

Association between jail-based methadone or buprenorphine treatment for opioid use disorder and overdose mortality after release from New York City jails 2011–17

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Abstract

Background and aims: Opioid overdose is a leading cause of death during the immediate time after release from jail or prison. Most jails in the United States do not provide methadone and buprenorphine treatment for opioid use disorder (MOUD), and research in estimating its impact in jail settings is limited. We aimed to test the hypothesis that in-jail MOUD is associated with lower overdose mortality risk post-release.

Design, setting and participants: Retrospective, observational cohort study of 15 797 adults with opioid use disorder who were released from New York City jails to the community in 2011–2017. They experienced 31 382 incarcerations and were followed up to 1 year.

Measurements: The primary outcomes were death caused by accidental drug poisoning and all-cause death. The exposure was receipt of MOUD (17 119 events) versus out-of-treatment (14 263 events) during the last 3 days before community re-entry. Covariates included demographic, clinical, behavioral, housing, health-care utilization and legal characteristics variables. We performed a multivariable, mixed-effect Cox regression analysis to test association between in-jail MOUD and deaths.

Findings: The majority were male (82%) and their average age was 42 years. Receiving MOUD was associated with misdemeanor charges, being female, injection drug use and homelessness. During 1 year post-release, 111 overdose deaths occurred and crude death rates were 0.49 and 0.83 per 100 person-years for in-jail MOUD and out-of-treatment groups, respectively. Accounting for confounding and random effects, in-jail MOUD was associated with lower overdose mortality risk [adjusted hazard ratio (aHR) = 0.20, 95% confidence interval (CI) = 0.08–0.46] and all-cause mortality risk (aHR = 0.22, 95% CI = 0.11–0.42) for the first month post-release.

Conclusions: Methadone and buprenorphine treatment for opioid use disorder during incarceration was associated with an 80% reduction in overdose mortality risk for the first month post-release.

KEYWORDS

All-cause mortality, drug-related mortality, jail, medication for opioid use disorder, opioid use disorder, urban population

INTRODUCTION

Opioid overdose is a leading cause of death during the immediate time after release from jail or prison [1–5]. This indicates an acute risk of overdose mortality post-release among individuals with opioid use disorder (OUD) who disproportionately experience incarceration in the United States (approximately 15–20%) [6, 7]. Methadone and buprenorphine, two medications for opioid use disorder (MOUD), are proven interventions that reduce overdose risk among people with OUD. Studies from Australia, Taiwan, Scotland and England show that MOUD provided during incarceration is associated with lower mortality after release from prison [8–11]. For example, Marsden and colleagues examined mortality risk by specific post-release time-periods among people with OUD incarcerated in England and found that in-prison MOUD substantially reduced risk of all-cause and overdose mortality within 1-month post-release [11].

Notwithstanding this evidence, MOUD remains largely unavailable in the United States' correctional settings due to regulatory and logistical reasons. Stigma is another major barrier to the implementation of MOUD. A widely held misunderstanding is that MOUD replaces one addiction with another [12, 13], and drug addiction is a moral failing rather than an illness [14]. This is true not only in prisons, but also in jails, where individuals are incarcerated for shorter periods of time for pre-trial detention and misdemeanor convictions [15, 16]. Because MOUD programming is scarce, research on MOUD's impact on mortality and other outcomes in US jail populations is limited which, in turn, may hinder wider implementation. To address this gap, we assessed the impact of the in-jail MOUD program in New York City (NYC) jails, the oldest and largest correctional-based licensed opioid treatment program in the United States. Using matched health and administrative data, we tested the hypothesis that in-jail MOUD for people with OUD was associated with a lower risk of overdose mortality after release from NYC jails to the community during May 2011–December 2017.

METHODS

Setting

This retrospective observational cohort study is part of a larger study involving researchers, clinicians and public health practitioners from academic institutions, NYC Department of Health and Mental Hygiene (DOHMH) and NYC Health + Hospitals/Correctional Health Services (CHS) to evaluate impact of jail-based MOUD on mortality and other health outcomes post-jail release [17].

NYC's jail system received more than 85 000 admissions in 2011 and nearly 56 000 in 2017 [18]. As the provider of health-care, social work services and discharge planning for NYC jails, CHS medical staff

perform a comprehensive medical intake evaluation, including substance use screening to identify current use or misuse of substances (e.g. frequency, type), risks of withdrawal from opioid, alcohol and other drugs based on assessment of self-reported behaviors, self-reported (and where possible confirmatory) enrollment in community MOUD programming, urine toxicology tests or other OUD or MOUD records. Additional screening by providers may take place during clinical encounters after intake. Individuals with positive screening results for opioid use based on the totality of these factors receive an OUD diagnosis, which is documented in the record by International Classification of Diseases, ninth and tenth revisions, clinical modification (ICD-9-CM, ICD-10-CM) codes, which serve as a marker of current OUD in the electronic medical records. Individuals with a recorded OUD diagnosis may then be eligible for jail-based MOUD programming.

Until late 2017, MOUD eligibility was based on legal charges. Although all individuals with OUD were offered short-course methadone or buprenorphine for the treatment of acute opioid withdrawal during incarceration, they were ineligible for MOUD maintenance if they had felony charges, parole violations or other active warrants which could result in discharge to state prison or other custody, partly due to lack of access to MOUD in New York State (NYS) prisons. Ineligible individuals who had been enrolled into community MOUD would be slowly tapered off MOUD ('withdrawal-only'). Eligible individuals, by contrast, were offered voluntary enrollment in the MOUD program, which involved induction or continuation on methadone or buprenorphine for maintenance along with linkage to community ('maintenance'). A change in legal status during incarceration could change eligibility. In late 2017, this legal eligibility impediment was removed by CHS.

Data sources

From their electronic medical records, CHS extracted identifiers, incarceration and health records for adults aged ≥ 18 years who were admitted and released from NYC jails during 1 May 2011 to 31 December 2017 and had an OUD diagnosis. These data were transferred to DOHMH and probabilistically matched with the NYC death certificate data using QualityStage Software (IBM, Armonk, NY, USA). Additionally, the identifiers were deterministically matched with NYS Medicaid claims and Statewide Planning and Research Cooperative System (SPARCS) hospitalization and emergency department (ED) records [19]. An independent human review of 300 match cases (0.7%) and 300 unmatched counterfactuals (0.2%), which were randomly selected using stratified sampling with stratification by matching algorithm and data sources, determined that matching quality was acceptable (sensitivity = 97%; specificity = 96%).

The Institutional Review Boards of DOHMH (18-106), two academic institutions (18-00445 and 1811019740) and Biomedical Research Alliance of New York (19-PRS-156-419(HHC)) reviewed and approved this study. It also received certification from the Office for Human Research Protections of the US Department of Health and Human Services. The analysis was not pre-registered and the results should be considered exploratory.

Study population

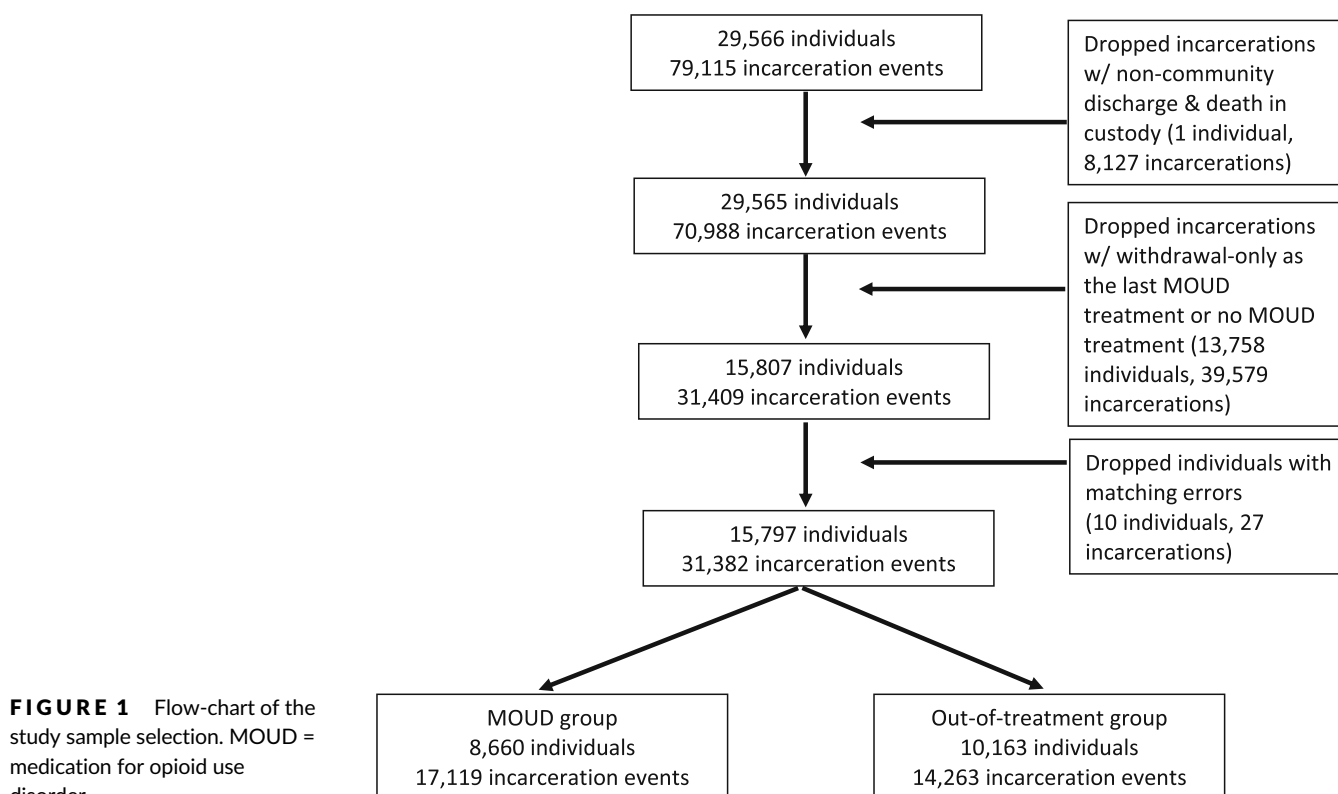
The study sample was composed of 79 115 incarceration events from 29 566 adults. Of these, we excluded incarceration events with non-community discharge or death in custody (Fig. 1). We also excluded incarceration events where no MOUD was provided during the entire incarceration largely because OUD was deemed not current. We further excluded events where only withdrawal was provided for the last 3 days before discharge because such discharges would be on indeterminate doses of MOUD that would range between maintenance and out-of-treatment, dependent upon the timing of discharge. Lastly, we excluded records of individuals who had subsequent incarceration events recorded after death, indicating potential recording or matching errors. The final sample included 31 382 incarceration events from 15 797 adults. The incarceration events were further categorized into MOUD ($n = 17\,119$) and out-of-treatment ($n = 14\,263$) groups using the definitions described in the exposure section below.

Outcomes

The main study outcome was death caused by accidental drug poisoning, identified from NYC death registry data using ICD-10-CM codes [X40–X49; X60–X69; X85–X90; Y10–Y19; Y35.2; U01(0.6–0.7), F11–16 and F18–19], text searches for overdose, poisoning, acute and chronic substance, acute complications, acute intoxication (by drug name) and intoxication (by drug name) in the multiple causes of death fields, and the manner of death certified by the NYC Office of the Chief Medical Examiner as accidental. We then categorized overdose death cases into three non-mutually exclusive groups, including heroin-related, fentanyl-related and cocaine-related deaths. Additionally, we used all-cause deaths as a secondary study outcome.

Exposure

The exposure variable was the receipt of in-jail MOUD. Throughout incarceration, treatment options for OUD (withdrawal-only, maintenance or out-of-treatment/no MOUD offered) could be modified based on an individual's decision or, less often, involuntarily (e.g. non-compliance with conditions of MOUD program). These changes were represented by 11 unique trajectories (Supporting information, Table S1). We combined in-jail MOUD trajectories into two groups (MOUD and out-of-treatment) based on MOUD received during the last 3 days before discharge. Note that the receipt of MOUD versus out-of-treatment was only measured during incarceration.



Person-time

Person-time was the time that individuals spent in the community after release from jail. For each discharge from jail, we counted days in the community to death or up to 365 days following release. If a re-incarceration event occurred before 365 days ($n = 17\,675$) or if the end of the 365-day follow-up period occurred after the end of the study period ($n = 2989$), the follow-up period was right-censored.

Covariates

We included self-reported or records-based demographic information (age at release from jail, sex, race, Hispanic ethnicity, marital status, education level); self-reported or confirmed HIV diagnosis; self-reported behavioral factors (life-time injection drug use, current smoker); self-reported homelessness or transient shelter stay at the time of incarceration (homelessness); criminal legal characteristics (incarceration length, highest charge severity, parole violation on a prior felony conviction); and count of previous NYC jail admissions events since 2011. We also included psychiatric variables, recorded by CHS mental health clinicians at the current incarceration: diagnosis of serious mental illness based on criteria from the NYS Office of Mental Health (until mid-2017) and Diagnostic and Statistical Manual of Mental Disorders (DSM) 5th edition (after mid-2017), depressive disorders, schizophrenia spectrum and other psychotic disorders, bipolar disorders, post-traumatic stress disorder based on DSM 5 and personality disorder based on DSM-IV or -5. We further included alcohol abuse/dependence/use disorder and cocaine abuse/dependence/use disorder presumptively based on DSM-IV or -5. Lastly, we included total numbers of ED visits within 3 months prior to discharge date from SPARCS.

Statistical analysis

We first compared demographic, clinical, behavioral, legal, homelessness and health-care utilization characteristics of MOUD and out-of-treatment groups using standardized differences, which were more informative than P -values from χ^2 or t -tests due to the large sample size. We then calculated crude all-cause and overdose mortality rates, and Kaplan–Meier curves by exposure. Lastly, we performed Cox proportional hazards regression analysis to assess whether in-jail MOUD was associated with greater mortality risk within 1 year of release from jail to the community. To address potential confounding, we included both time-invariant (sex, race and ethnicity) and time-varying covariates that were updated per incarceration discharge (all variables listed above, except time-invariant variables) in the Cox models. We tested the proportionality assumption using the weighted Schoenfeld residuals [20]. Violation of this assumption for the exposure variable led to modifying the models such that data were divided using three follow-up time-intervals (first 28 days, 29–56 days, 57–365 days) based on the weighted Schoenfeld residual plots/tests. We estimated

a time-specific hazard ratio (HR) for MOUD for each interval via a step function [21]. Violations of the proportionality assumption for other covariates (race and ethnicity, injection drug use, alcohol use disorder) were addressed via stratification analysis. To address correlation between multiple discharge events for the same person, we included individual-level random-effects in the regression model. To test whether association between in-jail MOUD and mortality differed by race and ethnicity, we stratified data by three majority groups (non-Hispanic white, non-Hispanic black, Hispanic) and repeated the regression analysis. Lastly, to address potential bias due to informative censoring, we conducted a sensitivity analysis where overdose death, non-overdose death and re-incarceration events were considered competing risks, and HRs for MOUD versus out-of-treatment were calculated via the Fine–Gray competing risk model [22].

All statistical analyses were conducted using SAS version 9.4/Enterprise Guide version 8.3 and R version 3.5.2. Statistical significance was determined using two-sided P -value < 0.05 .

RESULTS

Table 1 shows the characteristics of all eligible discharge events from adults with OUD who were incarcerated in NYC jails ($n = 31\,382$). Fifty-two per cent were for misdemeanor-related offenses, followed by 42% for felonies; 7% of incarcerations were associated with parole violations. Most incarcerations were 3 or more days in length (96%). Average age at jail admission was 42 years. Most individuals were male (82%), non-Hispanic black or Hispanic (74%) and single (79%). Thirty-five per cent and 5% were determined to have a mental health diagnosis and serious mental illness, respectively. Those with specific mental health diagnoses ranged from 5% (schizophrenia or psychotic disorder) to 13% (personality disorder or depressive symptoms). In addition to OUD, 25% had alcohol use disorder and 34% had cocaine use disorder. Life-time injection drug use (46%) and current smoking (82%) were prevalent. Lastly, 17% reported experiencing homelessness.

Incarceration events with MOUD versus out-of-treatment were more likely to have their highest charge severity recorded as misdemeanor and less likely to result from parole violation (Table 1). In-jail MOUD was more prevalent among individuals who were female, experienced homelessness, ever injected drugs, had cocaine use disorder and had visited an ED 3 months prior to discharge date. Mental health-related characteristics, marital status and the highest educational attainment were similar between two groups.

Mortality rates across MOUD and out-of-treatment groups

A total of 111 overdose deaths occurred within 1 year post jail release (Table 2). Crude overdose mortality rates for MOUD versus out-of-treatment groups were 0.49 per 100 person-years [95% confidence interval (CI) = 0.35–0.66] and 0.83 per 100 person-years (95% CI =

TABLE 1 Demographic, clinical and incarceration-related characteristics of the incarceration events

	Total (n = 31 382)	MOUD (n = 17 119)	Out-of-treatment (n = 14 263)	Standardized difference
Legal characteristics				
< 3 days in jail	4%	2%	6%	0.23
Highest charge severity at/near admission (≤ 15 days)				
Felony	42%	26%	61%	0.90
Misdemeanor	52%	71%	30%	
Other	6%	3%	9%	
Parole violation at/near admission (≤ 15 days)	7%	3%	12%	0.35
Average length of incarceration (SD), in days	60 (79)	44 (60)	79 (93)	0.45
Behavioral characteristics				
Self-reported injection drug use	46%	51%	39%	0.23
Current smoking	82%	83%	80%	0.06
Clinical characteristics				
Alcohol use/dependence/use disorder	25%	25%	25%	0.01
Cocaine use/dependence/use disorder	34%	38%	30%	0.16
Serious mental illness designation by CHS	5%	5%	5%	0.02
Personality disorders diagnosis	13%	11%	16%	0.13
PTSD, trauma, stress-related disorders diagnosis	9%	9%	9%	0.01
Depression and depressive symptoms diagnosis	13%	13%	13%	0.01
Bipolar and related disorders diagnosis	6%	6%	7%	0.02
Schizophrenia and psychotic disorders diagnosis	5%	5%	6%	0.06
HIV diagnosis	8%	9%	7%	0.06
Housing characteristics				
Homelessness	17%	19%	15%	0.11
Demographic characteristics				
Female	18%	23%	11%	0.33
Race and ethnicity				
Hispanic	44%	42%	45%	0.11
Non-Hispanic black	30%	30%	31%	
Non-Hispanic white	24%	26%	22%	
Others ^a	2%	2%	2%	
Education				
< High school degree	43%	43%	43%	0.02
High school degree or equivalent	37%	37%	37%	
Some college/trade school	17%	17%	18%	
Unknown	3%	3%	3%	
Marital status				
Single, never married	79%	79%	79%	0.03
Married/partnered	16%	15%	16%	
Others	5%	6%	5%	
Average age at admission, years (SD)	42 (11)	43 (10)	41 (11)	0.14
Health-care utilization				
Average number of emergency room visits for 3 months prior to discharge date (SD)	0.42 (1.37)	0.51 (1.57)	0.31 (1.07)	0.15

^aOthers include individuals who reported no or unknown Hispanic ethnicity and Asian or Pacific Islander, American Indian/Alaskan, other-unspecified race, or unknown race. SD = standard deviation; PTSD = post-traumatic stress disorder; CHS = Correctional Health Services; MOUD = medication for opioid use disorder.

TABLE 2 Overdose and all-cause death counts and crude mortality rates by receipt of in-jail MOUD^a

	MOUD		Out-of-treatment		Crude rate ratio (95% CI) ^b	P-value ^b
	No. of deaths	Rate (95% CI)	No. of deaths	Rate (95% CI)		
	1-year follow-up					
Overdose death	41	0.49 (0.35, 0.66)	70	0.83 (0.64, 1.04)	0.59 (0.40, 0.87)	0.01
Heroin-related ^c	26	0.31 (0.20, 0.45)	59	0.70 (0.53, 0.90)	0.44 (0.28, 0.70)	< 0.01
Cocaine-related ^c	22	0.26 (0.16, 0.40)	37	0.44 (0.31, 0.60)	0.60 (0.35, 1.01)	0.06
Fentanyl-related ^c	13	0.15 (0.08, 0.26)	20	0.24 (0.14, 0.36)	0.65 (0.33, 1.31)	0.23
All-cause death ^d	98	1.16 (0.94, 1.42)	121	1.43 (1.17, 1.68)	0.81 (0.62, 1.06)	0.13
	1-month follow-up					
Overdose death	7	0.59 (0.24, 1.22)	27	2.62 (1.73, 3.81)	0.23 (0.10, 0.52)	< 0.01
Heroin-related ^c	†	0.34 (0.09, 0.86)	23	2.23 (1.41, 3.35)	0.15 (0.05, 0.44)	< 0.01
Cocaine-related ^c	6	0.51 (0.19, 1.10)	18	1.75 (1.04, 2.76)	0.29 (0.12, 0.73)	< 0.01
Fentanyl-related ^c	†	0.08 (0.00, 0.47)	9	0.87 (0.40, 1.66)	0.10 (0.01, 0.76)	0.03
All-cause death	12	1.01 (0.52, 1.77)	40	3.88 (2.77, 5.29)	0.26 (0.14, 0.50)	< 0.01

^aReceipt of medication for opioid use disorder (MOUD) versus out-of-treatment was only measured during incarceration.

^bP-values for the exposure (MOUD) were derived from Poisson regression models with number of deaths as an outcome and person-years as an offset variable.

^cSpecific drugs that were related with overdose deaths were not mutually exclusive.

^dOther major causes of death include malignant neoplasms (*n* = 14), heart disease (*n* = 11) and HIV/AIDS (*n* = 6) for MOUD group. For out-of-treatment group, these include malignant neoplasm (*n* = 10), heart disease (*n* = 8), homicide (*n* = 7).

†Suppressed due to small numbers (*n* ≤ 5). CI = confidence interval.

0.64–1.04), respectively. After stratifying by drug types, the MOUD versus out-of-treatment groups had significantly lower crude heroin-related overdose death rates [rate ratio (RR) = 0.44, 95% CI = 0.28–0.70]. Restricting the follow-up period to 1 month following community reentry, we observed a lower overdose mortality rate among the MOUD versus out-of-treatment groups (RR = 0.23, 95% CI = 0.10–0.52). Lower crude mortality rates among the MOUD group within 1 month after release persisted when considering specific drug types. Similar to overdose mortality rates, significantly lower all-cause crude mortality rates were observed among the MOUD group during the first month following community re-entry (RR = 0.26, 95% CI = 0.14–0.50), but rate differences for the 1-year follow-up period were not statistically significant (RR = 0.81, 95% CI = 0.62–1.06). Figure 2 illustrates crude Kaplan–Meier survival curves by MOUD versus out-of-treatment groups, which were consistent with differences in crude overdose and all-cause mortality rates between two groups.

Adjusted HR for overdose and all-cause mortality by MOUD

After accounting for potential confounding and including individual-level random effects, we found that in-jail MOUD was associated with lower risk of overdose mortality for the first 28 days post-release (adjusted HR = 0.20, 95% CI = 0.08–0.46) (Table 3). We also observed a reduction of fatal overdose risk associated with in-jail MOUD in the remaining time-intervals, although associations were not statistically significant.

Similarly, we found reduction of all-cause mortality risk among MOUD versus out-of-treatment groups for the first 28 days after release (adjusted HR = 0.22, 95% CI = 0.11–0.42). This association remained significant for 29–56 days post-release (adjusted HR = 0.29, 95% CI = 0.09–0.89), but became non-significant for 57–365 days (adjusted HR = 1.20, 95% CI = 0.85–1.70). When stratified by race and ethnicity we observed a reduced overdose mortality risk associated with in-jail MOUD for non-Hispanic white and Hispanic individuals, but not for non-Hispanic black individuals (Supporting information, Table S2). Conversely, the findings for all-cause mortality were similar between the main and race- and ethnicity-specific analyses.

To assess potential bias due to informative censoring, we considered overdose mortality, non-overdose mortality and re-incarceration competing risk events and re-ran the analysis using both cause-specific and Fine–Gray models. Findings from these two models were not qualitatively different from our main results (Supporting information, Table S3).

DISCUSSION

In this study of adults with OUD who were released from NYC jails, receiving MOUD during incarceration was associated with an 80% reduction in overdose mortality risk for the first month following community re-entry. In-jail MOUD was also associated with a 78 and 71% reduction in all-cause mortality during the first and second months following re-entry, respectively.

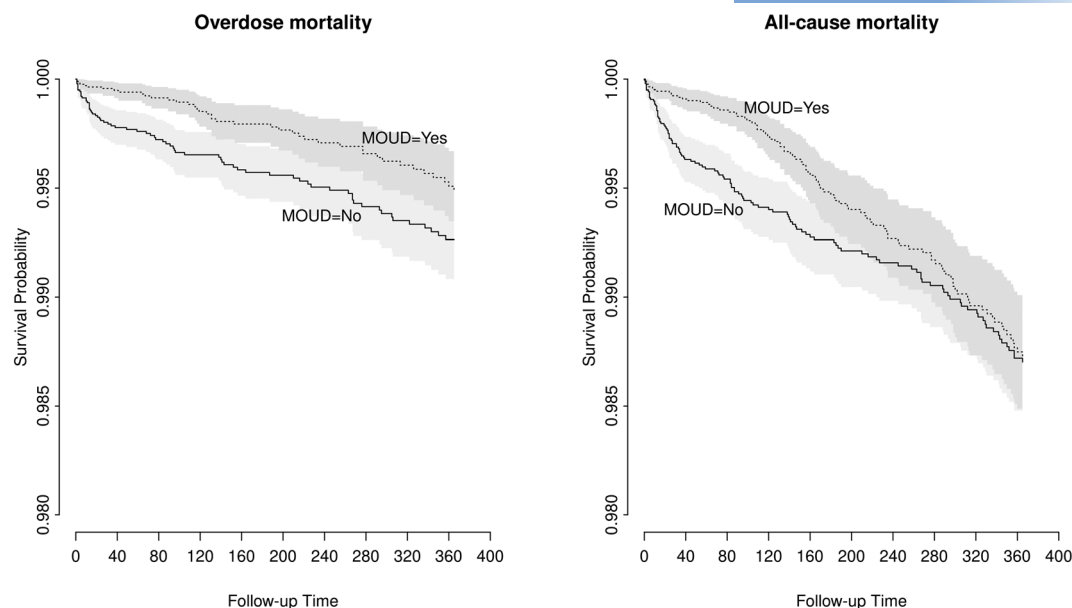


FIGURE 2 Crude Kaplan-Meier survival curves for in-jail medication for opioid use disorder (MOUD) versus out-of-treatment

TABLE 3 Time-specific hazard ratio from multivariable, mixed-effect Cox proportional hazard regression for overdose and all-cause mortality by in-jail MOUD receipt

	Overdose death		All-cause death	
	Hazard ratio	95% CI	Hazard ratio	95% CI
MOUD versus out-of-treatment for 1–28 days	0.20	0.08, 0.46	0.22	0.11, 0.42
MOUD versus out-of-treatment for 29–56 days	0.52	0.09, 2.91	0.29	0.09, 0.89
MOUD versus out-of-treatment for 57–365 days	0.84	0.51, 1.38	1.20	0.85, 1.70

A random effect was estimated, including a Gaussian frailty term to the model. Multivariable models include demographic (age, sex, race and ethnicity, marital status, the highest level of education), clinical (serious mental illness, personality disorder diagnosis, schizophrenia diagnosis, bipolar disorder diagnosis, alcohol use disorder, cocaine use disorder, HIV), behavioral (injecting drug use, current smoking), housing (homelessness), health-care utilization (total numbers of emergency department visits during 3 months prior to discharge date) and legal characteristics variables (length of incarceration, felony charges versus other charges and count of previous incarceration events). MOUD = medication for opioid use disorder; CI = confidence interval.

Our findings closely align with studies from other countries, such as Marsden *et al.*, who found that MOUD was associated with 75% reduction of adjusted overdose mortality risk during the first month after release from prisons in England [8–11]. The reduced mortality risk associated with in-jail MOUD beyond the first month may probably be mediated by increased engagement with treatment in the community among those who receive MOUD while incarcerated. Although this potential mechanism could not be tested, due to limited community treatment data, a Baltimore randomized control study reported evidence that in-prison buprenorphine treatment led to greater use of community-based MOUD upon release [23]. However, our null association between in-jail MOUD and mortality for 57–365 days post-release may indicate challenges of continuing long-term community MOUD despite receiving MOUD during incarceration. Further studies with community treatment data are necessary to test if use of the community-based MOUD mediates association between in-jail MOUD and mortality by different time-points post-release.

Structural racism in US drug policy has disproportionately incarcerated individuals of racial and ethnic minorities who are also medically underserved [24]. This, in turn, may potentiate racial and ethnic disparities in fatal overdose and treatment access, as the fastest-growing overdose death rates were observed in non-Hispanic black individuals [25–28]. In NYC, 2017 data show that overdose death rates due to heroin and/or fentanyl in the 55–84-year age category were substantially higher among non-Hispanic black and Hispanic New Yorkers than non-Hispanic white New Yorkers [29]. Our findings suggest that the jail-based MOUD program with linkage to community MOUD could alleviate the excess burden of fatal overdose among middle-aged non-Hispanic black and Hispanic individuals, mitigating some of the harm caused by structural racism in the criminal legal response to OUD [30]. The null impact among non-Hispanic black individuals may be a product of limited power due to the small number of overdose deaths in this group, but could potentially reflect gaps in access to MOUD in the community and warrants further investigation.

Our study has some limitations. Homelessness and comorbidities noted in electronic medical records may have been screened for differently during the study period and may be under-reported, especially in individuals with shorter lengths of stay. Our analysis assumes that individuals remained in NYC after release to the community; we do not have data regarding those moving out of NYC. If out-migration is higher among out-of-treatment over MOUD groups it could bias the estimated HR away from the null, as the true number of deaths among the out-of-treatment group might be underestimated. In addition, as residual confounding cannot be ruled out, we computed an E-value [31]. The E-value for the confidence interval was 3.8, implying that an unmeasured confounder would require at least that strong an association, on the risk-ratio scale, with both overdose mortality and MOUD, in order to nullify the adjusted HR for the first 28 days following community re-entry. Our study did not include more recent data where some major changes have occurred (e.g. increasing rates of overdose death rates in NYC, increasing enrollment of in-jail MOUD), and the estimated HR might be different if recent data were analyzed. Future studies with recent data are warranted to understand the extent to which the expanded in-jail MOUD has offset an increased risk of overdose deaths in NYC post-release among individuals with incarceration and OUD. Finally, we assumed that each discharge event was independent of all others, but it is highly plausible that events and outcomes are correlated within patients. To address this potential bias, we performed random-effects modeling. Despite these limitations, the study has notable strengths. It is one of the largest studies of MOUD in one of the largest jail systems in the country, providing an opportunity to test important public health and policy questions with sufficient power. Another strength is the use of linked health and administrative data that examine a broad range of exposures and outcomes and provide detailed baseline information.

CONCLUSION

To the best of our knowledge, this is the first study to evaluate the association between in-jail MOUD and risk of opioid overdose mortality following re-entry to the community using health and administrative data from a large urban jail setting in the United States. Findings from this study corroborate evidence that jail-based MOUD substantially reduces overdose risk. In 2019 there were 10.3 million incarcerations in US jails, and approximately 15–20% of those incarcerated in jails have OUD or misused opioids [7, 32, 33]. This population is at excess risk for overdose mortality after release [2, 5], yet most US carceral settings do not offer effective forms of MOUD [15, 16]. The expansion of MOUD access in carceral settings, and jails, in particular, should be an urgent priority of policy efforts to address the opioid crisis.

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DECLARATION OF INTERESTS

None declared.

AUTHOR CONTRIBUTIONS

Sungwoo Lim: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; writing-original draft; writing-review and editing. **Teena Cherian:** Data curation; validation; writing-original draft; writing-review and editing. **Monica Katyal:** Conceptualization; data curation; formal analysis; funding acquisition; supervision; writing-original draft; writing-review and editing. **Keith Goldfeld:** Conceptualization; formal analysis; investigation; methodology; writing-original draft; writing-review and editing. **Ryan McDonald:** Funding acquisition; investigation; project administration; writing-original draft; writing-review and editing. **Ellen Wiewel:** Conceptualization; data curation; formal analysis; methodology; writing-original draft; writing-review and editing. **Maria Khan:** Conceptualization; formal analysis; investigation; writing-original draft; writing-review and editing. **Noa Krawczyk:** Conceptualization; formal analysis; investigation; writing-original draft; writing-review and editing. **Sarah Braunstein:** Data curation; investigation; writing-original draft; writing-review and editing. **Sean M. Murphy:** Conceptualization; funding acquisition; investigation; writing-original draft; writing-review and editing. **Ali Jalali:** Investigation; methodology; writing-original draft; writing-review and editing. **Philip Jia-Chi Jeng:** Formal analysis; investigation; writing-original draft; writing-review and editing. **Ross MacDonald:** Conceptualization; funding acquisition; investigation; supervision; writing-original draft; writing-review and editing. **Joshua D Lee:** Conceptualization; funding acquisition; investigation; project administration; writing-original draft; writing-review and editing.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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