk dirty back to him, hoping that maybe he'd stop and let me out. So, you'll do whatever, you know what I'm saying? But that one didn't ever let me out, he just wanted to talk dirty to me. -- Alejandra, 40, F, Hispanic, Fresno County

Quantitative Findings - Intersectional Vulnerability to Abusive Policing

The above qualitative analysis suggests that abusive policing is not random or isolated. Instead, violence can be understood as largely stemming from routinized cycles of police harassment of PWID, which frequently escalate into overt violence or other forms of abuse. These cycles were described to be mediated by vulnerability; a finding confirmed in the quantitative data. Fig 3. 1 summarizes the main multivariable associations between personal vulnerability factors, and police interaction outcomes. In multivariate regression, higher odds ratios of no-arrest stops—a marker of police harassment—were reported by males (aRR=1.63; 95% CI: 0.99-2.80), individuals who had traded sex (aRR=2.18; 95% CI: 1.31-3.56), or people who were experiencing homelessness (aRR=2.13; 95% CI: 1.31-3.45). Intersectional analysis reveals that the number of no-arrest stops varied over tenfold between groups—from an average of 16.8 stops for females with no vulnerability factors, to 182.2 for men who were experiencing homelessness, had traded sex, and lived in a rural zip code (Fig 3.2 and Fig 3.4).

Gender emerged as a key factor driving the kinds of abuse PWID were most likely to experience. Females reported higher odds of sexual violence and exploitation (aOR= 4.2; 95% CI: 2.1-9.0) and males reported higher odds of physical violence (aOR=3.6; 95% CI: 2.4-5.6) and all other outcomes. Additionally, experiencing homelessness, having traded sex, and living in a rural zip code, were all factors independently associated with numerous forms of police abuse or harassment.

Independent positive correlations were seen between experiencing sexual violence or exploitation and being female (aOR=4.2; 95% CI: 2.1-9.0), having traded sex (aOR=1.9; 95% CI: 0.9-3.8), experiencing homelessness (aOR=1.7; 95% CI: 0.8-3.3), and being a person of color (aOR=1.6; 95% CI: 0.8-3.4), although some did not achieve statistical significance (Fig 3. 1). Male PWID with no other vulnerability factors had a total prevalence of sexual violence or exploitation by police of 1.7%. Females with no other factor had a prevalence of 16.1%, which increased to 42.9% for women who had traded sex, where not white, and were experiencing homelessness (Fig 3. 4).

Given that qualitative interview data suggested that intersectional vulnerability is a strong driver of police abuse, we developed an exploratory framework to assess this quantitatively using survey data. A visualization of the intersectional distribution of vulnerability factors in the survey data sample is provided in Fig 3. 2. The largest cluster (as defined by a particular set of vulnerability factors) were non-white males who dropped out of high school (n=55) and males with no other vulnerability factor (n=44). In general, clusters of women had lower outcome scores—reflecting a lower level of abusive experiences with police—than clusters of men, due to women's reduced risk for all outcomes except sexual violence or exploitation (Fig 3. 1). The male clusters with the highest scores included men who were experiencing homelessness, from rural areas, ever traded sex, and dropped out of high school (average score of 88%) followed by men who were experiencing homelessness (80%). The female clusters with the highest scores were women from rural areas (65%) followed by women who were experiencing homelessness, non-white, and dropped out of high school (58%).

There was an overall positive relationship between the number of vulnerability factors and the average police interaction score (Fig 3. 3), which was statistically significant (bivariate linear model p = .0248). One manner of visualizing the intersectional risk to police interaction outcomes associated with increasing numbers of personal vulnerability factors is shown in Fig 5. In general, the risk of negative police interactions increased among groups with progressively greater numbers of vulnerability factors.

Discussion

In this mixed methods study among PWID in California's Central Valley, respondents reported high rates of negative police attention, abuse, and violence. In our survey, 42.2% of PWID reported physical violence by police, 62.3% experienced verbal abuse, 9.1% reported sexual violence, and 38.5% reported the confiscation of new/unused syringes. To our knowledge, this represents the first characterization of abusive police practices towards PWID in the Central Valley. Furthermore, this study helps address the paucity of research describing experiences with abusive policing among PWID in rural/suburban areas of the United States. We find that rates of police violence are high in the Central Valley, and comparable to the highest rates observed previously reported in New York [14], and other international large metropolitan areas [18,20], though differences in methodology (e.g. recall window duration, outcome definition) make exact comparisons difficult.

Our study concurs with prior research indicating that specific vulnerability factors are strongly associated with negative police attention, harassment, and physical and sexual violence [15,30], and extends the importance of these findings to the Central Valley. Gender plays a strong role in shaping the risk environment for negative police encounters among PWID; women were over fourfold more likely to experience sexual assault, while men were at similarly elevated risk for physical violence. Experiencing homelessness was positively associated with a host of negative police experiences, as was having traded sex for money or drugs—findings that have been reported in large metropolitan contexts, yet have been understudied in areas like the Central Valley [16,20,31,32].

We also developed and implemented a mixed methods framework to assess the importance of intersectional structural vulnerability to this topic. Through intersectional data visualization we identified pockets of extreme vulnerability. For example, rates of police-perpetrated sexual violence and exploitation varied nearly thirtyfold, from 1.7% among men with no other vulnerability factors to 42.9% of women of color who were experiencing homelessness and had traded sex. The number of no-arrest stops—a marker of police harassment—varied over tenfold between groups, from an average of 16.8 stops for females with no vulnerability factors, to 182.2 for men who were experiencing homelessness, had traded sex, and lived in a rural zip code. Myriad other examples can be observed in the intersectional descriptive Figs presented here. Although we are not aware of other studies employing an intersectional framework of this nature to study police violence among PWID, we expect that similar results would be observed in other contexts. The framework developed here can be easily adapted for comparative work elsewhere, which could provide useful insight into the generalizability of these results.

The way that intersectional structural vulnerability mediates and potentiates police abuse is complex and non-linear – a finding reflected in both the quantitative survey data and qualitative interview findings. Nevertheless, amid the complexity of intersectional dynamics, a clear signal emerges reflecting the overall relationship between intersectional vulnerability and police abuse. The qualitative data help contextualize the mechanisms by which intersectional vulnerability may lead to higher rates of deleterious police interactions. Incidents of police violence are not random or isolated occurrences. Instead, they occur within a wider context of cycles of negative police attention and harassment of PWID. These cycles are mediated by numerous social factors, which can either help PWID avoid attention, or render them more vulnerable to it. These same cycles can often escalate into violence or other harmful forms of police attention, and therefore contribute to the macro-level disparities observed in the quantitative data. Understanding these cycles of police harassment is also key for implementing policy changes to ameliorate them.

This exploratory mixed methods study does have limitations that should be taken into account. The history of police violence is inextricable from structural racism in the United States, and Black Americans have generally received the most abuse [15,30]. Due to sample size limitations and the low percentage of the total sample who identified as Black, we were not able to assess rates of police violence specifically for this group of PWID. Instead, we were only able to assess racial disparities in a binary white/non-white scale which fails to capture the nuances of racism as a key mediator. This remains a highly important area for future study. Additionally, RDS methodologies are still under refinement, and there is disagreement about the best way to adjust for biases introduced by the sampling method. We chose to use unweighted regression analysis following recent evidence demonstrating that it has better performance [58], however, other methods could be used. Still, given the magnitude of the disparities we report here, they are unlikely to be affected greatly by biases introduced from RDS. Furthermore, RDS represents an extremely useful tool to reach a population such as PWID, who face high levels of stigma and legal risk in the Central Valley. Our sample was large compared to other studies of a similar nature, nevertheless, sample size did still place limitations on the methodologies employed. Extensive interaction terms in regression analysis, for example, was not a viable option in this case. Instead we opted for a descriptive approach to visualizing the intersectional distributions of vulnerability factors and associated outcomes. To have absolute confidence in results for any given small group, however, follow-up research with oversampling for that subpopulation would be required. Furthermore, the intersectional structural vulnerability to police abuse and misconduct that we describe here is specific to PWID in the Central Valley. Although our results are likely to have relevance to other similar social contexts, further research applying this framework to other locations would provide helpful insight into the generalizability of the trends noted here.

Overall, the high levels of police-perpetrated abuse and violence, and deep links to the structural vulnerability of PWID, suggest that structural solutions are required to protect vulnerable individuals in the Central Valley. In the short term, as a harm reduction measure, monitoring, prevention, and response to deleterious law enforcement practices can be integrated into policy interventions to protect vulnerable groups. This may include working to train police, equipping them with alternative approaches to handling drug-related encounters, or creating deflection and diversion programs. Furthermore, routinely collecting and analyzing data from PWID, through street-level outreach or service provision organizations, can help to monitor trends in deleterious police practices [60]. Centering the perspectives of PWID in discourse with the government is an essential step in implementing effective reform. In most of the world, the police overwhelmingly represent the branch of the government that interacts most with PWID in a face-to-face manner. Police are inherently ill-equipped to address the concerns of PWID, and much less when they are related to police brutality. In limited contexts, organized groups of PWID, such as drug users' unions, have had success in decreasing human rights abuses and implementing new policies, which may represent a key strategy for reducing police violence towards PWID [61–65].

More fundamentally, interventions to reduce abusive policing must take a more structural lens. This invokes the mounting, national calls for shrinking the footprint of police and other carceral.

The movement to tackle racist police brutality as a public health issue has made a case for reassigning resources away from police. [66]. Nevertheless, even now, rural/suburban areas continue to receive less consideration. We argue that understanding and ameliorating the role of policing as a deleterious structural determinant of health for PWID in rural/suburban areas may be of special importance, as such contexts increasingly represent the front lines of the US overdose crisis [38–43]. These areas represent an important focal point to reduce the social and health harms associated with injection drug use and addressing police-related violence should be a central consideration.

	Female (N=186)	Male (N=292)	Overall (N=483)
Sample Characteristics			
Age Mean (SD)	42.8 (11.6)	45.0 (12.9)	44.2 (12.4)
Injected Heroin N (%)	157 (84.4%)	259 (88.7%)	420 (87.0%)
Injected Methamphetamine N (%)	136 (73.1%)	229 (78.4%)	370 (76.6%)
Injected Amphetamine N (%)	47 (25.3%)	81 (27.7%)	129 (26.7%)
Injected Heroin and Methamphetamine N (%)	104 (55.9%)	178 (61.0%)	284 (58.8%)
Injected Cocaine N (%)	91 (48.9%)	170 (58.2%)	263 (54.5%)
Injected Crack N (%)	25 (13.4%)	45 (15.4%)	70 (14.5%)
Injected Heroin and Coke N (%)	93 (50.0%)	185 (63.4%)	281 (58.2%)
Injected Heroin and Crack Cocaine N (%)	17 (9.1%)	44 (15.1%)	61 (12.6%)
Injected Prescription Opioids N (%)	54 (29.0%)	108 (37.0%)	163 (33.7%)
Injected Prescription Benzodiazepines N (%)	19 (10.2%)	35 (12.0%)	54 (11.2%)
Completed Less than Highschool N (%)	99 (53.2%)	148 (50.7%)	251 (52.0%)
Person of Color N (%)	102 (54.8%)	179 (61.3%)	285 (59.0%)
Currently Experiencing Homelessness N (%)	56 (30.1%)	95 (32.5%)	154 (31.9%)
Traded Sex N (%)	70 (37.6%)	50 (17.1%)	124 (25.7%)
Currently Resides in Rural zip code N (%)	34 (18.3%)	46 (15.8%)	81 (16.8%)
Police Interaction Outcomes			
Verbal Abuse N (%)	100 (53.8%)	196 (67.1%)	301 (62.3%)
Physical Violence N (%)	46 (24.7%)	155 (53.1%)	204 (42.2%)
Sexual Violence or Coercion N (%)	30 (16.1%)	12 (4.1%)	44 (9.1%)
Times Stopped but Not Arrested Mean (SD)	19.0 (74.2)	27.6 (74.0)	24.4 (73.8)
Confiscation of New/Unused Syringes N (%)	63 (33.9%)	122 (41.8%)	186 (38.5%)
Confiscation of Any Syringes N (%)	84 (45.2%)	149 (51.0%)	234 (48.4%)

Table 3.1. Descriptive Characteristics of Survey Respondents
All self-reported experiences reflect lifetime incidence, except experiencing homelessness and residing in a rural zip code, which were assessed at the time of the survey.

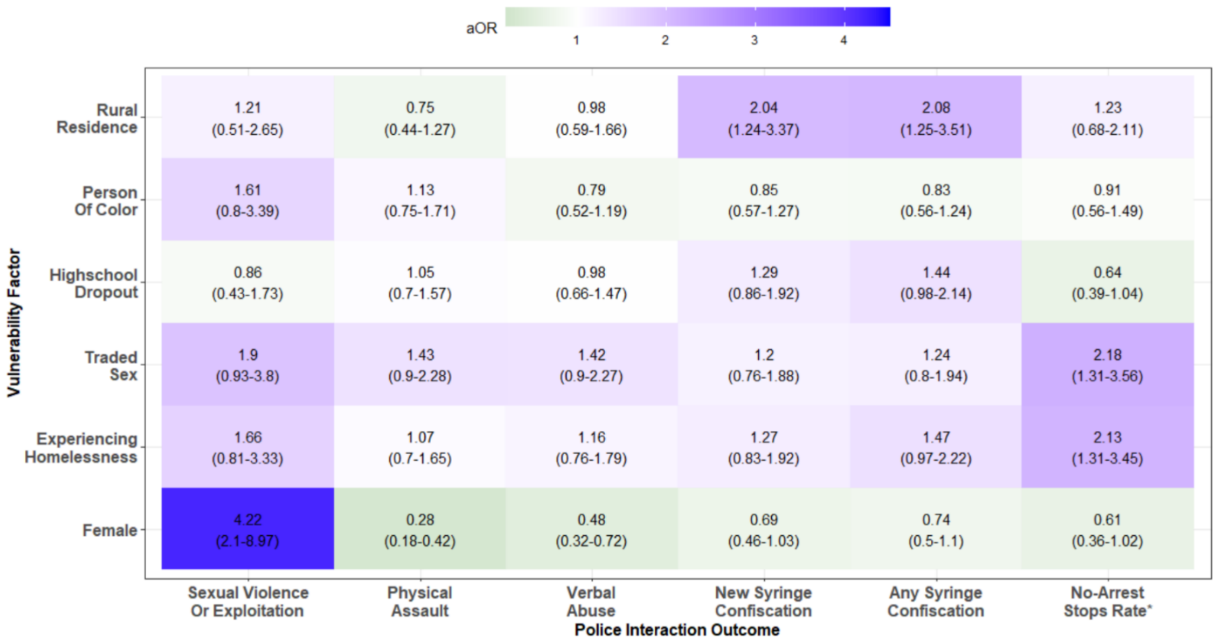

Fig 3.1. Multivariate Associations between Vulnerability Factors and Police Interaction Outcomes

Each column represents one multivariable regression between a police interaction outcome and 6 vulnerability factors. The adjusted odds-ratio for each vulnerability factor is shown in text, as well as the associated 95% confidence interval in parentheses. The color scale indicates the direction of the association, where green is protective, and purple indicates heightened risk.

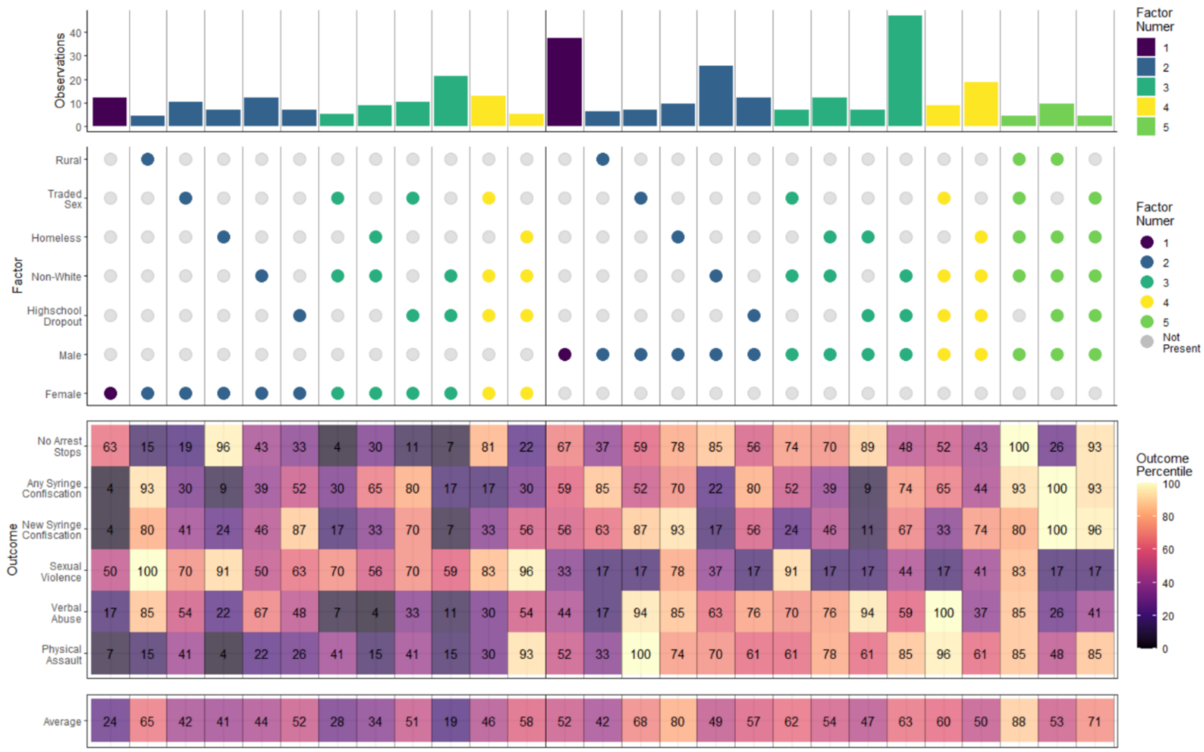

Fig 3.2. The Intersectional Distribution of Vulnerability Factors with Associated Police Outcome Scores

Each column represents one cluster of vulnerability factors; the same column represents the same cluster of individuals across all 4 panels. The top panel shows the number of individuals in each cluster. The second panel shows the particular vulnerability factors present in the cluster. The color used in the top two panels shows the total number of vulnerability factors present. The third panel shows the outcome score for each police interaction outcome, which represents the value in each group rescaled to a 0 to 100 scale across clusters. The bottom panel shows the average outcome score across the six outcomes for each cluster. A vertical black line separates clusters of males from clusters of females. Clusters are organized on the x-axis first by gender, and then by number of vulnerability factors.

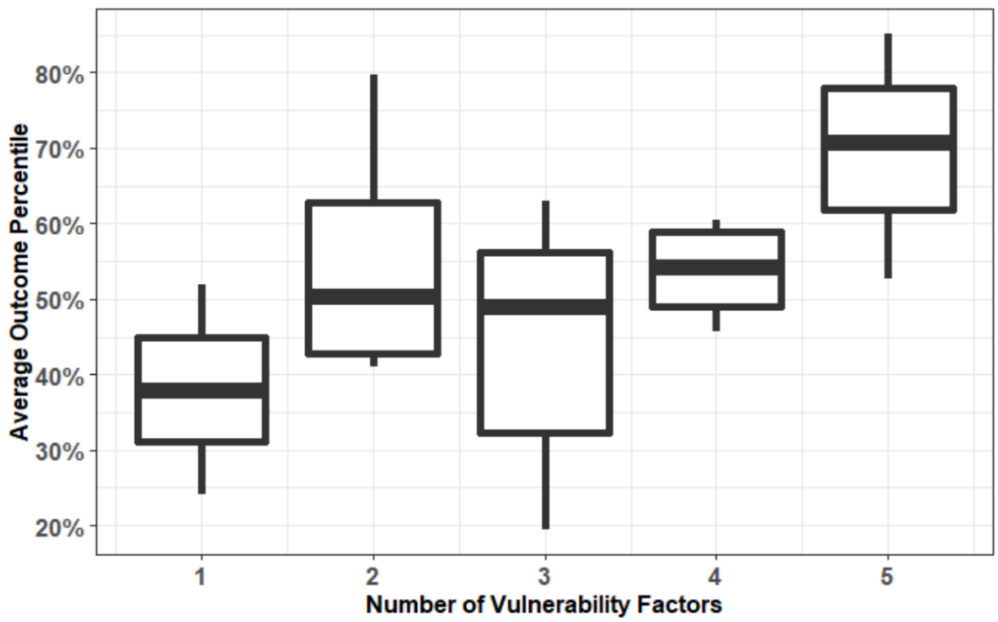

Fig 3.3. The Average Police Outcome Score by Number of Vulnerability Scores
The distribution of average outcome scores across all police interaction outcomes is shown as a boxplot, separate by number of vulnerability factors. This represents the distribution of values shown in the bottom panel of Fig 3.2, organized by the number of vulnerability factors (represented by color in the top two panels of Fig 3.2).

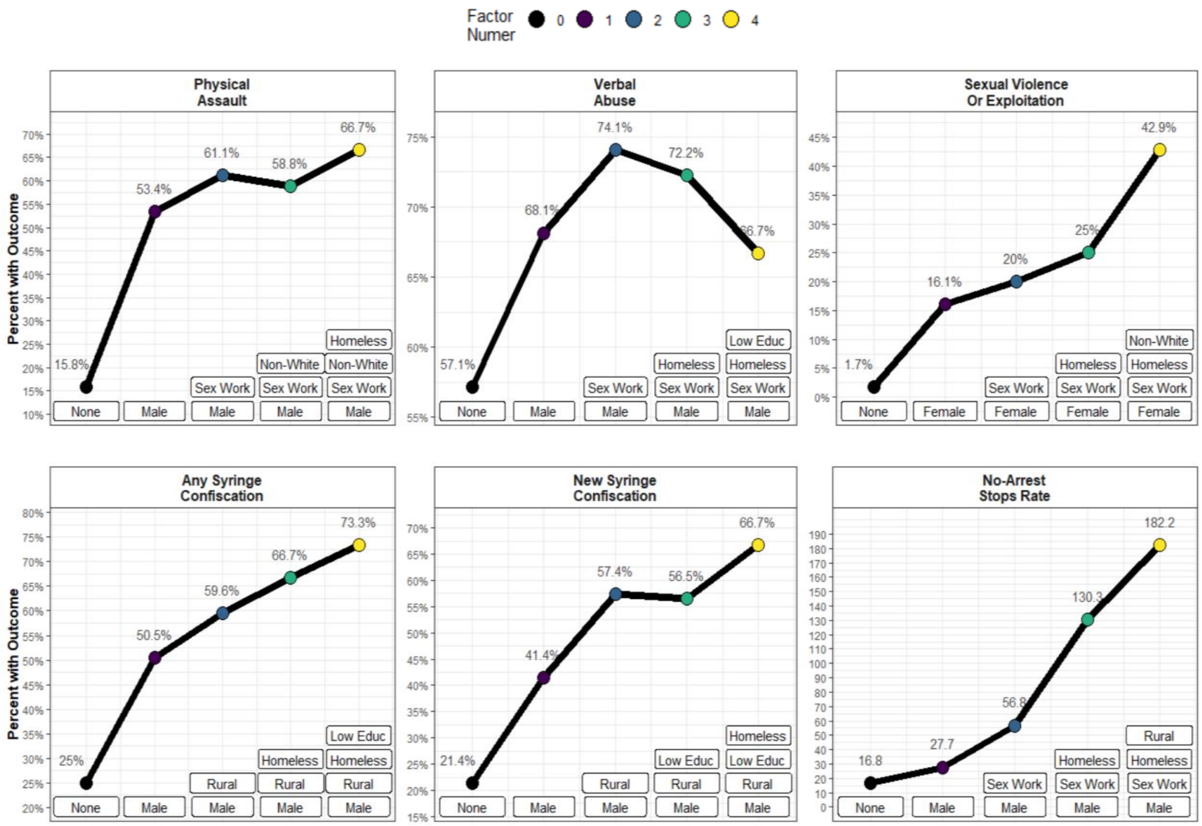

Fig 3.4. Risk of Police Interaction Outcomes with Increasing Numbers of Vulnerability Factors

This Fig represents one manner of visualizing the intersectional risk to police interaction outcomes associated with increasing numbers of personal vulnerability factors. One panel is shown for each outcome. The baseline group, which has zero vulnerability factors, is represented on the far left. Vulnerability factors are introduced in a stepwise fashion according to the magnitude of positive association observed in adjusted odds ratios, as shown in Fig 3.1.

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Chapter 4: The introduction of fentanyl on the US–Mexico border An ethnographic account triangulated with drug checking data from Tijuana

A modified version of this chapter appeared as a research article in the International Journal of Drug Policy:

Friedman J, Bourgois P, Godvin M, et al. The introduction of fentanyl on the US–Mexico border: An ethnographic account triangulated with drug checking data from Tijuana. International Journal of Drug Policy. 2022;104:103678. doi:10.1016/j.drugpo.2022.103678

This deep mixed methods case study documents clandestine dynamics of public health significance, namely, the spread of illicit fentanyls in the drug supply of Tijuana, Mexico. No traditional administrative records exist on this topic, despite its great importance for the health of people that use drugs in this borderlands city. It is therefore an apt topic for the mixed methods approach developed here. Further, it provides the opportunity to mix ethnography with drug checking, an important set of methods to describe the composition of the illicit drug supply. Both of these techniques are useful in data sparse situations such as describing the composition of an illicit clandestine market, and we find they have synergistic value when used together.

Introduction

The evolving street drug supply is fundamentally changing the risk environment for people who use drugs (PWUD)[1–6], understood as the space, both at an individual and societal level, where factors interact to increase the harm of substance use[7]. In particular, the rise of illicitly-manufactured-fentanyls (hereafter fentanyl) is of urgent concern as it is driving steeply rising overdose rates and other health risks for PWUD in North America. Fentanyl is a family of synthetic opioid agonists many times stronger than heroin. Sold in pure form, mixed with heroin, erroneously sold as heroin itself, or, increasingly pressed into pills (especially imitating oxycodone and benzodiazepines), fentanyl is increasingly present in the illicit opioid supply[1,6]. The increasing volatility of the drug supply—where presence or concentration of fentanyl are not known by consumers—is implicated in the worst overdose crisis seen in the United States to date, which claimed nearly 600,000 lives in the decade ending in 2020[8].

Fentanyl's transformative power in the risk environment reflects its pharmacological properties and their behavioral implications. When compared to non-synthetic opioids, fentanyls have a shorter half-life, but higher potency. This necessitates more frequent injection, as analgesia and euphoria wane, and withdrawal symptoms present more quickly[9]. Increased injection occurrence has been hypothesized to elevate the risk of myriad deleterious health outcomes, such as overdose, soft-tissue infection, and the transmission of infectious diseases such as HIV and Hepatitis C[4,10].

Drug market shifts have both local importance, and international implications, given the global nature of the drug supply. In the United States, the prevalence of fentanyl was initially heavily concentrated in Eastern US states[1,5]. However, in recent years it has begun moving Westward, including proximate to the US-Mexico border[5]. According to the US Drug Enforcement Agency, the vast majority of the opioid supply in the US originates from Mexican drug trafficking organizations[1,11].

Other than relatively isolated populations of PWUD in the country's largest cities, opioid injecting occurs almost exclusively along Mexico's northern border[12,13]. In this context, fentanyl is likely to be having similarly transformative effects on the risk environment for PWUD in Mexico, to those recently seen in California and other US border states[8]. Further, given that Mexican border cities act as transit through-points for the US illicit drug supply, fentanyl surveillance in US-Mexican border cities could provide early evidence about shifts that will subsequently occur in the US. Nevertheless, there is a dearth of drug surveillance data in Mexico, largely stemming from structural limitations on epidemiological and drug checking data streams. Toxicological and autopsy data is extremely limited in Mexico[14], and most overdose deaths are coded with so-called 'garbage codes' such as 'cardiac arrest' which are not informative as to the true underlying cause of mortality[14,15]. A previous study in three border cities in Mexico found a near absence of self-reported fentanyl use among PWUD, although individuals may be unaware of the composition of substances purchased on illicit and unregulated markets[16]. A prior study in Tijuana tested a convenience sample of n=89 syringes and additional components of injection equipment, and noted the presence of fentanyl[17]. Given limitations of the existing data, we draw on complementary methodologies to describe the shifting drug supply and risk environment for PWUD on the US-Mexico border.

Methods

We integrated fentanyl checking methodologies (leveraging fentanyl testing strips) [17,18] with participant observation ethnography among PWUD and other interlocutors. Through a longitudinal sample we documented geographic coverage of fentanyl positivity among syringes, monitored change over time and in different areas. Our mixed methods approach[19] entailed integrating the quantitative drug market data offered by this testing with ethnographic observations about drug market and use characteristics, and their variation over time and geography. The mixing of ethnographic and drug checking data offers powerful insights. For instance, in this analysis, ethnographic data and harm-reduction practice enabled the design and ongoing tailoring of data collection and analysis of findings--including specific selection of micro-neighborhood drug testing sampling sites and focus of ethnographic data collection.

This offers an understanding of the process by which fentanyl was introduced to the drug supply in Tijuana and its impact in increasing risks for PWUD as the drug supply shifted more broadly.

Fentanyl Positivity Testing Methods

Fentanyl positivity was determined using a sample of n=652 syringes collected at 4 mobile medical/harm reduction clinics locations throughout the city of Tijuana, Mexico, coordinated by the non-governmental harm reduction organization, Prevencasa A.C. Clinic locations were chosen in geographically diverse parts of the city, known to harm reduction providers as having PWUD living and working nearby. Sites covered both East and West Tijuana, and key areas identified in previous geospatial analyses in Tijuana[20]. Drug checking data collection spanned September 2020 to April 2021.

Sterile syringes are routinely distributed at outreach sites, and used syringes are collected. Following each mobile clinic event, a random sample of about 20 syringes per date-location was selected and tested for the presence of fentanyl analogues using immunoassay-based strips produced by BTNX laboratories[21,22]. Strips provide a binary presence/absence indicator of fentanyl presence, and have been shown to be extremely sensitive[21]. A precise protocol was followed for each testing event to ensure staff safety and standardize the data generating process.

Fentanyl positivity trends were overlaid by location on maps and graphed by location and date. We used ordinary least squares regression to examine the relationship between site and location-specific fentanyl-positivity $Pf_{d,l}$, and the passage of time ($Time_{d,l}$) controlling for the location of syringe collection with site-specific fixed effects (β_{1-3}). $Time_{d,l}$ was operationalized as the time passed since the first day of data collected in years, so the coefficient multiplied by the 8-month study duration can be interpreted as the total change in fentanyl positivity in the observed period, adjusting for site-specific heterogeneity in level. Formally we modeled:

$$Pf_{d,l} = \beta_0 + \beta_1 \cdot Site_2 + \beta_2 \cdot Site_3 + \beta_3 \cdot Site_4 + \beta_4 \cdot Time_{d,l} \qquad \textbf{(3.1)}$$

Ethnographic Methods

Ethnographic data was collected as part of a wider study examining shifting risk environments of PWUD in North America[23]. Here we draw primarily from data collected in Tijuana, Mexico, involving intensive participant-observation by JF and PB, collected during 30+ months in the 2018-2021 period. Fieldwork was initially targeted towards harm reduction venues (mobile and fixed-location harm reduction clinics) and organically extended to drug consumption sites, residences, homeless encampments, and other street-based income-generation environments (e.g. accompanying informants as they work odd jobs for shopkeepers, or find goods to sell in informal markets). Informants were recruited using the classic street-based ethnographic techniques available during longitudinal participant observation fieldwork[24,25]. PB and especially JF accompanied informants (and interviewed them while they participated in) routine daily activities enabling documentation of high-risk and stigmatized practices (e.g., injecting, fighting, scavenging) in real-time in their natural environment. This anthropological approach to ethnography enabled access to 'common-sense' understandings of drug use dynamics—pertaining to where and how PWUD generate income, purchase and consume drugs, access needed resources (e.g., syringes, clean water, food, shelter), and evade police and cartel violence. Urgent strategies are routinely discussed by PWUD in their daily scramble but can be difficult to confirm in formal questionnaire formats. Through long-term, empathetic, iterative, relationship-building and direct observation of drug consumption practices, we reduce desirability biases inadvertently arising when PWUD interface with public health, medical, or harm reduction practitioners often perceived as unrealistically hypersantitary[24,26,27]. With IRB approvals, we conducted interviews in conversational formats, often audio and/or video-recording them with participant permission. Interviews and analysis were conducted in English, Spanish, or Spanglish based on participant preference. Most participants were more formally interviewed multiple times during longitudinal relationships and featured I numerous field notes. All ethnographers were bilingual, and textual data were translated to English for presentation in the article by the first author or the ethnographer who collected the relevant data. More targeted topical conversations were conducted with strategically selected key informants (e.g. physicians, street outreach workers, law enforcement officers) because of their specialized knowledge of crucial components of the risk environment (e.g., injection practices, drug supplies, treatment services, de facto criminal justice practices).

The ethnographic database consisted of n=77 transcribed recordings, 300+ pages of fieldnotes, 500+ photographs, and dozens of videos documenting practices in natural environments unfolding in real time. Data were entered into NVivo and analyzed for emergent themes. In particular relevance for this analysis, direct observations of divergent consumption practices between sites and PWUD narratives of drug supply differences over time and between regions of the city, and their relevance for shifts in the risk environment, were assessed using cross-cutting memos after primary coding. As drug testing samples accumulated, ethnographic findings were brought into conversation along with qualitative key informant conversations and accompaniment strategies were further refined. For instance, targeted ethnographic exploration of the drivers of drug market composition in light of fentanyl positivity results.

Results

Study Population and Setting

PB's Fieldnotes, Tijuana, February 2019

We run out of free emergency survival supplies (bottled water, socks, sandwiches, Narcan, syringes, alcohol wipes) earlier than usual at this mobile harm reduction clinic in Tijuana. The clinic is perched on the embankment of the gargantuan concrete infrastructure of the Tijuana River canal, which carries sewage along the international border wall. As always, the doctors and nurses are in high demand, busy lancing abscesses, cleaning cuts, treating respiratory diseases and skin rashes. In one particularly hair-raisingly painful case—I watched them set a broken bone, with the patient stoically stuffing a rag into his mouth—agony literally etched into his deeply creased frown lines. I don't think I've ever seen so much raw, unmet desperate need and physical suffering. Still, most people somehow seems to be in a good mood, and thankful for the care and fellowship they are getting.

A long line of men, and a few women, seeking treatment sit patiently in the dozen-or-so flimsy plastic chairs that serve as both "consult room and operating table." It's been raining exceptionally hard these past few days and people look more disheveled than ever--ragged shoes full of holes bursting at the seams and everything covered in mud. I chitchat with a few people in the line. Most are deportees from Los Angeles eager to reminisce, homesick for their long-lost childhood neighborhood and speak perfect English--often with old-school So-Cal accents. Many are also heavily tatted-up with LA gang insignias adding the stigma of visible deportation status to their homeless injection drug user stigma.

A particularly friendly older guy is excited by my interest in the visibly changing heroin and fentanyl offered at salespoints in this neighborhood. He finally succinctly and emphatically clarifies my confusion over sometimes seeing the traditional "black tar heroin" but increasingly seeing the new incredibly light fine powder heroin "China White" morphing into dramatically different colors on my different visits (bright white, bright yellow, orange or brown). He dismisses the significance of powder colors "nah the china [white] is all the same. The same 'cartel' puts it all out right here and their different batches come out different colors. But the quality is always damn good." To quantify more precisely he explains, "Two people can split a 50 peso [US$2.5] bag and get real loaded." He critiques the quality of the black tar suppliers who are, "losing out in the market. They've gotta improve their quality or they'll just be a thing of the past!"

He speaks about shifting opioid availabilities here with the impassioned precision of a California luxury wine afficionado talking about the latest year's harvest and it seems to have triggered withdrawal symptoms because sweat is beading on his forehead, and he has started fidgeting. Suddenly he interrupts himself frowning and announcing, "Sorry, gotta run to go score." Noting my disappointment, he smiles, motioning for me to follow him. We trot to the edge of the super steep--at least 45°--concrete embankment incline at least 30 meter high and I suddenly find myself slipping and sliding unable to keep up with him. Klutzily terrified I almost fall head over heels cursing. This cracks him up (and me).

We are heading to the largest of the homeless encampments in the shade of a bridge carrying half a dozen lanes of speeding highway traffic over the river/sewage/rainwater runoff concrete canal infrastructure of the Tijuana River. He clambers adroitly over a wobbly ten-foot length of crushed aluminum highway guard rail that serves as a bridge over the fast-flowing sewage canal full of black, foul-smelling rushing water. Again, I pause klutzily and also repulsed. This unstable "bridge" and the gross smell/ appearance of the water obviously protects this encampment (somewhat) from surprise police raids.

Most of the 75 or so people milling around here seem relaxed. Many are sitting or lying on top their ragged bundles of possessions and scuffed up plastic bags. A few people are moving around in an almost surreal, slow-motion, drug-induced dance which doesn't seem to bother anyone. Most people are too busy nodding—often super heavily--from what is the presumably the highly potent "powder fentanyl-heroin" sold here. Some are standing still but with knees sagging slowly lower and lower until they snap back up to standing attention, only to start sagging back down again. Two tough looking men are embracing in an ecstatic slow-motion dance—smiles on their faces oblivious to everyone. Another guy is starting to irritate people for waving his arms around too fast, intimidatingly, in a helicopter motion obviously in a manic burst of methamphetamine energy.

My new friend disappears into the crowd, so I walk aimlessly and embarrassed to the back edge of the encampment along a gargantuan highway bridge pillar and find myself among a group of men and a few women half-lying, half-sitting or just squatting looking at the ground avoiding eye contact with anyone. Most appear to be obsessively hyper-focused on poking and re-poking themselves in multiple different parts of their body in search of a healthy vein. Several have blood dripping off their bodies and appear frustrated and desperate. Others are patiently smiling as they poke and then delicately wiggle the needle point around under their skin--as if feeling no pain.

To my delight, a friendly older man in a wheelchair calls out to me in perfect LA deportee English, "Yo professor! Come talk to me!" Somehow, he already seems to know what I'm interested in and immediately launches into his life story: taken to California as a baby, early gang involvement, perpetrating and suffering from violence, started using drugs in juvenile jail, incarcerated federally for a decade as an adult, deported to Tijuana, and becoming homeless on the streets of Tijuana, and having his ID card stolen by Tijuana cops, becoming effectively stateless. "I forgot all my Spanish by the time I was 20, and when I was deported (early 30s) I had to completely relearn Spanish in Tijuana. Back there [LA] they called me 'dirty Mexican' and here they call me 'gringo'". He was shot in his rear as a teenager in a drive-by shootout. Doctors inserted a metal plate into his back and down his thigh. He used to be able to walk. "Then three years ago [scowling] here in Tijuana," the police chased him from his salespoint by the side of the highway. Desperate to avoid arrest, a beating, and the loss of his precious stash he could be killed for not paying back, he sprinted into speeding traffic. Struck by a Chevy Suburban, he is paralyzed from the waist down. His body is visibly broken down, his eyes are bloodshot, and his skin is covered by mushy, small abscesses. He is obviously in pain, squirming to try to get more comfortable, but also enjoying his effusive pouring-out of his life story.

His tattoos are exceptionally well done. His gang namesake, "Eastside" wraps 360 around the entire front and back of his throat and neck. He flutters his eyelids down and urges me to photograph them. They are both delicately tattooed with the exact same

"Eastside" balloon script as his neck, but in tiny, fine script. I complement him for the quality of his tattoos, but that makes him sad, "They don't mean the same thing here. They don't mean the same thing to me no more."

The ethnographic sample reflects a population of mostly-male identified, precariously housed or unhoused individuals who inject and/or smoke heroin daily. Most participants reside in dense, low-income micro-neighborhoods across Tijuana with illicit drug and/or sex-work markets. Most are deracinated deportees from the US; their noticeable accent and tattoos reduce their linguistic, social, and cultural capital as native Mexicans[28]. Many bemoan lost contact with parents, siblings, children, and spouses in the US. Many of the key micro-neighborhoods in our fieldwork are pressed up against the border. Consequently, many of our informants carry out their lives in the literal shadow of the border wall that separates them from the lives they built and lost in the United States.

Although life is hard on the streets of Tijuana most of our informants were remarkably adept at quickly raising money by deftly navigating the informal markets and street interactions of the city. Most men generate income by 1) cleaning cars in traffic jams; 2) sweeping and running errands for local residents; 3) recycling scrap metal; 4) selling retail drugs for cartel networks; and/or 5) selling snacks and tourist trinkets "on the line [la linea]" (the hours-long line of vehicles waiting at US border checkpoints). Women and transgender individuals are less numerous in injection drug use scenes but are highly visible as desired sexual and/or emotional companions who generate funds quickly and reliably through sex work. Most report high rates of sexual coercion and rape. Male PWUD also frequently trade sex for drugs and money, but typically more clandestinely due to homophobic stigma.

Remittances from US-based family-members represent an especially large source of income for individuals lucky enough to receive them. Such individuals are more likely to secure stable housing, and purchase larger, cheaper quantities of drug supplies. With the exception of those who spend their remittance checks in a single binge, housing stability reduces their risk-taking, and shields them from the "everyday emergency" of the moment-to-moment day-and-night scramble for survival resources and physical safety which destabilize lowest-income PWUD in Mexico and most of the rest of the world[29]. Unhoused individuals often struggle for the 50-peso cost (about $2.5 USD) of a "*curita"* (retail bag of heroin). Consequently, they often *"hacer un vaquero* [pool resources]*"* multiple times per day to prevent withdrawal symptoms, avoid physical violence and humiliation and/or pursue ecstatic highs. These logics promote risky sharing practices, and are consistent with ethnographic and epidemiological evidence documented across the globe[27,30,31]. Those who are lucky enough to end the day with 100-200 pesos (~$5-$10 USD) can purchase a night's stay at one of the bargain hotels catering to sex workers and their clients, but many of our informants spend most or all nights outside.

Police violence and extortion was an ever-present strain on our informants, who we would often find with new police-inflected wounds or bemoaning the theft of recently generated funds to avoid incarceration. Although possession of small quantities of illicit drugs has been decriminalized in Mexico, it is well-documented in the literature that many police are unaware of these legal shifts[32]. In practice, 'looking homeless', not having a government-issued ID, possessing a syringe, or simply being 'known to police' triggers chronic cycles of short-term incarceration for 12 to 36 hours cycles, which may or may not include a gratuitous police beat-down, even in broad daylight.

Ethnographic Taxonomy of Opioids in Tijuana

In Tijuana, two main forms of heroin can be purchased in retail narcotics markets: 1) *goma negra,* the classic Mexican black tar heroin also available over the past decades in Western US states;[10] and 2) *china white,* powdered heroin that is typically white, but sometimes shades of brown or bright yellow/orange/brown depending on processing logistics, impurities, or possibly dyes added for brand recognition. Black tar heroin was consistently reported to have been available for 'as long as anyone can remember.' However, *china white* was described as a recent arrival to the scene, but increasingly available and potent in the past several years (~2018/~2021). It was portrayed as both continuously expanding to a wider range of locations across the city, and also increasingly present at each *connecta [*purchase point]. For example, some *conectas* were reported to have suddenly switched to *china white* and no longer offer black tar heroin.

Healthcare/outreach providers frequently link powder heroin to overdose (OD) risk. PWUD agree, but simultaneously praise its psychoactive impact:

> *"People are way more likely to OD with 'china' than with 'black'. Recently china is really becoming more of a thing, you know. When I first got here to TJ [~2017] china wasn't a big thing. Once in a while you'd see some powder stuff, but a lot of people didn't even know about it. Now most people around here are using china 'cuz it's way better than black. Stronger. Way stronger. I'm using almost entirely china these days 'cuz I like that rush, I want that rush that only china gives."*
>
> -Vanessa, F, 30, Injects Opioids and Methamphetamine

Strong preferences are emphatically expressed for each available heroin product. Older PWUD who have used black tar for decades often prefer its psychoactive effects. They describe it as "purer" or "the only real heroin." They frequently claim it is a safer option than *china white* for overdose and other health risks—especially soft-tissue infection.

> *"Drugs are for making you feel alright, getting high, and having fun, it's not worth dying over them, so I mostly only use 'goma'. I just feel like it's safer. I understand it better. China is stronger, and once in a while I'll snort some, if it's the only thing I can get, but I'd rather just stick with the goma."*
>
> -Ricardo, M, 55, Smokes and Sniffs Opioids

In contrast, younger PWUD often prefer powder heroin, prioritizing its cost effectiveness. When sales points offer both black tar and powder heroin options, *china white* is usually regarded as “more potent”. It is variably described as shorter-acting or as having a comparable duration to that of black tar heroin prior to the onset of withdrawal pangs. Both can be mixed with methamphetamine in preparation of a single injection, but power heroin is more soluble and is typically preferred for this purpose[24]. Both can be smoked or injected, but black tar is typically considered more appropriate for smoking due to its texture.

Even among PWUD who eagerly transitioned to *china white* when it became available, favoring its increased potency, many were initially weary about the health implications of its use. Concerns were especially related to an increased risk of soft tissue infection:

> *“Man, I been using china for like two 2 weeks now and pura goma [just black tar] before that. But that china is real bad, man. With china, your body eats its itself bit by bit. Carne y hueso [flesh and bone], but you don’t feel a thing. You see people with these big open wounds, carne y hueso an’ they don’t care, because that china white is just too good. That doesn’t happen with goma. That shit didn’t use to happen.”*
>
> -Enrique, M, 40, Injects Opioids and Methamphetamine

Abscesses and soft tissue infections were highly prevalent among PWUD in Tijuana even before powder heroin became commonplace. At harm reduction clinics, physicians would often treat an assortment of remarkably large and painful ulcers, abscesses, and other wounds, which were frequently accompanied by limb edema, and signs of systemic infections. With the advent of powder heroin, many harm reduction physicians worried that this already widespread problem was worsening rapidly.

Confirmation and Geographic Variation of Fentanyl Positivity

The “common-sense” understandings that PWUD convey about the differences between heroin varieties and potencies are strongly suggestive of the presence of fentanyl in powder heroin. Not only do they praise its psychoactive qualities and relatively recent arrival, but many (although not all) criticize its decreased duration of effect. Interestingly, some claim that its withdrawal symptoms are not as intense as those of black tar heroin. Confirmation with quantitative testing data offers a helpful point of confirmation and triangulation to better understand the shifts in the local street-level retail sales market. It also provides a window of insight into the global illicit drug market, as shifting wholesale supplies are smuggled through Tijuana on their way to the US and Canada.

Among n=652 syringes collected at 4 harm reduction clinics during an 8-month period, fentanyl positivity was 52.8% (95%CI: 48.9-56.6%). Clearly delineated micro-geographic variation was observed at salespoints across the city (Fig 4.1). Site 1 is a fixed location while sites 2-4 are mobile clinic/outreach locations. Site 1 is the closest to the concentrated drug and sex tourism markets of *Zona Norte* and consequently served the highest number of female and trans identified sex workers. Site 3 had the highest fentanyl positivity of 76.5% (68.2%-84.7%). This represented the only site where only powder heroin, and not black tar, was available in the locally proximate sales points. Site 4 had the lowest fentanyl positivity of 2.7% (0.0%-5.7%), and only black tar heroin was sold nearby. Testing sites 1 and 2 are located near the city center, proximate to a large concentration of *connectas* (drug sales points) and drug consumption spaces. Both black tar and powder heroin are sold in these areas—although specific sales points may sell only one or the other—and the market is highly mixed. These sites had intermediate fentanyl positivity prevalence of 56.7% (51.3%-62.1%) and 69.6% (61.1%-78.2%) at Site 1 and Site 2, respectively. This geographic variation indicates a highly heterogenous drug market and confirm that fentanyl positivity is strongly ecologically linked to the sale of powder heroin.

At each of the sites, an increase in fentanyl positivity was noted over time (Fig 4.2). In linear regression, controlling for the site of collection, fentanyl positivity increased by 21.7% (95% confidence interval: 10.1%-42.3%) during 8 months of testing.

The geographic variability of fentanyl positivity observed in the mapping exercise highlights the heterogeneity of the drug supply in Tijuana. The city is a key international passthrough point for large volumes of illicit drugs heading North. Several rival international drug trafficking organizations notoriously vie for monopoly in Tijuana, competing—often violently—for local sales points, influence over local and regional politicians and militarized police units, and border crossing routes. Fentanyl can therefore be added to the drug supply to differential degrees by distinct groups, and at different points along the heroin production/distribution chains. The result is high uncertainty of potency in the retail drug landscape. In ethnographic conversations, PWUD involved in retail sales frequently reported that fentanyl was added to the heroin supply at the level of the local neighborhood *conecta* (sales point):

> *JF: "Why do you think so many people overdosed this week?"*
>
> *"That's fucking obvious dawg! Because of the fentanyl. They cook that shit up every couple a' days in a pot like this [indicating with both hands a recipient approximately 12 inches in diameter]. That's only gonna' be enough for like maybe 3 days, 4 tops. So just depending on the motherfucker that cooked that shit up, it could be super bomb or total bunk. That's why you got so many fools dying this week. I'm tellin' you, the shit is good dawg! (laughing)"*
>
> -Guillermo, 30, M, Injects Opioids and Methamphetamine

This contrasts with—although does not necessarily contradict—media reports of fentanyl being added farther up wholesale supply chains, in chemical precursors processing camps in Mexico or those of foreign countries[33–35]. This hyper-local nature of the fentanyl-heroin supply also provides a window of insight into the unique overdose risk that fentanyl has added for people who use illicit drugs, as upstream supplier, and specific concentration of fentanyl used can vary day-to-day at the same site and between very proximate sales point locations.

Mixing with Methamphetamine

Co-occurring with fentanyl's introduction to the drug supply in Tijuana, participants described an increase in methamphetamine polysubstance use, which is also clearly visible ethnographically in the repetitive and energetic behaviors participants would often exhibit after a shot with a higher proportion of *cristal* [methamphetamine] (e.g. manically picking up tiny objects from the ground or scratching at superficial skin wounds).

People using powder heroin, in particular, were observed to frequently prepare injections containing both heroin and methamphetamine, colloquially known as '*doing a speedy'.* PWUD who consume *china white* frequently added a small amount of methamphetamine to each shot of heroin or made subsequent injections of methamphetamine after injecting opioids. The ratios and frequency of combined heroin/fentanyl injections versus solo methamphetamine follow-up injections vary, but JF often observed 5-to-10 parts heroin/fentanyl for 1 part *cristal* averaged out over a day*.* A typical consumer might therefore consume 4, 50-peso *curitas* of powder heroin over a 24-hour period, while a *globo* (balloon of methamphetamine) would last for several days, being consumed one small pinch at a time. Reported reasons for polysubstance use included improved overall euphoria, better "rush," increased delay or distraction from painful withdrawal symptoms, and as a strategy to prevent opioid overdose.

> *'Oh! About that [increase in overdose], it's 'cuz the china white around here is fucking crazy….doin' a full 50 [50 peso bag] is enough to kill you. But, I got a secret, you just gotta' mix in a little bit of cristal, and you'll never die. Otherwise, lots of people have been dying around here, but with just a little bit of cristal your heart will keep beating, no matter what.'*
>
> -Javier, M, 45, Injects Opioids and Methamphetamine

In contrast, a distinct subgroup of PWUD in Tijuana do not prefer to use methamphetamine. These were typically long-time consumers of black tar heroin, who were more likely to avoid *cristal* and describe it as ruining the blissful relaxation of the opioid high:

> *Look I've been using heroin for decades. Me and my wife, we go way back. I prefer black [tar heroin], but I'll do powder if it's all I can get. But cristal? Never. I hate the way it makes me feel. I can't sleep! The point of heroin is just to chill out and forget about everything.*
>
> *-Ed, M, 50, Injects and Smokes Opioids*

Methamphetamine was also frequently smoked by a wide range of individuals in Tijuana who did not consume heroin but frequented the concentrated drug use micro-neighborhoods where this ethnography was focused. It was therefore regularly consumed in social groups of mixed company of those who did and did not consume opioids. Some individuals in the scene exclusively consumed methamphetamine for several years before eventually starting to consume (initially smoked, and often subsequently injected) opioids as a way to "come down" from several-day-long methamphetamine sessions and overcome stimulant-induced insomnia.

Discussion

We characterize the arrival of illicitly manufactured fentanyls into the drug supply of Tijuana, Mexico, linked strongly to the proliferation and consumption of *china white* (powder heroin). In contrast to interviews conducted during 2017-2018 when very few PWUD in Tijuana reported consuming or having knowledge of fentanyl[16], during our study we observed a shift to nearly all participants having numerous experiences with fentanyl and clearly defined preferences regarding its use. We observe that fentanyl positivity is very heterogenous across the city, reflecting a criminalized market that is highly segmented because of competing cartels selling visibly distinct products in violent competition with one another. Further, we note a significant increase in fentanyl positivity over the duration of the study, consistent with the widespread notion among PWUD that fentanyl is gradually become more commonplace across the city.

Fentanyl prevalence has been associated with multiple increased health risks, from fatal and nonfatal overdose, to infectious disease transmission[5,10]. Our findings indicate that similar shifts are occurring in the Mexican drug supply, including an uptick of fentanyl and polysubstance methamphetamine use[5,36–38]. Yet a lack of reliable government statistics made elucidating the scope of the problem on Mexico's northern border more difficult. Substantial investments are needed in timely overdose and drug market surveillance, as the magnitude of the Mexican overdose crisis is currently unknown. During the COVID-19 pandemic in particular, fentanyl-related overdose deaths in the United States spiked to unprecedented levels[8,36,39]. Although similar increases have likely occurred in Mexico, without more robust toxicology, autopsy, and informatics systems, these deaths will continue to be attributed to other causes.

A slew of structural barriers exist to reducing deleterious health outcomes associated with fentanyl among PWUD in Tijuana. Naloxone is highly sought by PWUD in Tijuana, yet it remains in short supply, difficult and expensive to access. Each injectable 1ml intramuscular dose costs approximately $25 USD on the Mexican market (equivalent to approximately 4 days' wages at the Mexican minimum wage). Moving forward, more user-friendly nasal spray forms should be made widely available and coupled with street-based distribution and education campaigns. Further, access to medications for opioid use disorder must be greatly expanded. Buprenorphine is virtually non-existent in practice for PWUD, and methadone is costly and logistically complex to obtain because of regulations and stigma[40]. Recent federal austerity measures have also eliminated funding for harm reduction in Mexico, limiting syringe access, frontline medical care, and linkage to services.

Overdose mortality is the worst-case outcome of fentanyl proliferation, but other health risks are more frequent and require increased documentation for developing public health interventions. The high prevalence of soft tissue infection and necrosis reported to be associated with powder heroin by PWUD, healthcare providers, and frontline harm reduction activists requires urgent attention. Soft tissue infection risk depends on multiple factors, but potential mechanisms underpinning this proposed association could include more frequent injection, given the shorter half-life of fentanyl[4]. Alternatively or complementarily, it may simply be because powder heroin does not need the flash boiling required by black tar, removing a key step that can eliminate harmful bacteria[41]. For similar reasons, powder heroin and fentanyl consumption has been suggested as an emerging risk factor for HIV and hepatitis C transmission[4,10].

Our findings indicate that overdose mortality in Tijuana is most likely being increasingly driven by polysubstance combinations of synthetic substances, including fentanyls and methamphetamine. As novel polysubstance formulations of synthetic drugs are increasingly implicated in overdose mortality in numerous countries globally[5,42,43], investments in toxicological testing and autopsy services are urgently needed to precisely track overdose deaths in Mexico. Additionally, street-based drug checking services at harm reduction settings represents a promising avenue for tracking rapid shifts in the drug supply[44]. We posit that these methods may be especially powerful when combined with rich qualitative work that can help elucidate gaps in quantitative data, and when important shifts may be occurring[45].

Limitations

The fentanyl testing strips employed here provide a binary presence/absence indication. They are known to be very sensitive and show positivity even at very small concentrations of fentanyl analogues. This was a desired property given our study design, as we tested residues on injection equipment, where quantities available for testing may be minimal. Nevertheless, information about the quantity of fentanyl contained in drug samples is not available, which limits interpretation of the findings. Further, false positives using these strips have been reported in the presence of very high concentrations of stimulants and certain contaminants[46]. Those circumstances are unlikely to affect this study given that we were testing syringes, not drug samples directly, nevertheless, the possibility for false positives should be considered. Further, it is important to consider the information offered in this analytical approach, as the unit of analysis is the syringe, not the individual injection. Each positive or negative test is representative of the internal environment of the syringe at the time of collection. This is likely most representative of the last drug combination prepared for use, however it could indicate fentanyl positivity in a previous drug preparation event, especially if the syringe was not rinsed between uses. In sum we would argue that our results indicate a reasonable proxy of the level of exposure of people in the population to fentanyl analogues on a given day but may overestimate the level of fentanyl presence in any given drug sample.

Our study is also limited by the relative paucity of women in the ethnographic scene. We have included some limited data from female participants, but it was much more difficult to follow them ethnographically by a sexist and structurally violent environment towards women and trans individuals.

Conclusions

Fentanyl has become commonplace in Tijuana's heroin supply and appears to be increasing in prevalence. Fentanyl predominates in various points throughout city and is strongly linked to white powder heroin. Heterogeneity was observed between distinct parts of city, and overall fentanyl prevalence increased by about 20% during the 8-month study period.

Structural factors related to criminalization, regulation, austerity budgets and discretionary practices of frontline criminal justice personnel appears to be limiting effective systemic responses to a shifting risk environment due to fentanyl. Further surveillance is needed to quantify the magnitude of growing overdose and other health risks. Timely documentation is of binational interest given the linked nature of the US/Mexico drug supply-chains and their health implications. Investments in drug checking and toxicological testing are needed to better track shifting patterns of mortality and the contents of the illicit drug supply. Further, harm reduction resources are urgently needed to address the growing health risks of fentanyl and polysubstance methamphetamine injection drug use. In particular, large-scale efforts are needed to render naloxone cheap and widely available to PWUD[47]. The provision of fentanyl-testing services, and overdose prevention spaces, are additional important strategies[48]. Finally, more research is needed regarding the link between fentanyl contamination and novel health risks, such as soft tissue infection, hepatitis C, and HIV infection and polysubstance methamphetamine use.

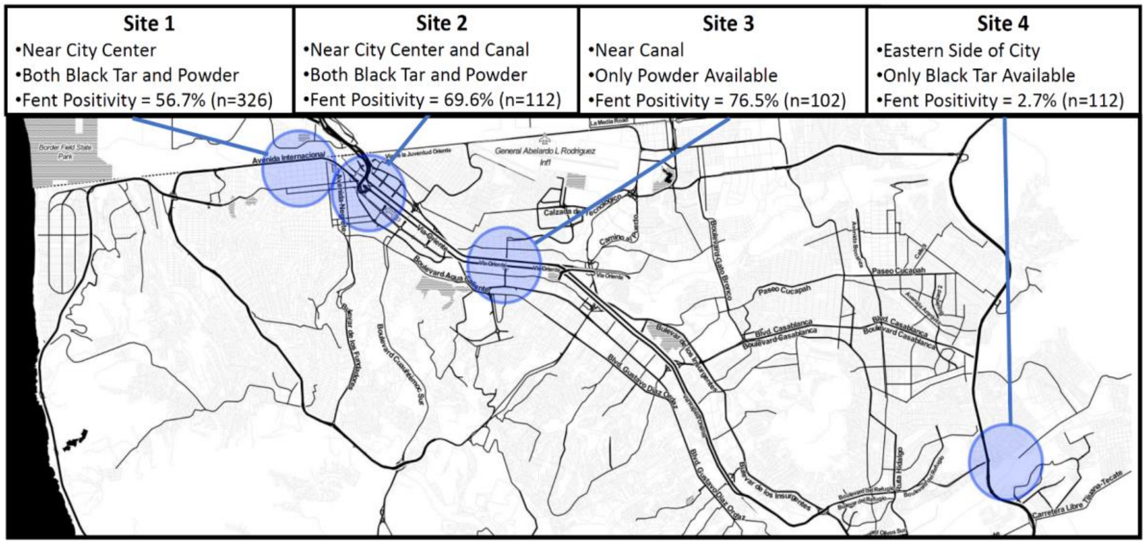

Fig 4.1. Fentanyl positivity rates at four mobile clinic locations throughout the city of Tijuana, Mexico.

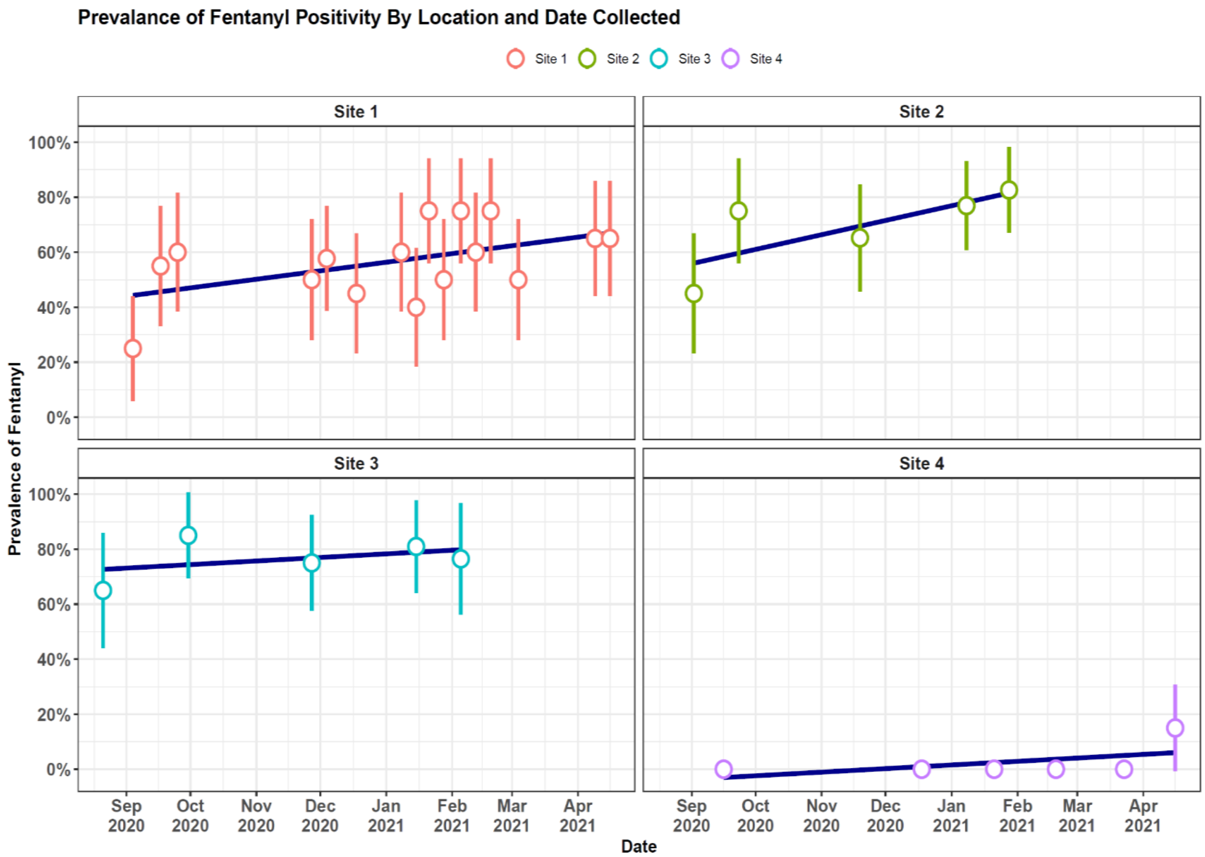

Fig 4.2. Fentanyl positivity rates at four mobile clinic locations throughout the city, by location and date. Points shown with 95% confidence intervals. A bivariate line of best fit is shown for each location.

Chapter 4 References

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Chapter 5: Structural Shifts or Business as Usual? An Ethnographic-Epidemiological Assessment of COVID-19–Related Changes to the Risk Environment for People Who Use Drugs in Tijuana, Mexico

A modified version of this chapter appeared as a research article in the American Journal of Public Health:

Friedman J, Calderón-Villarreal A, Adame RC, et al. An Ethnographic Assessment of COVID-19–Related Changes to the Risk Environment for People Who Use Drugs in Tijuana, Mexico. Am J Public Health. 2022;112(S2):S199-S205. doi:10.2105/AJPH.2022.306796

In this deep mixed methods case study we characterize the social and economic implications of the COVID-19 pandemic among people who use drugs in Tijuana, Mexico. Tracking the indirect effects of the pandemic represents a difficult, albeit important goal for public health surveillance. This task is made more difficult when measuring trends among largely unhoused and highly vulnerable individuals. However, we were able to provide insights using ethnographic data mixed with longitudinal quantitative records from a cohort study among people who inject drugs in Tijuana. In this case study, ethnographic data were used to design a set of quantitative questions and hypotheses that were tested using concurrently collected cohort data, highlighting a model for rapid mixed-methods surveillance during an ongoing health crisis.

Introduction

The COVID-19 pandemic disrupted the risk environment[1] of people who use drugs (PWUD). Early reports from numerous locations globally documented positive shifts in drug policy, including better access to medications for opioid use disorder (MOUD) and housing, and reductions in policing and incarceration for drug-related infractions[2–4]. For example the United States saw increased access to methadone take-homes, the removal of restrictions on buprenorphine prescription, and loosening federal restrictions on funding for harm reduction[5–7]. In some locations police intentionally decreased contact with PWUD[2].

Conversely, drug-related harms also reached newfound heights. Overdose deaths in the United States skyrocketed in 2020, with mortality during peak lockdown months elevated by 60% compared to one year prior[8–10]. Overdose deaths due to illicitly manufactured fentanyls, and the polysubstance use of opioids and psychostimulants jumped sharply during COVID-19[10,11]. Furthermore, many potential benefits, such as reductions in jail and prison sentences for drug possession, were inconsistently applied[2]. In many locations jail cycling continued even as longer-term incarceration rates declined, which contributed to COVID-19 transmission in overpoliced communities[12].

Many aspects of the pandemic's effects on PWUD remain poorly characterized in existing literature. For example, many experts predicted that disruptions to drug supply chains would lead to widespread shortages of illicit drugs.[13,14] However the effects of major world events on drug supply chains are notoriously difficult to predict[15].

Tijuana, a large city on Mexico's northern border, was hard-hit by COVID-19, yet accurate and timely statistics describing pandemic-related impacts were not systematically collected[16,17]. Data are especially scarce for stigmatized outcomes such as substance use disorders, overdose mortality, or HIV infection rates.[18]. Therefore, although important shifts in the risk environment for PWUD likely occurred in Tijuana, it is not possible to identify them through traditional administrative data sources.

In response, we employed a mixed methods approach to characterize COVID-related shifts in the risk environment of PWUD in Tijuana. We leveraged techniques effective for surveillance and description in data sparse environments, including 1) intensive participant observation ethnography, and 2) rapidly-deployed survey data among a longitudinal cohort of PWUD.

Methods

Ethnographic Methods

The ethnographic data used in this article were drawn from a wider study of changing risk environments for PWUD[19]. Here we use 30+ months of ethnographic fieldwork, spanning 2019-2021, conducted in Tijuana, Mexico, by JF and PB. Fieldwork was initially based at harm reduction sites and naturally expanded to include a range of other locations frequented by participants, including residences, encampments, and street spaces. The ethnographers accompanied PWUD in their daily lives allowing for the real-time documentation of practices that can be otherwise difficult to measure reliably, due to desirability or recall bias, especially injection practices and syringe sharing dynamics, income-generation tactics, and interactions with law enforcement and healthcare providers. By building long-term and iterative relationships with participants we were able to access 'common-sense' knowledge held by PWUD about survival strategies, drug consumption, and other dynamics. With IRB approvals, we interviewed study participants in a conversational format, in English, Spanish, or "Spanglish" depending on the context. We frequently used audio and video recording with participant permission. Specific interviews were also sought with key informants such as physicians, harm reductionists, outreach workers, emergency medical technicians, law enforcement officers, substance use treatment center staff, etc. regarding specific aspects of the risk environment for PWUD.

Quantitative Methods

Quantitative data were drawn from a sample of n=237 surveys conducted with PWUD in Tijuana, mainly July-September 2020 (although a small number of respondents were surveyed in later months, leading to longer recall times). Surveys were administered as a supplemental follow-up to a wider cohort study of people who inject drugs in Tijuana, *El Cuete IV*[20] Based on data availability, early ethnographic findings, and prior literature, six deleterious, pandemic-related outcomes were included in the analysis. To assess for differential vulnerability among specific groups of PWUD, we undertook an exploratory data analysis. In this aim, six vulnerability factor (potential predictor) variables were chosen, consisting of factors known to be related to vulnerability of PWUD in Tijuana. These factors were used as reported on pre-COVID-19 baseline interviews, in an effort to disentangle any subsequent COVID-19-related effects. Each outcome-vulnerability factor pair was assessed by calculating a series of bivariate risk ratios, with boot-strapped 95% confidence intervals. Ethics approval was received from the institutional review boards at the University of California, San Diego, University of California, Los Angeles, and Xochicalco University in Tijuana, Mexico.

Results

Police Violence and Harassment of PWUD in Tijuana

The kind of encounter with police shown in photo-ethnographic vignette 5.1 is a near-daily occurrence for Johnny, and a broad swath of marginalized people in Tijuana's impoverished *Zona Norte* neighborhood. Walking distance from the US border crossing, *Zona Norte* concentrates a dizzying array of retail drug sales points, brothels and independent sex-workers, U.S. tourists, shelters for migrant families and other marginally-housed individuals, government offices, religious and secular non-governmental organizations, formal businesses, small scale gambling operations, middle-class Mexican families (many who have lived there for decades), and informal street marketplaces in a relatively small, four by six block area. It is also home to a major police base. Police- and military-branded pickup trucks, paddy wagons, vans, motorcycles, and armored vehicles circulate constantly, directly patrolling the neighborhood, and passing by on their way to and from the base. This gives the neighborhood a remarkably surveilled feel, and at times, standing on a street corner, it feels that a police vehicle passes every minute.

For PWUD in Tijuana, interactions with the police are a daily source of anxiety, and uncertainty. Especially for individuals like Johnny, who often are unable to come up with 100 pesos (USD 5) for a cheap hotel, and consequently sleep on the street, confrontations with law enforcement are unavoidable, day and night. At a moment's notice he would routinely be surrounded by heavily-armored police and soldiers, held at gunpoint, searched, often beaten and mocked, and ultimately tossed into the back of a paddy wagon. There he would wait for hours, as the van is slowly crammed full with up to 30 human beings over the course of several hours[21].

It is common sense among PWUD that the presence of people perceived by police to be of higher socio-economic status (such as NGO staff, politicians, researchers, or well-meaning 'gringo' volunteers) reduces the immediate risk of police violence. In the above vignette, Johnny was surprised that the police did not "confiscate for re-sale the expensive-looking, albeit broken, plasma TV that he had found in the trash and was hoping would fund his next dose of heroin and methamphetamine. They also did not take him to jail, beat him, or even verbally abuse him to any significant degree. All in all, this was a 'best case' encounter with police, likely related to their eventual reading of my positionality as a U.S.-based professional. In front of a clinic doctor, for example, police may carefully search an unhoused person and allow them to go if no drugs or syringes are found, whereas in normal circumstances it is commonplace to see police unceremoniously throw all of the unhoused people on a given block into the back of police vans without searching them, leaving behind their possessions strewn on the street[22].

Police violence also contributes to injury and rapidly declining physical and mental health among PWUD. A constant string of police-inflicted wounds—such as baton-shaped bruises, broken fingers, fractured joints and appendages, and bloodied faces—stream into harm reduction clinics in Zona Norte each day. Many female PWUD report frequent rape and sexual assault by police officers, as well as pressure to perform sexual acts in lieu of incarceration[23,24].

The detainment procedures of the frequent cycles of short-term incarceration of PWUD in Tijuana are orchestrated to maximize opportunities for PWUD to 'buy their way out' at distinct prices. They include: 1) driving arrestees around in vans for hours, 2) detouring to short-term holding cells in the *fuerzas especiales* police base in *Zona Norte* to see a judge for several more hours delay prior to adjudication 3) serving a standard "drug nuisance" sentence of 12-to-36 hours. In each stage most police and corrections officers eagerly accept progressively smaller bribes to release them from the rest of the artificially prolonged cycle. Informants also report 'early-release' for volunteering to clean jail facilities, or wash police vehicles. Driving past the Zona Norte police we often saw up to a dozen police cruisers being washed by unhoused individuals, to "earn their freedom".

In the worst case, the full cycle takes up to 48 hours to complete (the Mexican legal infrastructure prevents short-term incarceration of longer than 36 hours without a more elaborate trial). Yet this time is sufficient for individuals that are physically dependent on heroin to being to experience excruciating withdrawal symptoms, often referred to colloquially as *'malilla'*. Once released, with no money, and many miles from where they were picked up, the hustle begins again to find 50 pesos (~2.5 USD), score heroin at the sales point immediately outside of the jail in order to 'get well', and travel by foot or public transport to *Zona Norte* to begin the cycle over again.

This tedious dance of evasion, capture, extortion, and violence exacts a punishing toll on PWUD, disrupting their efforts to achieve day-to-day stability, save money, pay rent, or find employment. For many, it is ever-present. In a recent study of people experiencing homelessness in Tijuana, 93.5% reported having ever been detained by police, and 70% were detained at least once per week[25]. For Johnny it would not be uncommon to repeat the entire ordeal 2 or 3 times in a week. Notably, recent incarceration has also been associated with SARS-CoV-2 infection[17].

This cycle of police harassment, violence, detention, and short-term incarceration disproportionately affects people who fit specific profiles, especially those who 'look homeless' or 'like a drug addict'. At times simply being in a certain neighborhood without a sufficiently socially prestigious reason is enough to trigger spontaneous incarceration. Consequently, a broad swath of working-class people in Tijuana who are not PWUD report having spent time in *la 20* at least once.

Johnny fit a profile that made him an especially frequent target for this cycle, as he was tall, confident, and gregarious, rendering him more salient, and covered in tattoos, having grown up rough in southern California. He was deported to Tijuana for his involvement with drugs, where he quickly became homeless.

A Temporary Cessation of Routinized Police Violence

During April-May 2020—the first peak COVID-19 mortality window in Tijuana—police remarkably ceased detaining PWUD almost entirely. The front door of the *Zona Norte* police base was boarded up, and the steady stream of police vehicles slowed to a trickle. Most PWUD reported that it had "been months" since their last incarceration. As income-generation opportunities dramatically diminished during lockdowns, Johnny quipped "the cops know we don't have 2 pesos left to steal, so they'd rather stay home and watch TV!" Others surmised that police were afraid of dying from COVID-19. Several high-profile COVID-19 deaths among police in the state of Baja California generated press outcry over lack of personal protective equipment for frontline workers. Whatever the causes, for a short period, abusive police interactions miraculously ceased for PWUD.

By June-July 2020, police returned to patrolling with renewed aggression. Reports of beatings, solicitation of bribes, incarceration, and informal, forced abstinence-based addiction treatment quickly followed. Local government announced new plans to raze homeless encampments. 57.4% of sex-worker PWUD respondents surveyed July-September 2020 felt that police violence worsened during the pandemic (Fig 5.1). This quantitative finding was consistent with the sentiments expressed by PWUD respondents in ethnographic interviews post-June 2020, follow police redeployment.

Notably, the lowest-income sex-worker respondents—earning <$5 USD per day—were disproportionately likely to report that police violence worsened, with a risk ratio of 2.1 (95%CI: 1.2-6.2) (Fig 5.1).

Nevertheless, April-May 2020 was the first time Johnny could ever remember going a full month without being jailed or beaten by police, a remarkable shift that eased his struggle-to-survive.

Access to Healthcare for PWUD

Low-income PWUD struggled to access basic, life-saving treatment, even before the COVID-19 pandemic, despite ostensibly universal healthcare for the poor in Mexico. Johnny's access to hospital care was structurally limited by intersecting factors of stigma against PWUD, lack of opioids (and other basic medications) in the hospital system, distrust of doctors, and extremely underfunded public hospitals. PWUD are routinely turned away from hospitals, even with life-threatening conditions, by untrained security guards, or overworked interns who are struggling to treat a huge volume of critical patients. On numerous occasions, JF or other volunteer health workers managed to insist that PWUD with grievous injuries be allowed past the front door. Yet, even then, numerous factors still impede treatment. *Tijuana General* often relies on having family members stand-by 24/7 and purchase medications in nearby private pharmacies. Socially-isolated, deported, broke, and covered in stigmatizing tattoos and injection scars Johnny simply did not fit the profile of a 'deserving patient'. Further, even if admitted, Johnny would never receive sufficient opioid medications to prevent withdrawal symptoms. In practice, PWUD only received effective healthcare in hospitals in Tijuana when 1) family members in the US paid for expensive care in a private facility for their deported relatives or 2) local harm reduction-activist doctors spent an enormous amount of time, social capital, and personal resources calling in favors to get a patient admitted, hand-deliver methadone daily, and advocate for a patient at each step of their treatment. Consequently, many PWUD with treatable conditions unnecessarily die on the streets. In response to mistreatment and rejection, most PWUD distrust the hospital system, and believe that *'Los medicos matan a los tecatos' (*'doctors kill junkies').

Healthcare for PWUD during COVID-19

During the COVID-19 pandemic, the *Tijuana General* hospital became designated as a COVID-19 center. Consequently, patients without demonstrable COVID-19 infection had to travel to neighboring cities for medical care. This further exacerbated access disparities for low-income people in Tijuana. It was in this context that Johnny's health—long precarious—suddenly worsened.

Hospital care was already difficult to access for many, and it became virtually inaccessible during the pandemic for a wide swath of people from Tijuana dying of non-COVID-19-related conditions. Johnny died during the pandemic, yet not from COVID-19. He died on the street, from treatable complications of a curable virus, unable to access hospital care.

Although the pandemic further stressed an already saturated health care system, it also offered glimpses of positive structural shifts in the medical treatment of PWUD. Remarkably, a government-funded, dedicated shelter and medical treatment facility was opened for PWUD and vulnerable individuals during the onset pandemic, in recognition of the population's particular medical vulnerability. For the first time, MOUD was authorized by the governmental healthcare system to be a necessary aspect of medical care for PWUD, albeit only those who contracted SARS-CoV-2. In practice, however methadone was never actually provided by the government due to logistical barriers, and it was instead funded and supplied by an NGO. Yet the simple fact that it was authorized and provided in an inpatient government medical facility represented a paradigm shift. This shelter was integrated with harm reduction services in Tijuana, in a public-private partnership representing a notable investment of public health sector resources in serving PWUD.

COVID-19 symptoms were a prerequisite to receive this governmental support, which limited the benefits to a specific subset of PWUD. Nevertheless, harm reduction-activists were thrilled by the remarkable progress of specific unhoused people that received housing and medical care. Long-festering abscesses healed, gaunt patients gained weight, outlooks improved, and newfound stability was achieved.

Increased Difficulty of Basic Survival

As lockdowns were imposed over Tijuana, income generation sources disappeared for PWUD reliant on face-to-face social interactions. Odd jobs dried up with businesses closed. Panhandling income plummeted in the absence of passersby on the street. With the border closed to Mexican nationals, many US citizens avoiding crossing (although the Mexican government never restricted their travel). Thus 'working the line' of cars trapped in traffic on the US border became less lucrative. One PWUD informant reported that *"People don't even want to lower the car window now to give us money. If I'm lucky they'll crack the window a tiny bit and push the money out."* Border closures and fear of travel also limited drug and sex tourism from the United States, a major source of funds for PWUD in Tijuana.

These ethnographic observations were mirrored among survey respondents. Insecurity in food, income and housing increased for 73.0%, 69.5%, and 29.8% of PWUD, respectively (Fig 5.1). The impact was greater for those with specific vulnerability factors such as participating in sex work or having been deported. Practicing sex work has also been associated with SARS-COV-2 infection[17]. People whose primary occupation was sex work were much more likely to report increases in housing, income, and food insecurity, with risk ratios (RR) of 1.7 (95% confidence interval: 1.1-2.5), 1.3 (1.1-1.5) and 1.3 (1.1-1.5) respectively. They were also twice as likely to report that the pandemic had an overall high impact on their life (RR: 2.0 (1.2-3.1).

Drugs, on the other hand, were not generatlly reported to be more difficult to access in ethnographic interviews, nor was psychoactive potency majorly affected. Yet the difficultly of daily struggle to fund the purchase of drugs increased, at least initially during lockdowns, making the process of 'staying well' and finding food and shelter harder than before.

Discussion

The COVID-19 pandemic arrived to an already fraught risk environment[1] for PWUD in Tijuana, Mexico. Routinized police violence and corruption, cyclic short-term incarceration, very poor access to basic housing, healthcare, water, sanitation and hygiene services, lack of governmental support for harm reduction or substance use treatment, fentanyl contamination of the drug supply, and high levels of violence associated with the narcotic economy have driven high rates of infectious and chronic disease, overdose, and premature mortality among PWUD[20,26–28]. In this context, we draw on ethnographic fieldwork triangulated with rapidly deployed survey data, to describe how the pandemic offered us glimpses of previously unthinkable structural shifts undertaken by government and civil society. Nevertheless, many of these measures quickly fell away, and basic survival generally became harder for many PWUD.

This co-existence of positive changes in policy alongside acute exacerbations of harms for people who inject drugs, has been noted in studies of pandemic-related shifts to drug policy[29]. Aronowitz et al. articulate this potential for the pandemic to offer positive change through the lens of *punctuated equilibrium theory*[29]. This theory described how rapid changes in policy can occur after extended periods of stagnation, prompted by a crisis such as a pandemic. In their analysis of Philadelphia, in the United States, they highlight a number of positive shifts, especially improvement in access to MOUD, general medical care, and harm reduction services. However, they also note that basic survival grew more difficult for PWUD in many respects. Alongside similar results from a host of cities, our findings from Tijuana reinforce the notion that times of crisis offer both the potential for profound structural change on issues of drug policy, as well as acute exacerbations of harms for PWUD that require urgent management. In Tijuana these dynamics were seen during the COVID-19 pandemic especially in shifts relating to policing, housing, and access to healthcare.

Several studies have noted reductions in police contact with PWUD during the COVID-19 pandemic, yet many have reported that reduction policies were applied inconsistently and/or briefly[4,12,30,31]. The pandemic has been highlighted as a moment of opportunity for reassessing the scope and goals of policing practices[32]. In cities across the US, police virtually ended drug-related arrests during the pandemic[29–31]. Similarly, in Tijuana the COVID-19 pandemic provided rare insight into what the world would look like without routine policing of PWUD. Notably, it occurred just as the abolition movement was surging in popularity and public recognition, calling for radical restructuring of spending on policing and carceral systems[33]. These discussions may be particularly relevant for a context such as Tijuana, where police violence and extortion is a highly disruptive force for PWUD, despite possession of all drugs being decriminalized (albeit within certain limitations) over a decade before the pandemic arrived[34]. Indeed in Mexico, a progressive regulatory framework of decriminalization exists at the federal level, yet is largely irrelevant to the lives of PWUD, as most police and PWUD are unaware of the law or disregard it[34]. Yet for two months during 2020, Tijuana saw life without routine and proactive policing of street scenes. No massive destabilizations resulted, and life continued on in a largely similar fashion for PWUD, yet with less police- and incarceration-related anxiety. The COVID-19 pandemic has been called an opportunity for reform by activist groups of PWUD[35], and indeed, in Tijuana it highlighted how cycles of abusive policing are unnecessary for maintaining public safety. COVID-19 therefore put on display a de facto police abolition scenario in Tijuana and allowed the city to observe life without a regular police presence. Nevertheless, these gains were short-lived in Tijuana, as they have been elsewhere.

Access to healthcare—both general and OUD-specific—has also been a key axis of change for PWUD during the COVID-19 pandemic. In high-income settings, expanded access to MOUD via telehealth appointments and increased take-home doses has been widely lauded as a positive shift for PWUD[36–39]. Many clinicians and researchers have argued that these changes should remain in place after the COVID-19 pandemic passes[2]. Nevertheless, many studies have noted that other aspects of routine healthcare were disrupted during the pandemic, for the general population, and for PWUD in particular[16,40,41]. In Tijuana, MOUD access is generally limited[17,26]. Some positive shifts were seen in increases in MOUD in clinical settings during the pandemic, but these shifts were very limited in scope and impact. Further, in the context of very poor access to healthcare in Tijuana for PWUD at baseline, pandemic-related disruptions to care were especially acute. For many PWUD, such as Johnny, the pandemic proved fatal not due to direct COVID-19 mortality, but rather because of lack of access to treatment for hepatitis C, HIV, and other treatable conditions. COVID-19 highlighted general health system dysfunction and lack of access to basic care for many low-income *Tijuanenses*, and especially PWUD. Despite the promise of universal healthcare for the poor in Mexico[42], in practice, the reality is much starker for low-income people in Tijuana. For PWUD these access gaps are further compounded by profound stigma, and a near universal lack of opioid replacement therapy to facilitate medical stays.

The COVID-19 pandemic also demonstrated the ability of local governments to effectively house PWUD experiencing homelessness given sufficient mobilization of resources and political will. In many cities, short-term improvements in housing have been reported[43,44]. Similarly, the pandemic led to a small example of a 'housing first' model to supporting unhoused PWUD in Tijuana. A small but notable number of PWUD received governmentally funded shelter with integrated medical services, including MOUD (ultimately provided by the civil sector). Promising improvements in physical and mental health were noted for vulnerable individuals. Although the shelter was quickly closed before the end of the pandemic, it offers insight into how larger-scale interventions could be developed in Tijuana to offer greater stability to PWUD. Nevertheless, a considerable fraction of PWUD respondents reported that housing instability actually worsened during the pandemic, reflecting the limited scope of interventions and increases in economic scarcity.

Although early reports indicate evidence of disruptions to drug supply chains in other contexts, such as Canada, Norway, and on crypto markets[45–47] this was not reported by PWUD in Tijuana. This may be related to Tijuana's position as a major hub for storage and transport of drugs heading north from South America. Border closures likely disrupted the transport of drugs into the United States and Canada but would not disrupt the supply in Tijuana.

This study is limited by several factors. The survey data was drawn from a convenience sample, as a subset of a larger cohort study, and may not perfectly represent the larger population of PWUD in Tijuana. Given that this survey was administered as a follow-up to a larger cohort study, there may be some survivorship bias at play, where the sample is more resilient than the wider population of PWUD. The reported level of outcomes, and the associations with vulnerability factors should be considered exploratory and hypothesis generating. Ethnographic data provides a rich source of data, but also represents a limited sample of the larger PWUD population in Tijuana.

Conclusions

In sum, we trace how the pandemic provided remarkable insight into specific structural interventions that could improve the risk environment for PWUD in Tijuana, Mexico. These include ending routine police interactions with PWUD, and government-provided shelter, medical care, and opioid replacement therapy. Nevertheless, without concerted efforts to institutionalize these measures, all signs indicate that high rates of preventable morbidity and mortality will continue for this population.

The specifics of many of the trends described here are unique to Tijuana, Mexico, and affect the large population of PWUD residing there. Nevertheless, many of the themes and findings presented here generalize to a wide swath of PWUD. For example, as we describe above, literature from other locations describe short-term shifts in policing, increasing availability of MOUD and housing services, coexisting with overall increasing difficult of basic survival and barriers to access to general healthcare. Our results reinforce these tensions and opportunities and extend these findings to a middle-income and border context. Further study is warranted to better characterize the long-term public health implications they may have, as well as how they may provide guidance for structural change in drug policy globally.

[Fieldnote excerpt from JF]: As Johnny and I step out into the sun, we hear the screech of braking tires, and in an instant, we are surrounded. As our eyes adjust, 4 police officers and 2 soldiers come into view. "Ponga sus manos en el carro"[put your hands on the car] they tell Johnny, quite unnecessarily, as two officers are already pushing his chest into the hood of their militarized pickup truck. The plasma TV that Johnny had been carrying on one shoulder was in the arms of a third officer. A fourth has his hand on my back and is (somewhat more gently) pushing me against the concrete outer wall of the rundown apartments where Johnny and three-dozen other people who inject heroin are staying in crowded quarters. The two soldiers stand by silently, peering at us from over their machine guns.

"Lo estas conectando?"[are you selling him drugs?] a heavyset cop barks into Johnny's face on the hood of the car, pointing at me. "No, he's a doctor!" he struggles to answer. The officer looks me over, trying to decide if I fit the profile of one of the gringo volunteers who frequent the numerous clinics and religious organizations in the area, or if I'm actually a drug tourist being "connected" by Johnny. "Lo ubican?" the cops asks his colleagues, "do you recognize him?". "Yeah I've seen him at the clinic" responds one of the other officers. "Entonces no hay problema" [ok, you're good then]. The other officer stops rifling through Johnny's pockets, and all the sudden the encounter takes on a tone of insincere respect. The officers make a big show of carefully handing Johnny the TV he had been carrying, and wishing us a good afternoon, and we quickly walk away. "Shiiiiit man, we got lucky" Johnny laughs once we are half a block away, "I can't believe they didn't take the TV!"

Photo-Ethnographic Vignette 5.1. Routinized Police Harassment and Violence Against PWUD

This vignette depicts overarching dynamics related to policing of PWUD in Tijuana. The images depict separate encounters from the text, albeit related to the same theme. The photos show a bruise left by a police baton (left), and an ongoing arrest in the Tijuana River Canal, *El Bordo* (right). These encounters occurred in 2019.

It's about 1pm on a Monday afternoon [before the pandemic] and Ana, Johnny's sister, comes running up the street to where I'm standing outside the harm reduction clinic. "Hey, come on man, Johnny needs you guys, he's real sick. He's been peeing blood all weekend!" I follow Ana for a few blocks, and we find Johnny in a particularly rundown maquinitas [small storefront specializing in cheap slot machines, that also sells cigarettes, sodas, and snacks] sitting in a broken white plastic chair, looking miserable. Johnny confirms that he started peeing blood on Saturday night. Since the harm reduction clinic was closed, he tried to go Tijuana General [the public hospital for those without access to one of the better systems] but he got turned away. "Shiiit man I didn't even make it inside! El guardia [the security guard who screens people before they enter the hospital] took one look at me and told me to get lost unless I had an ID. A little blood coming out yo' dick ain't enough to get you in there" Johnny laughs bitterly. Normally charismatic and gregarious, Johnny is depressed, in pain, and dopesick, with his ability to work and hustle compromised. He is clearly anxious to try to find heroin, but I convince him that first we need to go see one of the doctors at the harm reduction clinic, since the clinic closes in less than one hour and I am worried that he might have something life-threatening. He has back pain, and lots of swelling in his lower legs, but he manages to limp his way a few blocks to the clinic, and luckily is able to see a doctor right away.

Within 5 minutes the American volunteer physician who sees him asks the clinic manager to quickly call Johnny an Uber to take him to the hospital, because he urgently needs labs and inpatient medical care. It's her first week at the clinic, and she is astounded to hear that the hospital already turned him away and is unlikely to treat him if he goes back. Johnny also makes it clear that he's not going back to the hospital unless someone can give him methadone to stave off the withdrawal symptoms that are already gnawing at him. Slowly Johnny and the Mexican clinic staff convince her that—though it's not ideal, and it's uncomfortable for her sense of professional obligation—the best option is for her to treat Johnny as best as she can in the harm reduction clinic. She gives him a 10-day course of oral medications, and a prepaid voucher to get some blood tests done at a nearby lab. "It's extremely important that you go first thing tomorrow to get these tests done. Apparently, the lab needs you to be there before 11am or you'll have to wait another day. I know it's early but please do get the labs done tomorrow, I am worried that you might already be in kidney failure, and I really need those numbers to know what is going on." Johnny assures her that he will go the next day and get the labs, although I know that in practice there is a high chance that he will be too distracted by withdrawal symptoms, or that he'll be in police custody. Now, very dope sick and agitated, Johnny limps off, and I'm worried that he's just going to go right back into the alley to drown his sorrows in heroin and totally forgot about his medical situation. Hopefully he will at least take the meds and they will help."

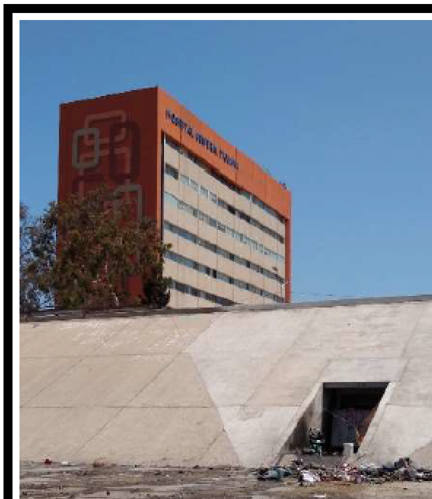

Photo-Ethnographic Vignette 5.2. Routine Denial of Healthcare for PWUD in Tijuana

The image depicts the Tijuana General Hospital, viewed from the Tijuana River Canal (*El Bordo)*, home to many PWUD. Although low-income residents of Tijuana are entitled to receive healthcare at Tijuana General, de-facto access for PWUD is often limited by stigma and bureaucratic barriers. This encounter occurred in January 2020, before the pandemic.

Karla, another volunteer, and I are in the front of the harm reduction clinic wearing N95 respirators and plastic face shields and having a conversation from 10 feet away from one another. The clinic is only open three days a week now, and the flow of people coming to exchange syringes is slower than usual. Ana runs past and I ask her about how Johnny is doing. "Not good man. He's in rough shape. He wants to come talk to you guys, but he can't even walk the past few days cuz' his feet are all messed up." Karla and I find an old wheelchair, and we head to the alley a few blocks away where Johnny and a few dozen other people who inject drugs have been sleeping in the open air. He's wrapped up in blankets and plastic, with his swollen feet sticking out of cheap sandals on the cold concrete. It's been raining, so the ground is wet, and the sky is grey, adding an especially somber tone to the day. Johnny's face is puffy and swollen, as are his lower legs and feet. He has an enormous, red, puffy abscess in his lower abdomen that he wants to get drained, but he's too fatigued to make it to the clinic. Karla and I hoist him into the old wheelchair and navigate big puddles and broken sidewalks for a few blocks to get him to the clinic. He winces in pain every time we go over a bump or he needs to stand up so we can make it over a curb.

The clinic doctor applies local anesthetic and uses a scalpel to make a small incision in the softball size abscess on Johnny's abdomen, and she squeezes what seems like an endless quantity of pus and blood out of the wound. Johnny writhes in pain, and at one point he asks a few clinic volunteers to hold his arms to prevent him from instinctively grabbing the doctors' wrists as she applies pressure. Once she's done draining and bandaging the abscess, the doctor talks to Johnny about his condition. Although he's not peeing blood anymore, she is very concerned for him. He has had cycles of edema in his legs for months now, and it seems like end-stage cirrhosis from hepatitis C. His prognosis is uncertain; he could die suddenly, or it could be years. He also could overdose more easily now since his liver might suddenly stop metabolizing opioids. The doctor thinks he ideally needs hospital care to have his condition stabilized, but she recognizes that he likely won't want to go to Tecate to do so, since it would mean an expensive and hours long ride on public transit to get back to Tijuana, he would almost certainly go into excruciating withdrawal without opioids, and there is a good chance he wouldn't be admitted to the hospital anyway.

After the clinical visit is over, Ana comes up to Johnny and gives him a package of two pairs of socks, since he had been complaining of cold feet (and was only wearing flip flops). It strikes me as a very kind gesture. She must know that the socks will soon be soaked and ruined by the downpour and filthy water everywhere and Johnny's inability to move well. She herself is also semi-unhoused and frequently dopesick, and yet she chose to spend some of her precious funds on her brother's momentary comfort. Johnny tells us not to worry, he's going to 'get himself to a [drug rehab] center and get clean as soon he sorts out a few last things he needs to take care of first'. Two days later the clinic is open again and Ana tells me that Johnny died the night before.

Photo-Ethnographic Vignette 4.3. Worsening Access to Critical Healthcare During COVID-19

The image depicts a clinic volunteer using a wheelchair to assist a patient in reaching the clinic to receive healthcare. This encounter occurred in 2020, during the pandemic.

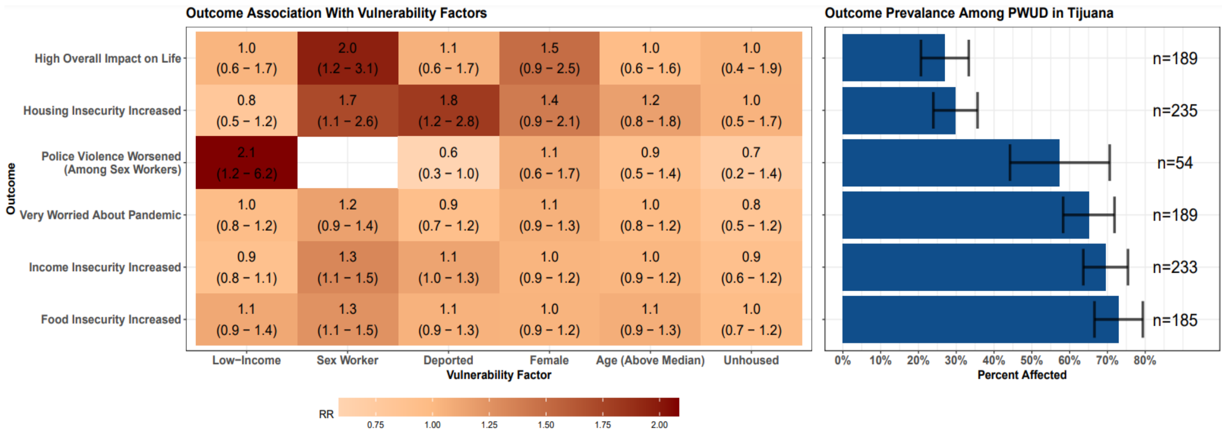

Fig 5.1. Pandemic-Related Outcomes among PWUD in Tijuana, Prevalence and Association With Vulnerability Factors

The proportion of respondents self-reporting each deleterious pandemic-related outcome is show along with 95% confidence intervals and the non-missing sample size for each variable (right). The association with six vulnerability factors, shown with bivariate risk ratios and bootstrapped 95% confidence intervals, is shown for each variable (left).

Chapter 5 References

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Chapter 6: Xylazine spreads across the US: A growing component of the increasingly synthetic and polysubstance overdose crisis

A modified version of this chapter appeared as a research article in Drug and Alcohol Dependence:

Friedman J, Montero F, Bourgois P, et al. Xylazine spreads across the US: A growing component of the increasingly synthetic and polysubstance overdose crisis. Drug and Alcohol Dependence. 2022;233:109380. doi:10.1016/j.drugalcdep.2022.109380

The last deep mixed methods case study focuses on the spread of xylazine, a veterinary tranquilizer and novel additive to the US illicit drug supply. This case study in particular highlights how ethnography can play a key role in serving as an 'early warning system' for the US illicit drug supply, detecting dynamics that are difficult to track with quantitative data, simply because the number of potential contaminants to the drug supply is so large. In this case study, the initial insight to monitor for xylazine came from ethnographic work of an embedded ethnographic team in Philadelphia. Subsequently, the ethnographic team inspired a national search for alternative sources of quantitative data describing xylazine's spread across the country. This analysis represented the first study to show that xylazine was spreading nationally and represents a key public health threat, which would not have been possible with traditional drug surveillance approaches.

Introduction

The US overdose crisis has accelerated exponentially for the past four decades, with a shifting profile of substances driving fatalities[1]. From 2000-2006 cocaine was the leading drug associated with overdose deaths, which was replaced successively by prescription opioids (2007-2013), heroin (2014-2015) and illicitly-manufactured fentanyls (2016-present)[1]. In recent years, sharp increases in fatalities have been linked to systemic polysubstance use and potent synthetic compounds in numerous drug classes, including synthetic opioids such as fentanyls, sedatives, stimulants such as methamphetamine, and novel benzodiazepines[2–6]. As overdose rates continue to reach unprecedented heights[7], there is a need to continue to examine novel synthetic compounds, and polysubstance use patterns, which are increasingly implicated.

Xylazine is a veterinary tranquilizer, which is not approved for human use in the United States, but is commonly used for sedating large animals[4,8]. Although human intoxication with xylazine has been reported sporadically over the past several decades in a number of case studies[8,9], it was first described as a more prevalent additive in the unregulated drug supply of Puerto Rico[4,10,11]. It was also noted in the literature describing drug overdose deaths in Philadelphia as early as 2006, yet it did not appear in high prevalence at that time[12]. However, since the mid-2010s, xylazine has been noticed by people who inject drugs (PWID) and public health practitioners as an increasingly commonplace additive in the street opioid supply of Philadelphia[13]. Further, recent reports from Connecticut implicated xylazine in a rising fraction of overdose deaths in 2019-2020[14,15]. A report released in September 2021 leveraged data from 38 states and Washington DC representing the year 2019, and found xylazine to be present in 1.8% of overdose deaths[16]. However, no time trends were provided, and results were not disaggregated below the level of US Census Region, with limits the usefulness of the results for frontline providers and harm reductionists. Additionally, reports from Philadelphia and Connecticut, as well as media reports from numerous cities, suggest that xylazine-present overdose have increased sharply in 2020-2021. Therefore, additional study with more recent and detailed geographic information is urgently needed to assess the national relevance and trajectory of xylazine-present overdose fatalities, and their role in the rapidly shifting US overdose risk environment. Further qualitative information based on the perspectives of people who inject drugs (PWID) is also needed to better understand why xylazine might be spreading across the US, and the potential health and other risks involved.

In the current sequential mixed methods analysis, over many years of participant observation fieldwork in Philadelphia (2007-2021) among drug sellers and people who inject drugs (PWID) in the Puerto Rican inner city, xylazine was frequently referred to as a powerful adulterant/enhancer of heroin, "back in Puerto Rico." In the mid to late 2010s, suddenly, Xylazine appeared in the Philadelphia fentanyl-dominated opioid supply, rendering it "difficult to obtain real heroin" according to street-based PWID. Subsequently, we systematically searched for records describing xylazine-present overdose mortality across the US and assessed time trends and overlap with other drugs.

Methods

Ethnographic methods

Beginning in 2007 our initial ethnographic team (PB and FM, later JF) set out to study urban poverty, violence, and drug markets in majority Puerto Rican neighbourhoods in North Philadelphia[17–19]. Leveraging a longitudinal ethnographic approach[20,21] to studying these topics, we rented an apartment adjacent to several cocaine and heroin sales points, in the heart of Philadelphia's sprawling open-air narcotics economy. Various members of the ethnographic team lived full-time in our field site for different periods, and all have since made periodic follow-up visits to conduct extensive interviews with longitudinal informants through the present. This has allowed us to participate in the local social scene as neighbours, and study drug markets by triangulating multiple local perspectives (drug sellers, drug consumers, residents, harm reduction providers, law enforcement) impacted by drug markets. This long-term triangulated immersion reduces social desirability bias, allowing for the comparison of self-reported practices beliefs and observation of real-time practices of stigmatized, illegal hard-to-document activities such as injection drug use, drug sales, and violence. With IRB approval, and full informant consent, we tape-recorded hundreds of interviews, and wrote detailed observational field notes. Most interviews were conducted informally in a conversational format, often in street-settings, while accompanying respondents in their normal neighbourhood activities. Over many years, we developed genuine friendships with many of our respondents, which we still enjoy. This facilitates long-term follow-up with difficult to reach, stigmatized, and structurally vulnerable populations. In particular, ethnographic immersion in drug use subcultures allows for real-time documentation of shifts in illicit drug markets and their multifactorial potential implications for health risks, which often cannot be ascertained from epidemiological records alone.

Our ethnographic database from Philadelphia consists of nearly 1,500 pages of field notes as well as transcriptions from hundreds of interviews, dozens of hours of video, and thousands of photographs. We loaded all textual data into the NVivo qualitative analysis platform and coded for emergent themes and characters. Analyses were conducted iteratively, throughout the fieldwork process, with emerging analytical insights further refining follow-up questions, and targeting follow-up research activities (see [17,18,20–22]). Qualitative data gathered during 15 years of ethnographic fieldwork generated numerous quantitative hypotheses, which we have explored through multimethod collaborations with quantitative researchers[17,23,24].

Quantitative methods

Quantitative data describing overdose deaths were collected as part of a larger research effort[25] to assemble and assess granular person-level records from medical examiner and coroner jurisdictions that publish overdose data ahead of federal statistics (which are typically available in their finalized form on a 12-24 month lag[26]). Although xylazine is not described in existing national-level records[26] at the time of writing this article, its presence in overdose deaths can be ascertained from the cause of death fields in records obtained from medical examiner and coroner offices from numerous jurisdictions. Therefore, we assessed our existing database of data from 10 jurisdictions for the presence of xylazine implicated in overdose deaths. Further, we systematically searched for additional jurisdictions where xylazine positivity has been noted, which we identified through popular press reports and official statistical reports. Wherever possible, we requested and incorporated person-level records describing xylazine deaths from each jurisdiction, as well as the overlap with other drugs. In some cases, only aggregated reports were available. Data were obtained from publicly available sources when available, or otherwise from records requests to medical examiner and coroner's offices, or state health officials. Each jurisdiction uses its own toxicological testing procedures, but xylazine is typically detected in overdose fatalities using gas chromatography–mass spectrometry.

We summarized xylazine-present overdose deaths per jurisdiction and year, both as counts, and as a rate per reported overdose deaths. For a small number of jurisdictions, the denominator (all overdose deaths) was not available from the same source as the numerator (deaths with xylazine present) and was obtained from federal statistics[26,27]. As this analysis was completed in September 2021, in some cases data for part of 2021 were available. In order to provide standardized metrics, counts of xylazine-present deaths and total overdose deaths for 2021 were estimated by assuming that both would continue linearly for the remainder of 2021. For jurisdictions where drug overlaps could be assessed, we visualized clusters of drugs found to co-occur with xylazine using UpSet visualization[28]. All quantitative analyses were conducted using R version 4.0.3.

Results

Ethnographic results

Popular conception of xylazine prior to widespread introduction - Connection to Puerto Rico

Prior to the widespread availability of xylazine in the Philadelphia drug supply, it was often mentioned in passing by residents of the majority Puerto Rican neighbourhood where our fieldwork was based as a powerfully psychoactive additive '"back on the Island".' Xylazine was occasionally detected in fatal overdoses in Philadelphia as early as 2006[12], but it was not common knowledge among PWID. Significantly, however, many of our long-term informants recently immigrating/returning from Puerto Rico spoke with a mix of intrigue and apprehension about the psychoactive effects and health risks of "*anastesia de caballo* [horse tranquilizer]". As early as 2009 xylazine was already beginning to achieve notoriety among PWID in Puerto Rican Philadelphia:

> *"Pero la droga aquí es muy diferente a la de Puerto Rico…[but the drugs here are very different from what they're using in Puerto Rico] over there they're lacin' it with that stuff…horse tranquilizer, what they call anastesia de caballo…for like 8 years now…and they inject it, and you see them fast asleep on the street corner. And also, they say that that when they shoot up and skin it, you know your skin gets, like, kind of fucked up and you get these big craters. And those craters over there, I mean, they're not like the ones that the dopefiends from here got." -Isabel, 40, Puerto Rican Resident of Philadelphia, interviewed in 2009 (all subsequently cited interviews were conducted in 2020-2021).*

Introduction of xylazine to Philadelphia drug scene

At least a decade after Xylazine became a fixture in Puerto Rico, it entered the street opioid supply in Philadelphia as a more prevalent additive in the mid-2010s. The shift was noted by PWID, as well as harm reductionists and city public health officials[13]. PWID began to describe xylazine—often referred to as *tranq*—as a known element of specific 'stamps' or brands of opioid products in the illicit retail market. Opioid formulations containing xylazine, (e.g.,"*tranq dope*") became largely sought-after, as the addition of xylazine was reported to improve the euphoria and prolong the duration of fentanyl injections, in particular, solving "the problem" of the "short legs" of the otherwise euphoric effects of illicitly manufactured fentanyl. Nevertheless, a ratio of too much xylazine to fentanyl was said to distort the initial injection "rush" and euphoric "nod" from opioids, and leave a consumer overly sedated:

> *"FM: Have you noticed changes in the heroin since you started using?*
>
> *Definitely. Here it's all tranqy, it's all tranq.*
>
> *FM: Do you like the tranq dope?*
>
> *Yeah I like a good tranq-fent bag. Some people don't like it, but plenty of people do. It's sought after. Certain stamps [brands printed on drug bags] that are known for tranq have better business, you know what I mean? I like it cuz, fentanyl is such a short-lived high… It's a good high, but it's so short that the nod is over real quick and you get sicker faster. See, the tranq like extends the high, it gives the dope more of a heroin effect, it's a good rush with the heroin-like effect. But then other times, they straight put bags out there that are just all tranq. You shoot it, you feel no rush, and you're just out, you're asleep for at least 40 minutes. You're sitting there one second talking, and then you're waking up 2-3 hours later in a weird position." -Henry, White 30, Injects Opioids, Xylazine, Methamphetamine, Cocaine*

Despite often expressing positive sentiments for the psychoactive potency of opioid-xylazine combinations, PWID frequently expressed concern about novel health risks from '*tranq dope'.* In particular, concerns related to increased risk of soft tissue damage:

> *"I got some friends out here that got really torn up by it, you know they got holes in them, abscesses, basically it's like the body is rotting. People here are losing limbs like with gangrene. Whatever they're doing with the tranq….everybody is getting these scabby sores all over their bodies… and many of them don't shoot meth. So it's from the dope. You know what I mean, you had the dope, then the fentanyl, now it's the "tranq-fent," the rhinoceros tranquilizer, the horse tranquilizer, you know? Cooked up and it's broken down and it's added to the dope and we seek that out, you know what I mean? Our habits are fentanyl and tranquilizer."-Annie, White 25, Injects Opioids, Xylazine, Methamphetamine*

For other PWID, concerns about the negative health effects of xylazine outweighed interest in its psychoactive potency. Further, some individuals expressed a strong preference for "real heroin" or fentanyl-heroin formulations, not containing xylazine, based on a different character of the euphoric effect:

"There's all kinds of weird cuts that are coming up now. You really can't know what you're getting these days. I stay with the same people every time I buy, to try to limit some of that. So I go over to [name redacted] because it's pretty good and it never has any tranq in it. Tranq causes people to black out, and causes amnesia, people do dangerous stuff they wouldn't normally do like walk in front of a car, and they don't even realize what's going on, they're in a whole other world. And if you fuck it up and miss [the vein], your whole arm turns black. Oddly enough, I would think that nobody would want to use it, but some people specifically seek bags that have tranq in it, or what they think is tranq (laughing).

FM: Have you used it?

Yeah accidentally. It's dangerous stuff. I was doing like zombie walks from the tranq, so I was walking, but I wasn't aware of what was going on, and I fell on the train tracks and cracked my skull. I literally cracked my skull open, and almost died. So yeah. You know, the old heroin, that was just heroin, was dangerous enough, but the tranq is just really a whole other world." -Mike, White 40, Injects Opioids

Harm reductionists and frontline medical providers also noted increased frequency and severity of injection-related soft tissue damage. One harm reductionist noted:

"People had been talking about it [xylazine] as a cutting agent or as a way of cheating drug users for a long time. But the intentional addition of high amounts of xylazine to help give fentanyl legs [increase the duration of effect] really started increasing since maybe 2019. And that's when we started to see way more people coming in with necrotizing skin and soft tissue issues. The amount of medical complaints related to xylazine was pretty astounding and terrifying. Xylazine wounds are a whole other kind of…just horror. And they were really exacerbated by the shift to fentanyl, since folks were injecting more and more frequently, so with each one of the injections, if there's xylazine in it, and if you miss [the vein], you were risking a really deep and necrotizing wound."

Xylazine was also linked by frontline providers to potentially increased, or shifting profiles of overdose risk:

"JF: what's your sense of overdose risk with xylazine?

The number of people I was reversing [administering naloxone] was definitely going up. There were people who would become only minimally alert and be only slightly responsive to Narcan. So that definitely concerned us that something different was happening, that there were non-opioid agents involved. We did a lot of Narcan training, and we had to focus more on the necessity of doing rescue breaths, instead of just Narcan."

PWID also noted that xylazine presence in street drug formulations could be distinguished by a characteristic taste that can be observed immediately after injection:

"*You know a bag got tranq in it because you'll shoot it and your mouth goes dry right away, and you know, you taste it."*

Xylazine in an evolving drug supply

It is important to note that the widespread introduction of xylazine into the drug supply of Philadelphia occurred at a time of numerous other shifts, which may complicate efforts to pinpoint the effects of xylazine on population health[29]. Of particular note, methamphetamine grew in popularity, prevalence, and ease of access in the years leading up to 2021:

> *"FM: And is it easy to find meth around here?*
>
> *Yeah. When we first started coming, back around like 2 years ago, it wasn't anywhere, nobody even knew what it was really. And now it's everywhere, it's just everywhere. I'd say on like ¾ of the corners they're selling it. They're starting to give [free] samples of it now."*

At the same time, the market in Philadelphia was in a longer-term process of shifting to an increasingly illicitly-manufactured-fentanyl-based opioid supply. PWID celebrated a highly visible ramification of this shift: the steep drop in the unit price of 'heroin'. Whereas a packet of heroin had a retail street price of $10 USD for the first decade of our fieldwork, the price suddenly dropped to $5 USD in the late 2010s, as fentanyl began to dominate the market[29]. At the same time, this also prompted PWID to increase the number of bags purchased each day, especially given the much shorter half-life of fentanyl analogues compared to traditional heroin[2]. This led to a sharp increase in the number of injections per day for the average consumer of street opioids.

The unregulated drug supply at the end of the 2010s and early 2020s in Philadelphia was undergoing a process of extensive experimentation with pre-packaged polysubstance combinations. Ratios of heroin to illicitly manufactured fentanyl were experimented with, as well as the addition of other psychoactive substances such as other benzodiazepines, xylazine, and other additives. At times customers would be unaware of these additions, yet in other moments, the alleged composition of polysubstance mixtures served as a point of street-based marketing to boost sales. In response, PWID became skilled at navigating a constantly shifting drug supply to maximize the potency per dollar spent:

FM: Do you go to the same corner every time, or do you switch it up?

Well, we usually ask around like "what's good". Because even if they give samples in the morning and it's good stuff, when you go back to buy it it's not the same stuff. So you've gotta ask everyone who's doing it around you, "What's good? What's good?" and then whatever they say is good right now, that's where we go. There's a couple spots where you can still get real heroin. Any $10 bag is usually gonna be straight heroin, straight dope. At [street name redacted], they're mixed, it's real dope but there's some fentanyl in it too. An' they cut it with Xanax, they put some benzos in. Everybody's got like, their own little flair, what they do with their shit.

Similarly, harm reductionists emphasized that xylazine became commonplace in the context of a rapidly shifting drug supply, especially with respect to the replacement of heroin and prescription opioids with illicitly manufactured fentanyls:

I would say that Xylazine is another trend in concert with K2 [synthetic cannabinoids] in Philly. Part of the reason that people use so much K2 here is because there's this belief that cannabinoids in general increase the half-life of opioids. When the switch to fentanyl happened, drug users were talking about how frustrating it is that fentanyl doesn't have legs. Manufacturers responded by trying to increase the amount of sedation, by adding xylazine. And likewise, people think that K2 can help 'give fentanyl legs' [increase the duration of effect]. So xylazine is really part of a larger story of both drug users and dealers adapting to the new world of fentanyl in both safe and unsafe ways.

Quantitative results

In overdose data from 10 jurisdictions—representing all four major US census regions—xylazine was found to be increasingly present in overdose mortality (Fig 6.1). The highest prevalence was observed in Philadelphia, (with xylazine present in 25.8% of overdose deaths in 2020), followed by Maryland (19.3% in 2021) and Connecticut (10.2% in 2020). In 2021, xylazine prevalence also grew substantially in Jefferson County, Alabama, reaching 8.4% of overdose fatalities. Across the four census regions, the Northeast had the highest prevalence, and the West had the lowest (Fig 6.2), with only six xylazine-present overdose deaths in total detected in Phoenix, Arizona, and 1 in San Diego County, California. Across jurisdictions, a clear increasing trend was noted. Pooling data for 2015, a total xylazine prevalence of 0.36% was observed. By 2020, this had grown to 6.7% of overdose deaths, representing a 20-fold increase. From 2019 to 2020—the last year of data available for all jurisdictions—the prevalence increased by 44.8%.

In four jurisdictions, xylazine was not found to be present in overdose deaths, including: Phoenix, Arizona; Tarrant County, Texas; Denver, Colorado; and North Carolina (Fig 6.2). However, in North Carolina, xylazine has been detected in drug checking data[30], and state officials confirmed that it has been found in toxicological testing during death investigations. However, it is not yet reflected in death certificates related to these cases.

Among the jurisdictions with a substantial number of xylazine deaths, and where full drug overlaps could be assessed (including Connecticut; Cook County, Illinois; Jefferson County, Alabama; and Philadelphia, Pennsylvania), xylazine was observed to co-occur with all six drug classes assessed (Fig 6.3). Fentanyl was the most commonly co-occurring drug, involved in 98.4% of xylazine-present overdoses, suggesting a strong ecological relationship. Cocaine (45.3%), benzodiazepines (28.4%), heroin (23.3%), and alcohol (19.7%) were also common. Methamphetamine was the least frequently observed overlapping drug, implicated in only 10.0% of xylazine-present overdose deaths.

Substantial variation was found between jurisdictions in the most common drug combinations observed (Fig 6.3). In Jefferson County, Alabama, and Philadelphia, Pennsylvania, xylazine was most commonly found with both fentanyl and cocaine, representing 32.0% and 20.0%, respectively, of all overdose deaths in those jurisdictions. In Cook County, Illinois, xylazine was most commonly found with fentanyl, and heroin, representing 19.6% of cases. In Connecticut, xylazine and fentanyl were most commonly found alone, constituting 28.0% of cases.

Discussion

We summarize longitudinal, recent, and geographically specific evidence describing how xylazine is increasingly implicated in overdose deaths in jurisdictions spanning all major US regions and link it to detailed ethnographic observations of its use in Philadelphia open-air narcotics markets. Xylazine presence in overdose deaths grew exponentially during the observed period, rising nearly 20-fold between 2015 and 2020. Whereas the most recent national data from the State Unintentional Drug Overdose Reporting System characterized the level of xylazine-present overdoses in 2019[16], we found that the prevalence increased by nearly 50% from 2019 to 2020 alone, indicating a need for more recent data to guide the public health response. Nevertheless, we find that even looking at only 10 jurisdictions a greater number of xylazine-present overdose deaths were seen in 2020 (854), than the previous study looking at 38 states in 2019 (826)[16], implying a very fast rate of growth nationally.

Xylazine prevalence was observed earliest and at the highest magnitude in the Northeast, and may be spreading west, in a pattern similar to the trajectory of illicitly-manufactured fentanyls in recent years[25]. This similarity may not be incidental, as an analysis of the co-occurrence of fentanyl and xylazine indicates a strong ecological link, with fentanyl nearly universally implicated in xylazine-present overdose deaths. Further, ethnographic data among PWID suggests that the use of xylazine as an illicit drug additive may predominantly serve as a response to the short duration of fentanyl. By 'giving fentanyl legs'—offering improved duration of effect—the addition of xylazine may confer a competitive market advantage for illicit opioid formulations that contain it, as it remedies one of the most commonly expressed complaints that PWID hold regarding fentanyl-based street opioid formulations.

Ethnographic data offer a potential explanation for Philadelphia's early adoption of xylazine in the drug supply, relative to other regions of the US. We observed that, for at least a decade before Xylazine became a widely used additive to the street opioid supply in Puerto Rican-dominated Philadelphia open-air drug markets, there was an existing commonplace conceptualization of it as a potent, exciting, and dangerous drug, based on local return migration ties to Puerto Rico. This may help explain why Philadelphia appears to be the earliest, and largest magnitude documented emerging epicentre of xylazine use in the United States. Additionally, it is noteworthy that the retail narcotics economy in Philadelphia is dramatically concentrated in the city's Puerto Rican neighbourhoods[17]. For example, based on geocoded data from the Philadelphia police department, the lowest-income Puerto Rican neighbourhoods in Philadelphia have a concentration of 'narcotics violations' over ten-fold higher than the most impoverished majority non-Hispanic Black neighbourhoods of the city[17]. Similarly, in ethnographic fieldwork it was clear that majority Puerto Rican neighbourhoods are host to remarkably higher-volume and more profitable retail narcotics markets compared to any other part of the city[17,18]. This has been hypothesized to reflect the unique function of majority-Puerto Rican neighbourhoods as a more phenotypically diverse meeting ground in an otherwise heavily residentially segregated city, where majority Black and White areas are typically clearly demarcated[17]. Puerto Rican cultural norms continue to play numerous key roles in Philadelphia's retail drug market, and Puerto Rican drug sellers control a large fraction of the street opioid sale[18,19]. In sum, the Philadelphia street opioid scene has numerous strong ties to Puerto Rico that may have influenced the early entrance of xylazine in Philadelphia, given an existing understanding and precedent for its use (See [17–19,29]) .

Ethnographic data also link the entrance of xylazine into the drug supply to novel health risks for PWID. In particular, both PWID and harm reductionists in Philadelphia reported a new prevalence and magnitude of soft tissue damage, which has also been described in the literature from Puerto Rico, where xylazine has had a longer-term presence[4,8]. Various mechanisms have been hypothesized linking xylazine use to increased soft tissue injury, including necrosis stemming from localized tissue hypoxemia, and reduce sensitivity to skin injury[4,10]. Xylazine was also linked in ethnographic accounts to the potential for increased overdose risk. As xylazine is known to cause hypotension and bradycardia, these effects may be synergistic with opioid agonists, exacerbating overdose risk[14]. Further, naloxone may not fully reverse overdose symptoms from opioid-xylazine formulations, given that naloxone does not act on non-opioid sedatives[13,14]. Xylazine causes potent central nervous system suppression via central alpha-2 receptor agonist activity[14]. Nevertheless, we note that xylazine gained popularity in Philadelphia—and the United States more generally—during a particularly complicated and multifactorial moment for the shifting drug supply. For example, the entrance of xylazine co-occurred with the increased polysubstance use of methamphetamine, numerous synthetic opioids, novel benzodiazepines, and synthetic cannabinoids, which could all exert overlapping influences on health risks. Careful study will be needed to parse out the health implications of each of these co-occurring factors.

The spread of xylazine across the US illustrates the increasingly synthetic and polysubstance-use-oriented nature of the US overdose crisis, which has profound implications for epidemiologic surveillance of overdose mortality. Improved efforts are needed to ensure that novel substances identified in overdose deaths anywhere in the US can be quickly added to toxicological testing across the approximately 2,000 medical examiner and coroner jurisdictions in the US[31]. As many jurisdictions are currently not routinely testing for xylazine in overdose fatalities, the magnitude of its epidemiological significance may be misunderstood at present. In the current data-sparse landscape about polysubstance drug formulations and overdose patterns, new efforts to provide routine, nuanced testing results from samples of drugs and syringes offer great value for guiding continuous improvements of surveillance systems[32–34].

Ideally, nuanced drug checking results assessing for the presence of various novel substances could be quickly linked to widespread toxicological analysis for death investigation at the national level. Standardized quantitatively toxicological testing is also needed, indicating the concentration of xylazine, and not simply the presence or absence. These aspects are currently quite challenging given the fractured nature of the US medical examiner and coroner system. However, the increased usage of centralized laboratories, either publicly or privately, represents a promising avenue. Further, federal data collection and reporting platforms[26] must be modified to convey the nuanced combinations of drugs driving the modern iteration of the US overdose crisis. Currently reported deaths can only be viewed separately by drug class, with impedes the assessment of polysubstance overdose deaths nationally. Streamlining the detection of novel substances, and integration into toxicological testing through reporting systems represents a key challenge, but an essential one for the rapid detection of overdose risks.

The limitations of this study are numerous and especially related to the limited nature of public, recent data pertaining to xylazine in the US drug supply. We track instances of xylazine presence in overdose deaths, which does not indicate that xylazine was the sole or even most important factor in the death. Typically, the inclusion of xylazine on a death certificate indicates that a medical examiner has determined it played at least a contributory role. However, we argue these results are most useful for provide a provisional national signal of xylazine's spread, not a definitive assessment of the contribution of xylazine to deaths. We provide data from only a sample of jurisdictions, which do not represent the wider US population. No publicly available data are available from the majority of the country, and we are therefore likely to be vastly underestimating the scope of xylazine entrance to the drug supply in terms of absolute numbers. As a rate of all overdose deaths, our non-representative could be biased up or down relative to the underlying—and unknown—national xylazine prevalence. The degree to which each jurisdiction tests for xylazine during overdose investigations is also difficult to determine with certainty. Wherever possible we have excluded data from the time period before each jurisdiction began routinely testing for xylazine in all overdose deaths. Nevertheless, xylazine prevalence in early years, before exponential growth begins for each locale, should be considered a potential underestimate, due to lab detection bias. Among the jurisdictions with exponential growth (Philadelphia, Connecticut, Alabama) we were able to ascertain that xylazine was routinely tested for in all overdose deaths. These limitations apply to all studies of overdose deaths. Many overdose fatalities continue to be listed as "substances unknown" nationally. The detection of emerging substances, and their wider inclusion in systematic toxicological analysis, is a key take-way from this type of research. Additionally, our ethnographic data and analysis should be regarded as mainly hypothesis generating, as they reflect data from a specific subset of PWID and harm reductionists from one city. It is also important to note that little data is available to track the non-fatal implications of xylazine, especially soft tissue damage, which was a major area of concern for PWID informants.

In sum, despite a severely limited data landscape, we found evidence of a national signal that xylazine is prevalent in the unregulated drug supply and increasing in specific jurisdictions. This growth is likely to have epidemiological significance in the coming years, following the trajectory of fentanyl's spread across the country. This has profound implications for the evolving risk environment for PWID in the US. Renewed efforts are needed to improve surveillance for novel substances and sharing of this data to researchers, policymakers, harm reductionists and people who use substances. Granular drug testing results with a more rapid turnaround are needed to avert the growing overdose epidemic. More urgently, PWID must be provided with resources that can help to minimize additional risks associated with a shifting and increasingly synthetic and polysubstance drug supply with drug formulation-specific harm reduction advice and services.

Given the widespread availability of xylazine as a veterinary medication, and the evolving nature of the illicit drug supply in many countries, further study is needed to assess the drug supply globally for the presence of xylazine. Especially given the strong ecological link between xylazine and fentanyl, and the signs that illicitly manufactured fentanyls are increasingly prevalent globally[35–40], xylazine should be considered for its potential as an emerging public health challenge globally.

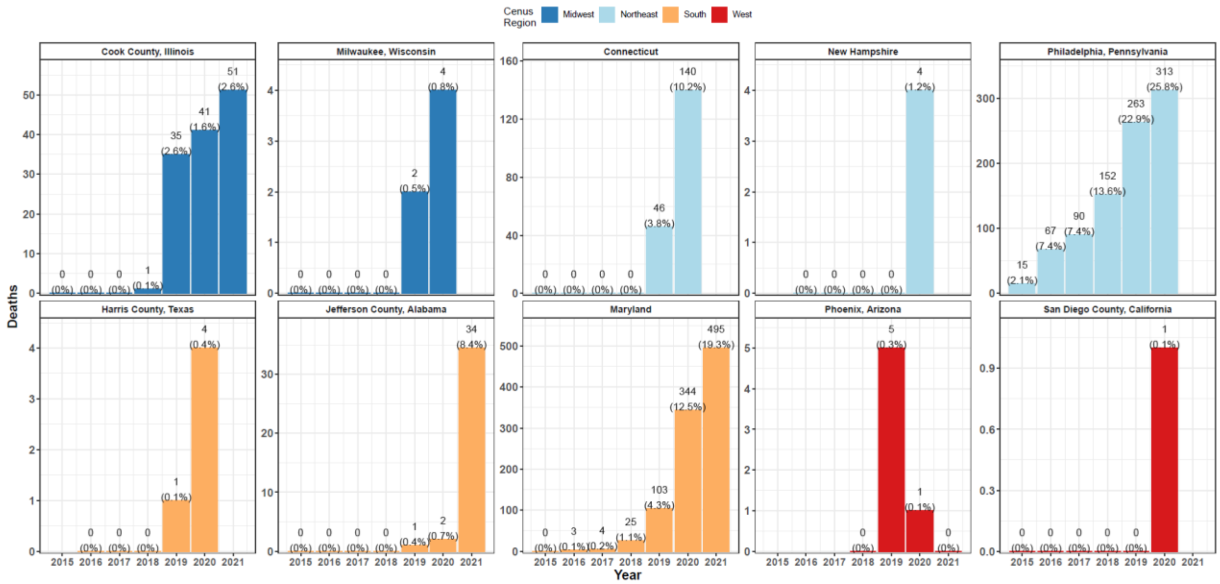

Fig 6.1. Xylazine-Present Overdose Deaths by Jurisdiction and Year

Xylazine-present deaths are show as counts and as a percent of all overdose deaths in text. Color indicates US census region. Values for 2021 represent estimates, should trends from the observed fraction of the year continue linearly.

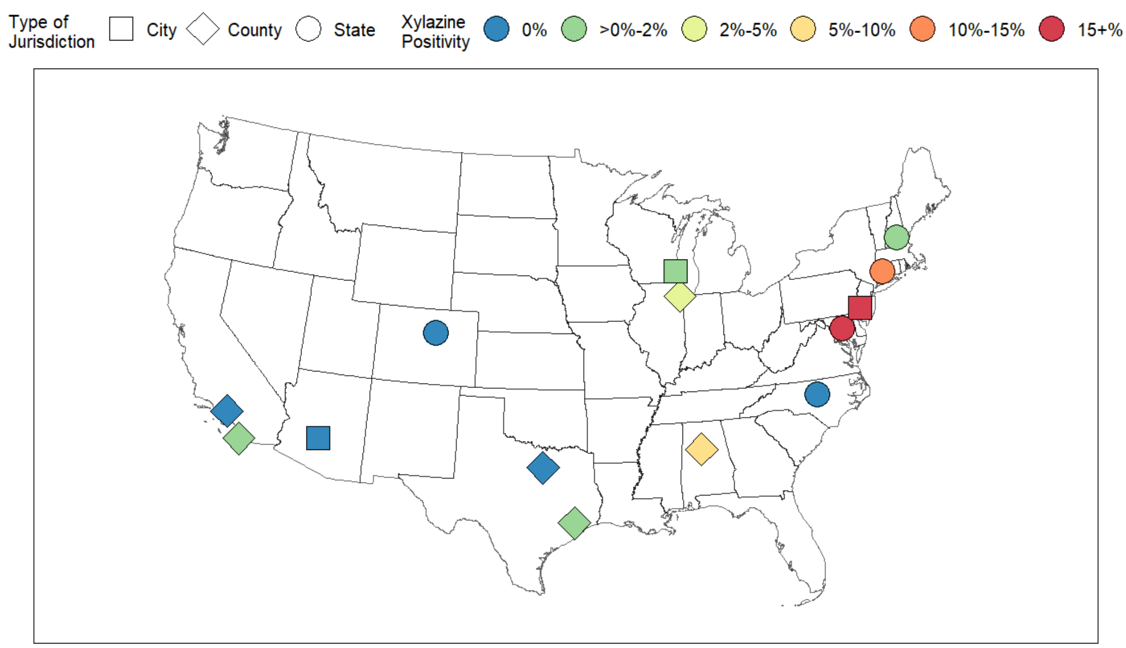

Fig 6.2. Geographic Distribution of Xylazine Positivity in Overdose Deaths
This figure summarizes the geographic distribution of xylazine positivity in overdose deaths in the full database of 14 locations. Point shape corresponds to type of jurisdiction. Color corresponds to the magnitude of xylazine positivity in the most recent year of data available for each location. Values for 2021 represent estimates, should trends from the observed fraction of the year continue linearly.

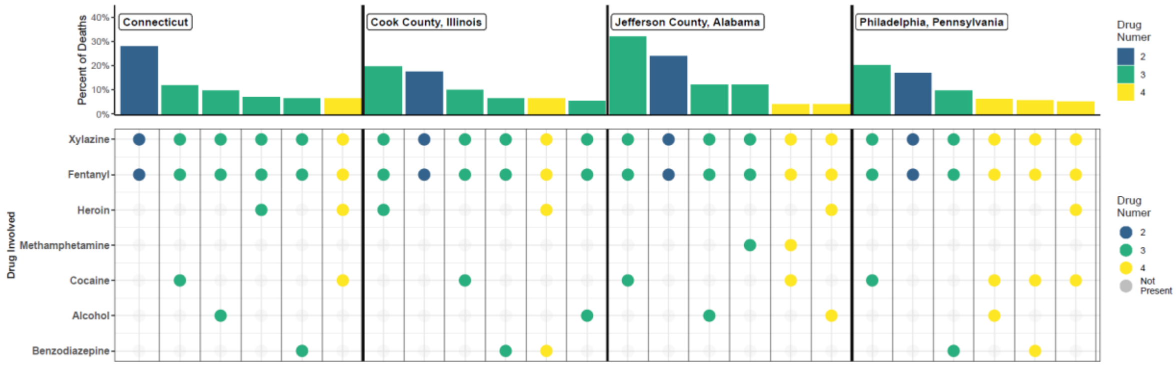

Fig 6.3. Drug Overlap in Xylazine-Present Overdose Deaths

Data are shown for the jurisdictions where drug overlaps with xylazine could be determined, for the six most commonly observed drug combinations in each jurisdiction. Each column corresponds to one cluster of drug classes. The drugs present in each cluster of deaths is indicated in the bottom panel, by the presence of a solid dot. The top panel shows the percent of all xylazine-present overdose deaths in that jurisdiction pertaining to each cluster. Color indicates the total number of drug classes implicated in each cluster. “Fentanyl” refers to any analogue in the fentanyl family.

Chapter 6 References

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4

Chapter 7: Excess out-of-hospital mortality and declining oxygen saturation: The sentinel role of emergency medical services data in the COVID-19 Crisis in Tijuana, Mexico

A modified version of this chapter appeared as a research article in Annals of Emergency Medicine:

Friedman J, Calderón-Villarreal A, Bojorquez I, Vera Hernández C, Schriger DL, Tovar Hirashima E. Excess Out-of-Hospital Mortality and Declining Oxygen Saturation: The Sentinel Role of Emergency Medical Services Data in the COVID-19 Crisis in Tijuana, Mexico. Annals of Emergency Medicine. 2020;76(4):413-426. doi:10.1016/j.annemergmed.2020.07.035

This chapter is the first 'out-of-the-box' data science case study of this dissertation, all of which entail using novel, or non-traditional data sources or methods to improve the speed and inequality-tracking of public health surveillance. This analysis leverages emergency medical services (EMS) data to rapidly track shifts in excess mortality occurring outside of hospital settings at the onset of the COVID-19 pandemic. EMS data are used across several chapters, given their rapid collection, even in middle- and low-income settings, and the minimal processing they require to be ready for aggregation and analysis. They also may include social, geographic, and demographic variables that are useful for rapidly tracking inequalities. In this case, they were used to describe a concerning number of individuals dying outside of the hospital system in Tijuana during the COVID-19 pandemic, suggestive of health system collapse. A social gradient was found, with lower socioeconomic status communities disproportionately affected.

Introduction

As the coronavirus disease, 2019 (COVID-19) spreads across most countries of the world, real-time information is required to detect and manage the health of populations. This is a particular challenge in low-and-middle-income countries (LMICs), such as Mexico, due to less rapid and robust vital statistic registration systems. Although a vital registration system does exist in Mexico, official statistics are available on an approximately 2-year lag, and records of mortality are not always reliable—a condition similar to most LMICs[1–5]. Although a number of reports in the popular press have suggested Mexico is drastically undercounting deaths from COVID-19[6,7], these claims have not been evaluated with excess mortality analyses, as official total mortality statistics were not available for Mexico beyond the year 2018, as of May 2020. Given these data restrictions, information from emergency medical services (EMS) may serve as a key source of real-time knowledge about the evolving health of COVID-19 affected populations, offering information of clinical significance.

Importance

EMS data may play a particular role in measuring out-of-hospital mortality. As the epidemiological properties of the COVID-19 pandemic have become more clear, excess mortality has become an important area of study. A small number of analyses have been published—initially largely by news organizations—describing excess total mortality[8–10]. However, due to the aforementioned limitations, no official data from Mexico, or the vast majority of LMICs, were available as of May 2020. Out-of-hospital deaths represent an important facet of total excess mortality, which may be particularly suited for measurement using EMS data. One recent report from the Lombardy region of Italy used EMS records to show an increase of 58% compared to prior year values, during the peak of the epidemic[11]. This phenomenon has also been documented in the popular press for certain cities in the United States[12,13]. It is unclear, however, how it would play out in LMICs with relatively weaker health systems[14–18]. In the context of COVID-19, an increase in out-of-hospital mortality could be expected, either directly from COVID-19, or indirectly as patients delay care and health systems become overwhelmed[19–21]. Nevertheless, rates of out-of-hospital mortality remain a generally understudied facet of the pandemic[9,10,22], and to our knowledge, there is little or no evidence on the topic for LMICs.

Another key area that can be monitored using data from EMS systems during the COVID-19 pandemic is the detection of "silent hypoxemia". Reports initially from China, and later Italy, the US, and Norway, have described many COVID-19 patients who initially present with hypoxemia without signs of respiratory distress ("silent hypoxemia") and later go on to develop respiratory failure[23–26]. It is possible that this kind of hypoxemia, and subsequent rapid decompensation[27], could result in mortality before patients are able to access EMS or hospital services, especially in areas were health systems are saturated or patients are not able to quickly access healthcare services when decompensation occurs.

Mexico is a middle-income country that saw its first confirmed case of COVID-19 on February 27th, and reached 10,000 cases by April 17th, according to official statistics[28]. Tijuana, in Northern Mexico, is a city of over 1.7 million inhabitants that shares a heavily crossed border with San Diego County, California, in the United States[29]. As of May 2020, the international border remained open to residents of the United States, although Mexican nationals with tourist visas were generally barred from crossing beginning in late March. Tijuana therefore may have been subjected to earlier exposure to SARS-CoV-2 than the rest of Mexico due to the importation of cases from California[30,31]. Reported cases of COVID-19 in Tijuana were among the first in Mexico—beginning on March 17th. On May 11th Tijuana had the highest number of COVID-19 deaths of any municipality in the country (170), and the mortality rate (17.3 per 100,000 people) was almost six times the national rate of 3.1 per 100,000 people[28,29,32]. Therefore, Tijuana may represent an important bellwether for the rest of Mexico and have general relevance to trends that will be experienced by the EMS systems of other LMICs.

Goals of This Investigation

Using EMS data from Tijuana, our primary objective was to describe the potential sentinel role for EMS data in monitoring the epidemiological profile of the COVID-19 epidemic in an LMIC context. We focused the analysis on trends in out-of-hospital mortality and silent hypoxemia among respiratory patients. We also sought to characterize any changes in demographics, geography, and neighborhood socioeconomic status (SES) among these patient groups. Additionally, we aimed to compare trends documented by the EMS system with official government statistics describing COVID-19 cases and deaths.

Methods

Study design and setting

We used data from the Mexican Red Cross in Tijuana, which responds to approximately 98% of 9-1-1-activations of EMS care in the city[33]. We drew upon routinely collected, deidentified, encounter-level records describing patient characteristics and the provision of emergency medical services. We conducted a retrospective, descriptive analysis comparing the observed peak epidemic to prior trends. We excluded calls that were cancelled before the ambulance arrived at the scene. Given that rates of violence in Tijuana have been highly variable in recent years, complicating the estimation of expected trends, we also excluded patients suffering from traumatic injuries from all analyses. Data were available for most of the January 2014 through July 13th, 2020, period, although some records, including files from 2018 and February 2020, were not available in digital form on the rapid timescale required to conduct this analysis. Publicly available data describing official confirmed cases and deaths stemming from COVID-19 were obtained from the Mexican National Office of Epidemiology[34]. This study was deemed exempt from review by the University of California, Los Angeles Institutional Review Board.

The EMS system in Tijuana, Mexico is run as a collaboration between the local city government, and the Mexican Red Cross, a non-governmental organization. The systems serves an estimated population of 1.75 million people (based on the 2010 census), with a mixed social profile spanning very low-income and high-income areas[35]. EMS care is regulated at the municipal and national level[36]. A 9-1-1 dispatch center is operated by the city of Tijuana. Once a 9-1-1 call has been deemed a medical emergency, EMTs from the Tijuana chapter of the Mexican Red Cross classify the incident based on dispatch protocols and triage information and direct the closest first responder unit to the scene. The Mexican Red Cross EMS personnel respond to ~98% of 9-1-1 activations leading to medical care in Tijuana, with the remainder being attended to by the city fire department, or private ambulance companies. The Mexican Red Cross operates with 13 ambulances distributed in 6 EMS-bases throughout the city. In Mexico there are three levels of EMT training: basic (EMT-B), intermediate (EMT-I), and advanced (EMT-A). The ambulances are staffed with an EMT-B and either a second EMT-B or an EMT-I. In addition, there is 1 rescue unit, and one rapid response vehicle. The latter responds to emergencies and is staffed by an advanced provider (prehospital physician, EMT-A or EMT-I) but is not designed for patient transfer. The field staff is currently composed of 80 EMT-B, 13 EMT-I, 3 EMT-A and 3 prehospital physicians. EMTs work 24-hour shifts while prehospital physician's shifts are 8 hours. In addition, there is a field supervisor that helps coordinate and manage care during each 24-hour shift. Medical control is provided by either the prehospital medical director or by physicians who staff the Mexican Red Cross Hospital's Emergency Department. During the study period, the Mexican Red Cross in Tijuana responded to an average of 30,500 completed calls per year.

For the duration of the study period, data collection at the Mexican Red Cross in Tijuana has been performed through a prehospital electronic medical record. Data is entered in a tablet during the patient encounter, and is transferred at the end of each shift to a central repository. Completeness of the medical record is checked in weekly audits, and monthly case review sessions.

Measures

Out-of-hospital mortality was defined as a case in which a patient was found dead-on-arrival, or died before reaching a hospital, as documented by EMS. We also assessed the number of cases of respiratory morbidity. This was defined as either a) a chief complaint of "respiratory", "difficulty breathing", or "respiratory infection" or b) a chief complaint that was metabolic or gastrointestinal in nature, combined with an SpO2 of less than 92%. The first group compromised the vast majority of respiratory cases. The decision to include gastrointestinal or metabolic patients with low SpO2 reflected recent reports of atypical COVID-19 presentations with chiefly gastrointestinal symptoms[37] as well as the association with diabetes mellitus[38]. In all cases, if a series of SpO2 measurements were taken, we used the first available value, taken before treatment began. It was protocolized that initial SpO2 was always taken prior to applying oxygen.

For cases of out-of-hospital mortality, we assessed patient age, gender, health insurance status (including uninsured, privately insured, or membership in one of several main public healthcare systems), time from ambulance dispatch to ambulance arrival, if CPR was administered, neighborhood of residence, and administrative geostatistical-area level SES. For respiratory cases, we assessed the aforementioned variables as well as level of consciousness and SpO2.

The neighborhood (*colonia*) of residence was mapped using a shapefile from the Mexican National Population Council (CONAPO). An index of SES *(índice de marginación*) and populations were provided at the level of basic geostatistical area (AGEB, in Spanish) defined by the Mexican Institute of Statistics and Geography (INEGI)[39,40], which typically include several neighborhoods, and are based on 2010 census data. We created a categorical SES variable, defined as population-weighted quintiles of the continuous SES variable, categorized as "lowest", "low", "medium", "high", and "highest". As neighborhoods and AGEB do not overlap perfectly, a linkage was performed between neighborhood and AGEB, in order to assign SES values to each neighborhood. This involved finding the midpoint of each neighborhood and assigning it the SES value of the basic statistical unit where it was located. In the small number of cases where the midpoint of a neighborhood fell outside of a defined AGEB, the neighborhood cluster was assigned to the closest AGEB to the midpoint.

Official data describing COVID-19 cases and deaths[34] in Tijuana were aggregated to weekly totals, and graphed alongside EMS-documented numbers.

Analysis

Changes in out-of-hospital mortality were assessed by comparing weekly statistics from January through July of 2020, to forecasted values estimated using baseline trends from January 1st, 2014 to December 31st, 2019. The process was repeated for the primary outcome measures (number of out-of-hospital deaths, number of respiratory cases) as well as two outcomes assessed as sensitivity analyses (proportion of cases that result in out-of-hospital mortality, proportion of cases that are respiratory in nature) to control for potential differences in case volume. Using OLS regression we modelled the seasonal time trend with a fixed effect dummy variable on each week of the year. The secular trend was captured using a linear continuous fixed effect on year. Forecasts with 95% prediction intervals were made by extrapolating the model through July 2020. Ratios of observed to expected numbers and proportions, and their uncertainty intervals were calculated by dividing the observed value in each week by the forecasted value and prediction interval. We compared pre-epidemic SpO2 values with those seen during the peak epidemic period. We also described trends in the distribution of SpO2 during the epidemic, as measured by quintiles of the distribution of SpO2, and examined the relationship between SpO2 and level of consciousness. For all analyses, "peak COVID" windows were defined as starting the week in which the outcome—either out-of-hospital mortality, or respiratory morbidity—rose clearly above the baseline 95% prediction interval, and ending after the outcome value began to fall sharply or become insignificantly elevated above baseline projections.

We also sought to ensure that no difference in nomenclature, classification, or life support practices occurred in response to the onset of the COVID-19 crisis that could cause an apparent increase in out-of-hospital mortality. We therefore assessed rates of cardiopulmonary resuscitation (CPR), ambulance transit times, and the total composition of all cases, before and during the COVID-19 period.

All cases were included in the sections of the analysis for which they had available data. Missing values are noted as applicable in Tables 6.1 and 6.2.

Results

Overall Profile of EMS Cases

The total number of EMS cases was relatively similar before and during the peak observed COVID period. There was an average of 410 weekly cases between April 14^{th} and May 11^{th}, compared to a weekly mean of 382.9 in 2019 (Fig 7.1). There was, however, a notable shift in the composition of cases. We observed a dropping quantity of non-urgent cases, which fell to 39.0% of all cases in the April 14^{th} to May 11^{th} window, as compared to a 59.1% average for 2019, likely due to social distancing and increased reluctance to use healthcare services for non-urgent matters. Contrastingly, both urgent and deceased cases rose, reaching 11.2% and 20.0% respectively during this period, as compared to 6.7% and 7.9% respectively in 2019.

There were no substantial differences in CPR rates before or during the COVID-19 period (Table 7.1), likely because overall CPR administration rates were generally quite low among non-trauma patients in Tijuana. Average ambulance travel time from dispatch to arrival-on-scene was slightly longer during the observed COVID-19 peak period (20.5 minutes) compared to 2019 (16.4 minutes). Of note, pre-epidemic time-to-arrival intervals were higher than those typically seen in higher-income urban areas, and may help explain low life-support rates among critical patients.

Out-Of-Hospital Mortality

From January to March 2020, the number and proportion of out-of-hospital mortality cases was within or below the 95% prediction interval based on trends observed from 2014 to 2019 (Fig 7.2). However, the week of April 14th saw 80 out-of-hospital deaths (Fig 7.3, Part A) exceeding the previously observed maximum in the timeseries (Fig 7.2). The peak epidemic window for out-of-hospital mortality lasted from April 14th to May 11th. During this time, 329 deaths occurred, which were compared to the predicted number of 134.3 (95%CI: 75.1-193.5) for the same period, yielding an estimated excess of 194.7 (95%CI: 135.5-253.9) deaths. This represents an increase of 145.0% (70.1%-338.2%) compared to expected trends. Similar results were seen when modelling the percent of cases represented by deaths, and when restricting the analysis to only dead-on-arrival pre-hospital mortality. The peak epidemic window of out-of-hospital mortality was observed at the same time as the highest rates of COVID-19 deaths according to official statistics (Fig 7.3, Part C). 418 deaths among confirmed COVID-19 patients were reported during the same peak COVID window (according to official data released on July 15th, 2020). However, only 5 of these deaths were reported as occurring "in an outpatient context", the remainder being reported as occurring among "hospitalized patients"[34].

Out-of-hospital deaths during the peak epidemic period were majority men (68.4%), of working age 18-64 (64.1%), who were beneficiaries of the Mexican National Institute for Social Security (IMSS) healthcare system (45.9%) (Table 7.1). IMSS is a social security scheme providing health care to individuals employed in the private formal sector. Although the age and gender patterns were largely similar to those observed throughout 2019, they were more likely to be IMSS beneficiaries, (45.9% vs. 29.9%, difference=16.3% [95%CI: 10.0%-22.0%]).

Respiratory Morbidity and Oxygen Saturation

In addition to out-of-hospital mortality, we also noted an increase in respiratory cases, which had a peak epidemic window that started earlier than that of out-of-hospital mortality. Respiratory cases rose above the prediction interval of expected values during the week of March 31st (Fig 7.3, part B). Nevertheless, the peak observed to expected ratio occurred in the same week as that of out-of-hospital mortality, reaching 90 cases on the week of April 28th. During the March 31st to May 11th window, 448 respiratory cases were observed, representing 314.9 (224.8-404.9) more than expected, an increase of 236.5% (100.7%-940.0%). Similar results were seen when modelling the percent of respiratory cases. Similar to the trends observed for out-of-hospital mortality, respiratory patients during the March 31st to May 11th period were majority men (61.5%), of working age (72.0%), and IMSS beneficiaries (66.4%) (Table 7.2). Compared with respiratory patients in 2019, respiratory patients in the peak observed epidemic period more likely to be IMSS beneficiaries (66.4% vs. 38.9%, difference=27.6% [22.3%-32.9%]), and have an SpO2 lower than 90% (54.8% vs. 32.4%, difference=22.4% [17.0%-27.9%]).

The overall trend of EMS-documented respiratory cases was quite similar to that observed in confirmed COVID-19 cases reported in official statistics (Fig 7.3, Part D). However, the magnitude was substantially lower; the week of April 14th, for example, saw 314 COVID-19 cases, 188 of which were hospitalized, which greatly exceeded the 79 total EMS-documented respiratory cases.

The mean SpO2 value among respiratory patients declined steadily, from 90.0% during the pre-epidemic period of 2019, reaching a low of 77.7% during the week of April 28th (Table 7.2). Fig 7.4 shows the weekly evolution of the distribution of SpO2 values among respiratory patients.

The highest quintile of the distribution of SpO2 values remained fairly stable throughout the study period, with a median value above 95%. Nevertheless, the remaining quintiles of the distribution generally decreased in their SpO2 values, and a widening of the distribution of SpO2 was observed as a result. In the week of April 7th, the lowest quintile of the distribution of SpO2 values fell sharply, reaching a median SpO2 of 55%. Notably, despite the lower average SpO2, the proportion of patients presenting as alert and oriented did not see a commensurate drop relative to baseline (Table 7.2), even among the lowest quintile of SpO2 values (Fig 7.4).

Socioeconomic Status

EMS data can also provide insights into the location of outbreaks and to social disparities in the distribution of the COVID-19 mortality and morbidity. Fig 7.5 highlights the SES and geospatial distribution of out-of-hospital mortality and respiratory cases in Tijuana. It is noteworthy that the largest clusters of out-of-hospital mortality did not occur in the same locations as the largest clusters of respiratory cases. We observe that clusters of respiratory cases during the peak epidemic period were most concentrated in highest-and high-SES quintiles of Tijuana. Contrastingly, the largest clusters of out-of-hospital mortality cases were seen in the low-SES quintile. As rates per 100,000 people the low-SES quintile of the population saw the highest rate of out-of-hospital mortality at 24.5, while the high-SES quintile saw the highest rate of respiratory cases, at 30.9.

Limitations

We are unable to differentiate whether observed excess out-of-hospital mortality is solely attributable to COVID-19 infections, or if it also reflects increased death rates from other causes. For example, increased cardiac arrest frequency could arise if patients stayed home during ischemic chest pain episodes, because the system was saturated, or they were afraid to seek care. Although we did examine the diagnostic codes associated with each death, the EMTs completing the records were unable to reliably ascertain the cause of death in the majority of cases, and information about prior COVID-19 tests was typically not available. Similarly, our measure of respiratory cases only reflects SpO2 values below 92%, or other respiratory symptoms, and cannot directly indicate patient COVID-19 status. Like any analysis using EMS data, the out-of-hospital mortality statistics presented here cannot capture events occurring in the absence of 9-1-1 activations. Though we note a large increase in out-of-hospital mortality, our results may not represent the full in increase in absolute numbers. However, if the proportion of deaths resulting in 9-1-1 activations were to be correlated with the onset of the COVID-19 pandemic, that could bias our results in an unpredictable direction.

We use neighborhood-level SES which is an imperfect measure of person-level SES. Furthermore, we use population and SES values from the most recent census, 2010, as newer data were not available. This may miss trends in some rapidly changing parts of Tijuana. This analysis should be updated when 2020 census data become available. Additionally, the model we used to extrapolate past trends into 2020 was straightforward in design, and we did not perform out-of-sample predictive validity testing or compare alternative predictive model forms. Nevertheless, given the magnitude of the disparities observed, and the presence of some missing data in past years of observed trends, we opted for a simple and easy-to-interpret model. Furthermore, we note that many studies of this nature simply use the prior year's values as a comparison group[11], and therefore a simple approach may be preferable. Finally, as our results and conclusions were drawn from an observational study from a single context, additional confirmation studies from other settings would be helpful in strengthening the evidence based for these potentially critical aspects of COVID-19 epidemiology.

Discussion

We used data from Tijuana, Mexico to illustrate how EMS systems may be a useful source of real-time information for tracking the COVID-19 epidemic, perhaps especially in LMICs contexts where other sources of information are not rapidly available. We showed that out-of-hospital mortality documented by the EMS system increased dramatically during the peak observed COVID-19 epidemic period seen in April and May 2020. The relative excess mortality—145% above baseline—represents between a two and-threefold higher magnitude increase compared to the 58% figure reported in a recent similar study from the Lombardy region of Italy[11]. This may be related to Tijuana being in a middle-income country, with a relatively more fragile healthcare system and lower-income population. These results suggest that other regions of Mexico, and LMICs in general, may need to plan for, and ameliorate, sharply increasing rates of out-of-hospital mortality in order to prevent a large burden of potentially unmeasured death stemming from the COVID-19 pandemic. These findings echo a growing number of calls for health system strengthening in LMIC in the face of the COVID-19 pandemic[14–18].

During the April 14th to May 11th period in which we estimate 194.7 excess deaths occurred, only 5 official COVID-19 deaths were reported as "outpatient", the remainder being categorized as "hospitalized". This suggests that the increase in out-of-hospital mortality that we observed cannot be explained by official COVID-19 statistics. Importantly, we were not able to ascertain the etiology of the excess mortality we observe. It is therefore possible that most of the excess deaths resulted from non-COVID-19 causes of death, stemming from delay of care or health system saturation. It is also possible that many of the deaths we observe represent COVID-19 patients who were never diagnosed or formally tracked as such. Finally, delays in reporting or data presentation may simply have led to lower weekly totals for out-of-hospital mortality among known COVID-19 patients who are not hospitalized[41]. In any case, EMS data represent an important source of near-real-time information that can be used to rapidly track the evolving health of COVID-19 affected populations. We propose that EMS systems may play an especially important sentinel role in LMICs, and can be used to monitor excess out-of-hospital mortality during the COVID-19 crisis. This function may be of particular importance in LMICs given the lack of access to rapid vital registration records. Nevertheless, we also note that similar trends have been noted in a number of higher-income locations[12,13], and therefore these findings may have relevance to a wide range of contexts.

More research is required to explore what role access to COVID-19 tests, lags in official COVID-19 statistics, or access to hospital beds, may be playing in driving differences between EMS-documented, and official statistics. Increased testing in out-of-hospital settings may be required to determine if excess mortality is being driven by COVID-19 infection, health system saturation, or patient avoidance of healthcare.

Although EMS staff were not able to generate substantial clinical information about patients who died before reaching a hospital, as most were found dead-on-arrival, important clues about the etiology of out-of-hospital mortality may be gleaned by assessing clinical and demographic characteristics among living patients seen for respiratory symptoms during the same period. During the window of observed peak excess mortality, we also observed a concurrent elevation in the rate of patients presenting with respiratory symptoms. These patients had similar demographic characteristics to the out-of-hospital mortality cases. Although the number of respiratory patients reached the highest rate observed during the 2014-2020 period studied, they were still lower than the number of official COVID-19 patients that were hospitalized. This suggests that most officially documented COVID-19 patients are reaching healthcare facilities independently of the EMS system in Tijuana.

The detection of silent hypoxemia is difficult by definition. Patients typically present to EMS services only after they experience dyspnea. Nevertheless, it is possible that some indirect evidence about silent hypoxemia can be observed in the declining SpO2 values seen among respiratory patients during the observed peak COVID-19 window. We saw a sharp decline in mean SpO2 values, although no concomitant decrease was seen among the percentage of patients who were alert on presentation. Hypoxemia is a known predictor of mortality among COVID-19 patients[42], and these data may suggest that silent hypoxemia and subsequent rapid decompensation is a relevant factor to understanding out-of-hospital mortality rates.

Given the novel nature of the COVID-19 pathophysiology, more education about silent hypoxemia is needed for physicians to better manage it clinically, and patients to better understand the risks[27,42]. As COVID-19 quickly overwhelms frail health-systems, clinicians on the frontlines may easily overlook a "well appearing" patient despite a low SpO2, to make room for patients who are overtly sick. It is important for patients to understand that in silent hypoxemia, dyspnea is a late-stage symptom, and their condition may be deteriorating without perceived decreases in subjective respiratory ability[24]. Detection of hypoxemia in the general population should be undertaken, and priority areas can be identified using clusters from EMS data, such as those shown in Fig 7.5 of this text.

The social pattern of out-of-hospital mortality and respiratory cases also deserves consideration and monitoring in the COVID-19 crisis context. We observed a differential trend by neighborhood-SES between out-of-hospital mortality and respiratory cases. Although respiratory cases were strikingly concentrated in the high- and highest-SES quintiles, the highest out-of-hospital mortality rates were observed in low-SES areas. There is a notable difference between respiratory cases and deaths, which may suggest that the profile of individuals who have the economic or social capital to seek care early for respiratory symptoms in Tijuana differs from those who do not interact with the medical system until they are gravely ill. This finding adds to a growing body of literature and social commentary suggesting that social inequalities may be translating into inequalities in the risk of infection or death from COVID-19 in numerous contexts[43–49].

Conclusions

EMS data provide a valuable tool to rapidly track the health of populations at risk of COVID-19 in LMICs, where other forms of real-time data may not be available. EMS information can be used to track excess out-of-hospital mortality and respiratory disease burden, as well as changing clinical or demographic features. Detected clusters of out-of-hospital mortality or cases can be subsequently targeted for screenings for hypoxemia and/or COVID-19 status. Social disparities in COVID-19 and out-of-hospital mortality should be monitored, and additional resources may need to be directed to low-SES areas.

Among respiratory patients, the drop of SpO2 observed during the peak epidemic period suggests that hypoxemia precedes clinical manifestations such as dyspnea, a term coined “silent hypoxemia”. The lack of overt clinical manifestations early in the disease, and the resulting difficulty of detecting silent hypoxemia, may be a driver of out-of-hospital mortality in LMICs where the health system is easily overwhelmed, and accessing EMS services is more difficult.

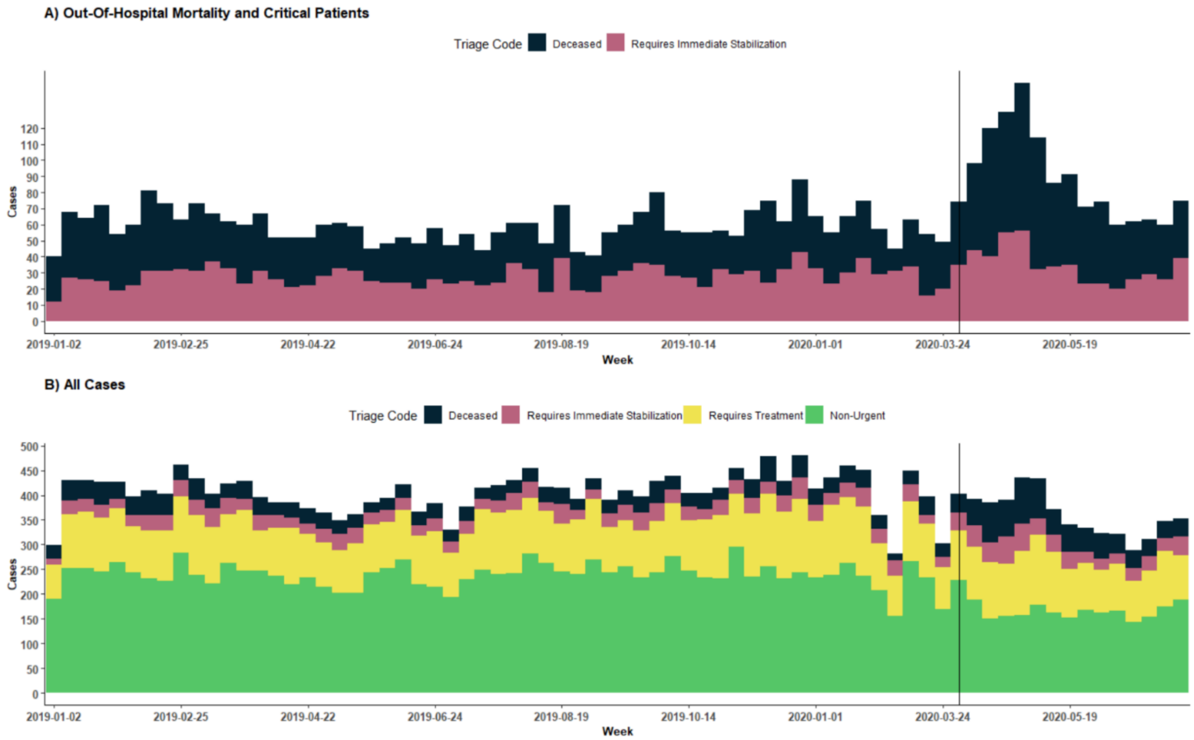

Fig 7.1. Weekly Case Breakdown by Triage Priority Code, 2019-2020
Part A shows only pre-hospital mortality cases and patients in critical condition who require urgent hospitalization. Part B shows the full distribution patients. Both parts refer to non-trauma patients, and include data from 2019 through June 2020. The vertical black line marks the week of March 31st, when respiratory morbidity cases began to rise.

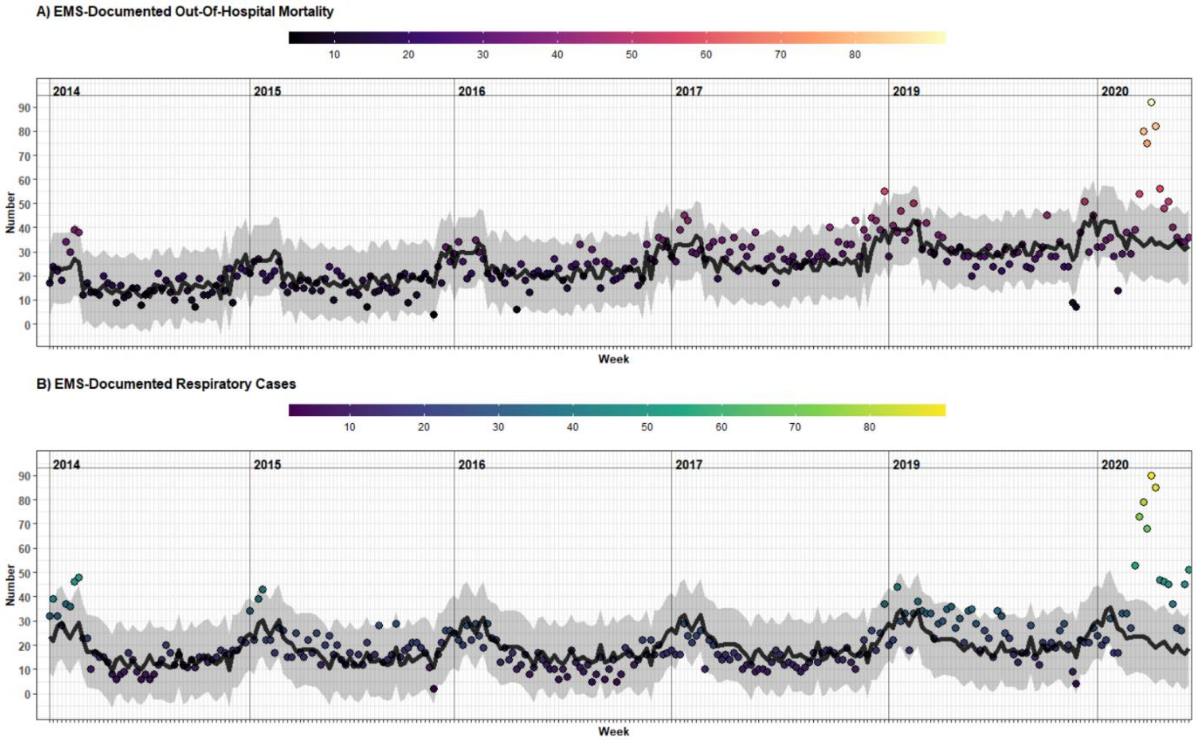

Fig 7.2. Long-Run EMS-Documented Out-Of-Hospital Mortality and Respiratory Cases, 2014-2020

A) EMS-documented out-of-hospital mortality. B) EMS-documented respiratory cases. Parts A and B include expected values (black line) and 95% prediction intervals (grey band) based on model fit on data from 2014-2019, with forecasts through June of 2020. Both series exclude trauma-patients.

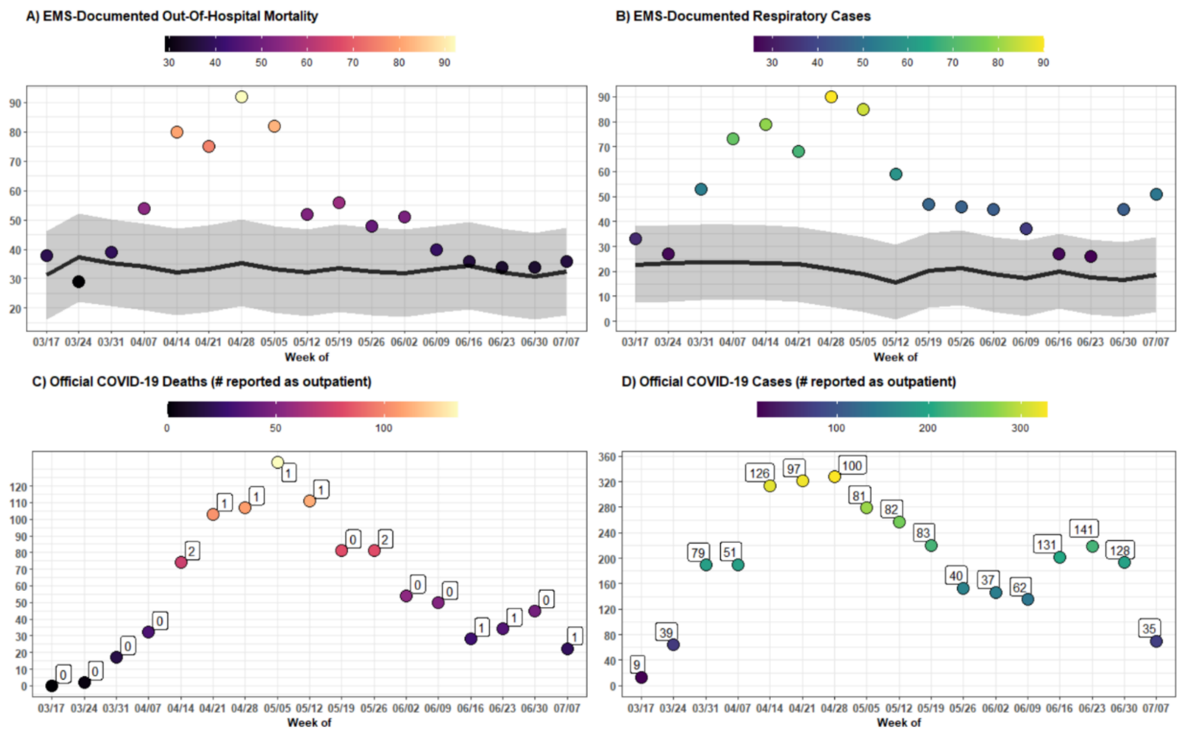

Fig 7.3. EMS-Documented Out-Of-Hospital Mortality and Respiratory Cases Compared to Official COVID-19 Case and Mortality Numbers, March 17th – June 29th

A) EMS-documented out-of-hospital mortality, with the observed and expected number shown in text. B) EMS-documented respiratory cases, with the observed and expected number shown in text. C) Deaths among patients with confirmed COVID-19, according to official national government statistics, with the number reported as managed in the outpatient setting and the total reported in text. D) Number of patients with confirmed COVID-19, according to official national government statistics, with the number reported as managed in the outpatient setting and the total reported in text. Parts A-D refer to weekly totals. Parts A and B include expected values (black line) and 95% prediction intervals (grey band) based on forecasted trends from 2014-2019. Parts A and B exclude trauma patients.

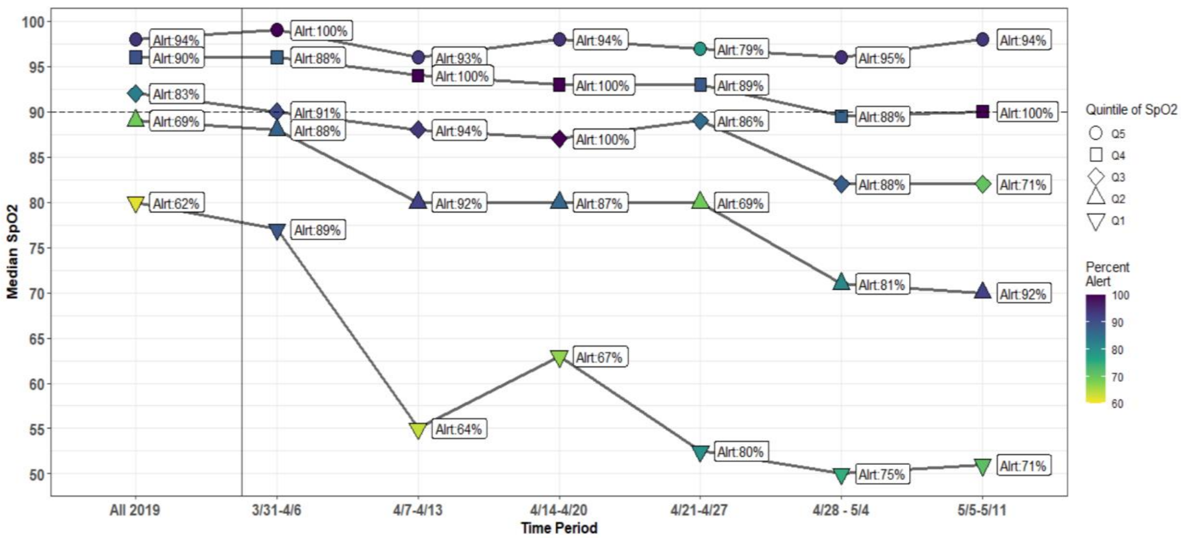

Fig 7.4. Trends in SpO2 and Percent Presenting Alert Among EMS-Documented Respiratory Cases

The distribution of SpO2 values over time is visualized weekly from March 31st to May 11th, 2020 and compared to all data from 2019. Respiratory cases were divided into 5 quintiles of SpO2 values, and the median of each quartile is plotted. The color reflects the percent of individuals in each quartile that presented as alert, which is also plotted as text next to each point.

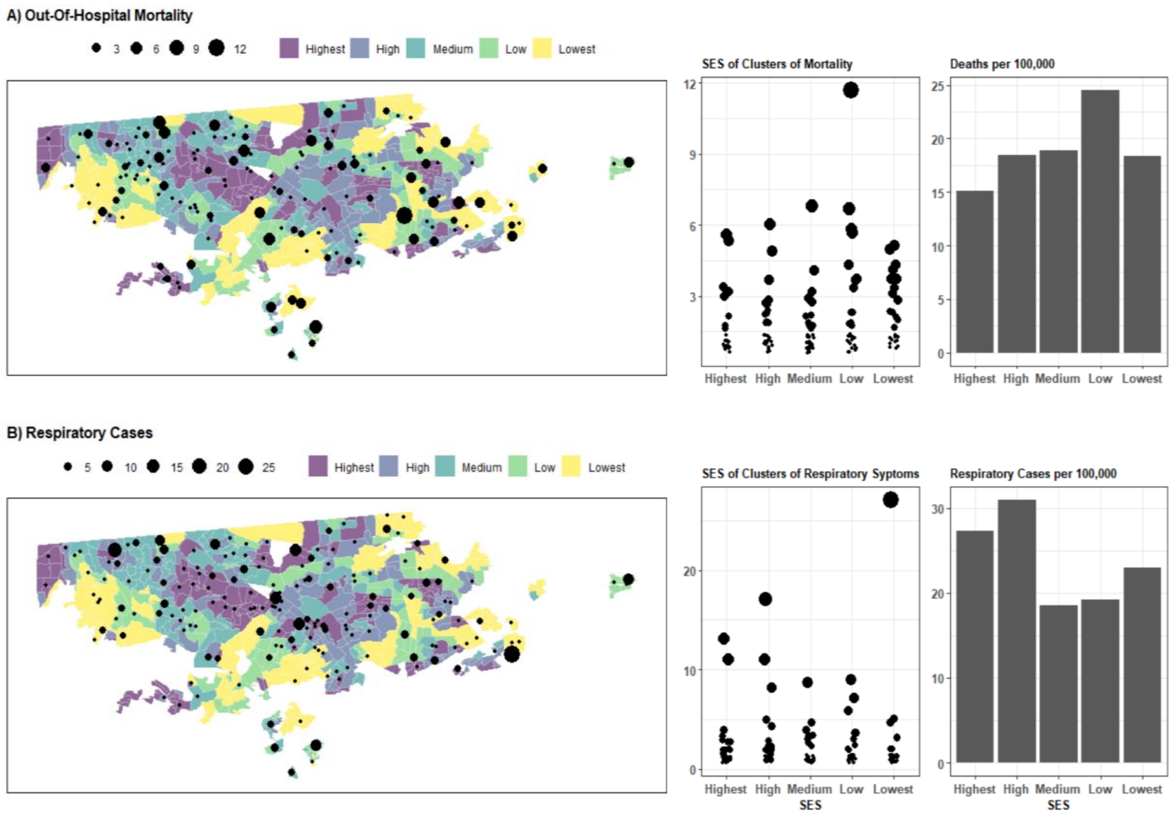

Fig 7.5. Out-Of-Hospital Mortality and Respiratory Cases by Neighborhood and Neighborhood SES

The categorical socioeconomic status (SES) of each basic statistical unit (*ageb)* is mapped for Tijuana. Overlaid is the out-of-hospital mortality occurring during April 14th to May 11th (part A) and respiratory cases occurring during March 31st to May 11th (part B). The number of cases in each neighborhood (*colonia*) is shown as a point, with the size reflecting the magnitude. In the middle column, the points are organized by neighborhood SES. On the right, the number of cases is shown as a rate per 100,000 people, for each quintile of neighborhood SES.

	All 2019 (N=1569)	April 14th to May 11th (N=329)
Age		
Mean (SD)	59.2 (20.1)	58.0 (17.4)
Median [Min, Max]	60.0 [1.00, 104]	59.0 [1.00, 97.0]
Missing	3 (0.2%)	0 (0%)
Categorical Age		
0-18: Pediatric	43 (2.7%)	5 (1.5%)
18-64: Adult	871 (55.5%)	211 (64.1%)
65+: Senior	652 (41.6%)	113 (34.3%)
Missing	3 (0.2%)	0 (0%)
Gender		
Female	499 (31.8%)	104 (31.6%)
Male	1070 (68.2%)	225 (68.4%)
Health Insurance		
IMSS	469 (29.9%)	151 (45.9%)
ISSSTE*	51 (3.3%)	6 (1.8%)
Uninsured	686 (43.7%)	140 (42.6%)
Seguro Popular/INSABI**	285 (18.2%)	20 (6.1%)
Private Insurance	78 (5.0%)	12 (3.6%)
CPR		
Advanced CPR	21 (1.3%)	1 (0.3%)
Basic CPR	47 (3.0%)	4 (1.2%)
None	1501 (95.7%)	324 (98.5%)
Call-to-Arrival Time		
Mean (SD)	16.4 (10.1)	20.5 (12.6)
Median [Min, Max]	15.0 [0, 190]	19.0 [0, 135]
Missing	65 (4.1%)	26 (7.9%)

Table 7.1. Characteristics of Out-Of-Hospital Mortality Patients

Numbers exclude trauma-related deaths. The peak observed mortality period, from April 14th to May 11th, is compared to all of 2019.

*Health insurance for government workers (*Instituto de Seguridad y de Servicios Sociales de los Trabajadores del Estado)*

**Social safety net health insurance *(Instituto Nacional de Salud para el Bienestar)*

	March 31st (N=53)	April 7th (N=73)	April 14th (N=79)	April 21st (N=67)	April 28th (N=90)	May 5th (N=84)	All 2019 (N=1253)
Age							
Mean (SD)	55.8 (18.6)	51.3 (17.1)	49.6 (18.9)	53.8 (15.6)	55.1 (15.9)	57.8 (14.5)	53.5 (24.6)
Median [Min, Max]	55.5 [1.00, 95.0]	51.0 [19.0, 89.0]	44.0 [1.00, 94.0]	52.5 [2.00, 97.0]	56.0 [4.00, 88.0]	58.0 [28.0, 92.0]	56.0 [1.00, 105]
Missing	1 (1.9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (0.2%)
Categorical Age							
0-18: Pediatric	1 (1.9%)	0 (0%)	1 (1.3%)	1 (1.5%)	2 (2.2%)	0 (0%)	118 (9.4%)
18-64: Adult	37 (69.8%)	59 (80.8%)	57 (72.2%)	51 (75.0%)	63 (70.0%)	55 (65.5%)	666 (53.2%)
65+: Adult Mayor	14 (26.4%)	14 (19.2%)	21 (26.6%)	16 (23.5%)	25 (27.8%)	29 (34.5%)	467 (37.3%)
Missing	1 (1.9%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (0.2%)
Gender							
Female	24 (45.3%)	30 (41.1%)	24 (30.4%)	28 (41.2%)	29 (32.2%)	37 (44.0%)	569 (45.4%)
Male	29 (54.7%)	43 (58.9%)	55 (69.6%)	40 (58.8%)	61 (67.8%)	47 (56.0%)	684 (54.6%)
Health Insurance							
IMSS	35 (66.0%)	54 (74.0%)	56 (70.9%)	42 (61.8%)	57 (63.3%)	53 (63.1%)	487 (38.9%)
ISSSTE*	2 (3.8%)	1 (1.4%)	0 (0%)	3 (4.4%)	2 (2.2%)	6 (7.1%)	46 (3.7%)
Uninsured	11 (20.8%)	11 (15.1%)	16 (20.3%)	18 (26.5%)	23 (25.6%)	18 (21.4%)	310 (24.7%)
Seg.Pop / INSABI**	2 (3.8%)	4 (5.5%)	4 (5.1%)	5 (7.4%)	5 (5.6%)	5 (6.0%)	359 (28.7%)
Private	3 (5.7%)	3 (4.1%)	3 (3.8%)	0 (0%)	3 (3.3%)	2 (2.4%)	51 (4.1%)
CPR							
Advanced CPR	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (0.2%)
Basic CPR	0 (0%)	1 (1.4%)	1 (1.3%)	1 (1.5%)	0 (0%)	0 (0%)	7 (0.6%)
None	53 (100%)	72 (98.6%)	78 (98.7%)	67 (98.5%)	90 (100%)	84 (100%)	1243 (99.2%)
Call-to-Arrival Time							
Mean (SD)	18.1 (10.4)	28.7 (63.3)	19.8 (9.62)	21.3 (9.05)	19.8 (14.7)	22.4 (13.4)	16.4 (26.1)
Median [Min, Max]	17.0 [0, 61.0]	17.0 [0, 517]	18.5 [0, 42.0]	20.0 [8.00, 43.0]	18.0 [0, 88.0]	21.5 [0, 67.0]	14.0 [0, 620]
Missing	0 (0%)	8 (11.0%)	11 (13.9%)	10 (14.7%)	13 (14.4%)	4 (4.8%)	57 (4.5%)
Level of Conscious							
Alert	46 (86.8%)	60 (82.2%)	67 (84.8%)	48 (70.6%)	72 (80.0%)	64 (76.2%)	930 (74.2%)
Verbal Stimulus	2 (3.8%)	3 (4.1%)	2 (2.5%)	4 (5.9%)	8 (8.9%)	2 (2.4%)	65 (5.2%)
Painful Stimulus	2 (3.8%)	4 (5.5%)	3 (3.8%)	5 (7.4%)	3 (3.3%)	9 (10.7%)	107 (8.5%)
Unresponsive	0 (0%)	1 (1.4%)	3 (3.8%)	3 (4.4%)	2 (2.2%)	0 (0%)	78 (6.2%)
Missing	3 (5.7%)	5 (6.8%)	4 (5.1%)	8 (11.8%)	5 (5.6%)	9 (10.7%)	73 (5.8%)
SpO2							
Mean (SD)	89.0 (10.4)	83.1 (15.4)	83.1 (14.6)	81.8 (16.2)	77.1 (19.8)	77.7 (18.5)	90.0 (10.6)
Median [Min, Max]	90.0 [50.0, 99.0]	88.0 [40.0, 98.0]	86.5 [30.0, 100]	88.0 [43.0, 100]	82.0 [0, 98.0]	83.0 [31.0, 98.0]	92.0 [0, 100]
Missing	3 (5.7%)	4 (5.5%)	3 (3.8%)	6 (8.8%)	5 (5.6%)	6 (7.1%)	65 (5.2%)

Table 7.2. Characteristics of Respiratory Patients by Week

Numbers exclude trauma-related patients and pre-hospital deaths. The peak observed respiratory case period, from March 31st to May 11th, is compared to all of 2019.

*Health insurance for government workers (*Instituto de Seguridad y de Servicios Sociales de los Trabajadores del Estado)*

**Social safety net health insurance *(Instituto Nacional de Salud para el Bienestar)*

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Chapter 8: Racial/ethnic, social, and geographic trends in overdose-associated cardiac arrests observed by US emergency medical services during the COVID-19 pandemic

A modified version of this chapter appeared as a research article in JAMA Psychiatry:

Friedman J, Mann NC, Hansen H, et al. Racial/Ethnic, Social, and Geographic Trends in Overdose-Associated Cardiac Arrests Observed by US Emergency Medical Services During the COVID-19 Pandemic. JAMA Psychiatry. 2021;78(8):886-895. doi:10.1001/jamapsychiatry.2021.0967

This chapter takes many of the insights derived from the work laid out in Chapter 7—especially the value of EMS records for tracking rapid shifts during the pandemic in an inequalities-oriented fashion—and applies them to shifts in the overdose crisis. Critically, EMS records provided the opportunity to surveill rising racial, ethnic, and geographic inequalities in overdose, which could not be accomplished with 'gold standard' administrative records at the time. Sharp disparities were detected, and this chapter provides a good example of how non-traditional or out-of-the-box approaches can be useful in filling the gap when government actors do not provide socially-stratified data.

Introduction

As the COVID-19 pandemic arrived in the United States, the country was in the midst of a several-decades-long—and accelerating—overdose crisis, with over 70,000 deaths in 2019[1,2]. At the outset of the pandemic, many experts predicted that overdose mortality would increase sharply—due to increased social isolation and instability, and shifts in the drug supply— if adequate measures were not taken to flatten the overdose curve as part of the COVID-19 response[3]. In December 2020, provisional records were released by the Centers for Disease Control (CDC), confirming this prediction; in the first months of the pandemic overdose fatalities spiked sharply, reaching a total of 82 thousand deaths in the 12-month period ending in May 2020[4].

These preliminary data strongly suggest that the social and economic fallout from the pandemic may have exacerbated already increasing overdose rates in the United States. However, existing surveillance systems that could be used to confirm this have significant limitations[5]. For example, the released figures covered only the first two months of significant pandemic-related disruptions—April and May 2020—and trends were not disaggregated by month. Instead, the large increases in mortality seen during those months were averaged together with—and therefore masked by—ten months of relatively lower mortality preceding them.

Importantly, the provisional records are not broken down by race/ethnicity or other social dimensions. This is especially concerning, as the demographics of the overdose crisis has shifted in the years leading up to 2020, driven by several factors, including increasing penetrance of the heroin market with illicitly-manufactured fentanyls[6]. These changes have led to an increasing burden of overdose mortality in communities with historically lower rates, such as among Black, Latinx communities, and in Western states[7,8]. However, it is unclear how the fallout from the COVID-19 pandemic may be affecting this changing social and geographic profile of the overdose crisis.

Given the limitations of traditional mortality databases, data from emergency medical services (EMS) have been increasingly used during the pandemic as a source of near-real-time epidemiological surveillance[9–13]. In this analysis, we expand upon a previously defined methodology[10] to track changes in overdose mortality during the pandemic using a large, national EMS database. We provide updated overdose mortality trends through December 2020, which are stratified by characteristics such as race/ethnicity, geography, urbanicity, and neighborhood poverty level. We also assess the concordance of EMS-based results with provisional total overdose mortality data from the CDC through July 2020, and offer a more thorough characterization of the methods and findings.

Methods

We conducted a retrospective cohort study using data from the National EMS Information System (NEMSIS), a large of cohort of over 11,000 EMS agencies in 49 states, which represented more than 87% of all EMS activations nationally in 2020[9]. Patient care reporting is standardized across the US and data are electronically submitted in near real-time, allowing for rapid surveillance of trends, although some agencies submit records up to a few weeks after incidents occur[14].

We calculated weekly rates of reported overdose-related-cardiac-arrests, as determined by EMS professionals on-scene. In line with prior studies drawing on NEMSIS data, we measured each outcome as a rate per 100,000 EMS activations with patient contact, to adjust for increases in call volume over time, as new agencies join the NEMSIS system[9,10]. Both the numerator and denominator were drawn only from calls for which patient contact occurred, therefore calls canceled prior to arrival on scene, or which no patient was found, were excluded.

Rates were calculated by month and year nationally, as well as stratified by four US census regions and nine US divisions, county urban/rural status (based on 2013 Urban Influence Codes[15]), patient race/ethnicity as identified by EMS provider, and ZIP Code-level education, poverty, and neighborhood racial composition (based on 2013 American Communities Survey files[16]). Missing values in both the numerator and denominator were assessed (see Table 8.1), and missingness was assumed to be proportionally equal across the levels of each stratifier.

As a drop in call volume (the study denominator) has been noted during the initial months of the COVID-19 pandemic[9], we conducted a sensitivity analysis to examine whether a smaller denominator (decreased EMS runs) would explain our findings of an increased overdose fraction. This analysis entailed holding call volume constant for April-June 2020 at March 2020 values, before call volume decreased (illustrated in Fig 8.1).

Provisional rolling aggregates published by the CDC provide the earliest direct evidence about total overdose mortality at the national level, and are generally reported 6 to 12 months later than NEMSIS data[1,5]. We conducted a validation exercise to assess concordance between these two measures. The CDC provisional death records are made available in rolling windows, each representing a 12-month period[1]. The most recent window, at the time of this analysis, covered August 2019 to July 2020. The NEMSIS data used for this analysis were processed in the same fashion (rolling 12-month sums) and compared for concordance in percent change and level. In the CDC data, percent change for a given period reflects the difference between total deaths in a 12-month period, and the 12-month period ending one year prior. For example, the most recent results showed an 24.2% increase between August 2018-July 2019 and August 2019-July 2020. Calculating percent change thus requires data covering a 24-month window. Assessing the level (rate for a given period) requires data for a 12-month window. Monthly NEMSIS data were available for 2017-2020, and therefore concordance in level could be assessed for rolling 12-month windows with end months from January 2018-July 2020. Concordance in percent change could be assessed for rolling 24-month windows with end months spanning January 2019 to July 2020.

Statistical Analysis

Pearson correlation coefficients were calculated to assess the concordance between EMS-observed and total overdose deaths in each rolling 12-month period, for both level and percent increase. Additionally, concordance was assessed graphically, using Bland-Altman plots[17,18]. The average relationship between the level of each measure was calculated using linear regression and applied to the most current EMS data through December 2020, to estimate total overdose deaths for the same period, assuming prior relationships hold true. A 95% confidence interval was calculated based on the uncertainty in the modeled relationship.

This study was deemed exempt from review and informed consent by the UCLA Institutional Review Board. This study follows the STROBE reporting guideline for cohort studies[19].

Results

The 2020 NEMSIS database represented 33.4 million EMS patient-encounters, including 20.0 thousand overdose-cardiac arrests, as defined by EMS professionals on-scene (Table 8.1). The proportion of baseline characteristics among all calls, such as patient race/ethnicity, and census region, remained relatively constant between the baseline years (2018 & 2019), and 2020. Encounters in 2020 were administered to 50.2% female patients, and 48.8% non-Hispanic White individuals.

EMS-observed overdose-cardiac arrests rose sharply during April 2020, reaching the highest value ever recorded for a single month of 2,112 in May 2020 (Fig 8.1, Part A). Total patient-encounters decreased by about 20% in this period, to a low of 2.3 million in April 2020 (Fig 8.1, Part B). Overdose-cardiac arrests per 100,000 EMS activations with patient contact increased to a high of 78.9 in May of 2020 (Fig 8.1, Part C), representing +98.3% above baseline (Fig 8.1, Part D). The rate slowly declined over the remainder of 2020, reaching 56.7 per 100,000 by December 2020, 21.4% above baseline. Overall, values in 2020 were elevated by 42.1% above baseline. In the sensitivity analysis, assuming a constant call volume (denominator) during April through June 2020, overdose cardiac arrests remained elevated in 2020 by 38.4%.

Stratified Trends

Among multiple strata of demographic variables, groups with historically lower overdose mortality—such as African Americans, and people in Western states—saw the highest percent increases in 2020. For example, although White patients began with the highest rate of overdose-cardiac arrests, larger relative increases were seen among Black and Latinx patients, with 49.7% and 50.3% respectively, compared to 38.3% among white patients (Fig 8.2). Similarly, the largest relative increases were seen among medium, and high-poverty ZIP Codes, although low-poverty areas began with the highest levels. Rates in 2020 increased 54.6% in rural counties, compared to 38.2% in urban counties, although urban areas had the highest starting rates of 44.5 per 100,000.

This effect was especially pronounced across geographies (Fig 8.3). The Northeast census region started with the highest level of overdose-cardiac-arrests, at 67.8 per 100,000, though it had the smallest percent increase in 2020, of 4.8%. The largest relative increases were seen in the West (52.2%) and South (48.5%). At the census division level, New England had the highest rate in 2020 of 70.2 per 100,000, yet this represented a small decrease of -3.8% from 2019. The Pacific Census Division had lower rates in 2019 (33.1 per 100,000) with the largest percent increase in 2020 of 63.8%.

Stratified trends should be assessed in the context of missingness, which varied by the dimension used to stratify. Not surprisingly, missing patient race/ethnicity data was common, approximately 20%, because it can be difficult to assess in an emergency situation (Table 8.1). Variables derived from incident location had much lower missingness, such as census region and division, with less than 2%. Stratifying variables defined at the ZIP Code level had intermediate missingness of about 5-10%, depending on the time period and measure.

Validation Exercise

At the national level, high concordance was detected between EMS-observed and provisional total overdose death figures, both in percent increase (r=.97) and level (r=.98). Concordance was also assessed visually using a Bland-Altman plot (Fig 8.4, Part B), which also showed good agreement. Across 19 distinct periods for which 12-month rolling window comparisons were possible, EMS-observed deaths could be seen to both underestimate and overestimate total overdoses, suggesting no systematic bias up or down (Fig 8.4, Parts A and B). However, in the most recent data through July 2020, EMS-data showed an increase of 34.6%, compared to only 24.4% in the CDC total overdose trends. This time period also represents the largest magnitude increase in both timeseries. If the historical average relationship between EMS-observed and total overdose mortality holds true for the most recent EMS data, we expect 90.6 thousand (95% confidence interval: 85.7 thousand – 95.5 thousand) overdose deaths to eventually be reported by the CDC for 2020.

There was general concordance between the two estimates when stratified by census regions and divisions, although with increasing geographic granularity the relationship became noisier. In the Midwest, reported EMS-observed overdose deaths overestimated the percent change seen in total overdose mortality, with 45.6% and 22.9% increases respectively, whereas they were largely concordant in the Northeast, West, and South.

Discussion

The COVID-19 pandemic has highlighted the need for faster data collection mechanisms to track overdose mortality in an up-to-date manner, and facilitate a more precise public health response[20,21]. Provisional mortality records often lag by many months due to delays in the data generating processes such as toxicology and autopsy services[5]. Furthermore, these records are often not disaggregated by race/ethnicity or other social categories, although important changes are known to be occurring along these dimensions.

In light of these limitations, our findings suggest that EMS databases may provide a unique opportunity to rapidly surveil shifts in overdose mortality in the United States. Although EMS databases have limitations that should be considered, the high degree of concordance with recent trends in total overdose mortality suggests they may serve as a reliable proxy. Further, EMS data can be uploaded to the NEMSIS system in near-real-time. A recent estimate indicates that records pertaining to 75% of the incidents occurring on a given day are uploaded and available in the NEMSIS system with 7.75 days[22]. Additionally, EMS trends can be broken down by exact date of occurrence, as well as race/ethnicity, and other social and geographic characteristics to monitor the shifting profile of the overdose crisis. Further study is warranted to assess exactly how NEMSIS and other related EMS databases may be able to serve effectively as an early warning system, to give public health officials highly current information regarding changes in overdose. A similar approach would likely also be useful for monitoring other outcomes such as suicide attempts and mortality, and myriad other conditions for which rapid shifts could occur. Additional study should also consider differences between fatal and non-fatal overdose trends occurring during the COVID-19 pandemic, and dig deeper into the causal mechanisms underlying increases in overdose in 2020.

We note sharply increasing overdose rates in all regions of the continental United States, except for the Northeast, which had relatively stable—albeit previously the most highly elevated—trends. This observation is consistent with recent evidence suggesting rising overdose deaths in the Western United States in recent years, largely being driven by the entrance of illicitly manufactured fentanyls into the drug supply[4,7]. The COVID-19 pandemic appears to have accelerated this trend, with greater than 40% increases in EMS-observed overdose death rates occurring in the West, South, and Midwest census regions.

Stratifying by race/ethnicity, we saw that the largest relative increases in overdose-cardiac-arrests during the pandemic occurred among Black and Latinx individuals, despite White individuals having had the highest rates at baseline. This finding is consistent with recent data showing the fastest growth in overdose mortality among communities of color[23]. This likely reflects the overall evolution of the overdose crisis, often described to have 3 waves[24,25]: 1) initially driven by opioid pain relievers that were disproportionately marketed and prescribed to White patients[26–29], 2) subsequently transitioning to being driven by heroin, once regulations of opioid prescribing were strengthened, and 3) most recently reflecting the spread of illicitly manufactured fentanyls, a family of ultrapotent synthetic opioids, which are less bulky and easier to smuggle than heroin, and have been added to a growing percentage of the heroin supply[6,7]. Disproportionate numbers of Black people who use drugs are exposed to fentanyl[30,31], which may reflect a relative lack of social power, given that the inability to avoid unintentional fentanyl exposure has been characterized as an inequality between different groups of people who use drugs[32]. Furthermore, the high prevalence of fentanyl has strengthened recent incarceration as a risk factor for overdose, as many individuals are released with lowered tolerance and unaddressed substance use disorder, into a context of great difficulty securing social and medical services[33]. Combined with deep-seated racial inequalities in incarceration rates[34,35], this may reflect an important driver of growing fentanyl-related overdose among Black communities. Given pre-existing racial/ethnic inequalities in access to treatment and prevention efforts[36], and the disproportionate direct and indirect effects of the pandemic born by communities of color[37], this suggests structural interventions are required to stem the rising tide of overdose mortality in more vulnerable communities.

Commonalities between rising overdose rates and a greater burden of COVID-19 mortality in more socioeconomically disadvantaged areas, and in communities of color, likely reflect similar structural drivers. The United States has a long history of deep-seated disparities in economic opportunities, employment, housing, access to healthcare, education, and incarceration rates, many of which have been exacerbated by the fallout from the COVID-19 pandemic[37–40]. The overdose crisis has played out in a racialized manner for many reasons, and structural racism in the healthcare system and US drug policy has harmed both White communities and communities of color, in different ways, and at distinct historical moments[26,26–28]. Moving forward, ameliorating these fundamental drivers of inequalities in overdose mortality and myriad other public health outcomes, must be prioritized[25].

Unprecedented increases in overdose deaths during the pandemic necessitate investments in overdose prevention as an essential aspect of the COVID-19 response and post-pandemic recovery. This should entail increased resources for substance use treatment, harm reduction, reducing the toxicity of the opioid supply, and systems-level approaches to addressing the structural, social and economic drivers of overdose risk[25,41]. Given the current crisis, many evidence-based interventions should be considered, including: lowering barriers to accessing methadone, including allowing it to be dispensed from pharmacies, eliminating the X-waiver and byzantine bureaucracy to prescribe buprenorphine, providing a safe supply of legal opioids free of harmful contaminants, and supporting overdose prevention sites[3,42,43]. Furthermore, as survival becomes more difficult for millions of Americans, economic investments in ensuring adequate employment, housing, healthy food, and healthcare for all Americans will be needed to avoid exacerbating these root drivers of overdose[25,44], as well other "deaths of despair" such as suicide[45].

Limitations

This study has several limitations that should be considered. EMS-observed overdose deaths are only a proxy for total overdose mortality. If the proportion of national overdose deaths that is observed by EMS shifts due to the pandemic, that could bias our results up or down. High concordance through the most recent total mortality database is encouraging, but further validation will need to be sought once final statistics for 2020 are available.

High missingness in the race/ethnicity variable of about 20% limits confidence in race/ethnicity-stratified trends. However, trends using this variable did have generally good concordance with the dichotomous white/non-white ZIP Code level variable, which had lower missingness.

Conclusions

In this cohort study, records from EMS agencies—which were available 6-to-12 months ahead of total mortality records from the CDC—were found to serve as a reasonable proxy for forthcoming overdose mortality. Both of these datasets demonstrated a large magnitude national increase in overdose mortality during the COVID-19 epidemic in the US, with EMS data through December 2020 showing annual values elevated by 40% above baseline. If the historical relationship between EMS-observed and total overdose mortality holds true, we expect that from 85 to 95 thousand overdose deaths will eventually be reported by the CDC for 2020, making it the deadliest year on record. EMS trends disaggregated by race and geography indicated that the largest percent increases were observed among groups with historically lower mortality, such as African Americans, people living in Western states, rural counties, and more impoverished areas. Such unprecedented increases in overdose deaths during the pandemic necessitate investments in overdose prevention as an essential aspect of the COVID-19 response, especially for low-income communities and communities of color that are now experiencing the double burden of disproportionate COVID-19 mortality, and more rapidly rising overdose deaths.

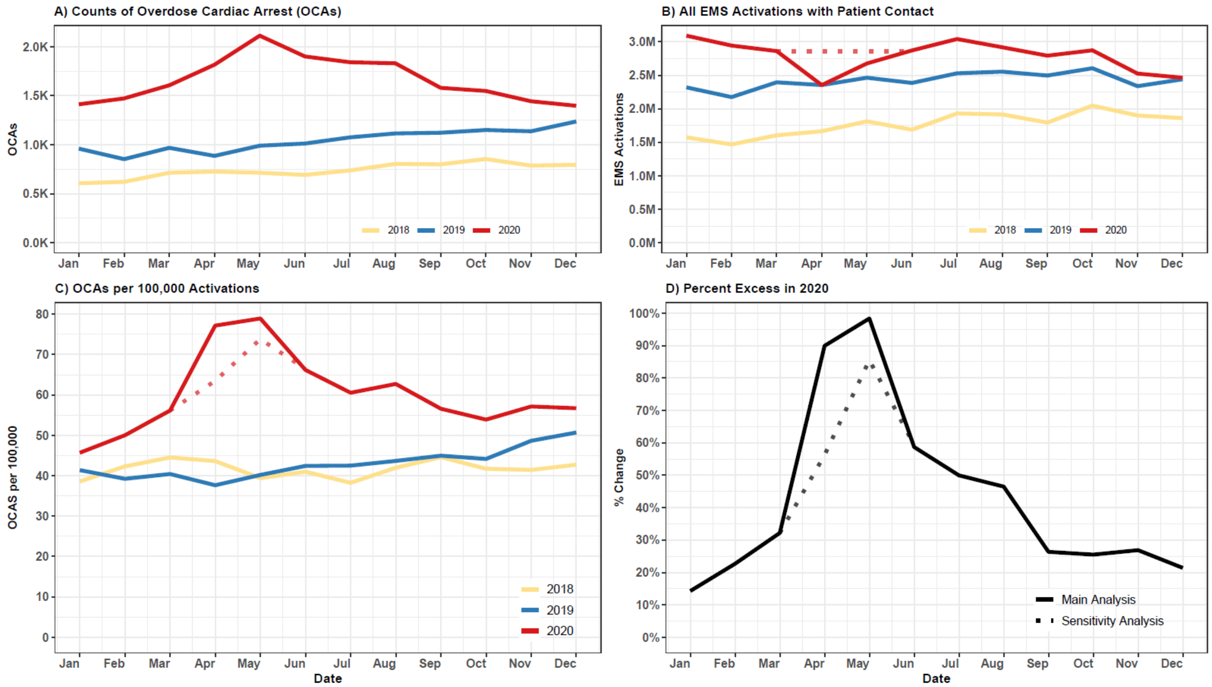

Fig 8.1. Overdose-Related Cardiac Arrests, Counts and per 100,000 EMS Activations, 2018-2020

Part A shows total counts of OCAs observed by EMS each month in the NEMSIS database. Part B highlights the outcome denominator, EMS activations (excluding calls where no patient contact was made). The dotted line highlights the denominator used in the sensitivity analysis. Part C shows the study outcome variable, OCAs per 100,000 activations. Part D shows the percent excess observed in 2020, relative to the baseline (the average of monthly values from 2018 and 2019), for the main and sensitivity analyses.

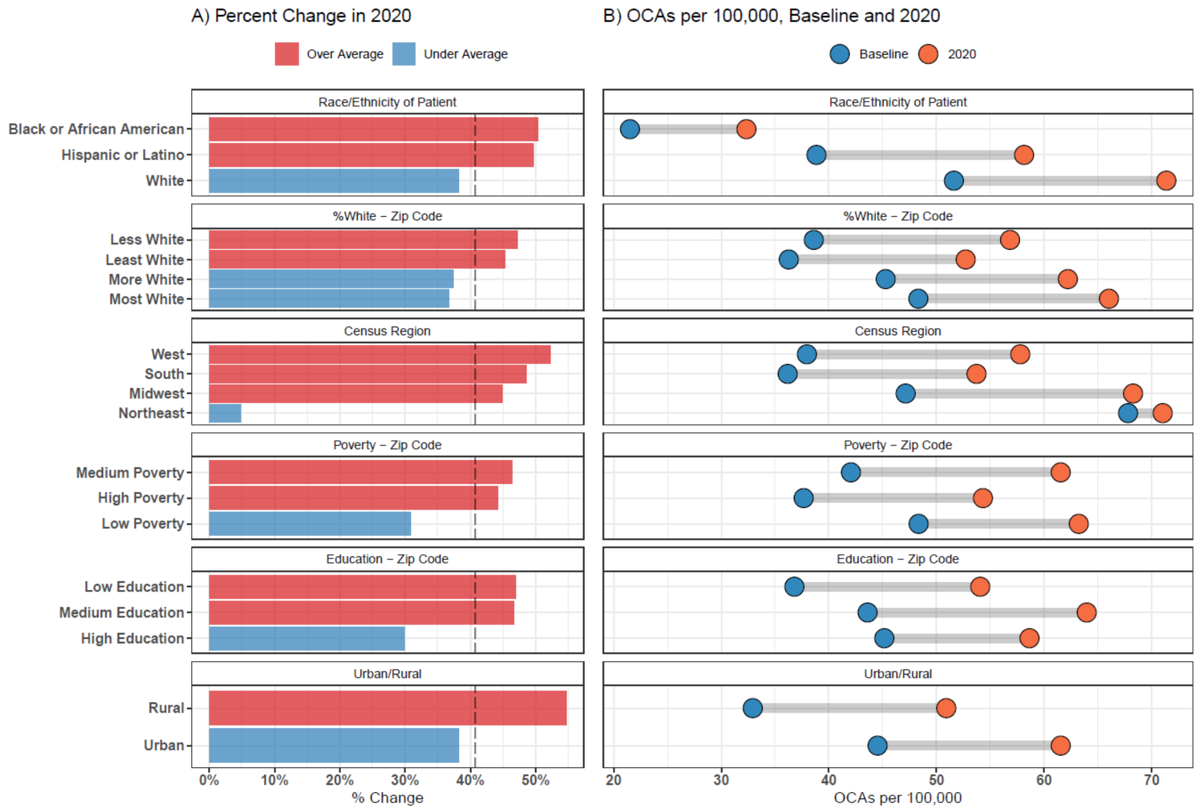

Fig 8.2. Overdose Cardiac Arrests (OCAs) % Change and Level Stratified by Race, Census Region, and Neighborhood Characteristics

This figure provides trends for the main study outcome—overdose-related cardiac arrests per 100,000 EMS activations—stratified by patient race, census region, and neighborhood characteristics including % white, % living under the poverty line, % achieving at least high school education, and urbanicity. Part A shows the increase in 2020 relative to baseline (defined as the average of 2018 and 2019). Part B shows the level in 2020 and at baseline. The definitions of each category (such as 'high poverty') can be found in Table 2.

I

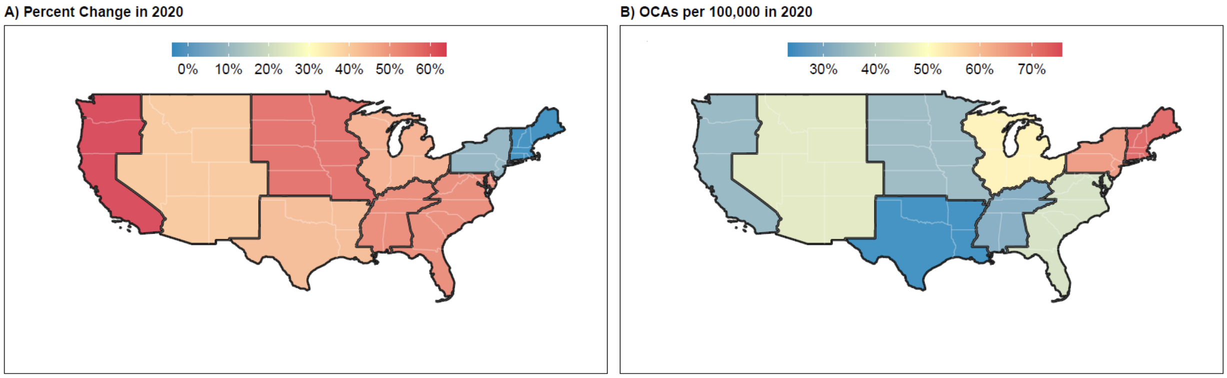

Fig 8.3. OCAs per 100,000 Activations, Percent Increase and Level of OCAs by Census Division, 2020

This figure provides trends for the main study outcome—overdose-related cardiac arrests per 100,000 EMS activations—stratified by census division. Black lines demarcate separate census divisions—the level at which the data are shown—and state boundaries are shown in white for additional context. Part A shows the increase in 2020 relative to baseline (defined as the average of 2018 and 2019). Part B shows the level in 2020.

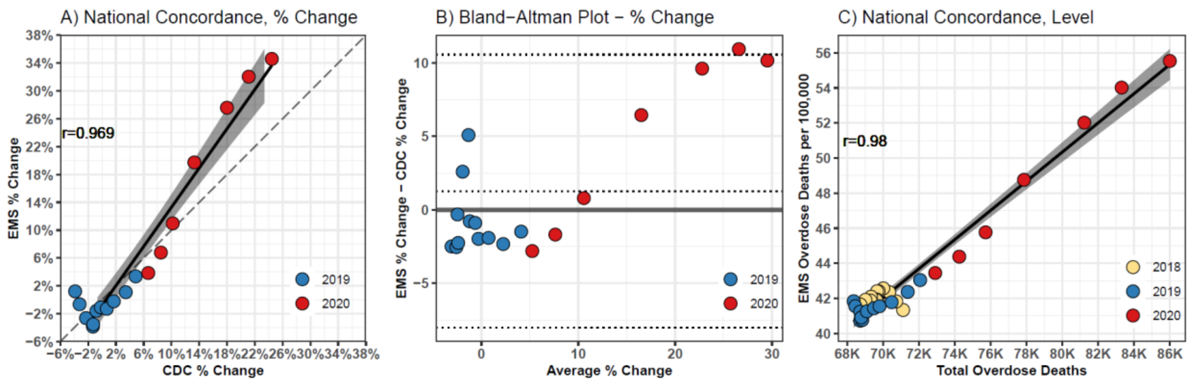

Fig 8.4. Validation Exercise - Concordance Between EMS-Observed (NEMSIS) and Total Provisional Overdose Deaths (CDC)

This figure summarizes the validation exercise, assessing the concordance between reported EMS-observed overdose cardiac arrests from NEMSIS, and provisional total overdose deaths from the CDC. In Part A, a dashed line of equality is plotted to show where the percent change in both metrics is equal. A line of best fit and 95% confidence interval is also shown for both percent increase and level, and the correlation coefficient (r) for each relationship is highlighted in the top left corner (Parts A and C).. Part B shows a Bland-Altman diagram for percent change in both measures. The solid line marks 0, and the central dashed line shows the average difference between the percent errors in both datasets, which was very close to 0, suggesting good agreement on average. The outer dashed lines mark two standard deviations from the mean. Ideally, 95% of points should fall within these bounds, and in the observed data, only 1 of 19 points exceeds them.

	Overdose Cardiac Arrests (Thousands)		EMS Activations (Millions)	
	2020	**2018-2019**	**2020**	**2018-2019**
Total	**20**	**21.4**	**33.4**	**50.3**
Census Region				
South	8.4	8.7 (41.0%)	15.6	24.3 (48.2%)
Northeast	4.1	4.4 (20.5%)	5.8	6.5 (12.9%)
West	3.8	4.0 (18.8%)	6.5	10.6 (21.1%)
Midwest	3.4	3.8 (17.6%)	5.0	8.0 (15.9%)
Missing	0.3 (1.7%)	0.5 (2.1%)	0.5 (1.6%)	0.9 (1.9%)
Census Division				
South Atlantic	5.8	6.3 (29.5%)	8.8	14.6 (29.1%)
Middle Atlantic	3.2	3.1 (14.4%)	4.6	4.7 (9.3%)
East North Central	2.5	3.0 (14.1%)	3.3 (9.9%)	5.8 (11.6%)
Pacific	2.2	2.1 (9.8%)	4.1	6.3 (12.6%)
East South Central	1.1 (5.4%)	0.9 (4.3%)	2.3 (6.9%)	3.0 (6.0%)
Mountain	1.6 (7.8%)	1.9 (9.0%)	2.5 (7.4%)	4.2 (8.4%)
West South Central	1.5 (7.4%)	1.5 (7.2%)	4.5	6.6 (13.2%)
West North Central	0.9 (4.5%)	0.7 (3.5%)	1.7 (5.0%)	2.2 (4.3%)
New England	0.8 (4.2%)	1.3 (6.1%)	1.2 (3.6%)	1.8 (3.5%)
Missing	0.3 (1.7%)	0.5 (2.1%)	0.5 (1.6%)	0.9 (1.9%)
Urban/Rural County				
Urban	16.4	17.6 (82.6%)	25.9	38.5 (76.6%)
Rural	2.8	2.8 (13.3%)	5.3	8.4 (16.6%)
Missing	0.8 (4.0%)	0.9 (4.2%)	2.3 (6.8%)	3.4 (6.8%)
% High School in ZIP Code				
High Education (91-100%)	6.1	7.2 (33.8%)	10.0	15.5 (30.7%)
Medium Education (81-90%)	4.4	4.3 (20.2%)	7.8	11.3 (22.5%)
Low Education (<81%)	8.6	8.9 (41.5%)	13.1	19.7 (39.1%)
Missing	0.9 (4.3%)	1.0 (4.5%)	2.5 (7.5%)	3.8 (7.6%)
% Poverty in ZIP Code				
High Poverty (>20%)	5.5	5.7 (26.6%)	9.7	14.6 (28.9%)
Medium Poverty (11-15%)	7.9	8.1 (38.0%)	12.3	18.6 (37.0%)
Low Poverty (<11%)	5.7	6.6 (30.8%)	8.8	13.2 (26.1%)
Missing	0.9 (4.4%)	1.0 (4.6%)	2.6 (7.7%)	4.0 (7.9%)
%White in Zip Code				
Least White (<50%)	3.2	3.1 (14.3%)	5.9	8.1 (16.2%)
Less White (50-74%)	5.0	5.3 (24.9%)	8.6	13.3 (26.5%)
More White (75-89%)	6.0	6.8 (31.7%)	9.4	14.4 (28.7%)
Most White (>89%)	4.7	5.2 (24.3%)	6.9	10.4 (20.7%)
Missing	0.9 (4.6%)	1.0 (4.8%)	2.6 (7.8%)	4.0 (8.0%)
Race/Ethnicity of Patient				
White	11.7	13.3 (62.3%)	16.3	26.0 (51.7%)
Black or African American	2.1	2.1 (10.0%)	6.4	10.0 (20.0%)
Hispanic or Latino	1.3 (6.5%)	1.3 (6.1%)	2.2 (6.6%)	3.4 (6.8%)
Other	0.3 (1.5%)	0.3 (1.3%)	0.7 (2.0%)	1.0 (2.1%)
Missing	4.5	4.2 (19.8%)	7.6	9.5 (18.9%)
Gender of Patient				
Female	6.2	7.0 (33.0%)	16.8	26.0 (51.6%)
Male	13.7	14.2 (66.4%)	16.4	23.9 (47.6%)
Missing	0.1 (0.4%)	0.1 (0.7%)	0.2 (0.7%)	0.4 (0.8%)

Table 8.1 Characteristics of Overdose Cardiac Arrests and EMS Activations

Characteristics of the study numerator and denominator occurring in the 2018 to 2020 time period are shown as counts (percentages). Baseline refers to 2018 and 2019. Overdose cardiac arrests (numerator) are shown in thousands, and EMS activations entailing patient care (denominator) are shown in millions.

Chapter 8 References

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Chapter 9: COVID-19 and the drug overdose crisis: Uncovering the deadliest months in the United States, January-July 2020

A modified version of this chapter appeared as a research article in the American Journal of Public Health:

Friedman J, Akre S. COVID-19 and the Drug Overdose Crisis: Uncovering the Deadliest Months in the United States, January–July 2020. Am J Public Health. Published online April 15, 2021:e1-e8. doi:10.2105/AJPH.2021.306256

The third 'out-of-the-box' data science case study is an exersize in critiquing the format of 'gold standard' administrative records for their usefulness in monitoring rapid shifts, such as those occurring during the COVID-19 pandemic. This case study demonstrates that the format used by the CDC for providing provisional overdose deaths during the pandemic actually masked many of the most important shifts and state-level inequalities. Using a straightforward algorithm the CDC's aggregation function was reverse-engineered and the underlying monthly values were recovered and provided in a public format for use in tracking rapid shifts. Similar approaches can be used to increase the public usability of surveillance records made available in difficult or cryptic formats—often a requirement to conduct rapid or inequalities-oriented surveillance.

Introduction

Unofficial data sources, proxies, and provisional records indicate that overdose deaths in the United States are spiking during the COVID-19 pandemic[1–4]. National Emergency Medical Services (EMS) data—disaggregated by week—show very large magnitude increases in overdose during the pandemic period, reaching over double baseline values by May 2020[2]. Syndromic surveillance data from emergency-departments show similar increases in visits for overdose, as well as mental health conditions, and intimate partner violence[5]. Several states have also published provisional mortality records for the same period, demonstrating large magnitude spikes in overdose deaths[6,7]. A similar pattern is likely to be present at the national level. However, given limitations of provisional overdose mortality reporting, the magnitude of the increase cannot yet be determined from official mortality statistics.

In December 2020, the Centers for Disease Control and Prevention (CDC) released an emergency advisory, showing that from June 2019 to May 2020, 81,320 people died of a drug overdose in the United States—representing an increase of 18.0% over the prior 12 months[8]. However, this 12-month period covered only the first three months of pandemic-related disruptions—March through May 2020. As provisional trends are disaggregated by month, any large spikes occurring during the pandemic would be combined with—and potentially masked by—9 months of lower, pre-pandemic values.

In a typical year, the practice of providing rolling aggregate trends is useful for stabilizing rates—especially in states with small populations—given numerous challenges in overdose surveillance. Mortality records are contributed by all 50 US states and the District of Columbia to the National Center for Health Statistics, where they are analyzed centrally[9]. The lag time between a death's occurrence and the date upon which it is reported to the central repository is generally longer for overdose than other causes of death[10], and can vary by state[9]. Therefore, provisional estimates of overdose mortality are typically released on at least a 6-month lag. Even then, modelling is undertaken to correct estimates for additional underreporting[11]. Provisional records consequently include both 'reported' deaths for a given period, as well as 'predicted' deaths, which are estimated by observing prior reporting delays and assuming they will affect current death levels in a similar fashion[11]. In this context, reporting rolling 12-month sums can help to insulate estimates against stochasticity or shocks, which could stem from shifts in reporting lags, and also adjust for seasonality, as all 12 months of each calendar year are always included in each estimated rate[9,11].

Nevertheless, during an unprecedented event such as the COVID-19 pandemic—where the potential exists for drastic month-to-month shifts—we argue there is value in assessing the existing data for the presence of shocks alongside smoothed trends. In this article we estimate the original monthly mortality values underlying aggregated provisional trends, in order to determine how many individuals died of overdose in March through July of 2020, as the pandemic dramatically changed life in the United States.

Methods

We estimate the original monthly mortality values underlying provisional aggregate trends. To accomplish this, we leverage the fact that a) precise monthly values are known through the end of 2019[12], and b) provisional rolling sums are released for 12-month periods with end dates spanning January to July 2020[9]. By cross-referencing these two timeseries, we can estimate monthly values for 2020, drawing on a straightforward algorithm.

For example, let us consider the case of overdose mortality for January 2020. We have a 12-month cumulative value (for a particular state) pertaining to February 2019-January 2020. We subtract off monthly values for February 2019-December 2019, leaving only the monthly value for January 2020. We can subsequently extract the value for February 2020 using the 12-month data from March 2019-February 2020 and subtracting off precise monthly values from March 2019-January 2020. This exercise is repeated for March, April, May, June, and July 2020. In this way, each recovered value is used to help extract data from the next month, in a set of chained calculations. We do this for each US state, and aggregate them up to the level of census divisions and the national total.

We also quantify how precisely this algorithm can recover monthly values, by assessing its performance on previously released provisional aggregates, for which we now have exact monthly values. This method can perfectly recover monthly values when the final and provisional statistics provided by the CDC are internally consistent. In practice, though, these two data sources do have small differences, largely because the provisional numbers use modelling to attempt to compensate for reporting lags of greater than 6 months, but these methods are imperfect. Furthermore, there are some small definitional differences between the two data sources which could introduce errors. For example, provisional records include all deaths occurring in a given states, while final numbers reflect the deceased's state of residence. Additionally, counts of fewer than 10 deaths are suppressed in final monthly death data, requiring assumptions about the distribution of deaths for the small number of state-months with low values.

We quantify the errors stemming from these differences by comparing the data sources for the period for which both are complete, 2015 through 2019. We calculate the average degree to which our algorithmically derived values deviate from subsequently released final trends and use these errors to produce empirically derived 95% prediction intervals. The algorithm, and all code used in this analysis, is available in a public repository (https://github.com/akre96/cdc_overdose).

Results

We find that 9,192 (95% prediction interval: 8,988- 9,397) people died of overdose in May 2020—making it the deadliest month on record—representing a 57.7% (54.2% - 61.2%) increase over May 2019 (Fig 9.1). Values remained elevated in June 2020, at 35.8% (32.8% - 38.8%) above June 2019. Mortality rates increased again in July 2020, reaching 43.6% (40.4%-

46.9%) above July 2019. Overall, values in the first seven months of 2020 were elevated by 34.8% (31.9% - 37.8%) relative to the equivalent months of 2019.

At the Census Division level, the largest relative increases in overdose deaths in May 2020 compared to May 2019 were seen in the East South Central, South Atlantic, and Pacific divisions, with increases of 99.2% (87.8% - 110.7%), 72.7% (66.6% - 78.8%), and 62.0% (56.4% - 67.7%), respectively (Table 9.1). New England had the smallest relative increase of 25.1% (17.8% - 32.3%).

At the state level, a large magnitude increase in May 2020 could be seen for nearly every state with a large enough population to assess monthly trends (Fig 9.2). West Virginia, Kentucky, and Tennessee had the highest per-capita monthly death rates in May 2020 of 93.2 (81.6- 104.8), 56.0 (52.1– 59.8) and 51.0 (48.3– 53.7) per million inhabitants, respectively, representing 178.3% (143.6% - 213.1%), 140.4% (123.8% - 157.0%), and 97.7% (87.2%-108.2%) increases over May 2019, respectively.

The states with the greatest pandemic-related increases were, in many instances, not the same states with the largest 12-month increases in the latest CDC-produced aggregates ending in 2020. For example, West Virginia and Connecticut had similar percent increases in rolling aggregates ending in May 2020, of 22% and 24%, respectively. However, in monthly data from May 2020, West Virginia had an increase of 178% compared to only 14% in Connecticut. Nevada had a negative percent change of -4% in rolling 12-month trends ending in May 2020, nevertheless monthly data from May 2020 showed a 63% increase. The overall R^2 between the percent increase in monthly data from May 2020 and 12-month rolling sums ending in May 2020 was 0.272, reflecting a relatively low level of correlation.

On average, the algorithmic approach outlined here was able to estimate monthly values from provisional aggregates with a high level of precision, compared to subsequently released finalized monthly values, for the 2015-2019 period where both could be compared.. At the national level, for example, estimating from 1 to 7 months out from the most recent final monthly trends (the task necessary to recover values from January to July 2020) the median absolute percent error (MAPE) was 0.47%. In other words, the method predicted subsequently reported monthly values on average within half a percent. The standard deviation of the percent error was 1.1%. Therefore, a 95% prediction interval for a national-level estimate would reflect that we expect the final monthly value to fall within a margin of approximately +/- 2% of the prediction made using our algorithm. MAPEs for division-level statistics also tended to be quite small, ranging from 0.7% in East North Central division to 2.8% in New England. State level errors varied to a much larger degree. For example, Ohio and California had very low MAPEs of 1.1% and 1.3%, respectively. A handful of states with smaller populations—for which results are not highlighted in the main text of this analysis—had substantially larger MAPE values. For 44 states, the MAPE was found to be below 10%, indicating relatively reliable predictive performance.

Discussion

By disaggregating monthly trends, we find that unprecedented increases in overdose mortality occurred during the early months of pandemic in the United States. At the peak, overdose deaths in May 2020 were elevated by nearly 60% compared to the prior year, and the first seven months of 2020 were overall elevated by 35% compared to the same period for 2019. To put this in perspective, if the final values through December 2020 were to be elevated by a similar margin, we would expect a total of 93 to 98 thousand deaths to eventually be recorded for the year. Values for the remaining 5 months of 2020 have yet to be seen, however is it very likely that 2020 will represent the largest year-to-year increase in overdose mortality in recent history for the United States.

The very sharp increases observed in this analysis highlight the value of more granular data for detecting shocks related to major disruptive events. In many cases smoothed rolling aggregates tell a very different story from monthly values that highlight pandemic-related shocks. In future epidemiological surveillance efforts of overdose mortality, the presentation of monthly or weekly values alongside smoothed trends may be helpful for more fully characterizing the available data. While this may be difficult for states with small populations, we find that the majority of US states, all census divisions, and certainly national-level statistics have relatively small prediction errors when data are displayed in a monthly format.

More generally, the COVID-19 pandemic has highlighted issues related to the timely reporting of publicly available data for key public health issues. In the case of direct COVID-19 mortality, the pandemic proved that daily, public reporting of mortality is feasible, given sufficient governmental coordination and political will. Yet for the nation's overdose crisis—which has increased constantly over the past several decades, and claimed nearly 600,000 American lives in the decade prior to the pandemic[12]—mortality statistics lag by considerable margins for many jurisdictions.

Furthermore, provisional national records do not include any details about the race, ethnicity, or other social characteristics of the people dying of overdose. Just as with direct COVID-19 mortality, overdose death data disaggregated by race/ethnicity are often available only at a significant lag compared with total numbers. This is especially concerning because recent trends suggest a rapidly shifting social profile of the US overdose crisis, with racial/ethnic minorities most affected[13–15]. Communities of color are likely facing a dual burden of disproportionate

COVID-19 mortality, and rapidly rising overdose deaths during the pandemic, yet the depth of this issue cannot yet be described in the available data.

The rapid reporting of overdose mortality is complicated by numerous challenges. The detection and registration of overdose deaths can be delayed by backlogs in medical examiner's or coroner's offices, lengthy toxicological analyses, or other bottlenecks in data processing[10]. Many important efforts have been undertaken by a number of states to improve the timeliness of overdose death reporting[16], but results remain heterogenous between locations, and overdose mortality reporting still lags behind that of other causes nationally[10]. Further investments in data infrastructure for vital records systems are therefore warranted to improve the speed of reporting on this critical public health issue.

The results presented here provide public information characterizing national and regional trends in monthly overdose mortality more rapidly than they would otherwise be available. Additionally, for states that do not already provide expedited public data releases—which include many of the states that we find had the largest increases during March-July 2020— the trends presented here may also represent the first publicly available monthly values. These data may be most helpful when considered together with other forms rapid surveillance, such as syndromic surveillance tools drawing on EMS and ED data. These forms of data are available in many states with short lags. Similar information is provided by the CDC National Syndromic Surveillance Program[5] and the NEMSIS platform[2], which are national samples of EMS agencies and emergency departments, respectively. Although they represent proxies of overdose mortality, they are available much more rapidly than final mortality numbers, and can therefore provide a very useful early-warning system for rapid increases[4].

Importantly, these early data resources, as well as other forms of real-time overdose surveillance, are often available to decision-makers much more rapidly than they are made publicly available. Although the sensitive nature of these data and reporting lags can understandably delay public reporting, we argue that in the context of a large magnitude and growing public health crisis such as overdose in the United States, public data transparency is paramount. Many groups working on issues related to overdose, such as harm reduction and other community organizations, may not have access to early epidemiological information unless they are made publicly available. Additionally, public statistics often garner significant media attention, and can galvanize political conversations, public support, and additional resources to address public health challenges.

Our results are limited in several important ways. Perhaps most notably, provisional overdose statistics leverage models that assume that historical levels of reporting lags will continue. If underreporting was exacerbated by pandemic-related strain on public health data systems, then provisional CDC records, and subsequently our results, could underestimate the true level of monthly mortality. Our results should perhaps therefore be regarded as a conservative estimate of the true burden of overdose during the COVID-19 pandemic. Reported decreases following peaks in May 2020, perhaps in particular, should be interpreted with caution, as under-reporting may have worsened during this period, artificially deflating overdose mortality estimates. A key area of future research will entail assessing how reporting lags differed during the pandemic, once final numbers are available. For a limited set of states with small numbers of overdose fatalities, our methods rely on assumptions to distribute deaths when state-month counts are below 10. Our empirically-derived prediction intervals reflect the degree of uncertainty introduced by these limitations, yet they should be considered for the potential to affect emergent trends. Also, given the observational nature of the results, we cannot assure that our findings were directly caused by the COVID-19 pandemic. Although timing and ubiquity of increases during the initial stages of COVID-19-related lockdowns is highly suggestive of the pandemic playing a key role, we cannot rule out other contemporaneous factors that may have also contributed to the increases during this period.

Public Health Implications

Assessing the driving forces behind large increases in overdose mortality during the pandemic will be a complicated task, and it remains an important area for further study. Social isolation is likely playing a role[2], with a greater proportion of individuals using substances alone, where they are less likely to receive life-saving help quickly in the event of an overdose. Treatment for substance use disorder, and other medical care, has also been disrupted during the pandemic[17]. With treatment limited—and in a context of increased levels of social and economic stress—many individuals may turn to illicit markets to purchase substances, which are increasingly contaminated with unpredictable quantities of powerful synthetic opioids such as fentanyl[18]. Pandemic-related disruptions to the illicit drug supply may have also accelerated this trend[19,20]. Further, many upstream structural drivers of addiction and overdose mortality—such as precarious access to housing, employment, quality education, and health care—have been sharply exacerbated during the pandemic[21,22]. In the wake of COVID-19, the social and economic fallout may continue to drive increasing rates of overdose mortality and other "deaths of despair."[5,23]

The drastic exacerbations of the US overdose crisis described here warrant renewed investments in overdose surveillance and prevention during the pandemic response and post-pandemic recovery efforts. Lowering logistical and financial barriers to accessing substance use treatment is paramount. Proposed strategies include facilitating pharmacy-based methadone prescription[19], eliminating special requirements for the prescription of buprenorphine[24], and providing financial support for patients to pay for these often costly medications and related medical visits[25]. In the context of widespread and increasing fentanyl prevalence in the illicit drug supply, making substance use safer is also a key objective[26,27]. This can be accomplished through harm reduction strategies such as: increasing the availability of naloxone to reverse overdoses[28,29], providing 'drug checking' services to test substances for the presence of illicit fentanyl[8,30], providing individuals with a safe supply of opioid medications known to be free of contaminants[31], and creating overdose prevention sites where individuals can use in the presence of medical professionals prepared to reverse overdoses[32]. Investments in upstream social determinants will also represent a key aspect of post-pandemic recovery for the prevention of overdose and a host of other related, socially-bound public health concerns[22,23]. Finally, in order to ensure that such efforts are guided by the best possible information, continued investments in public, transparent, and actionable overdose surveillance remain of paramount importance, to equip a broad range of decision-makers, frontline organizations, and community members to work on this growing public health challenge.

Location	Deaths in May 2020	% Change 2020 vs 2019	Deaths per Million
National	9,192 (8,988 – 9,397)	57.7 (54.2 - 61.2)	28.0 (27.4 - 28.6)
East South Central	779 (735 - 824)	99.2 (87.8 - 110.7)	40.6 (38.3 - 43.0)
East North Central	1,706 (1,665 – 1,748)	55.4 (51.6 - 59.2)	36.4 (35.5 - 37.3)
New England	489 (461 - 518)	25.1 (17.8 - 32.3)	32.9 (31.0 - 34.8)
South Atlantic	2,150 (2,074 – 2,227)	72.7 (66.6 - 78.8)	32.7 (31.5 - 33.8)
Middle Atlantic	1,209 (1,158 – 1,261)	36.3 (30.5 - 42.1)	29.4 (28.1 - 30.6)
Mountain	637 (597 - 678)	53.5 (43.7 - 63.3)	25.6 (24.0 - 27.3)
Pacific	1,097 (1,059 – 1,136)	62.0 (56.4 - 67.7)	20.5 (19.8 - 21.2)
West North Central	421 (405 - 438)	60.7 (54.4 - 67.0)	19.6 (18.9 - 20.4)
West South Central	704 (671 - 738)	52.1 (44.8 - 59.3)	17.3 (16.5 - 18.2)

Table 9.1 Overdose Deaths in May 2020 by Census Division

Overdose deaths occurring in May 2020 are shown as counts, and rates per million people, by 9 US Census Divisions. The percent change between overdose deaths in May 2019 and May 2020 is also shown and used to sort the row order. Counts of deaths are rounded up to the nearest whole person.

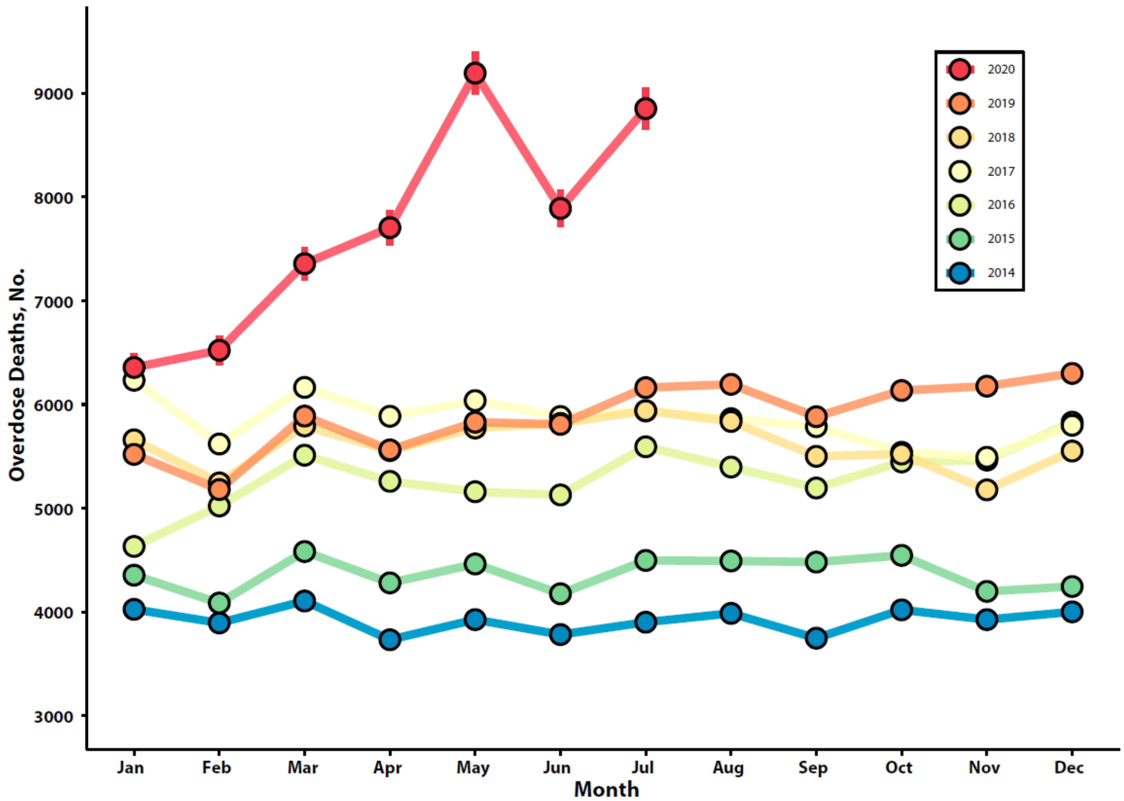

Fig 9.1 Monthly Overdose Deaths January 2014 - July 2020, United States

Overdose deaths in the United States are shown by month, from January 2014-July 2020. 95% prediction intervals are shown for values in 2020, recovered using the algorithm described in this analysis. This figure reveals that May 2020 was the deadliest month for overdose death in the United States in recent history, elevated above May 2019 by about 60%.

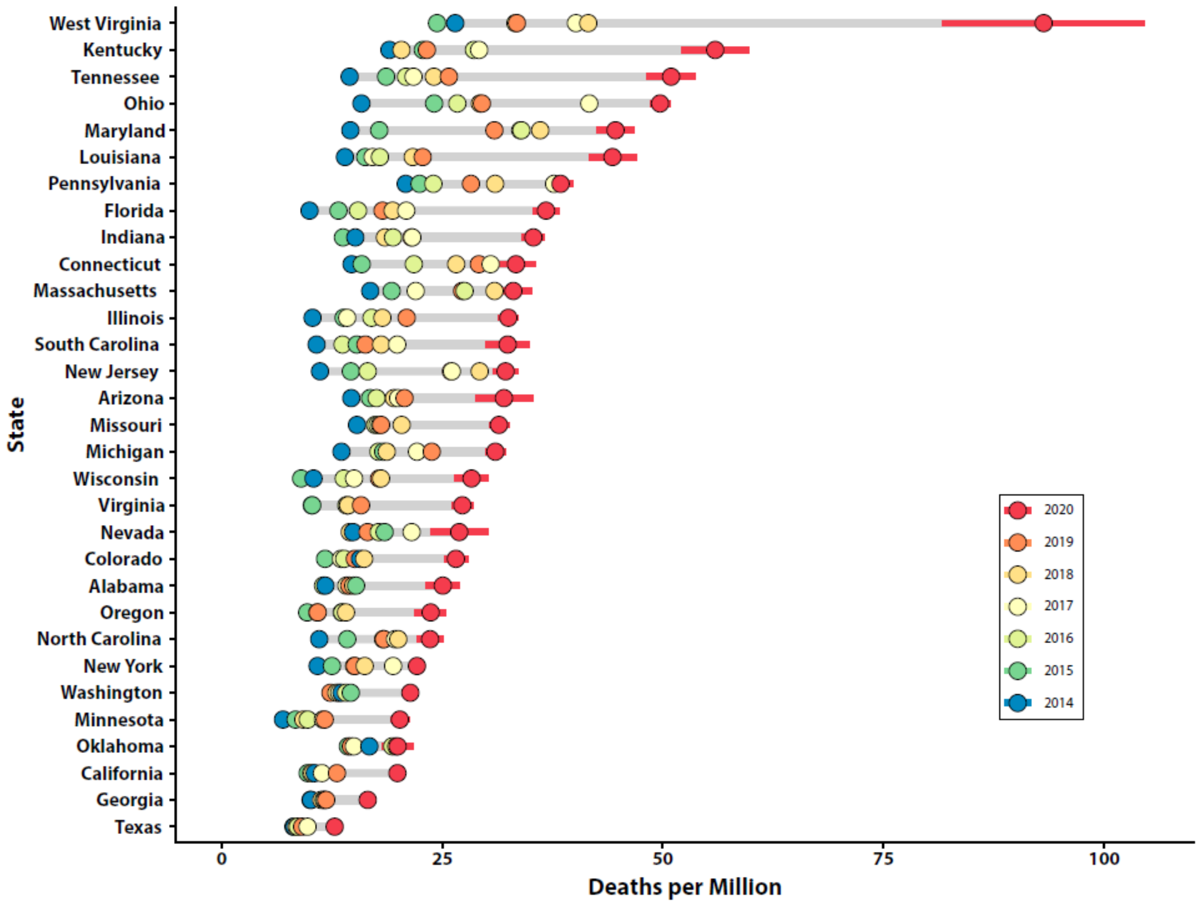

Figure 8.2. Monthly Overdose Deaths in May, 2014 - 2020, Selected States

Deaths per million people in the month of May are shown for 2014 through 2020, for a subset of states with the highest total number of overdose deaths in 2020 (to avoid states with small numbers, where trends are less stable). 95% prediction intervals are shown for values in 2020, recovered using the algorithm described in this analysis. This figures highlights large magnitude increases in overdose deaths in May 2020 compared to prior years, for nearly all states assessed. Particularly large increase were seen in West Virginia, Kentucky, and Tennessee.

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Chapter 10: Surging Racial Disparities in the US Overdose Crisis

A modified version of this chapter appeared as a research article in the American Journal of Psychiatry:

Friedman J, Beletsky L, Jordan A. Surging Racial Disparities in the U.S. Overdose Crisis. AJP. 2022;179(2):166-169. doi:10.1176/appi.ajp.2021.21040381

This chapter begins a series of analyses focused on the social epidemiology of drug overdose deaths, as a key public health inequality that has not received sufficient attention, and which has shifted rapidly in recent years. Chapter 9 examines two decades of drug overdose death rates by race ethnicity drug involved and state, before the onset of the COVID-19 pandemic. The critical contribution is highlighting the dramatic reversal of the racial pattern seen in 2010 (with White overdose death rates double those of Black overdose death rates). By 2019, this gap had closed, as Black overdose death rates "caught-up" driven by a disproportionate impact of fentanyls.

Introduction

As the four-decade long overdose crisis enters its 'fourth wave'— characterized by polysubstance use of potent, illicitly-manufactured, synthetic opioids, psychostimulants, and other drugs[1–4]—renewed attention is warranted to trends stratified by race and ethnicity. Although in recent years the drug crisis has been largely portrayed as a "White problem" this narrative has never accounted for evident racial disparities[5,6]. New data paint a stark picture of worsening burden of overdose on minoritized communities[7].

Using records from the National Vital Statistics System we examined drug-related overdose mortality per 100,000 people separately by race/ethnicity, state, and type of drugs involved from 1999 to 2019. For state-years where comparisons could be made, the rate for each racial/ethnic group was compared to that of Non-Hispanic White individuals as a ratio.

Overdose mortality per capita among Non-Hispanic Black individuals more than tripled between 2010 and 2019, compared to a 58% increase among Non-Hispanic Whites during the same period (Fig 10.1). In 2010, Non-Hispanic Black individuals had an overdose mortality rate that was 0.50 times that of Non-Hispanic Whites. Yet by 2019 the ratio had surged to 0.99 (Fig 10.2). In 2010, the Black-White overdose mortality ratio was above 1.0 in only n=5 (13.5%) of 37 states with sufficient population size for comparisons. However, by 2019, Black mortality exceeded that of White individuals in 23 (57.5%) of the 40 states covered (Fig 10.2). These shifts were largely driven by elevated rates of overdose involving fentanyl and its analogues (with a Black-White ratio in 2019 of 1.13), heroin (1.07), and cocaine (2.50).

Overdose rates among Non-Hispanic American Indian or Alaska Native (AI/AN) individuals rose from 1.03 times that of White individuals in 2010, to 1.15 in 2019. Increases in methamphetamine-related overdose represented the largest component of the increase, rising over 8-fold between 2010 and 2019 to reach 12.30 per 100,000 people. In 2019, the AI/AN-White overdose mortality ratio was above 1.0 in n=18 (85.7%) of 21 states where comparisons could be made.

Distinct age and sex patterns can be observed by race/ethnicity. Among males, the highest observed race/ethnicity- and age-specific total overdose death rates were observed among Non-Hispanic Black men 55-59 years of age. Their rate of 89.5 deaths per 100,000, represented nearly double the rate of Non-Hispanic White individuals of the same age. Conversely, the highest total overdose death rates among Non-Hispanic White men were observed in the 35-39 years age category, with 74.3 deaths per 100,000. This represented 23.5% higher than Non-Hispanic Black Men of the same age. The Black-White overdose death gap is therefore distinct for younger and older men. Yet the disparities between older Black and White men are the largest magnitude. This drives an average trend of higher overdose mortality for Black men relative to their White counterparts, in both age-standardized and population weighted terms. Among women, the highest total overdose rates were observed among AI/AN women 35-39 years of age, with 55.1 deaths per 100,000. This represented a death rate 56.5% higher than that of Non-Hispanic White women of the same age.

The data presented here should be interpreted in the context of limitations affecting overdose surveillance in the United States. Quality of reporting is known to vary between states, and race/ethnicity may be incorrectly assigned for some deaths, especially among American Indian and Alaska Native populations[8]. Although clear trends can be observed at the national level, caution is warranted in interpreting specific state and race/ethnicity-specific findings, given potential for variability in quality and reporting standards.

These trends are particularly concerning given that the COVID-19 pandemic has drastically exacerbated overdose mortality in the United States[9]. Recent surges are likely to widen racial/ethnic overdose disparities[5,7,10]. Troublingly, provisional CDC overdose mortality reports and modelling efforts documenting recent trends contain no information about race or ethnicity[11,12]. This impedes timely surveillance of disparities in overdose and delays efforts to address them.

As the nation grapples with the fallout from the COVID-19 pandemic, racial disparities have gained increased research and policy attention[13,14]. Similarly, rapidly-surging overdose burden among Black and AI/AN communities must be understood as a symptom of structural racism[13]. This includes discriminatory criminal laws and their inequitable enforcement by police, as well as systematic barriers in access to healthcare. This has resulted in a landscape of decreased substance use treatment initiation and engagement[15], and poor access to addiction specialists, especially from underrepresented minority backgrounds[16]. Additional upstream drivers of overdose include gaps in education, employment, and access to medical care. The pandemic has deepened many of these inequalities, as communities of color have been disproportionately affected by disruptions to schooling and employment and healthcare, in particular[17,18]. These shifts necessitate centering an anti-racist approach in the national response to the growing overdose crisis, during the pandemic and post-pandemic recovery period.

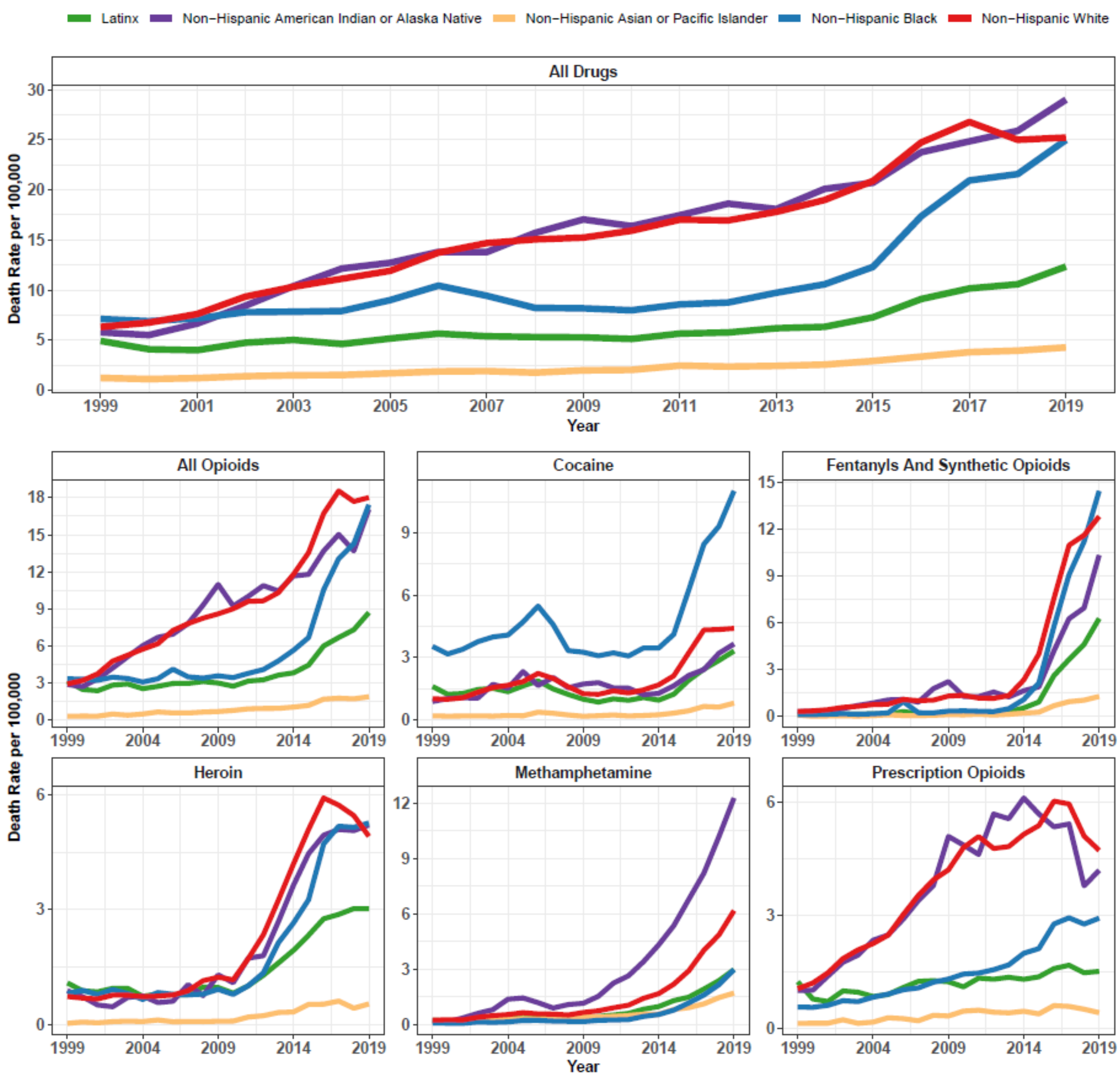

Fig 10.1. Drug-related overdose mortality per 100,000 by race/ethnicity and type of drugs involved, 1999-2019. Both numerator and denominator are specific to each racial/ethnic group.

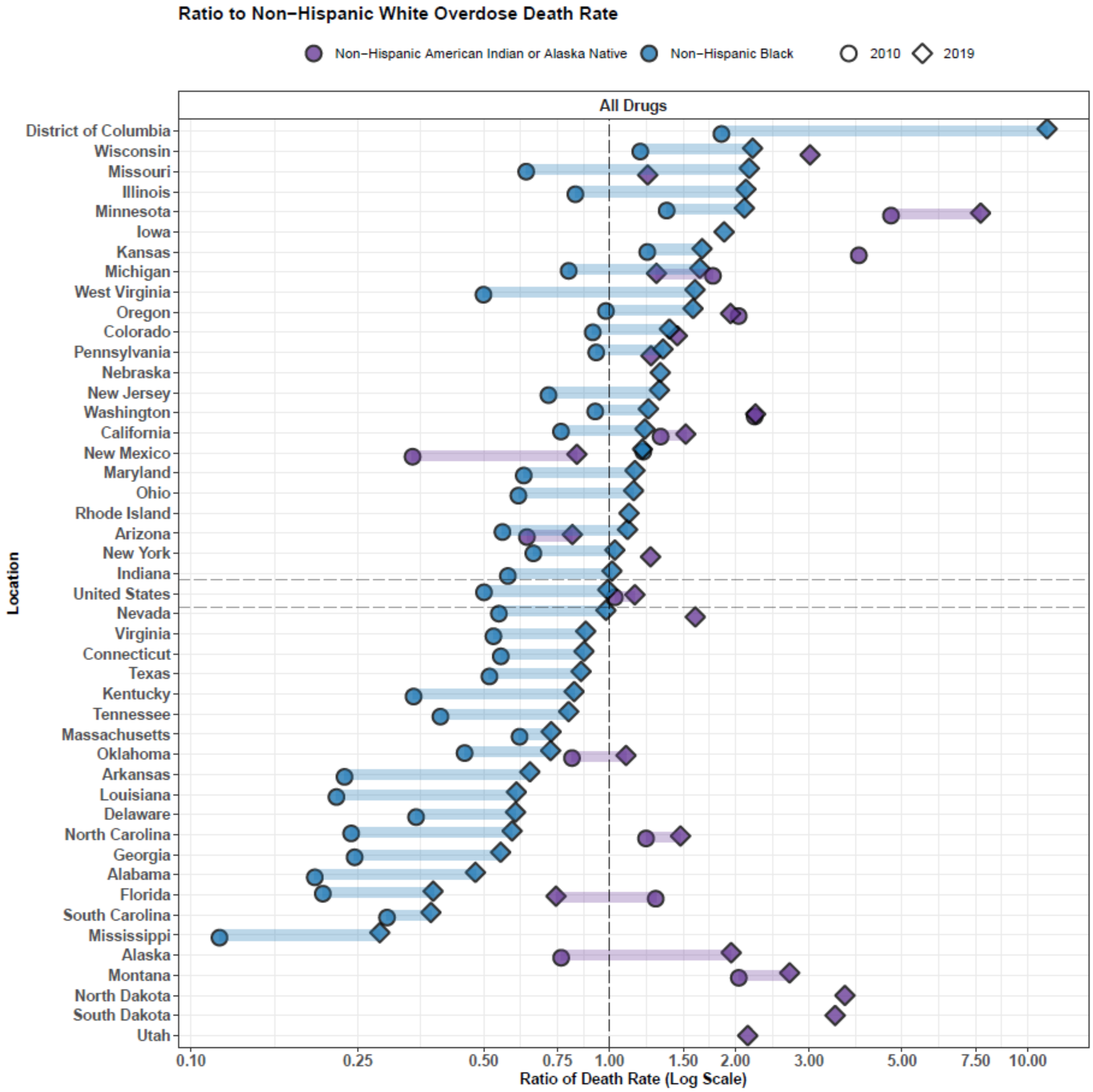

Fig 10.2**.** Ratio of total drug-related overdose mortality per 100,000 for Non-Hispanic Black individuals (shown in blue) and Non-Hispanic American Indian or Alaska Native individuals (shown in purple) relative to Non-Hispanic White individuals. Results shown for states with sufficient population to allow for at least one comparison in 2010 (shown as circle) or 2019 (shown as diamond).

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Chapter 11: Racial Ethnic Disparities in Overdose Before and During COVID-19 Pandemic in California

A modified version of this chapter appeared as a research article in Preventive Medicine:

Friedman J, Hansen H, Bluthenthal RN, Harawa N, Jordan A, Beletsky L. Growing racial/ethnic disparities in overdose mortality before and during the COVID-19 pandemic in California. Preventive medicine. 2021;153:106845.

In the absence of race and ethnicity stratified overdose death data corresponding to the COVID-19 pandemic at the national level, this analysis uses records from California. As a large and diverse state where overdose rates have been growing rapidly in recent years, California is also apt for study because it publishes race and ethnicity specific overdose trends ahead of the CDC. The chapter also leverages a forecasting approach to evaluate the statistical significance of pandemic-related increases, by comparing the observed trends in 2020 to expectations forecasted from previous years of data. This chapter highlights that California has had earlier and more pronounced racial inequalities in overdose compared to the national average. The forecasting approach shown here can be widely applied to rapid surveillance applications as a way to assess the statistical significance of shifts during key exogenous factors.

Chapter 11 Abstract

As overdose mortality is spiking during the COVID-19 pandemic, few race/ethnicity-stratified trends are available. This is of particular concern as overdose mortality was increasing most rapidly in Black and Latinx communities prior to the pandemic. We used quarterly, age-standardized overdose mortality rates from California to assess trends by race/ethnicity and drug involved over time. Rates from 2020 Q2-Q4 were compared to expected trends based on ARIMA forecasting models fit using data from 2006-2020 Q1. In 2020 Q2-Q4 overdose death rates rose by 49.8% from 2019, exceeding an expected increase of 11.5% (95%CI: 0.5%-

22.5%). Rates significantly exceeded forecasted trends for all racial/ethnic groups. Black/African American individuals saw an increase of 52.4% from 2019, compared to 42.6% among their White counterparts. The absolute Black-White overdose mortality gap rose from 0.7 higher per 100,000 for Black individuals in 2018 to 4.8 in 2019, and further increased to 9.9 during the pandemic. Black overdose mortality in California was therefore 34.3% higher than that of White individuals in 2020 Q2-Q4. This reflects growing methamphetamine-, cocaine-, and fentanyl-involved deaths among Black communities. Growing racial disparities in overdose must be understood in the context of the unequal social and economic fallout from the COVID-19 pandemic, during which time Black communities have been subjected to the dual burden of disproportionate COVID-19 deaths and rising overdose mortality. Increased investments are required to ameliorate racial/ethnic disparities in substance use treatment, harm reduction, and the structural drivers of overdose, as part of the COVID-19 response and post-pandemic recovery efforts.

Chapter 11 Text

Introduction

The COVID-19 pandemic has sharply exacerbated the decades-long North American overdose crisis[1,2]. In the US, overdose deaths were elevated by about 30% in 2020 relative to 2019[1], with the pandemic implicated as a likely driver of the increase[3]. Nevertheless, these provisional data[1] have not been disaggregated by race/ethnicity.

This gap is especially concerning because in the years leading up to the COVID-19 pandemic, overdose mortality increased most rapidly among Black and Latinx communities in many areas[4,5]. The changing social profile of the US overdose crisis has been linked to shifts in the drug supply, especially the rising prevalence of illicitly-manufactured fentanyl (fentanyl) contaminating the heroin and cocaine supply[4,6], a growing preference for fentanyl among people who use drugs[7], increased use of methamphetamine[8], and polysubstance use. Communities of color have been disproportionately burdened by direct COVID-19 mortality, and the indirect social and economic fallout from the pandemic for myriad outcomes[9]. There is therefore ample concern that rising inequalities in overdose mortality by race/ethnicity will continue to worsen during the pandemic[10]. This may be especially likely given deep-seated disparities in access to medications for opioid use disorder (MOUD)—especially buprenorphine—and inequalities in access to the telehealth visits required to initiate MOUD in many contexts during the pandemic[11–15]. A study using data from Philadelphia identified an increase in overdose mortality among Black individuals in 2020[16]. The state of California may be a particularly apt place to assess for early indications of rising disparities, as it has a large and diverse population and has experienced sharply increasing overdose fatalities in recent years.

Methods

Data Sources

We obtained quarterly, age-standardized, annualized overdose mortality rates from the California Department of Public Health[17,18]. Trends were obtained by race/ethnicity and drug involved from 2006 to 2020, for overdoses related to all drugs, any opioid, fentanyl, heroin, prescription opioids (excluding synthetics like fentanyl), psychostimulants of abuse potential (which are mostly comprised of methamphetamine, and referred to as such[8]), cocaine, benzodiazepines, opioids with benzodiazepines, and opioids with stimulants. These categories are not mutually exclusive, so an overdose fatality related to fentanyl and methamphetamine would show up in both categories separately, as well as the combined category. This study was a secondary analysis of aggregated, publicly available statistics, and was therefore deemed exempt from institutional ethics review at UCLA.

Forecasting Analysis

Observed rates in Q2-Q4 2020 were compared to expected trends based on autoregressive integrated moving average (ARIMA) forecasting models[19]. Models were fit on quarterly trends from 2006 to 2020 Q1 and used to predict for 2020 Q2-Q4. ARIMA models are a family of flexible timeseries forecasting models, with parameters that can be adjusted to account for seasonality and other aspects of the underlying trends. In this work, consistent with other recent analyses describing pandemic-related shifts[20], we follow the ARMIA model selection approach defined by Hyndman and Khandakar, wherein numerous model specifications are tried, and the best-performing model is used[19]. For each race/ethnicity and drug-specific time series parameters are selected using a grid search and the Akaike information criterion to maximize model fit. The statistical significance of observed trends compared to expectations from model predictions was conducted by comparing rates from 2021 Q2-Q4 to the 95% confidence intervals from each forecasted trend for the same period. All analyses were conducted in R version 4.0.3.

Results

The total age-adjusted overdose rate in California increased from 15.0 per 100,000 in 2019 to 22.4 in 2020 Q2-Q3, representing a 49.8% increase (Table 11.1). This exceeded the expected value based on forecasted trends, of 16.7(95% CI: 15.1-18.3), which would have represented a 11.5%(0.5% - 22.5%) increase. During the COVID-19 pandemic, all racial/ethnic groups saw greater-than-forecasted overdose deaths in California (Fig 11.1). The largest absolute increase was seen for Black overdose mortality, increasing from a rate of 27.0 per 100,000 in 2019, to

41.1 per 100,000 in 2020 Q2-Q4. This represented a 52.4% increase—which exceeded the predicted increase of 22.0%(3.9%-40.1%).

After an upward trajectory in California, in 2018 Black overdose mortality overtook that of White individuals, with an absolute gap of 0.7 per 100,000. This rose sharply to 4.8 per 100,000 in 2019, and further increased to a gap of 9.9 per 100,000 during 2020 Q2-Q4, exceeding the forecasted gap of 8.1 per 100,000, although falling within the 95% confidence interval of 3.3-13.4. Through 2017, White individuals experienced higher overdose mortality rates, largely driven by elevated rates of overdose involving synthetic opioids, heroin, and benzodiazepines (Figure 10.1). The reversal in 2018, and dramatic exacerbation in 2019 and 2020, largely reflected higher and climbing rates of overdoses involving fentanyl (+3.1 per 100,000 higher for Black individuals than White individuals in 2020 Q2-Q4), methamphetamine (+3.4), and cocaine (+8.6). Through 2020 Q2-Q4, White individuals continued to experience higher rates of overdose death involving benzodiazepines (+1.3 per 100,000 higher than Black individuals), heroin (+0.9), and prescription opioids (+1.7).

Although the largest absolute increases were seen among Black individuals, Latinx and Asian/PI communities saw the largest relative increases of 68.1% and 62.1%, respectively, despite lower overall rates. Rising rates for these groups reflected particularly large increases in fentanyl-related overdose deaths, of 175.1% and 231.4%, respectively.

Discussion

We document evidence that an already-accelerating overdose crisis in California was exacerbated during the COVID-19 pandemic, affecting all racial/ethnic groups examined. The observed increases in overdose mortality were over fourfold larger what would be expected based on prior trends. Furthermore, we find that racial/ethnic disparities in overdose mortality—

already sharply increasing prior to the pandemic—grew substantially worse in 2020, reaching unprecedented levels.

Although similar disparities in overdose mortality have likely occurred nationally during the pandemic, the available national provisional data[1] have not been disaggregated by race or ethnicity. The COVID-19 pandemic has shown that rapid—even daily—data collection and reporting on emergent public health crises are possible when political and logistical hurdles can be overcome. Nevertheless, for the decades-old overdose crisis, data often lag by months or years[21]. Further, even the existing provisional data sources (available on a ~7-month lag) are not disaggregated by race/ethnicity, extending the wait to up 24 months for data regarding racial/ethnic inequalities. This limits the timeliness, precision, and cultural relevance of interventions.

Among other factors, these rising inequalities likely reflect a shifting drug supply, increasingly characterized by a high prevalence of illicitly manufactured fentanyl, methamphetamine, and polysubstance use. Previous waves of the overdose crisis stemming from prescription opioids, and later heroin, were more concentrated among White communities[22,23], which was likely related to systematic bias in the prescription of opioids in the healthcare system, and disparities in access to healthcare, among other factors[22,24]. However, we find that overdose deaths involving fentanyl and methamphetamine are now disproportionately affecting Black communities in California. Previous studies have shown that Black people who use drugs may be disproportionately likely to be exposed to fentanyl, often unintentionally, perhaps reflecting power dynamics and a decreased ability to avoid unwanted exposure[25,26]. Fentanyl is also increasingly found in samples sold as other drugs, such as cocaine, which have historically been involved in higher rates of overdose mortality among Black communities[27]. As fentanyl and methamphetamine continue to drive a shifting overdose crisis nationally, similar disparities are likely to become more acute in other regions of the country. Nevertheless, minority populations have been largely overlooked in the overdose crisis, which has been overwhelmingly portrayed in the media and national political stage as a "White problem" in recent years[4,28].

We report increasing rates of overdose mortality among Latinx and Asian/PI communities that are large in magnitude, which could relate to factors such as 1) the increasing contamination of ostensibly non-opioid street drugs—such as cocaine—with fentanyl[27], 2) the increase of fentanyl in new population centers[6], and 3) social and economic disparities stemming from the pandemic. Further study is warranted to explore underlying drivers and solutions, especially given that overdose in these groups have received considerably less attention.

Our findings suggest that during the pandemic, Black communities in particular have been subjected to the dual burden of disproportionate COVID-19 mortality and rising overdose deaths. Similarities between COVID-19 and overdose mortality disparities likely reflect that they share some common structural, socioeconomic drivers. The United States has deep-seated inequalities in access to healthcare, housing, education, and employment—symptoms of institutionalized racism[29]—that are known drivers of overdose, and have been further exacerbated by the pandemic[10,30,31]. Of particular concern, the variable and high potency of fentanyl has increased the lethality of recent incarceration as a risk factor for fatal overdose, as individuals recently release from jail or prison are more likely to have a lower tolerance to opioids and also lack knowledge of recent shifts in drug strength[32]. Combined with racialized policing and incarceration policies that have led to profound racial disparities in incarceration rates, this may be an important factor driving increased overdose death rates in Black communities[33]. Increased jail cycling or longer duration of pretrial detention among Black communities during the pandemic may have played a contributing role[34,35]. Criminal justice reform is likely to play a key role in preventing overdose in Black communities. Additionally, programs to provide methadone and buprenorphine in jails and prisons, and naloxone distribution upon release, are key strategies to reduce the role of incarceration in driving overdose mortality and morbidity[36–40]. Against a backdrop of pre-existing disparities in naloxone access for Black communnities[41,42], naloxone distribution may have been further limited during the pandemic, leading to lower probability of overdose reversal.

While fatal overdose represents a "worst possible" outcome of substance use, these overdose trends foreshadow impacts on morbidity that could occur years into the future. For example, the replacement of black tar heroin with fentanyl has been associated with increased risks for HCV and HIV infection, due to increased injection frequency and differences in drug preparation[43,44]. Additionally, non-fatal overdoses are associated with substantial morbidity and increased risk of mortality[45,46].

Limitations

This study is limited by its observational nature; we cannot eliminate the possibility that some other factor beyond the COVID-19 pandemic is driving the trends we note here. Nevertheless, the widespread increases in overdose deaths observed across numerous geographies and forms of provisional data[1,47] suggest that the pandemic is likely to be playing a key role. Further research into the effects of the pandemic on patterns, settings, and social networks of substance use is needed. Furthermore, due to small numbers, we were not able to assess disparities for Indigenous or Native Americans individuals, which remains an important area for further study, especially given historically higher rates of overdose in these communities.

Conclusions

Black individuals in California now suffer substantially higher rates of overdose mortality than their White counterparts. We find that racial/ethnic disparities in overdose were rising prior to the pandemic and were considerably exacerbated during the social and economic fallout from the pandemic in 2020. As the United States navigates the pandemic and post-pandemic recovery, increased investments will be required to flatten the overdose curve overall and combat rising inequalities. Access to substance use treatment—especially buprenorphine—has long lagged for Black and other racial/ethnic minority communities[11]. Steps taken by the federal government to decrease logistical barriers for buprenorphine prescribers are laudable and should be coupled with additional deregulation and financial supports to increase effective access. In this aim, greater funding and outreach efforts are required to increase access to telehealth visits. There are also a remarkably low number of addiction specialists in the United States, especially from underrepresented minority backgrounds[48]. Improving access to harm reduction, including overdose prevention sites and drug checking to detect the presence of fentanyl, represent important strategies that have been incompletely enacted in California[49,50]. However, these approaches are unlikely to be fully sufficient to reverse rising disparities in overdose. As basic survival has become more difficult for millions of Americans, investments in housing, employment, food security, and medical care—as well as dismantling racist policies that limit them for communities of color[29]—will be essential to address many of the structural drivers of inequalities in overdose and other causes of death such as suicide and firearm violence[10,51].

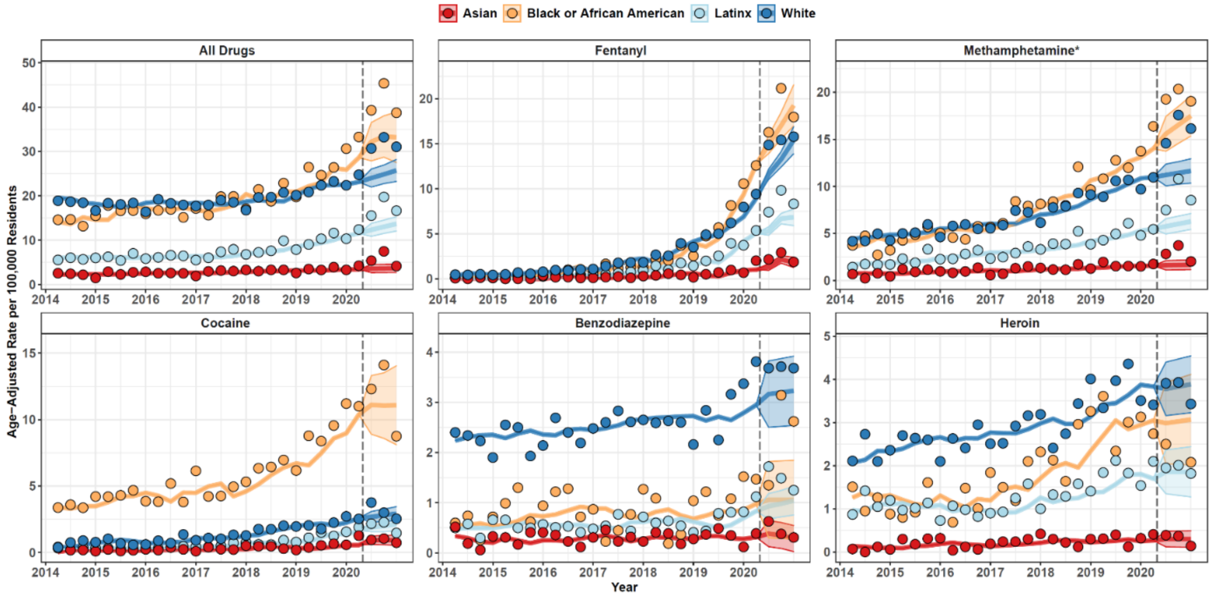

Fig 11.1. Observed and Forecasted Quarterly Trends in Overdose Mortality by Race/Ethnicity and Drug Involved, 2015-2020

Quarterly, age-adjusted, annualized overdose mortality rates per 100,000 residents are shown by race/ethnicity and type of drug involved for 2015-2020. Points represented observed data. Lines and shaded bands represent forecasts and 95% prediction intervals for 2020 Q2-Q4 based on ARIMA models fit on data from 2006 to 2020 Q1. *Deaths coded as involving 'psychostimulants with abuse potential' predominantly refer to methamphetamine and are labeled as such.

Drug	Group	2017	2018	2019	2020 Q1	2020 Q2-Q4 Forecasted [95% CI] (% change vs 2019; 95% CI)	2020 Q2-Q4 Observed (% change vs 2019)
All Drugs	Total	11.6	12.9	15	17.1	16.7 [15.1-18.3] (11.5%; 0.5%-22.5%)	22.4 (49.8%)
All Drugs	Black or AA	18.1	20.7	27	33.3	32.9 [28.0-37.8] (22.0%; 3.9%-40.1%)	41.1 (52.4%)
All Drugs	White	18.1	20.1	22.2	24.8	24.9 [22.7-27.1] (12.0%; 2.1%-21.9%)	31.7 (42.6%)
All Drugs	Latinx	7	8.2	10.3	12.4	13.0 [11.5-14.5] (26.3%; 11.5%-41.2%)	17.3 (68.1%)
All Drugs	Asian	3.1	3.1	3.5	4.2	3.6 [2.7-4.5] (3.6%; -22.8%-30.0%)	5.7 (62.1%)
All Drugs	(Black – White)	0	0.7	4.8	8.5	8.1 [3.3-13.4] (67.3%; -31.4%-177.7%)	9.5 (96.5%)
Fentanyl	Total	1.1	2	4	6.7	8.6 [8.0-9.2] (114.4%; 100.0%-128.8%)	10.6 (165.0%)
Fentanyl	Black or AA	1.3	2.6	7.3	12.6	17.1 [15.5-18.7] (133.8%; 112.1%-155.5%)	18.5 (153.1%)
Fentanyl	White	1.7	3.2	6	9.4	13.4 [12.5-14.4] (123.8%; 107.5%-140.1%)	15.4 (156.1%)
Fentanyl	Latinx	0.7	1.4	3.1	5.4	6.3 [5.6-6.9] (102.5%; 81.3%-123.7%)	8.5 (175.2%)
Fentanyl	Asian	0.2	0.4	0.7	2	1.8 [1.3-2.2] (152.7%; 87.6%-217.8%)	2.3 (231.4%)
Fentanyl	(Black – White)	-0.4	-0.6	1.3	3.2	3.6 [1.8-5.5] (188.2%; 43.8%-332.4%)	3.1 (146.1%)
Heroin	Total	1.7	1.9	2.4	2.3	2.4 [2.0-2.7] (0.3%; -15.5%-16.1%)	2.4 (0.9%)
Heroin	Black or AA	1.8	2.5	3	2.7	3.0 [2.0-4.0] (0.9%; -32.3%-34.1%)	2.8 (-5.4%)
Heroin	White	2.9	3.1	3.8	3.4	3.8 [3.2-4.5] (0.9%; -16.0%-17.7%)	3.8 (-1.1%)
Heroin	Latinx	1.2	1.4	1.8	2.1	1.9 [1.3-2.4] (3.2%; -27.1%-33.5%)	1.9 (7.0%)
Heroin	Asian	0.3	0.2	0.3	0.4	0.3 [0.1-0.5] (0.3%; -61.7%-62.2%)	0.3 (0.0%)
Heroin	(Black – White)	-1.2	-0.7	-0.8	-0.7	-0.8 [-2-0.4] (4.4%; 164.0%--148.9%)	-0.9 (19.1%)
Meth*	Total	4.6	5.8	6.9	7.7	8.2 [7.4-9.0] (18.6%; 6.5%-30.6%)	11.4 (64.4%)
Meth*	Black or AA	7.6	9.5	12.3	16.4	16.5 [14.6-18.5] (34.4%; 18.3%-50.5%)	19.5 (58.9%)
Meth*	White	6.7	8.5	10	11	11.4 [10.2-12.6] (14.3%; 2.1%-26.5%)	16.1 (61.0%)
Meth*	Latinx	3.1	4.2	5	5.4	6.0 [5.2-6.8] (20.4%; 3.8%-36.9%)	8.9 (78.8%)
Meth*	Asian	1.2	1.3	1.6	1.8	1.7 [1.1-2.2] (3.4%; -28.2%-35.0%)	2.9 (79.0%)
Meth*	(Black – White)	1	1	2.4	5.4	5.1 [2.9-7.5] (116.4%; 23.4%-215.7%)	3.4 (46.0%)
Cocaine	Total	1	1.4	2	2.6	2.9 [2.5-3.2] (42.4%; 25.0%-59.9%)	2.8 (40.6%)
Cocaine	Black or AA	4.7	6.5	9.5	11	11.1 [8.5-13.6] (16.6%; -10.2%-43.4%)	11.7 (23.3%)
Cocaine	White	1.2	1.9	2.2	2.5	2.8 [2.3-3.3] (27.4%; 6.3%-48.5%)	3.1 (40.9%)
Cocaine	Latinx	0.6	0.7	1.4	1.9	2.0 [1.6-2.4] (44.0%; 13.5%-74.4%)	2.0 (41.0%)
Cocaine	Asian	0.3	0.4	0.5	1.3	0.9 [0.6-1.3] (86.0%; 16.4%-155.5%)	0.9 (82.7%)
Cocaine	(Black – White)	3.5	4.6	7.3	8.5	8.3 [5.8-11.1] (13.6%; -21.0%-52.0%)	8.6 (18.3%)
Benzo	Total	1.4	1.3	1.5	2	1.7 [1.4-2.0] (12.6%; -8.8%-34.0%)	2.2 (46.4%)
Benzo	Black or AA	0.7	0.7	1.1	1.5	1.1 [0.3-1.8] (-3.5%; -73.7%-66.7%)	2.4 (115.5%)
Benzo	White	2.7	2.5	2.9	3.8	3.2 [2.5-3.9] (10.2%; -13.1%-33.5%)	3.7 (27.2%)
Benzo	Latinx	0.6	0.5	0.7	1.1	1.0 [0.7-1.3] (40.7%; 2.5%-78.8%)	1.5 (112.4%)
Benzo	Asian	0.3	0.3	0.3	0.4	0.3 [0.1-0.6] (13.6%; -72.7%-99.8%)	0.4 (46.7%)
Benzo	(Black – White)	-2	-1.8	-1.8	-2.3	-2.1 [-3.1--1.1] (21.1%; 77.5%--40.4%)	-1.3 (-25.1%)

Table 11.1. Observed and Forecasted Annual Trends in Overdose Mortality by Race/Ethnicity and Drug Involved
Annual age-adjusted overdose mortality per 100,000 residents are shown by race/ethnicity and type of drug involved for 2017-2020 Q1, compared to 2020 Q2-Q4, both observed and forecasted. Absolute differences in Black overdose rates compared to White individuals are shown in the rightmost column. For observed and forecasted values in 2020 Q2-Q4, percent increases from 2019 are shown in parentheses. 95% confidence intervals are shown for forecasted quantities in 2020 Q2-Q4 in brackets. *Deaths coded as involving 'psychostimulants with abuse potential' predominantly refer to methamphetamine and are labeled as such.

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Chapter 12: Evaluation of Increases in Drug Overdose Rates in the US by Race and Ethnicity Before and During the COVID-19 Pandemic

A modified version of this chapter appeared as a research article in JAMA Psychiatry:

Friedman JR, Hansen H. Evaluation of Increases in Drug Overdose Mortality Rates in the US by Race and Ethnicity Before and During the COVID-19 Pandemic. JAMA Psychiatry. Published online March 2, 2022. doi:10.1001/jamapsychiatry.2022.0004

This chapter analyzed the first race and ethnicity stratified data overdose death data made available by the CDC representing the national picture during the pandemic. Confirming the predictions made in previous chapters of this work, and mirroring the state level trends seen in California, large magnitude increases in racial inequalities in overdose were seen. At the national level, Black overdose death rates overtook those of White individuals for the first time since 1999. Native overdose death rates rose to be about 30% higher than those of white individuals. This contribution is straightforward methodologically, but valuable in that it provided the first national confirmation of this critical health inequality.

Introduction

Drug overdose mortality rates have increased sharply during the COVID-19 pandemic[1]. In recent years, overdose death rates were rising most rapidly among Black and Latinx communities[2]. The pandemic has disproportionately affected racial and ethnic minoritized communities for a wide swath of health, social, and economic outcomes. Careful attention is therefore warranted to trends by race and ethnicity before and during COVID-19.

Methods

We calculated drug overdose death rates per 100,000 population by race and ethnicity for the 1999-2020 period[3]. Records from 2020 were provisional and may underestimate final mortality rates. Drug overdose deaths were defined by underlying cause of death ICD-10 categories of unintentional, suicide, homicide, or undetermined intent (X40-44, X60-64, X85, or Y10-14, respectively). Racial and ethnic group was defined first by ethnicity (Latinx) and subsequently race (for non-Hispanic Black, White, and American Indian and Alaska Native (AI/AN) individuals). Analyses were conducted using R version 4.0.3. This study was deemed exempt from review and informed consent by the UCLA Institutional Review Board.

Results

In 2020, Black overdose mortality overtook that of White individuals for the first time since 1999. Black overdose death rates rose to 36.8 per 100,000 in 2020, representing 16.3% higher than the rate for White individuals. This is a sharp reversal of the Black-White overdose mortality gap noted in 2010, when the rate among White individuals was double (100.1% higher) than that seen among Black individuals. These shifts reflect that Black communities have experienced higher annual percent increases in overdose deaths compared to their White counterparts each year since 2012. In 2020, Black individuals had the largest percent increase in overdose mortality, of 48.8%, compared to 26.3% among White individuals.

AI/AN individuals experienced the highest rate of overdose mortality in 2020, of 41.4 per 100,000, representing 30.8% higher than the rate among White individuals. Between 1999 and 2017 AI/AN overdose mortality rates were close to those experienced by White individuals, with rates among AI/AN first becoming disproportionately higher in 2019. In 2020 overdose mortality increased by 43.3% for AI/AN individuals.

Drug overdose rates among Latinx individuals remained the lowest among the groups assessed throughout the study period; however, they also experienced a large percent increase in 2020 of 40.1%.

For all racial and ethnic groups assessed, the relative increases observed in 2020 were higher than any prior increase between 1999-2019.

Discussion

The overdose crisis in the United States is increasingly driven by a toxic illicit drug supply characterized by polysubstance use of potent synthetic opioids and benzodiazepines, as well as high-purity methamphetamine. The high—and unpredictably variable—potency of the illicit drug supply may be disproportionately harming racial and ethnic minoritized communities for various reasons. Deep-seated inequalities in living conditions including stable housing and employment, policing and arrests, preventive care, harm reduction, telehealth, medications for opioid use disorder (MOUD) and naloxone, are likely playing a key role[4,5].

Further, the increasing toxicity of the drug supply has increased the lethality of recent incarceration—which disproportionately affects Black, AIAN, and Latinx individuals due to structural racism in the criminal justice system—as a risk factor for overdose mortality. Recently incarcerated individuals have reduced opioid tolerance and less knowledge of shifts in drug potency[6].

Drug overdose mortality is increasingly becoming a racial justice issue in the United States and appears to have been exacerbated during the COVID-19 pandemic. Providing individuals with a safer supply of drugs, closing gaps in access to MOUD, health care, and harm reduction services, and ending routine incarceration of individuals with substance use disorders represent urgently needed, evidence-based strategies that can be employed to reduce rising inequalities in overdose.

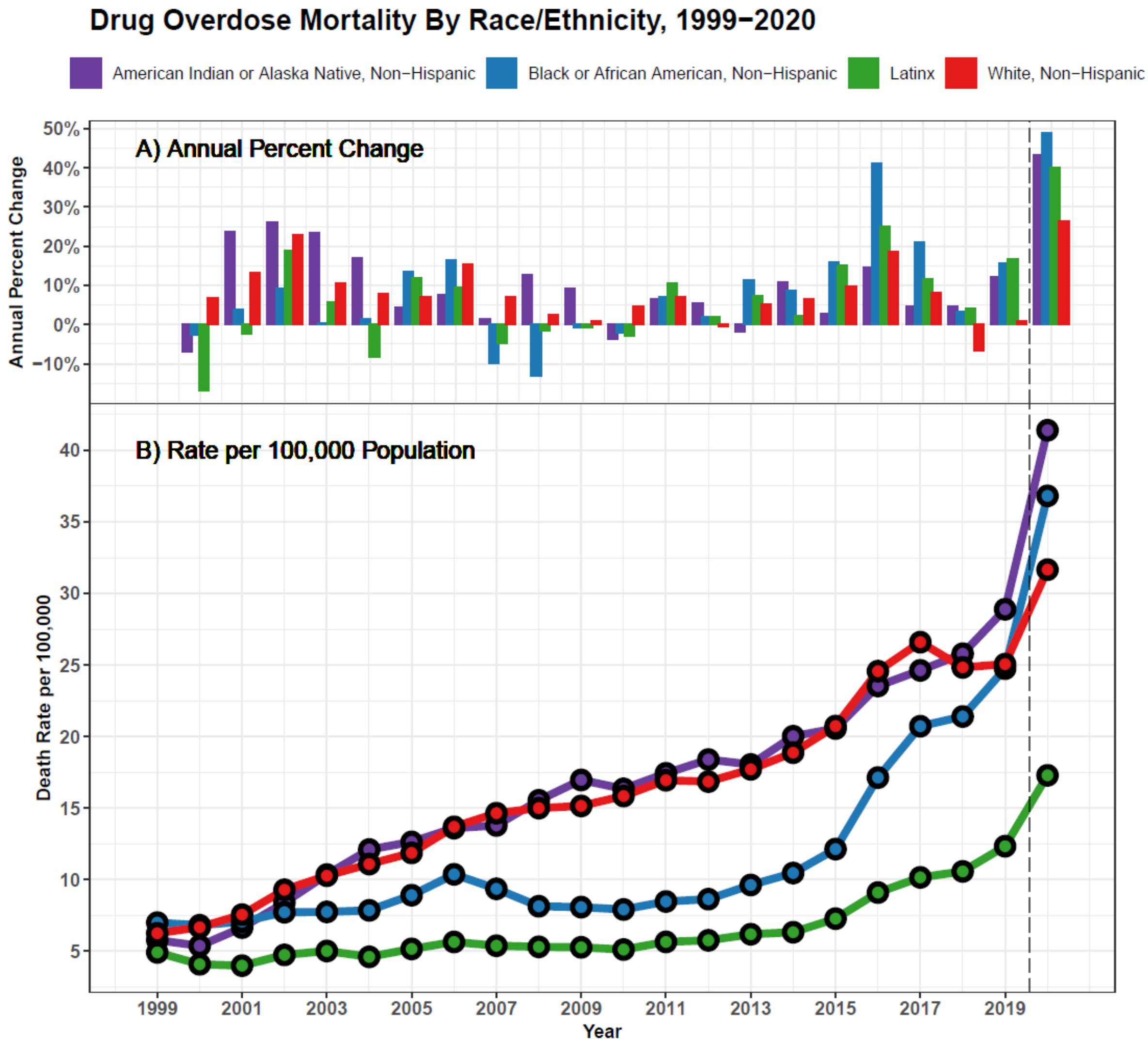

Fig 12.1. Drug Overdose Mortality by Race and Ethnicity, 1999-2020

Year-to-year percent change in drug overdose mortality by race and ethnicity (top). Drug overdose mortality per 100,000 population by race and ethnicity (bottom). A vertical dashed line separates the COVID-19 pandemic period from prior trends.

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Chapter 13: Trends in Drug Overdose Deaths Among US Adolescents, January 2010 to June 2021

A modified version of this chapter appeared as a research article in JAMA:

Friedman J, Godvin M, Shover CL, Gone JP, Hansen H, Schriger DL. Trends in Drug Overdose Deaths Among US Adolescents, January 2010 to June 2021. JAMA. 2022;327(14):1398. doi:10.1001/jama.2022.2847

This chapter provides rapid surveillance of a particularly concerning shift in the overdose crisis, documenting a rapid rise in high school age adolescent overdose deaths. This trend is largely driven by counterfeit pills, containing illicit fentanyls, which are increasingly spreading across the country. Similar to the picture seen with adults, pronounced racial and ethnic inequalities can also be seen.

Introduction

The illicit drug supply has increasingly become contaminated with illicitly manufactured fentanyls and other synthetic opioid and benzodiazepine analogues[1]. Adolescent drug use rates remained generally stable between 2010 and 2020, with 30.2% and 30.4%, respectively of tenth-graders reporting any illicit drug use in the past 12 months, which declined to 18.7% of tenth-graders in 2021[2]. However, given the increase in illicit fentanyls and potential associated risks, we assessed shifts in overdose deaths among adolescents.

Methods

We calculated drug overdose deaths per 100,000 population for adolescents (14-18 years), compared with the overall population, during January 2010-June 2021, using data from CDC Wonder (Wide-ranging OnLine Data for Epidemiologic Research)[3], containing records on all US deaths where drug overdose was listed as the underlying cause of death. January-June 2021 values were provisional and annualized by proportional scaling. Descriptive trends by specific substance involvement were assessed using ICD-10 multiple cause of death codes and by ethnicity (Latinx) and race (American Indian and Alaska Native [AI/AN], Black, White) as categorized in the underlying records. Analyses were conducted using R version 4.0.3. This study was deemed exempt from review and informed consent by the UCLA Institutional Review Board.

Results

There were 518 deaths among adolescents (2.40 per 100,000 population) in 2010, with rates remaining stable through 2019, with 492 deaths (2.36 per 100,000). Deaths increased to 954 (4.57 per 100,000) in 2020 and 1,146 (5.49 per 100,000) in 2021. Between 2019 and 2020, overdose mortality increased by 94.03% and from 2020 to 2021, by 20.05%.

In the overall population, numbers of overdose deaths were higher, and rates increased steadily from 2010 (38,329; 12.4 per 100,000) to 2020 (91799, 27.86 per 100,000) and 2021 (101,954, 31.06 per 100,000). The percent change was 29.48% from 2019 to 2020 and 11.48% from 2020 to 2021 (Table 13.1).

Among adolescents, fentanyl-involved fatalities increased from 253 (1.21 per 100,000) in 2019 to 680 (3.26 per 100,000) in 2020, a 168.96% increase, and to 884 (4.23 per 100,000), a 29.91% increase, in 2021 (Figure 12.1, A). In 2021, fentanyls were identified in 77.14% of adolescent overdose deaths, compared with 13.26% for benzodiazepines, 9.77% for methamphetamine, 7.33% for cocaine, 5.76% for prescription opioids, and 2.27% for heroin.

AI/AN adolescents experienced the highest overdose rate in 2021 (24, 11.79 per 100,000), followed by Latinx adolescents (354, 6.98 per 100,000) (Figure 12.1, B).

Discussion

Beginning in 2020, adolescents experienced a greater relative increase in overdose mortality than the overall population, driven by fatalities involving fentanyls. In the context of decreasing adolescent drug use rates nationally[2], these shifts suggest heightened risk from illicit fentanyls, which have variable and high potency[1]. In recent years, fentanyls have been increasingly added to counterfeit pills resembling prescription opioids, benzodiazepines, and other drugs, which adolescents may not identify as dangerous, and which may be playing a key role in these shifts[1,4].

The highest rates of overdose deaths were among AI/AN adolescents, which have also been reported among adults in this population in 2020[5]. High rates among Latinx adolescents contrast with relatively lower rates among Latinx adults[5]. These adolescent trends fit a wider pattern of increasing racial/ethnic inequalities in overdose that deserve further investigation and intervention efforts[5].

Study limitations include the observational design that cannot establish causality, that race and ethnicity may be incorrectly assigned in some death investigations, that results from 2021 were provisional and include proportionally scaled values from January-June, and the small numbers in some subgroups. In addition, the contribution of factors unique to the COVID-19 pandemic, such as suicidal ideation, mental illness, social isolation, and disruptions to illicit drug markets, cannot be discerned[6].

Rising adolescent overdose deaths, in the context of increasing availability of illicit fentanyls, highlight the need for accurate, harm-reduction education for adolescents and greater access to naloxone and services for mental health and substance use behaviors.

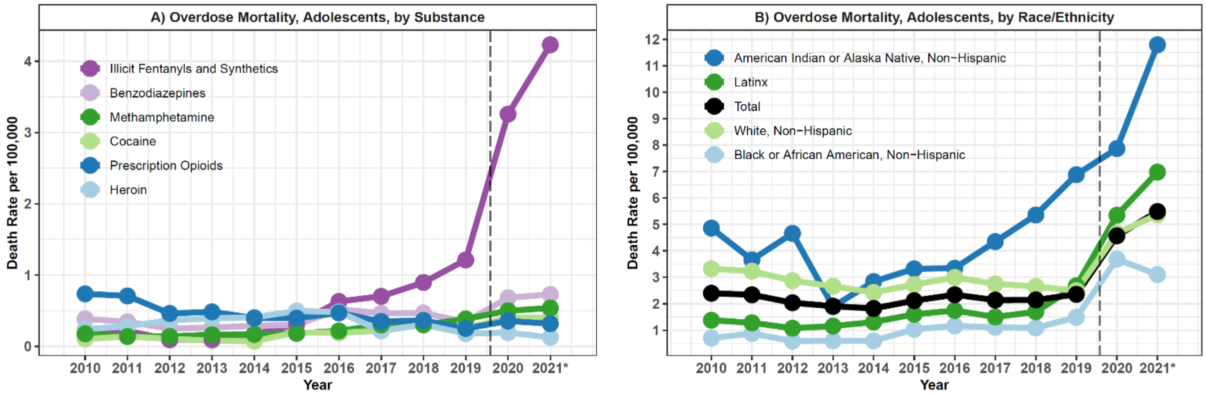

Fig 13.1 .Adolescent Overdose Deaths, 2010-2021

Drug overdose rates per 100,000 adolescents are shown by substance involved (A) and race/ethnicity (B) *2021 refers to January-June 2021, and rates have been annualized.

	2010		2019		2020			2021*		
	Deaths	*Rate*	*Deaths*	*Rate*	*Deaths*	*Rate*	*% Change*	*Deaths**	*Rate**	*%*
Overall Population										
Total	38329	12.41	70630	21.52	91799	27.86	29.48	101954	31.06	11.48
Adolescents										
Total	518	2.40	492	2.36	954	4.57	94.03	1146	5.49	20.05
Substance										
Benzodiazepines	83	0.38	71	0.34	142	0.68	100.13	152	0.73	6.97
Cocaine	22	0.10	53	0.25	84	0.40	58.59	84	0.40	-0.07
Heroin	52	0.24	37	0.18	40	0.19	8.18	26	0.12	-35.04
Illicit Fentanyls and Synthetics	38	0.18	253	1.21	680	3.26	168.95	884	4.23	29.91
Methamphetamine	38	0.18	80	0.38	104	0.50	30.09	112	0.54	7.62
Prescription Opioids	159	0.74	52	0.25	74	0.35	42.40	66	0.32	-10.87
Race/Ethnicity										
American Indian or Alaska Native, Non-Hispanic	11	4.86	14	6.88	16	7.87	14.37	24	11.79	49.89
Black or African American, Non-Hispanic	24	0.70	46	1.49	114	3.69	148.22	96	3.10	-15.92
Latinx	62	1.38	136	2.68	276	5.35	99.44	354	6.98	30.51
White, Non-Hispanic	412	3.32	281	2.50	521	4.67	87.02	604	5.36	14.93

Table 13.1. Characteristics of Adolescent Overdose Deaths, 2010, 2019, 2020, and 2021

Drug overdose deaths among high-school age adolescents (age 14-18) are shown as counts, and rates per 100,000 population for 2010, 2019, 2020 and 2021, and compared to values for the all-age population. Data for adolescents are also stratified by substance involved, and race/ethnicity. Year-to-year percent increases are shown for 2020 (relative to 2019) and 2021 (relative to 2020). *2021 refers to January-June 2021, and rates and counts have been annualized.

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Chapter 14: Far From a White Problem Responding to the Overdose Crisis as a Racial Justice Issue

A modified version of this chapter appeared as an editorial article in the American Journal of Public Health:

Friedman J, Hansen H. Far From a "White Problem": Responding to the Overdose Crisis as a Racial Justice Issue. Am J Public Health. 2022;112(S1):S30-S32. doi:10.2105/AJPH.2021.306698

This chapter builds on the critically-applied aspect of this body of work discussing racial and ethnic inequalities in overdose mortality. We summarize evidence laid out in chapters 10 through 12 of worsening racial and ethnic inequalities in overdose and connect them to social theory to describe the social and public health implications.

Introduction

The United States is in the midst of an overdose crisis of tremendous proportions. Even before overdose death rates spiked sharply during the COVID-19 pandemic, the US had twice the mortality rate of the second highest country, and twenty times the global average[1]. Deaths from overdose have increased year over year—nearly uninterrupted—for the past four decades. During the pandemic, the United States crossed the grim milestone of 100,000 overdose deaths in a 12-month period[2].

Although overdose deaths have increased for all racial-ethnic and socioeconomic groups, these increases have not been felt equally among all Americans. Overdose and addiction have long predominated among low-income communities[3], and during the "first wave" of the overdose crisis in the early 2000s, deaths were concentrated in low-income White communities[4].

However, the racial-ethnic profile of the US overdose crisis has changed sharply[5]. In 2020, Black overdose death rates overtook those of White individuals by a nearly 20% margin. Native Americans now have the highest overdose mortality rates of any group, reaching over 30%

higher than White individuals. Far from a "White Problem," overdose prevention is now a key racial justice issue.

An analysis of a national dataset by Pro et. al considers the individual and state-level factors that help explain racial disparities in addiction treatment. Economic and community distress—including low education, high unemployment, and housing vacancy—had the strongest negative relationship to treatment success across all racial-ethnic groups. Black and American Indian/Alaska Native patients disproportionately presented for treatment in mid- to high-distress communities. Black patients were also much more likely to experience poor treatment outcomes. In addition, patients in states that have not expanded Medicaid were less likely to experience successful treatment.

These findings urge us to consider approaches to the overdose crisis that address the underlying causes of economic and community distress, with a focus on systemic racial-ethnic inequalities.

Moving Beyond Overdose as a "White Problem"

Although overdose has been largely painted as a "White Problem" in popular press and academic literature in recent years—as deaths among low-income White communities garnered significant public attention—racial justice advocates have disputed this narrative[6].

For example, Native communities have long experienced overdose deaths of at equal or higher rates than their White counterparts, yet this has not received the same recognition[5]. Further, Black people who use drugs face much higher risk of arrest, imprisonment, and other drug-related harms—despite using drugs at similar rates, due to well-documented racial bias in the criminal justice system[7].

Yet, the perception of addiction as primarily affecting White Americans has led to a softening of US drug policy[6]. Minimum sentencing laws were reversed. Possession of drugs was downgraded from a felony to a misdemeanor in many cases, or even decriminalized in many cities.

People experiencing addiction were also humanized. They came to be regarded as "struggling with illness" instead of "immoral criminals", which had been the prevailing societal view during previous waves of addiction, such as crack cocaine in the 1980s, which was represented as a Black problem[6]. Even conservative politicians began to emphasize the need for medical treatment, when just a few years prior they had advocated for criminal punishment. President Trump declared the opioid epidemic a "public health emergency" unlocking new resources for treating addiction as a medical problem.

Now that overdose mortality is becoming a racial justice issue of enormous proportions, we must ensure that this push for evidence-based policies does not falter.

Addressing Racial-Ethnic Inequalities as Drivers of Overdose

We are living in an incredibly dangerous time to purchase street drugs. People seeking to buy opioids in illicit markets are now being sold illicitly-manufactured fentanyls and other powerful synthetic drugs, often mixed together in powders and pressed into counterfeit prescription pills. This has led to massive day-to-day fluctuations in the potency of the drug supply that can catch even experienced users off-guard. Although prescription opioids continue to garner significant public, media, and policy attention[3], a very small percentage of overdose deaths now involve them[2]. Continued reductions in access to opioid prescriptions through the healthcare system are unlikely to curb the rising tide of overdose deaths, as illicitly-manufactured fentanyls and other synthetic compounds are the key substances driving increases.

This increasing danger of using street drugs has disproportionately harmed communities of color for various reasons. Importantly, the variable potency of street drugs has increased the lethality of recent incarceration. While in jail or prison, opioid tolerance is reduced, and upon release, people who use drugs are less likely to be aware of shifts in street drug composition. Furthermore, incarceration destabilizes people socially and economically[8]: they leave prison with reduced social supports, disqualified from many forms of housing and employment, and with minimal or no access to treatment for substance use disorders.

This is how mass incarceration, which disproportionately targets Black and Native communities[7], is supercharging the US overdose crisis. Notably, the carceral response to the illicit fentanyl crisis, including increasing penalties for fentanyl analogues, is reversing progress towards decriminalization. Similarly, the growing trend of prosecuting overdose deaths as homicides has led to long prison sentences for many people who use drugs and exchange them with their friends and family members[9]. These shifts threaten to worsen racial disparities in incarceration and overdose rates.

Moving forward the overarching drivers of overdose—include structural, social, and economic inequality—must be addressed. As Pro et al. highlight, community distress is inversely related to treatment success. Patients of color are more like to reside in areas with poor housing, employment, and educational opportunities, which are strongly related to overdose[3]. Racial segregation in housing, employment and education, tied to disinvestments from Black and Brown neighborhoods in US cities, has fueled drug-related harms for decades[3,7]. These factors are compounded by deep inequalities in the US healthcare system in which Black, Native, and Latinx Americans have less access to addiction treatment[10,11].

A Path Forward: Tackling the Overdose Crisis as a Racial Justice Issue

Many treatment advocates call for improved access to evidence-based medications such as buprenorphine, methadone, and naloxone. Although these medications represent important strategies, they are not magic bullets. Ample evidence indicates that social-structural inequalities reduce medication effectiveness. Therefore, medications alone will not remedy substance-related harms in a context of deep inequalities. Instead more comprehensive services are needed that address housing and economic stability, to promote better treatment outcomes[12].

To effectively address racial-ethnic inequalities in overdose and treatment outcomes, overdose prevention efforts must be connected to broader racial justice movements in the United States. The criminalization of drug use drives poor outcomes for people who use drugs. Similarly, racial justice advocates seek to reduce the disproportionate policing and incarceration of communities of color, which often stem largely from drug law enforcement. Drug decriminalization is a therefore key strategy for both overdose prevention and racial justice efforts.

Overdose prevention requires what racial justice movements call for: the reallocation of public funds away from racially targeted law enforcement and towards economic development in low-income communities of color. Instead of bolstering a militarized drug-focused police force, investing in small business ownership, employment, education, and housing leads to multi-generational improvements in a wide range of health outcomes, including those related to substance use[13]. This kind of economic development has also been called for by those who identify the overdose crisis in rural, deindustrialized White communities as contributing to "deaths of despair." However, this economic development must foreground racial equity, in order to redress the harms of decades of racially stratified disinvestments from, and drug law enforcement in, communities of color.

As the US overdose crisis continues to evolve, robust and sustained attention to both economic development and racial justice are crucial to combat rising drug related harms.

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Chapter 15: Deaths of Despair and Indigenous Data Genocide: the Pandemic as a Turning Point

This chapter appears here for the first time in any form.

Building further on the 'critically-applied' aspect of this body of surveillance work, here the original framing of the concept of "Deaths of Despair" is critiqued. I argue that this framework could only be articulated as such due to the exclusion of data representing Native individuals. Implications for wider societal narratives and the distribution of resources are discussed.

Text

The concept of 'deaths of despair'—mortality stemming from drug overdoses, suicide, and alcoholic liver disease (ALD)—has emerged as a key frame for understanding US exceptionalism in mortality[1]. From its origin, the framework was cast in racial terms, focused on disproportionate levels of midlife (age 45-54) mortality among White communities.

The term was coined in the wake of a seminal analysis published in 2015, showing that midlife mortality rates among White individuals were increasing—a very rare epidemiological finding[1]. This was argued to be due, in large part, to deaths from suicide, overdose, and ALD. In effect, White America was theorized to be killing itself, either quickly by suicide, or more slowly with drugs and alcohol.

In this foundational analysis, midlife mortality among White individuals was compared to that of US Latinx and Black individuals, as well as cohorts of people from other wealthy nations, and increasing trends were found to be unique to US White communities. Native American individuals (descendants of American Indian, Alaska Native, or Native Hawaiian populations), however, were not considered in this analysis, nor in the vast majority of follow-up studies on the topic of mortality stemming from deaths of despair.

If Native American individuals had been included in these analyses, increases in midlife mortality would not have been determined to be uniquely high among White individuals. According to our calculations, between 1999 and 2013 (the final year of data used in the original study) White midlife mortality rose from 381.5 to 415.4 per 100,000, an increase of 33.9 per 100,000 (Figure 15.1, panel A). In contrast, midlife mortality rose among Native American individuals during the same period from 481.6 to 622.7 per 100,000, an increase of 141.0 per 100,000—a rise over fourfold greater than that seen among White Americans.

In the years since this seminal analysis—and especially during the COVID-19 pandemic—sharp inequities for Native American communities have substantially worsened. By 2019, midlife Native American mortality had risen further to 695.0 per 100,000, and in 2020 it increased precipitously to 974.7 per 100,000. These rates represented 71.1% and 111.8% higher than the midlife mortality seen among White Americans in 2019 and 2020 respectively.

Similarly, mortality from overdose, suicide, and ALD have collectively been higher among Native Americans relative to their White counterparts for all of recent history. In 2013, Native American individuals experienced a total midlife death rate from these causes of 126.9 deaths per 100,000, representing 75.9% higher than the rate of 72.2 among White Americans. By 2019, the gap had increased to 80.9% higher for Native American communities, and in 2020 it rose to 102.6% higher for Native American individuals, indicating that Native American midlife mortality from the 'deaths of despair' causes were now over double that seen among White Americans.

In sum, across the board, Native American communities have exhibited substantially higher midlife mortality, and mortality from so-called 'deaths of despair,' among all years of available data. These inequities have worsened considerably over time. Nevertheless, the narrative of overdose, suicide, and ALD as "White Problems"— tied to economic disinvestment from working class White areas—has achieved widespread prominence as an explanatory framework in academic and popular press literature[2,3]. Yet this core idea—of the uniqueness of White suffering from these causes of death—was only made possible through the erasure of data describing Native Americans. Narratives that center poor outcomes among White communities must be assessed critically, as they have historically overlooked and ignored higher rates of economic, social, and health inequities among minoritized populations in the US[3].

The term "Data Genocide" has been used by researchers at the Urban Indian Health Institute and other organizations to describe the *erasure* of data attesting to deleterious health outcomes for Native American communities[4]. The omission of these data for Native American groups is commonplace, with sobering implications for attending to and remedying health inequities, underfunded programs, and inaccessible services. Although health policies are increasingly 'data-driven,' Native Americans are often excluded from data used to make decisions[4]. The omission of data describing pressing health needs within Native American communities thus allows for the propagation of these inequities, extending a long and tawdry history of government-sanctioned erasure and genocide of Native Americans.

COVID-19 has also highlighted the pervasive exclusion of Native American individuals from public health databases and analyses[4]. Although the pandemic ushered in a profound revolution in the speed of data collection, aggregation, and publication, many data sources were published without information about race or ethnicity. Many data providing racial information omitted Native American communities entirely.

However, the pandemic also showed that progress on data equity can be made rapidly. Lawsuits and public pressure forced the CDC to publish race-specific data for most indicators in relatively short order. Though far from perfect, provisional data were made available quickly by race and ethnicity for direct COVID-19 mortality as well as a host of other causes of death.

Now, in order to ensure that inequities are not overlooked moving forward, inclusion of data for Native American individuals is essential. We propose the following guiding principles to protect against exclusionary data policies—or data genocide—with respect to Native American populations.

First, when collecting data representative at the national and state level, especially, the 'other' category should be eliminated for Native Americans individuals, who should be specifically enumerated. When small sample sizes are prohibitive, leading to highly uncertain trends, data can be further aggregated, smoothed statistically, and shown in a distinct format in a supplemental figure, if necessary. Concerns over small sample size should be avoided whenever possible as a justification for Native American data exclusion. However, great care must also be taken to avoid showing incorrect or highly uncertain findings that may be stigmatizing.

Second, in the context of a long-history of disrespectful, irrelevant, and exploitative research among Native American communities[5], it is essential that Native American concerns are centered in collection, maintenance and sharing of community data. Most relevant for national surveillance efforts, this could be accomplished via Tribal consultation to establish a national Tribal data access and protections policy, investing in and partnering with Tribal Epi Centers for rapid data response and sharing; partnering with a small number of larger Tribal communities for sentinel public health data collection and sharing (with concrete local benefits for Tribes); and partnering with urban Indian health programs for Native-led data collection and analysis.

These data (infra)structural changes are necessary to make sure that data collection strategies attend to the most urgent inequities in health status across ethno-racial communities in the US. Native American communities now have the highest rates of each of the 'deaths of despair,' as well as the highest overall rates of mid-life mortality of any group. In these facts lies a double moral injury: not only do Native American communities suffer from the highest rates of midlife mortality and from each of the causes of deaths of despair, but these realities are also entirely missing from powerful mainstream narratives that have once again erased contemporary Native American presence and visibility, thereby depriving these communities of desperately needed access to additional health resources.

Instead, deep investments are needed in Native American communities to address centuries of dispossession and impoverishment—maintained today through systematic exclusion and public erasure—toward community-driven, self-determined initiatives that will preserve Indigenous futurity. To address unparalleled mortality from overdose, suicide, and ALD we suggest properly funding the chronically underfunded Indian Health Service; devoting resources to tribally-controlled, evidence-based, and culturally-grounded substance use treatment programs; and investing deeply in housing, employment, healthcare, and other community resources that address the upstream drivers of premature mortality.

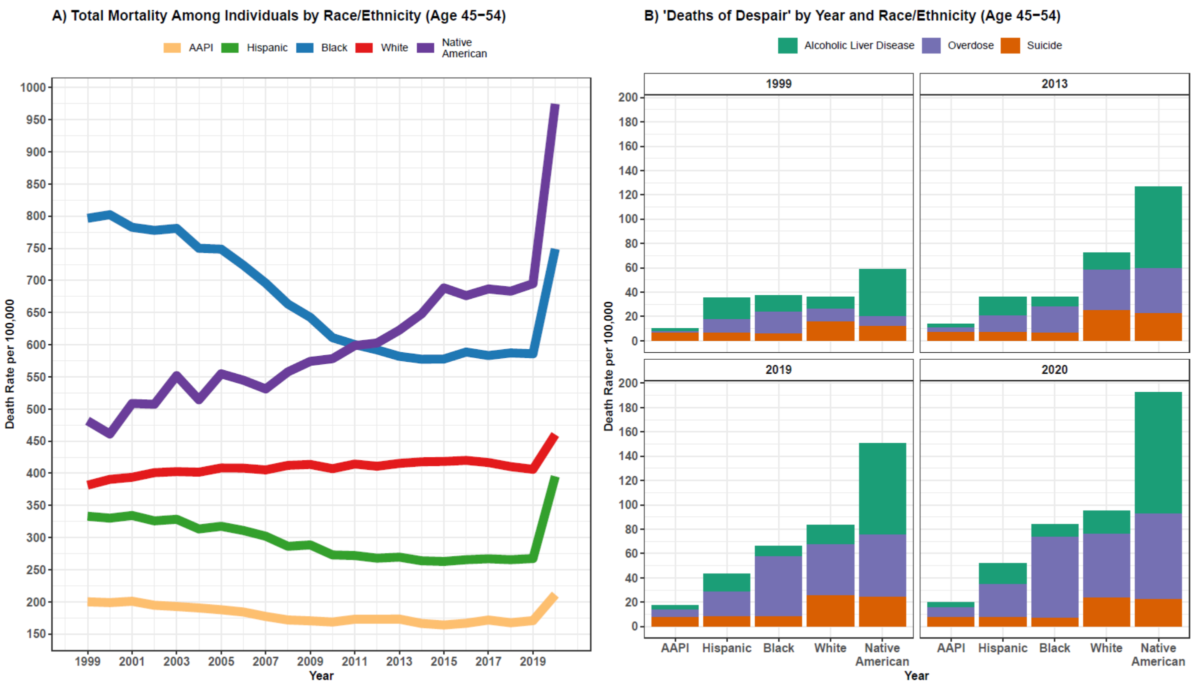

Fig 15.1 Total Mortality and Deaths of Despair Among Individuals Age 45-54 by Race/Ethnicity

Panel A shows total mortality among individuals age 45-54, by race/ethnicity, from 1999-2020. Part B shows mortality from ‘deaths of despair’ causes, including alcoholic liver disease, drug overdose, and suicide, by race/ethnicity, for the years 2005, 2010, 2015, and 2020 as stacked bars.

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Chapter 16: Conclusions

'Deep Mixed Methods' Combining Data Science and Ethnography

Chapters 2-6 of the text are focused on the integration of data science and ethnography for the rapid and critically-applied surveillance of emerging health inequalities and other novel trends in population health. I refer to this here as "deep mixed methods" to reflect that ethnographic data provides a very rich and comprehensive source of qualitative information. I argue that ethnography is distinct from more cursory forms of qualitative data that are typically mixed with epidemiological records in mixed method studies. Of course, there is a rich literature mixing qualitative and quantitative information in epidemiological studies describing health outcomes[6–9]. However, the vast majority is not ethnographic in nature. In fact, it is relatively rare in the literature to find instances of true mixed methods work leveraging ethnography in direct conversation with quantitative research in a responsive fashion[10].
Towards the amelioration of this gap, here I present five case studies that seek to achieve this mix. Each involves an exploratory research process mixing ethnographic and some form of quantitative information. All leverage rich, longitudinal ethnographic data and put them directly in the conversation with quantitative findings.

In addition to methodological similarities, the five case studies cover topically related materials. All relate broadly to substance use and highly vulnerable populations. However within this area they cover diverse topics ranging from novel additives to the drug supply, to the spread of fentanyl throughout Mexico, to police violence against people who use drugs, to the interpersonal violence that is inherent to prohibition markets. Yet what these studies have in common is that in each case, they document phenomena that are difficult to describe solely using traditional administrative databases, or quantitative records from cohort studies. The topics covered are largely stigmatized, clandestine, and in many cases illegal. Nevertheless in each case, it is possible to find or generate quantitative data sources that can shed light on the evolution of the dynamics being studied. In many cases these sources may be 'out of the box,' i.e. using non-traditional information streams. But critically, the quantitative data are selected, and their analysis is guided, based on insights drawn from the theoretical frameworks derived from prior ethnographic work.

In this exploratory, multi-stage mixed methods framework, years of ethnographic fieldwork served as the first step, generating deep understandings of population and personal-level dynamics. Subsequently, quantitative research questions could be developed based on preliminary ethnographic results through a structured, multi-step exploratory research process. The process was carried out in a slightly different manner depending on if the same investigator conducted the ethnographic and quantitative components of the research. When the same researcher conducted both components of the analysis, the multi-step process involved 1) preliminary coding of ethnographic data, 2) the generation of hypotheses about wider dynamics and 3) the conversion of these hypotheses into testable quantitative statements, followed by 4) the collection and/or analysis of quantitative data.

When distinct researchers conducted the quantitative and qualitative sides of the research, the preliminary qualitative analysis was performed by the primary ethnographic researcher or ethnographic team, who subsequently had a series of conversations and shared a set of cross-cutting memos with the quantitative researcher who completed the subsequent research phases. In all such cases, the quantitative researcher also conducted additional coding and analysis of the ethnographic data.

This 'deep mixed methods' approach may be most helpful or appropriate for instances where the population level phenomena being surveilled are stigmatized, or otherwise difficult to track or access through other methods. For instance, there is a distinct obvious benefit of this approach for studies of the evolving drug supply, the overdose crisis, and intersecting social and health crises affecting people who use drugs. All of the case studies here reflect such populations in North America. Among these individuals there is great value in having the research process reflect "common sense" logics i.e. understandings that are obvious and intuitive to people on the ground who are living them, but may be surprisingly inaccessible to traditional epidemiological researchers[10–12]. Put simply, when you live among people and spend enough time with them, you will inherently grow to deeply understand the logics and dynamics that guide their daily life. This is a powerful core insight of anthropology that is surprisingly absent from the realities of most epidemiological research processes and large cohort studies.

There is also unique benefit to using ethnography to guide epidemiological analysis of dynamics that are changing rapidly and may not be visible in traditional surveillance registries. We see this for instance with Chapter 6, which describes the emergence of xylazine in the US street drug supply. While quantitative data describing xylazine is limited by numerous factors—especially limited drug checking and toxicology testing for novel psychoactive substances checking in the US—ethnographically the presence of xylazine has been noted very plainly by participants in the drug scenes where it has landed. This facilitated more rapid quantitative detection and analysis of xylazine leveraging alternative data sources that may not have been analyzed without the initial ethnographic insight.

Additionally, a rich literature has identified the ways that ethnography can be used to critique and refine public health discourses that can be out-of-touch with on-the-ground realities of people who use drugs[13]. In a classic example from Bourgois (1998), set in an encampment in San Francisco, homeless individuals who inject heroin reassure passing harm reductionists that they never share injection equipment[13]. Nevertheless, shortly after the well-meaning harm reduction workers leave, the moral economy and urgent realities of 'staying well' all-but require that they share syringes as they desperately navigate the collection of funds and ever-recurring pangs of excruciating drug withdrawal symptoms. In this case, public health discourses, embodied in frontline health workers, simply lack compatibility with common sense logics of the target population. Similar dynamics have been observed in other ethnographic field sites discussed here, including Tijuana and Philadelphia, as well in published literature from numerous corners of the world. Nevertheless these practices were only truly observable through sustained trust-oriented relationships where participants allow researchers to observe them and participate in their daily lives. In surveys, individuals are very likely to claim that they never share syringes because there is powerful stigma and bias towards answers that are perceived as desirable. Whereas ethnography strips away many of these biases through the simple fact that people are observed while they are exposed to all of the normal stresses of daily life that drive deleterious health outcomes.

Ethnography in drug scenes may be particularly powerful when coupled with drug checking techniques[14–16]. These are client-facing technologies administered at harm reduction spaces that can allow for a sample of drugs to be processed in a matter of minutes, presenting the client with an ingredient list of all of elements present in the drug sample and at what concentration. This represents a key public health strategy for preventing overdose deaths, as it equips consumers to have access to detailed information that shapes their demand for safer drugs. Relatedly, this represents a powerful research approach to better understanding shifts in the drug supply and their population-level impacts. Brought into a mixed methods context, drug checking can tell us what is happening in the drug supply, and ethnography can tell us what it actually means in the lived experience of people who are exposed to novel drugs, as well as generate hypotheses about current and future implications for public health trends.

Despite these benefits, it is important to consider that ethnography is not a perfect tool for surveillance. Ethnography inherently deals with micro niches and small sample sizes. Furthermore, conducting ethnography is very time- and labor-intensive for each units of 'sample size.' In many instances, it is much more feasible to study a large number of individuals—and wider breadth of ecological niches—using quantitative methods. Therefore, ethnography for the purposes of surveillance may be best conceptualized as a deeply powerful engine of hypothesis development, rather than a source of definitive population-level data. The use of quantitative data can verify that insights derived ethnographically are valid at the population level (or not) and provide other nuances about geographic, temporal and social group dynamics. In sum I would argue that these two very different methodologies, "big data" epidemiological data science, and deep, longitudinal, intensive, participant observation ethnography make a natural, albeit perhaps surprising, complementary pair in the pursuit of detailed granular, nuanced and socially and culturally relevant surveillance.

Although ethnography has not been systematically used for drug market or wider public health surveillance in the US, pharmaceutical companies have been well aware of its benefits towards this purpose for decades. Evidence suggests that pharmaceutical companies hired ethnographers to track the way that their opioids were being diverted and used differently than prescribed—inherently very difficult phenomena to measure quantitatively. A pragmatic market-driven impetus exists for companies to leverage ethnography to obtain rich information about trends in the way drugs are used in clandestine settings.

Despite the myriad benefits of ethnography for drug surveillance, ethnographic approaches have not been widely institutionalized by public health authorities for this purpose. Most innovations in drug surveillance have been almost entirely quantitative in nature. For instance, the State Unintentional Drug Overdose Reporting System (SUDORS) network was implemented to provide rapid and improved surveillance of novel substances detected in overdose deaths[17]. Many such approaches have been piloted, funded, and expanded nationally in recent years in response to the overdose crisis. However, nothing similar has been piloted--to this author's knowledge—for ethnographic approaches. Nevertheless it is easy to imagine the benefit of a network of ethnographers funded to monitor drug user health and the evolving drug supply in diverse contexts across the United States, integrated with drug checking and other quantitative sources of information.

Of course, ethnographers do participate in these kinds of activities of their own accord, funded by numerous public and private mechanisms. However, they lack central coordination or any formal mechanism to serve as an 'early warning system.' Further, many ethnographers are not directly linked with quantitative researchers. Exchanges of information do occur through the scientific literature and other mechanisms. However, a well-funded and intentional investment would be needed to institutionalize an ethnographic approach to surveillance of drug market and drug user health and render it a rapidly response system.

The under-development of ethnographic approaches to surveillance likely reflect a general bias in public health research, and substance use research, towards quantitative forms of information. For instance, numerous studies over the years have shown a consistently low percentage of qualitative research articles among the top substance use journals, and described the marginalization of qualitative research within the field[18,19]. The lack of improvement over time indicates a persistent overall trends towards the hegemony of quantitative data in substance use research. Should this exercise be repeated for public health research as a whole, the percent qualitative figure may be even lower.

In sum, in the case studies presented here I develop and implement a model for 'deep mixed methods' blending ethnography and data science for public health surveillance, especially focused on drug markets and the health of drug-using populations. I argue that this model would have great value if institutionalized nationally as part of an early warning public health surveillance system. Such a system would need public funding and would entail a paradigm shift about which sort of insights into the drug market and population health dynamics as are valued by central government actors.

'Out-Of-the-Box' Data Science Techniques to Rapidly Track Evolving Health Inequalities

Chapters 7-9 detail a series of three case studies that exemplify novel, or 'out-of-the-box,' data science approaches to surveillance. Many opportunities for this kind of analysis were provided by the COVID-19 pandemic. The pandemic pushed the speed of data collection and reporting and highlighted the pervasive lags in public health surveillance systems that stymie rapid surveillance[20]. These concerns are especially acute where social inequalities are concerned. In many cases the problem was not the collection of data, rather the timely and granular reporting of information by key social groupings[20,21]. For instance, at the outset of the COVID-19 pandemic it was common knowledge among harm reductionists and people on the ground that overdose deaths were surging (see above description of the value of ethnographic research in this context). However, no quantitative data were made available that could describe these increases quantitatively for many months. A New York Times investigative article attempted to cast light on the issue by gathering preliminary data from jurisdictions that make rapid data available[22]. However, this is obviously less than ideal for various reasons. Public health surveillance should not be left to journalists. Not surprisingly the analysis lacked documentation to facilitate replication, full results, or methodological details. Yet their findings, suggestive of a large increase in overdose deaths in the early months of the pandemic, proved to be relatively correct, albeit an undercount of the full magnitude of increases. Further, the incident highlighted the inept state of US overdose surveillance, wherein the efforts of non-scientific and non-government actors seeking to make improvements in the space were the most notable aspects of the data landscape.

The first provisional data from the CDC describing increases in overdose deaths during the pandemic were not published until approximately eight months after the onset of the pandemic[23]. When these results were released, and promoted by the CDC, there was a large media response. However, in the interim, many deaths occurred, and there was great squandered potential for interventions to be conducted, should more rapid data have been made available.

This concerning data landscape prompted the case study laid out in Chapter 8, which leverages an alternative data source to track overdose deaths. Using the National Emergency Medical Services Information System (NEMSIS[24]) (which represents ~90% of EMS activations occurring in the United States, as of 2020) shifts in overdose trends could be tracked rapidly. We found that EMS-observed overdose deaths—admittedly only a fraction of the total overdose death count—can serve as a reliable proxy for the total. Furthermore, these data are available with an only one-to-two-week lag, as opposed to the six-to-eight-month lag seen in provisional total overdose mortality data seen in the best-case reporting scenario from the CDC. This is an example of what I define here as 'out-of-the-box' data science, in that a scientific analysis is able to leverage alternative data sources and methods to adapt them to tasks for which the current "gold standard administrative data" are simply not sufficient or available. Critically, these analyses must demonstrate that alternative data sources and methods are at least close to the quality of the "gold standard" data sources, wherever possible, using concordance analysis.

This approach had the added benefit of providing data that was race- and ethnicity-specific. Despite the eventual release of provisional overdose death records for 2020 showing a big increase in overdoses, these numbers were not made available by race or ethnicity for a long additional period. This was highly concerning because prior to the pandemic, the biggest increases in overdose deaths had been occurring among Black and Latinx communities. We were able to provide our much more rapid proxy measure broken down by race and ethnicity highlighting, just as feared, much larger increases among minoritized communities.

Chapter 9 deepens my critique of the provisional overdose trends made available by the CDC in the wake of the pandemic. It centers on the counterintuitive nature of the format that overdose trends were provided in. Although the detection of temporal shocks requires the most granular time information possible, the CDC initially provided provisional overdose deaths in rolling 12-month cumulative totals that were widely misinterpreted in the media and by academic researchers, very confusing to work with, and masked many of the most important short-term time spikes occurring in the early months of the pandemic, because they occurred in states with declining trends prior to the pandemic. The rolling aggregate approach does have the advantage of increasing the sample size and stabilizing trends for small states, yet they have the very serious disadvantage of masking sharp increases in month-to-month overdose trends for many states. We find that rolling 12-month averages told a very different story of which states were the most effected by overdose spikes. Using a simple algorithm, we were able to unroll the rolling 12 months averages and recover the true underlying monthly overdose death numbers with a 95% confidence interval, that reflected, not only the uncertainty in our process but the differences between provisional and final CDC overdose death reporting. A main outcome of this effort was highlighting how frustratingly simple and unnecessary the CDC's formatting of these data were. So simple, as to be undone by two graduate, students using basic mathematics. This case study serves as an example of where out-of-the-box data science can involve improvements to the format of traditional administrative data, not necessarily finding an alternative data source, in the pursuit of more granular and timely surveillance.

Chapter 7 concerns the rapidly evolving academic topic of excess mortality. Excess mortality became a central concern during the COVID-19 pandemic as researchers and health authorities realize that only a fraction of death stemming from the pandemic were actually recorded as formal COVID-19 deaths in many countries[25,26]. This gap was as large as 10- or 20-fold in many countries[27,28]. Therefore the true impact of the pandemic on mortality must be measured using alternative measures. Specifically, looking at the difference in all-cause mortality before and during the pandemic provides a level of excess mortality stemming from the pandemic, either directly through COVID infections, or indirectly through other social and economic consequences of the pandemic and its societal responses.

Mortality data were subject to many of the same limitations as overdose mortality data. As described above, data lags were often acute, data were most often not broken down by race and ethnicity, and data quality varied greatly between jurisdictions. Therefore, in chapter 8, we provide an alternative approach using again, EMS data. In this case, excess EMS-observed all-cause deaths. In other words, excess deaths occurring in a pre-hospital setting, i.e. an out-of-hospital setting. This approach was especially appropriate for the context of the study in

Tijuana, Mexico, where accurate all-cause mortality data were not made available for a great deal of time by the Mexican government.

The study took place in the early months of the pandemic, when COVID testing rates were very low in Mexico, virtually reserved only for gravely ill hospitalized patients. Subsequently, official COVID-19 mortality rates deeply undercounted relative to excess mortality totals that would be released many months later. Therefore, we were able to greatly improve the detection of excess out of hospital mortality in a nuanced and inequalities-oriented fashion using EMS data from the Mexican Red Cross, which operates the pre-hospital medical system for all of Tijuana.

The study highlighted clusters of excess out-of-hospital deaths and linked this to neighborhood socioeconomic status. This allowed for both the documentation of a socioeconomic gradient of excess out-of-hospital death and for highlighting outbreak clusters, which were directly targeted by the local municipal government for COVID-19 outreach and interventions.

This analysis contributed to a national controversy in Mexico about the reporting of COVID-19 deaths. The report was the first published work to highlight the extreme undercounting of COVID-19 deaths in Mexico. Additionally, another analysis essentially hacked death registry data from a semi-public portal in Mexico City, finding similar rates of excess mortality. This was reported in Spanish in a popular press venue. Both analyses were covered in popular media and led to increase public pressure on government for the release of excess mortality data. When these figures were eventually published, they showed that Mexico was among the worst total death tolls per capita in the world. However the statistics were released very late, after public attention had moved on to other matters, and the opportunity for intervention was diminished.

In sum, these three papers highlight how out of the box data science—finding new data sources and methods that have distinct advantages over traditional administrative surveillance—can offer improvements in terms of speed, granularity, and inequality measurement in routine public health surveillance.

Critically-Applied, Inequalities-Oriented Social Epidemiology of the "Deaths of Despair"

Chapters 10-15 deal with the social epidemiology of the so-called "deaths of despair." This term was coined by Case and Deaton in a prominent 2015 paper that identified three causes of death—drug overdose, suicide, and alcoholic liver disease—as driving unprecedented increases in midlife mortality (and decreases in life expectancy) for White Americans[1]. Specifically, these increases in death rates were seen among White Americans without a college degree. This theory posited that low-income White America had been 'left behind' by deindustrialization and a shift to a skills-based economy that required at least university education for economic success[29]. In the wake of broader economic shifts, the lowly-educated segment of White America was hypothesized to be killing itself, either quickly, through suicide (with guns) or more slowly through drugs and alcohol.

Critically, this theory was always centered on race, specifically the unique levels of mortality seen among White individuals, which was offered as a surprising finding[3]. A non-sequitur, bucking the trend of expected findings in the context of pervasive, systemic racism that results in people of color having worse health outcomes for nearly every possible health condition. Countless media articles trumpeted this theory. In fact, it quickly achieved widespread reach in the American consciousness, as a powerful explanatory frame for the American propensity for death from these highly socially bound causes of mortality.

However, the Deaths of Despair theory is flawed in deep and superficial ways. For instance, very soon after it was posited, a group of demographers argued that the core findings were not robust after controlling for differences in the age composition of the key 45-54 age group used[30]. Furthermore, in a more profound way, the centering of *White Suffering* deserves critique as a highly problematic framing for social epidemiological analysis.

As I highlight in Chapter 15, it was only possible to argue for the unique nature of White deaths from these causes by excluding deaths among Native Americans from view. Consistent with a long history of Native exclusion from data landscapes and resulting discourses[4], data from Native communities were not included in the seminal analysis defining Deaths of Despair, nor in the vast majority of follow-up literature on the topic. Nevertheless, I show that Native communities have had higher rates of the Deaths of Despair causes in all available years of data, and significantly higher rates of midlife mortality, which were also increasing to a greater degree during the period of time studied in the seminal paper. In short, the "uniquely White" nature of the Deaths of Despair, could not have been articulated as the 'just-so' story that it became without the exclusion of data representing indigenous individuals. This exclusion has powerful implications for narratives of socially-bound mortality in the United States, and for the provision of resources to address it.

A further point, minimally acknowledged in the seminal work, but not recognized for the profound magnitude of its importance, is that Black midlife mortality has been much higher than that of White individuals for all available years of data. In effect, the White life expectancy loss observed over the past 20 years is a small fraction of the persistent life expectancy loss suffered by Black communities due to systemic racism in the United States. However, the fact that background rates of Black mortality are substantially higher has not received the kind of magnetic interest from media that the Deaths of Despair concept has garnered. In effect, the emergence and spread of the Deaths of Despair theory highlights, by contrast, that deep structural inequalities among Black America and other minoritized groups are viewed as routine and expected—and therefore relatively less newsworthy—whereas a smaller, temporary, upward blip in White mortality commanded a great deal of public interest.

In the chapters of this section, I offer an alternative vision of the Deaths of Despair, especially through focusing on deaths stemming from drug overdose. This cause of death serves as a particularly useful focal point because the racial composition and overall level of overdose death rates has shifted rapidly over the decades. The US has become an extreme global outlier in overdose deaths in the past two decades. According to data from the Global burden of Disease study, in 2019 the US had a drug overdose death rate double the second highest country, and approximately 20 times the global average[31]. Nothing as dramatic has been seen with suicides or alcoholic liver disease, because these reflect more stable epidemiological processes. Although US rates of these causes of death are relatively high compared to some wealthy peer nations, the US is not such a global outlier. In 2019 the US had all-age crude mortality rates from suicide and alcoholic liver disease that were close to the global average in both cases. The US did not rank close to the top in either condition[31]. Drug overdose is therefore the quintessentially American cause of Deaths of Despair, where we are a true, extreme global outlier.

The chapters in this section cover numerous aspects of the evolving US overdose crisis, especially in terms of social inequalities. There are a number of empirical insights that are critical to track in the academic literature, and perhaps even more importantly, promote in the media, given their profound political implications. As I show in detail, the racial composition of the US overdose crisis has shifted considerably since it was de-facto labeled as a White Problem with the advent of the Deaths of Despair narrative.

In Chapter 10, two decades of (pre-pandemic) overdose trends are explored by race, ethnicity, drug-involved, and US state. Tracing the racial breakdown of overdose through the four waves of the modern overdose crisis[32] distinct patterns can be seen for each. Only in the first wave of the crisis—predominantly driven by prescription opioids—were White individuals disproportionately affected relative to their Black counterparts. This was a short-lived phenomenon, yet a profound one. The reasons for this 'unexpected' disparity can be found in structural racism in the provision of controlled substances through the health care system.

A robust literature has highlighted how White individuals are prescribed opioids at a much higher rate through the health care system than Black individuals, regardless of true, underlying medical need[33–35]. This is due to deep-seated inequalities in access to health care, implicit and explicit biases held by physicians, the racialized implementation of prescription drug monitoring systems, and other factors[34,36]. For example, in California, simply based on the racial and income composition of a neighborhood, a 300% gradient in the percent of the population receiving an opioid prescription was seen during the first-wave overdose crisis period[35]. This gradient in prescription was similar to the gradient of overdose deaths in California for the same time period, suggesting an ecological link.

It is also important to note that prescription opioids were aggressively marketed to low-income White America as non-addictive, with this group perhaps chosen as a market segment less likely to receive regulatory scrutiny. This is a good example of how poorly-regulated legal markets (unchecked capitalism) can be harmful in terms of creating predatory and deleterious market effects for drugs, just as prohibition markets consistently do[37].

With the transition from legal market opioids to illicit market opioids driving the overdose crisis, the racial composition of the crisis flipped. Between 2000 and 2010 the White overdose death rate rapidly grew to double the rate among Black individuals. However, as we show in Chapter 11 for California, and Chapter 12 for the United States as a whole, between 2010 and 2020 overdose deaths grew more rapidly for Black individuals. In 2019 in California, and in 2020 for the nation, Black overdose mortality overtook that of White individuals. These shifts reflect that Black individuals have been disproportionately impacted by overdose deaths from illicitly-manufactured-fentanyls, for various reasons related to gaps in housing, medical care, services, and other resources required to stay safe in the presence of a volatile drug supply.

Fentanyls have also widened the scope of who is affected by overdose deaths. Instead of overdose almost-exclusively affecting individuals who have had an opioid use disorders for decades, they are increasingly affecting intermittent or infrequent consumers of cocaine, pills, and other drugs that can be cut with or confused with fentanyls. Particularly tragically, as I show in Chapter 13, drug overdose deaths among high-school age adolescents are now starting to spike, after decades of flat trends among this age group. Teens on the west coast have been disproportionately affected by these increases, reflecting the geographic spread of "blues"--counterfeit pills containing fentanyls[38]. Latinx and Native teens have also been disproportionately affected, reflecting an overall trend towards increased racial and ethnic inequalities in overdose seen across nearly all age groups.

In Chapter 14, I argue that overdose mortality—far from a "White Problem"—is a critical racial justice issue. Overdose now disproportionately affects communities of color, the same communities that have fewer access to resources for substance use disorders and other resources needed to stay safe in the face of such a dangerous drug supply[39]. Even when overdose rates were higher among White communities, Black, Native, and Latinx individuals bore a disproportionate burden of the harms of US drug policy[40]. Now that the racial pattern of overdose has shifted, it is even more critical to align US drug policy with the goals of racial justice movements: shifting resources away from racialized policing of minoritized communities and into social, health, and economic services for groups that have been historically excluded from these resources.

A Model for Critically-Applied, Deep Mixed Methods, Inequalities-Oriented Public Health Surveillance

In sum, in the 14 analytical chapters of this work I have sought to advance a model for critically applied, deep mixed methods, inequality-oriented public health surveillance. This is a form of tracking health trends that is specifically focused on detecting inequalities for the explicit purpose of working towards their amelioration. This model rejects health inequalities as the natural state and instead brands them as an unfortunate—and ultimately modifiable—consequence of structural social and economic inequalities. This work is therefore critically applied, grounded in social science theory, but with the main goal of affecting change in the real world. This has many implications for the choice of journal, and the way that results are disseminated to media and potential policymaker audiences. This work does seek to advance social theory, but the framing, argumentation, and dissemination of results must also be carefully crafted to maximize potential benefit in shifting narratives around health trends and leading to a more equitable distribution of societal resources to address them.

This form of surveillance can also be 'deeply mixed methods' in nature, leveraging longitudinal participant observation ethnography and mixing it with forms of novel data science. Although most public health surveillance is quantitative in nature, in this text I provide numerous examples of how ethnography can offer much in terms of granular details of rapidly shifting health trends, not easily gleaned from routine quantitative databases. Further I argue that ethnography can provide a useful first phase for grounding subsequent data science analysis in common-sense on-the-ground logics of the population of study.

The past few years have borne witness to a global pandemic, deepening political and social divides, and rising levels of social inequalities. Yet there is also much room for hope, as social movements evolve and continue to strive for a better world. It is this author's belief that a valuable contribution can be made in measuring what matters, connecting these observations to social theory and ethics, promoting important messages in as many ways and platforms as possible. It is my hope that the model defined in this text can be further refined and implemented broadly in the coming years to improve the state of knowledge regarding a wide range of socially-bound health topics.

Future Work and Directions

The future directions for this body of work include the application of the model developed here to the most urgent set of evolving health trends and inequalities. There is particular value for the study of the increasingly toxic US drug supply and the health of the people routinely exposed to it. A deep mixed methods approach should be applied to study of novel benzodiazepines, stimulants, tranquilizers, and many other drugs being rapidly synthesized and mixed into the drug supply. In the context of an unprecedented overdose crisis, the development and piloting of an 'early warning system' for the US drug supply leveraging both embedded ethnography and novel data science techniques could be particularly valuable at the national level.

Additionally this model should be applied to deeply characterizing rising racial, ethnic, and social inequalities in the highly socially bound causes of mortality seen in the US, including drug overdoses death, suicide, firearm violence, among others. These causes represent highly visible and preventable manifestations of social inequality in this country that should be urgent priorities for measurement and amelioration.

The true value of the model developed here is its highly responsive fashion, able to adapt to rapidly evolving situations and study phenomena as they emerge. Therefore many of the most important questions for study in this fashion have likely yet to be defined. Instead a prospective monitoring framework should be employed, leveraging embedded ethnographers and a team with the capacity to and analyze novel sources of quantitative information as they become available.

Chapter 16 References

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