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## Fatal and non-fatal opioid overdose risk following release from prison: A retrospective cohort study using linked administrative data

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### Abstract

**Introduction:** Among individuals who are released from prison, opioid overdose is a leading cause of death with a risk more than ten-fold the general population. Although the epidemiology of opioid-related fatalities has been described, few studies have characterized both fatal and non-fatal opioid-related poisonings. The objective of this study was to estimate risk of fatal and non-fatal opioid overdose among adults released from prison.

**Methods:** Fatal and non-fatal opioid overdose rates were estimated using linked corrections, Medicaid, hospital discharge, and vital statistics from the state of Oregon from 2014 to 2018. Multivariable proportional hazards models identified demographic and prison-related factors associated with overdose.

**Results:** There were 18,258 individuals released from prison between 2014 and 2017. A majority of individuals were male (87%) and ages 26 to 64 (83%). Two-thirds had a documented substance use disorder treatment need and 20% demonstrated mental health treatment need. Following prison release, there were 579 opioid overdose events; 65 (11%) were fatal. The rate of opioid overdose was 1085.7 per 100,000 person-years (PY). Rates were highest in the first two weeks (2286.7 per 100,000 PY), among women (1582.9 per 100,000 PY), and those with mental health (1624.3 per 100,000 PY) or substance use disorder treatment needs (1382.6 per 100,100 PY). Only mental health (adjusted hazard ratio [aHR] 1.54, 95% CI 1.24 to 1.90) and substance use need (aHR 2.59; 95% CI 2.01 to 3.34) remained significant in multivariable models.

**Conclusions:** The rate opioid overdose is markedly elevated after prison release, particularly in the first two weeks. In women, the higher rate of opioid overdose is mediated by a greater mental health burden.

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## 1. Introduction

Worldwide, drug-related overdose is a leading cause of death among persons who have recently been released from prison (WHO, 2014) (Binswanger, Blatchford, Mueller, & Stern, 2013). As of 2019, approximately 1.4 million individuals in the United States (US) were housed in state and federal prisons, and more than 600,000 people are released annually from custody (Carson, 2020). Nearly two-thirds of all US adults in custody have a documented substance use disorder (SUD) (Bronson, Stroop, Zimmer, & Berzofsky, 2017). The risk of overdose death is more than 10-fold higher among adults released from prison relative the general population (Binswanger et al., 2013; Binswanger et al., 2007; Kinner, Gan, & Slaunwhite, 2021; Ranapurwala et al., 2022). Relative to non-overdose mortality, excess overdose mortality is driven by deaths in the first two weeks after release (Binswanger et al., 2013; Kinner et al., 2021; Merrall et al., 2010). Although women have a lower risk of all-cause mortality following release, their risk of overdose death is significantly elevated compared to men. For both men and women, opioids are the largest contributor to overdose deaths.

While evidence that delineates the risks of overdose mortality following release from prison is established, less is known about the epidemiology of non-fatal overdose which is substantially more common and one of the largest risk factors for a subsequent fatal overdose (Darke, Mattick, & Degenhardt, 2003; Hartung et al., 2020). Moreover, non-fatal overdose is associated with numerous other types of morbidity such as fall-related injury, burns, seizures, neuropathy, and infection (Warner-Smith, Darke, & Day, 2002). In a cohort of individuals using illicit drugs in Vancouver BC between 1996 and 2010, the incidence of non-fatal overdose was two-fold higher among those who had experienced an incarceration compared to those who had not (Kinner et al., 2012). Another retrospective cohort study of 1325 individuals released from prisons in Australia estimated the risk of opioid-involved non-fatal overdose was 1600 per 100,000 person-years overall and 17,300 per 100,000 person-years in the first two weeks after prison release, 5.7 times higher than the rate in the ten subsequent study weeks (Keen, Young, Borschmann, & Kinner, 2020). Although the unadjusted incidence rate of overdose was nearly 50% higher in women than men, sex was not a significant risk factor after multivariable adjustment for several mental health and addition severity variables.

To date, there have been no population-based studies examining both fatal and non-fatal opioid overdoses in the United States (US). Using an innovative dataset that linked prison release, Medicaid, hospital discharge data, and death records (vital statistics data) in the state of Oregon, we sought to estimate the risk of fatal and non-fatal overdose among recently released individuals and specifically examine the risk profile by sex.

## 2. Methods

### 2.1 Data Sources

The objective of this study was to characterize the rate of fatal and non-fatal opioid overdose following release from Oregon's prison system between January 1, 2014 and December 31, 2017. For this analysis we used data from four state sources (Oregon Department of

Corrections [DOC] release data, Medicaid administrative claims data, hospital discharge data, and death records) to measure fatal and non-fatal overdoses through 2018, allowing for at least one year of follow-up. We used Medicaid claims data as our primary source to identify overdose encounters in the emergency department (ED) and inpatient admissions. Medicaid is the state administered healthcare program that provides insurance for low income and disabled individuals. Oregon DOC submits Medicaid enrollment applications nearly all individuals prior to release from custody, and nearly 90% of individuals with criminal justice involvement are enrolled in the Medicaid program (Renfro, 2021).

We used Oregon's hospital discharge data to supplement the administrative claims to identify inpatient admissions that may not have been captured in the claims data. Finally, we used state death records to identify opioid overdose fatalities. Data were linked to DOC release records through unique identifiers provided by Oregon Department of Human Services Integrated Client Services.

## 2.2 Overdose Outcomes

Opioid-involved overdose were identified using international classification of disease (ICD) 9<sup>th</sup> and 10<sup>th</sup> revision codes summarized in Supplemental Table 1. ICD9/10 codes for opioid poisoning included opium (96500, T400x), heroin (96501, E8500, T401x), methadone (96502, E8501, T403x), other opioids (96509, E8502, T402x), and synthetic narcotics (T404x). Encounters originating in the ED were identified using revenue center codes (450-459, 0981). Medicaid claims for an inpatient admission were the primary indicator for a hospital admission. Validation studies have shown these codes to perform well (sensitivity 97%, specificity 85%) in several populations including Medicaid (C. A. Green et al., 2019). We supplemented these data with hospital admission data from the state's hospital discharge database, which contains admissions data across all payers. We considered admissions the same if they had the same discharge date; if the admission dates were different, we assigned the episode the earlier date. Admissions that were off by one day, but had the same discharge date, were considered the same episode and assigned the earlier admission date. If an ED encounter occurred on, during, or one day prior, we considered the ED encounter to be part of the admission (i.e. not counted as a distinct ED visit).

We used Oregon's death record data to identify opioid-related fatalities using ICD10 codes (Supplemental Table 1). If a fatality occurred on or during (+/- one day) an ED or inpatient admission, we considered that event to be fatal (i.e., not counted as two events).

## 2.3 Covariates

Demographic data were derived from Oregon DOC release files and included: age at release, sex, and mental health and substance use disorder 'treatment need', drug-related offense, and county of release. Although race/ethnicity is captured in Oregon's DOC data, it is not self-reported, but rather assigned at the time of first arrest within the state and never updated. We therefore omitted race/ethnicity data from our analysis to avoid inappropriate inference because of misclassification.

Mental health treatment need is derived from the DOC Mental Health Code Definitions, ranging from 0 (less severe) to 3 (most severe). We collapsed the top two DOC codes

(MH-2 and MH-3), which indicate diagnosis of a condition that requires active therapeutic intervention or symptoms cannot be controlled through medication alone. Substance use disorder (SUD) treatment need indicates that an individual was assessed while in custody as having substance “dependence/addiction” based on DSM-IV guidelines. Drug Offense is derived from DOC administrative data indicating whether an individual was serving a sentence for only drug offenses, some drug offenses, or no drug offenses. For analysis, we collapsed “only” and “some.”

## 2.4 Analysis

Our primary objective was to estimate the incidence rate of opioid overdose following prison release. Follow-up for individuals began on their most recent prison release date and ended if they reached the end of the study period (December 31, 2018) or died of any cause. We first computed unadjusted rates per person-year of follow-up overall and across subgroups using Poisson test, R software, version 4.0.5. Because several studies have reported the risk of overdose death is particularly high in the period immediately following prison release (Binswanger et al., 2013; Binswanger et al., 2007; Kinner et al., 2021), we also estimated risk in the first two weeks separately. We used univariate and multivariable Cox proportional hazards regression models to estimate the association between the time to first fatal or non-fatal opioid overdose and demographic and incarceration-related factors. Proportional hazards assumptions were assessed and verified using three methods: 1) visual examination of survival curves 2) exploration of transformed martingale residuals (empirical score process), 3) testing proportionality through adding interactions between selected covariates and time to event; also known as time-varying covariates. All models reported met proportional hazards assumption for one or more of these approaches. Analyses were performed using SAS software, version 9.4, SAS Institute Inc., Cary, NC, USA. and p-values less than 0.05 were considered statistically significant.

This study was approved by the Oregon Health & Science University Institutional Review Board and the Oregon DOC Research Committee. In adherence with terms of our data use agreement, we suppressed summary counts under 11 using a cell coarsening approach (“CMS Cell Suppression Policy. Guidance for CMS Cell Suppression Policy Web Page.,”).

## 3. Results

### 3.1 Study population characteristics

Between 2014 and 2017, 18,258 adults were released to the community from the Oregon prison system. As summarized in Table 1, 87% of the study population was male. The median age upon release was 36 (Interquartile range 29 to 45) and 83% of the study population was aged 26–64 at release. About 63% of individuals had at least a high school (or equivalent) educational attainment. One in five individuals had a mental health treatment need, with higher mental health need reported among women than men (46% vs 17%). About two-thirds (67%) of individuals were reported to have SUD treatment need, with higher levels reported for women than men (84% vs 64%). Similarly, women were more likely to have a drug-related offense than men (24% vs 16%).

### 3.2 Crude overdose estimates

Following release, the median follow-up time was 2.9 years (IQR, 1.9-3.9). There were 579 (452 unique persons) fatal or non-fatal opioid overdose events over 53,327.3 person-years (PY) of follow-up yielding an unadjusted overdose rate of 1085.7 per 100,000 PY (Table 2). Among the 71 individuals who had more than one overdose, the median number of overdoses was (interquartile range 2-3). The risk of opioid overdose in the first two weeks following release (2286.7 per 100,000 PY) was more than twice as high as the risk in other periods of time (1,069.8 per 100,000 PY). Unadjusted overdose rates were more than 50% higher for females versus males (1582.9 vs 1009.7 per 100,000 PY). Overdose rates were markedly elevated among individuals with SUD (1382.6 vs 490.4 per 100,000 PY) or mental health treatment need (1624.3 vs 950.4 per 100,000 PY).

### 3.3 Multivariable models to identify factors associated with overdose

Unadjusted and adjusted proportional hazards models are reported in Table 3. There was no evidence of violation of Proportionality test assumptions for SUDs treatment need ( $p=0.86$ ), mental health treatment need ( $p=0.10$ ), drug offense ( $p=0.39$ ). Similar to the unadjusted overdose rates, females had a significantly higher crude hazard for opioid overdose compared to males (hazard ratio [HR] 1.34; 95% CI 1.05 to 1.71). However, in the multivariable model, the adjusted hazard among females did not differ from males (aHR 1.02; 95% CI 0.79 to 1.32). Those with SUD treatment need (aHR 2.59; 95% CI 2.01 to 3.34) or mental health treatment need (aHR 1.54; 95% CI 1.24 to 1.90) had significantly higher hazards for opioid overdose.

We used interaction terms to assess the influence of sex by mental health and SUD treatment need. The interaction sex and SUDs treatment need was statistically significant ( $p<0.01$ ). Among those with a documented SUDs treatment need, the overdose risk for females versus males continued to be non-significant (aHR 0.90; 95% CI 0.68 to 1.19). However, in those without documented SUDs treatment need, females had significantly higher risk of overdose (aHR 2.62; 95% CI 1.41 to 4.88). The interaction of sex and mental health treatment need was not significant ( $p=0.053$ ).

### 3.4 Fatal overdose

There were 65 opioid overdose fatalities during the study period with an unadjusted overdose rate of 121.9 per 100,000 PY (100.4 – 144.6 per 100,000 PY). Factors associated with fatal overdose generally mirrored results for fatal and non-fatal events except for age, where those over 64 had significantly higher risk than those under 65 (Supplemental Tables 2 and 3).

## 4. Discussion

Numerous studies have established the risk of drug-related overdose among individuals released from prison, particularly in the first two weeks of their transition to the community (Binswanger, 2019; Binswanger et al., 2013; Merrall et al., 2010; Rosen, Schoenbach, & Wohl, 2008). Although a large literature provides insights about specific factors that may modify overdose risk, much of this research is derived from vital statistics data (fatalities),

which constitute a minority of all overdose events. In this study, we use an innovative linked dataset developed in the state of Oregon to estimate both fatal and non-fatal events, we found the rate of fatal and non-fatal opioid overdose was exceedingly high (1,086 per 100,000 PY), more than ten times the rate in the general population (93 per 100,000 PY) (Vivolo-Kantor et al., 2020) and five-times the rate observed in a Medicaid population of new prescription opioid users (247 per 100,000 PY) (Nam, Bilker, DeMayo, Neuman, & Hennessy, 2020). The risk for fatal and non-fatal opioid overdose was particularly pronounced in the first 14 days after release, among females, and those with documented SUD treatment need or a drug offense.

We also found that the rate of fatal opioid overdose (121.9 deaths per 100,000 PY), which was 20 times the rate than in the general population (Rudd, Aleshire, Zibbell, & Gladden, 2016), to be similar to post-release estimates reported in Washington State (109 deaths per 100,000 PY; years 1999 to 2009) but substantially less than the overdose rate reported in North Carolina during a comparable period (184 to 474 deaths per 100,000 PY from 2014 to 2018) (Binswanger et al., 2013; Ranapurwala et al., 2022). The marked increase in post incarceration overdose fatalities in North Carolina was attributed to the rise in illicit fentanyl in the drug supply occurring this period (Ranapurwala et al., 2022; Shiue et al., 2021). The penetration of fentanyl in Oregon and other western states has been rising rapidly since about 2019 (Shin et al., 2022).

Consistent with others (Binswanger et al., 2013; Keen et al., 2020; Merrill et al., 2010), we found the risk of opioid overdose after release was elevated in females. However, this was attenuated after adjustment for other variables indicating that the increased risk of overdose for females is likely mediated through higher burden of both SUD and mental health treatment need. In our exploration of interactions, we found that the overdose risk in females was significantly elevated among those with no documented SUD treatment needs. As SUDs are ubiquitous in prisons and jails, those without documented SUD treatment need likely includes adults who simply did not disclose substance use history to prison intake staff. The reasons why risk among women remained elevated relative to men are unclear and may be a chance subgroup finding that requires further investigation.

Although we are not aware of other US-based studies examining both fatal and non-fatal opioid overdose post prison release, several international studies provide some useful contrasts. Using a similar linked administrative dataset, Keen et al reported a similar rate of non-fatal opioid overdoses among individuals released from prison in Australia (16.0 per 1000 PY or ~1,600 per 100,000 PY) (Keen et al., 2020). Like our study, they also found the risk of overdose was markedly elevated in the first two weeks after release.

The magnified risk for opioid overdose among individuals recently released from prison underscores the need to develop strategies and interventions to protect those re-entering community during this vulnerable period. There is broad consensus that medications for OUD (MOUD) are highly effective at reducing the risk of overdose and other addiction-related health outcomes (Nunn et al., 2009; Wakeman & Rich, 2015). Despite this, provision of MOUD for individuals in prison remains relatively uncommon (Brinkley-Rubinstein et al., 2018; Csete, 2019; Neill-Gubitza, Graves, & Barbosa-Leiker, 2022). During the

study period Oregon DOC had a small MOUD program that focused on continuation of treatment for individuals who entered custody already on an established MOUD protocol. This program, however, was limited in size during the study period with approximately 85 individuals participating. In recent years the Oregon DOC has significantly expanded their MOUD programming to include both continuation of established treatment upon entry and induction of eligible patients onto an MOUD protocol when they reach 13 months prior to planned release date (Bajpai, personal communication, September 15, 2022).

Studies indicate that MOUD during incarceration contributes to improved outcomes during their incarceration and following release into the community (Malta et al., 2019; Moore et al., 2019). Evidence from several randomized clinical trials indicate that individuals treated with methadone during incarceration are substantially more likely to engage treatment and less likely to use opioids following their release (Dolan et al., 2003; Kinlock et al., 2007; McKenzie et al., 2012; Rich et al., 2015). The benefits of agonist-based MOUD in the prison or jail setting also extend to the use of buprenorphine where studies have shown that in prison buprenorphine treatment is associated with improved engagement in treatment upon release (Gordon et al., 2014; Gordon et al., 2017). One comparative randomized trial at Rikers Island in New York comparing buprenorphine to methadone reported that individuals provided buprenorphine were more than 3-fold more likely to report to treatment following prison release than those who received methadone (48% vs 14%) (Magura et al., 2009). Observational studies strongly suggest that prison-based opioid agonist therapy is associated with significant reductions in overdose (Bozinoff et al., 2018; T. C. Green et al., 2018; Larney et al., 2014; Marsden et al., 2017). A large retrospective cohort study in Australia found that opioid agonist-based MOUD reduced the risk of death in the first four weeks after release by 94% (Degenhardt et al., 2014). The opioid antagonist extended release naltrexone is often favored by those in the criminal justice community because it is not controlled has also been studied in the prison setting and been shown to reduce post-release opioid use and improve treatment retention (Friedmann, Wilson, Hoskinson, Poshkus, & Clarke, 2018; Gordon et al., 2015; Lee et al., 2016).

Although the evidence is less developed, take home naloxone programs have also been adopted in criminal justice settings as another approach to reduce overdose risks following release from prison (Horton et al., 2017). Survey data indicate a large majority of adults in custody have expressed a willingness to engage in naloxone training programs prior to release (Curtis et al., 2018; Wakeman, Bowman, McKenzie, Jeronimo, & Rich, 2009). Evidence from Scotland, which implemented a nation-wide naloxone distribution program that included prisons, found that the percentage of opioid overdose deaths in those released from prison declined from 9.8% to 6.3% (Bird, McAuley, Perry, & Hunter, 2016). Another promising approach to target high-risk communities include programs that provide naloxone and training to people who visit individuals in prison (Horton et al., 2017).

This study has limitations. First, data for this study are from Oregon and may not reflect overdose rates and risk factors in other regions of the country. In the last several years, Oregon and other western states have seen large increases in overdose attributed to synthetic opioids (Shover et al., 2020) and commonly involve methamphetamine. (Hedegaard, Bastian, Trinidad, Spencer, & Warner, 2019; O'Donnell, Gladden, Mattson, Hunter, & Davis, 2020).

Second, as with all studies of administrative data not intended for research, demographic variables may be subject to misclassification that can lead to biased risk estimates. Additionally, although we made attempts to identify overdose outcomes in three different data sources, it is possible that overdoses that were not processed as a Medicaid claim (e.g. paid by a different payer), recorded in the state's hospitalization records, or not treated in a healthcare system may not have been identified. Additionally, we may have missing outcome data for individuals who left the state. Consequently, rates reported may underestimate the actual overdose rate. Thirdly, we lacked data on re-incarceration of individuals and considered all time after index release to be at-risk. We also did not adjust follow-up time for situations where person might not be at risk for an overdose (inpatient hospitalization). Because over estimation of at-risk time inflates the denominator, we believe the risk estimates reported are likely conservative. Finally, we had a limited number of demographic and incarceration-related variables to evaluate. Future studies will benefit from inclusion of a wider set of demographic, including self-reported race and ethnicity, prison-provided MOUD, and comorbidity variables to better identify those individuals at greatest risk for a post-release overdose. Severity of illness variables provided by Oregon DOC such as SUDs and mental health 'treatment need' may not be perfect indicators of true SUDs or mental illness.

## 5. Conclusions

Justice-involved individuals are a large segment of the population with a very high prevalence of SUDs and its attendant health consequences. Our study confirms that these individuals experience rates of fatal and non-fatal opioid overdose many times higher than the general population. Even though a large proportion of individuals with SUDs pass through the criminal justice system, prisons and jails remain under equipped to manage the healthcare needs for these high-risk individuals. While we identified several factors that exacerbate post-release overdose risk, there is an urgent need to further refine tools to improve identification of those who are at high risk. Additionally, there is an urgent need for prisons and jails to develop and scale programs to ensure incarcerated individuals have access to lifesaving MOUD and other harm reduction interventions both during and after their release into the community.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Funding:

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### Highlights

- Justice-involved individuals have a high burden of addiction and overdose risk
- Opioid overdose is markedly elevated after prison release
- The risk of opioid overdose is particularly high in the first two weeks
- In women, elevated overdose risk is mediated through greater mental health burden.

**Table 1:**

Demographics of male versus female adults released from the Oregon Department of Corrections from 2014 to 2017.

	Overall (n=18,258)		Male (n=15,823, 86.6%)		Female (n=2,435, 13.3%)	
<b>Age at release (n, %)</b>						
<26	2,709	14.8	2393	15.1	316	13
26-64	15,224	83.4	13127	83	2097	86.1
>64	325	1.8	303	1.9	22	0.9
<b>SUD treatment need (n, %)</b>	12,227	67	10180	64.3	2047	84.1
<b>Drug offense (n, %)</b>	3,138	17.2	2560	16.2	578	23.7
<b>Mental health treatment need (n, %)</b>	3,728	20.4	2,618	16.5	1,110	45.6
<b>Education (n, %)</b>						
None Documented	6,813	37.3	5914	37.4	899	36.9
HS/GED	11,213	61.4	9713	61.4	1500	61.6
AA/BS/BA/Graduate	232	1.3	196	1.2	36	1.5
<b>Release Year (n, %)</b>						
2014	4,436	24.3	3857	24.4	579	23.8
2015	4,449	24.4	3849	24.3	600	24.6
2016	4,579	25.1	4004	25.3	575	23.6
2017	4,794	26.3	4113	26	681	28

**Table 2:**

Opioid overdose unadjusted incidence rates post release from the Oregon Department of Corrections from 2014 to 2017.

Factor	Events	Person-Years	Events per 100,000 person-years	95% Confidence Interval
<b>Total</b>	579	53,327.3	1,085.7	(1021.4 to 1151.5)
<b>Sex</b>				
Male	467	46,251.6	1,009.7	(947.7-1073.2)
Female	112	7,075.7	1,582.9	(1505-1661.9)
<b>Age</b>				
<26	>79 *	*	1,034.4	(971.9-1099)
26-64	489	44,336.7	1,102.9	(1037.9-1169)
>64	<11 *	*	689.5	(638.5-742.4)
<b>SUD treatment need</b>				
Yes	492	35,585.4	1,382.6	(1310.1-1456.8)
No	87	17,741.9	490.4	(447.6-535.4)
<b>Drug offense</b>				
Yes (Only or some)	121	9,327.0	1,297.3	(1227.4-1369.6)
No (None or NA)	458	44,000.3	1,040.9	(977.7-1105.2)
<b>Mental health need</b>				
No	405	42,614.9	950.4	(890.5-1012.4)
Yes	174	10,712.4	1,624.3	(1546-1705)
<b>Time since release</b>				
1-14 days	16	699.7	2,286.8	(2193.2-2381.7)
>14 days	563	52,627.6	1,069.8	(1005.9-1135.1)

\* Suppressed for low sample size; NA = not available; SUD = substance use disorder;

**Table 3:**

Proportional Hazards Model of factors associated with opioid overdose following t release from the Oregon Department of Corrections from 2014 to 2017.

	Unadjusted Hazard Ratio		Adjusted Hazard Ratio	
	HR (95% CI)	p-value	aHR (95% CI)*	p-value
<b>Sex</b>				
Female	1.34 (1.05-1.71)	0.02	1.02 (0.79-1.32)	0.87
Male	Reference		Reference	
<b>Age</b>				
<26	1.44 (0.58-3.58)	0.43	1.11 (0.44-2.76)	0.83
26-64	1.52 (0.63-3.67)	0.35	1.08 (0.45-2.63)	0.86
>64	Reference		Reference	
<b>SUD treatment need</b>				
Yes	2.61 (2.03-3.35)	<0.0001	2.59 (2.01-3.34)	<0.0001
No	Reference		Reference	
<b>Drug offense</b>				
Yes (Only or some)	1.25 (0.99-1.56)	0.06	1.21 (0.96-1.52)	0.11
No (None or NA)	Reference		Reference	
<b>Mental health treatment need</b>				
Yes	1.65 (1.35-2.02)	<0.0001	1.54 (1.24-1.90)	<0.0001
No	Reference		Reference	

HR = hazard ratio; NA= not available; SUD = substance use disorder

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