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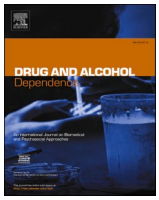

Overdose and substance-related mortality after release from prison in Washington State: 2014–2019

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ABSTRACT

Background: Persons released from prison are at an increased risk of mortality compared to the non-incarcerated population, particularly from drug- and opioid-related overdose. Contributors to overdose mortality vary with changing patterns of substance use and updating overdose and mortality statistics may help focus resources for persons released from prison.

Methods: In this retrospective cohort study, records for 33,811 people released from Washington State Department of Corrections prisons between 2014 and 2018 were linked to Washington State death records from 2014 to 2019. We calculated post-release mortality rates by cause of death, including overdose and substance-related mortality. Hazard ratios for risk factors for all-cause, non-overdose, and overdose mortality were estimated using Cox proportional hazards regression.

Results: 862 deaths were identified among persons released from prison. The all-cause mortality rate was 747 per 100,000 person-years (95 % CI: 699–800), and drug overdose was the leading cause of death (216 per 100,000 person-years; 95 % CI: 190–244). Psychostimulant-related mortality (152 per 100,000 person-years; 95 % CI: 131–177) and opioid-related mortality (138 per 100,000 person-years; 95 % CI: 118–161) were the most prevalent among substance-related causes of death, with the greatest mortality risk occurring within two weeks after release. Older age at most recent release, previous incarceration, and drug-related convictions were significant risk factors for all-cause and overdose mortality within six years after release.

Conclusions: Psychostimulants were the greatest contributors to substance-related mortality for persons released from Washington State prisons. Greater efforts to prevent psychostimulant- and opioid-related overdose are needed.

1. Introduction

Overdose is the most prevalent cause of mortality after release from prison, and numerous studies highlight the excessive mortality burden that overdose places on formerly incarcerated people (Binswanger et al., 2007, 2013; Gan et al., 2021; Merrall et al., 2010; Mital et al., 2020; Ranapurwala et al., 2018). Substance use is common among incarcerated people, with over 80 % reporting lifetime use of illicit substances (Chamberlain et al., 2019). Substance use disorder is a strong predictor of post-release mortality, but only 20 % of people with a substance use disorder receive treatment while incarcerated (Fazel et al., 2017). Previous research found that overdose mortality rates were greatest in the first week after release, and opioid use was an acute risk factor for overdose mortality (Binswanger et al., 2013; Mital et al., 2020). Reduced physiologic opioid tolerance after abstaining from use while in prison may contribute to the high risk of overdose seen in the formerly incarcerated population (Marsden et al., 2017). There is growing evidence that treating opioid use disorder with medications and providing naloxone reduces overdose mortality after prison release (Green et al., 2018).

In the United States (U.S.), the prevalences of drug use and availability of drugs shift geographically, and sub-epidemics of specific drugs like methamphetamine and fentanyl within states and regionally occur over time (Jalal et al., 2018). Nationwide, overdose mortality rates

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increased exponentially over recent decades, and the use of multiple substances taken in combination (e.g., opioids and psychostimulants), or polysubstance use, is increasing (Jalal et al., 2018). Since the 1990 s, an increase in opioid-related mortality motivated distribution of take-home naloxone, a life-saving medication administered to reverse opioid overdose (Banta-Green et al., 2019; Wheeler et al., 2015). However, polysubstance use complicates prevention of overdose mortality. Addiction and substance-use treatment after release from prison requires comprehensive consideration of polysubstance use, whether polysubstance use is intentional or unintentional. For example, fentanyl may be inadvertently mixed with heroin and therefore used unintentionally (Dowell et al., 2017). Vigilance in regularly assessing trends in post-release mortality may aid prevention and intervention efforts focused on overdose and substance-related mortality.

In 2007, Binswanger et al. established overdose as the leading cause of death after prison release in Washington State for persons released 1999–2003 (Binswanger et al., 2007). Cocaine contributed most to overdose mortality among these formerly incarcerated persons (Binswanger et al., 2007). Washington State post-release mortality statistics were later updated, and findings emphasized the outsized burden of opioids on post-release mortality among an expanded 1999–2009 cohort (Binswanger et al., 2013). Opioids overtook cocaine as the most prevalent substance related to overdose deaths with opioids involved in 14.8 % of deaths by any cause and in 58.6 % of deaths due to overdose (Binswanger et al., 2013). This change reflected a nationwide increase in opioid-related mortality in the late 2000 s, particularly from prescription opioids (Jalal et al., 2018). Shifting drug use in the U.S. suggests that substances associated with post-release mortality among people who were formerly incarcerated may have further changed in the decade since these cohorts were examined.

To keep pace with the ever-evolving drug overdose epidemic and as part of broader strategic efforts to reduce post-release mortality, updating mortality information for people released from prison may more accurately inform prevention measures and policies. This study aimed to estimate post-release mortality rates, including overdose and substance-related mortality rates, and mortality risk factors among people released from prison in Washington State from 2014 to 2019.

2. Material and methods

2.1. Study population and data

This retrospective cohort study of Washington State Department of Corrections (DOC) prison release records identified 34,044 people released from Washington State prisons between January 1, 2014 and December 31, 2018. People incarcerated for the full length of the study were omitted. DOC records included incarceration and release dates, incarceration characteristics, and demographic information, including personal identifiers, for formerly incarcerated persons. Of the people we identified, 233 (0.7 %) were excluded from analysis for the following reasons: (1) less than 18 years at time of release (17 persons), (2) known to have died in prison (196 persons), (3) died before release but was not known to have died in prison (19 persons), or (4) died on the day of release (1 person). The final sample consisted of 33,811 unique formerly incarcerated persons. The Washington State Institutional Review Board approved this study.

To identify people who died after release, DOC records were linked using personal identifiers to the Washington State death records provided by the Washington State Department of Health (DOH) for January 1, 2014 and December 31, 2019. Death records included people who died in Washington State or Washington State residents who died out of state. Deterministic matching linked prison release and death records based on Social Security Number (SSN), gender, first and last name, alias names, and date of birth. Linking was performed for multiple combinations of personal identifiers as many subjects had multiple names and aliases and a quarter of subjects had more than one SSN. Potential name misspellings, including misspellings for alias names, were considered individually for matching when SSN, gender, and date of birth matched. Race and ethnicity were not used as linking variables due to data quality inconsistencies.

2.2. Measurements

Mortality rates were calculated as the number of deaths for the population released from prison during the study period divided by the total person-years at risk after release. Time at risk was calculated as total person-years from release to a subsequent incarceration, death, or the end of the study. Time spent in prison for persons with multiple incarcerations during the study period was excluded. Data were censored as of December 31, 2019, or the date of re-incarceration if the person was incarcerated at the end of the study period.

In the Washington State death records, decedents had one underlying cause of death listed; however, there were up to 20 contributing causes of death in the multiple cause of death fields. Causes of death were coded using International Classification of Disease codes, 10th Revision (ICD-10). Overdose deaths were identified as deaths with drug overdose (either unintentional, suicide, assault/homicide, or of undetermined intent) listed for the underlying cause of death. Substance-related deaths were identified as deaths with opioids, prescription opioids, cocaine, other unspecified narcotics, benzodiazepines, psychostimulants (e.g., methamphetamine), or alcohol listed in the contributing causes of death fields. Opioid-related deaths were identified as deaths listing heroin, natural semisynthetic opioids, methadone, synthetic opioids in the contributing causes of death fields. Cause of death fields did not necessarily differentiate between substances obtained through prescription, illicit, or other means, and overdose was not necessarily the underlying cause of death for substance-related deaths. For example, if the underlying cause of death was a stroke but alcohol was listed in the multiple cause of death fields as a contributor, then the death would be considered substance-related but not an overdose death. Substance combinations were reported for common combinations of substances when multiple substances were listed under contributing causes of death. See Appendix Table A1 for coding of overdose and substance-related causes of death. To prevent identification of individuals based on cause of death, the DOC restricted reporting of counts of 10 people or fewer for each cause of death.

Previous incarcerations were restricted to those reported in the Washington State prison system (non-Washington State incarceration data were not available) at any point in a person's lifetime. If people were incarcerated out-of-state, we are unable to identify this based on DOC data. Drug-related convictions were convictions associated with a drug offense, though the drug offense may not have been the charge resulting in prison confinement. The Washington State DOC records system used probabilistic identification of Washington State laws listed for each conviction to determine if convictions were drug-related (see Appendix Table A2).

2.3. Statistical analyses

Mortality rates and 95 % confidence intervals (CIs) were calculated for all-cause mortality, leading causes of mortality, substance-related mortality, and non-overdose versus overdose mortality. Overdose and non-overdose mortality rates were calculated weekly for the first eight weeks after release and for the period beyond eight weeks after release. Substance-related mortality was calculated overall and for four mutually exclusive time periods after release: two weeks, one month, six months, and longer than six months after release.

Cox proportional hazards regression with the Efron method for handling ties (Stata, 2020) was used for the risk factor analysis of all-cause, non-overdose, and overdose mortality. Individual characteristics tested for associations with survival included age at release, gender (male and female), race (white, black, and other), number of

Table 1
Characteristics of people released from Washington State prisons from 2014 to 2018*.

Characteristic	n	%
Sample of people released from prison	33,811	–
Unique releases from prison	39,338	–
Age at most recent release		
18–24 years	4,011	11.9
25–34 years	12,718	37.6
35–44 years	9,194	27.2
45–54 years	5,596	16.6
55–64 years	1,935	5.7
65 + years	357	1.1
Gender		
Male	29,547	87.4
Female	4,264	12.6
Race†		
White	25,034	74.0
Black	5,124	15.2
Other	3,653	10.8
Number of incarcerations prior to latest release (Range 0–17)‡		
0	16,250	48.1
1–2	11,828	35.0
> 2	5,733	17.0
Drug-related conviction for most recent incarceration		
No	19,327	57.2
Yes	14,484	42.8
Release year		
2014	5,549	16.5
2015	5,940	17.7
2016	6,629	19.8
2017	7,313	21.8
2018	8,130	24.2

†Race categories were not differentiated by Hispanic or other ethnicities. Ethnicity information was missing for 30 % of formerly incarcerated people.
‡This data only included the number of known Washington State prison incarcerations. If a person had been incarcerated out-of-state, we are unable to identify this based on Washington State Department of Corrections data.
* Defined as Washington State residents ever released from a Washington prison between January 1, 2014 to December 31, 2018.

Table 2
Mortality rates for leading causes of mortality after release from prison.

Underlying cause of mortality	Overall	
	Deaths (n) (N = 862)	Deaths per 100,000 person-years (95 % CI)
All-cause	862	747 (698–798)
Overdose	249	216 (190–244)
Cardiovascular disease	102	88 (73–107)
Homicide or assault	89	77 (63–95)
Cancer	72	62 (49–79)
Motor vehicle accident	63	55 (43–70)
Suicide	57	49 (38–64)
Respiratory diseases	35	30 (22–42)
Liver disease	30	26 (18–37)
Mental and behavioral disorders due to psychoactive substance use*	30	26 (18–37)
Other accident	26	23 (15–33)
Legal intervention involving firearms	14	12 (7–21)
Other	95	82 (67–101)

* Deaths were drug-related but were not classified as overdose deaths in the Washington State DOH death records.

incarcerations prior to latest release, drug-related conviction, and release year. These characteristics were analyzed using information provided by the DOC. Approximately one-third of the study cohort was missing self-reported ethnicity information in DOC records. Ethnicity was not included in regression analyses. Robust standard errors accounted for clustering of multiple releases per person. All analyses were performed using Stata software (version 15.1) (StataCorp, 2017).

Table 3
Substance-related mortality rates after prison release*.

Substance involved in death†	Deaths (n) (N = 276)	Deaths per 100,000 person-years (95 % CI)
Psychostimulant (including methamphetamine)	176	152 (131–177)
Opioid	159	138 (118–161)
Heroin	122	106 (88–126)
Natural and semisynthetic opioid (i.e. codeine, morphine)	34	29 (21–41)
Methadone	16	14 (8–23)
Synthetic opioids (including fentanyl)	17	15 (9–24)
Alcohol	33	29 (20–40)
Cocaine	22	19 (13–29)
Benzodiazepines	16	14 (8–23)
Other and unspecified narcotics	105	91 (75–110)
Substance combination‡		
Opioid and psychostimulant	83	72 (58–89)
Opioid and alcohol	18	16 (10–25)
Opioid and cocaine	17	15 (9–24)
Opioid and benzodiazepines	13	11 (7–19)

†Not mutually exclusive as multiple substances may be listed for persons with multiple causes of death.
Not all substances listed as causes of death were reported in the table due to data suppression requirements.
‡Not all substance combinations were listed due to suppression requirements for counts of 10 people or fewer.
* Overdose may not have been listed as the underlying cause of death.

3. Results

The study cohort included 33,811 people representing 39,705 releases from prison between 2014 and 2018. The accumulated exposure time after release was 115,469 person-years, and the mean follow-up time per person through the end of 2019 was 3.1 years, with a range of 0–6.0 years. Mean age at release was 37.0 years, most people released were male (87.4 %) and white (74.0 %), and 88.4 % of the cohort were Washington State residents. Table 1 reports additional characteristics of this study cohort. Number of incarcerations in a Washington State DOC facility prior to the latest release ranged from 0 to 17, and over half of people in the study cohort had at least one previous release from a Washington State prison in their lifetimes. Drug-related convictions were associated with 42.8 % of recent releases.

There were 862 deaths among persons released from prison with an all-cause mortality rate of 747 deaths per 100,000 person-years (95 % CI: 698–798). Of the identified deaths, 789 were men and 73 were women. Drug overdose was the leading cause of death and was listed as the underlying cause of death for 28.9 % of people who died after release (n = 249). The drug overdose mortality rate was 216 deaths per 100,000 person-years (95 % CI: 190–244). Ordered by incidence, other leading causes of death were cardiovascular disease, homicide or assault, cancer, motor vehicle accidents, and suicide (Table 2).

Of the 276 substance-related deaths identified for this cohort (Table 3), psychostimulants were the most prevalent substance reported as a cause of mortality (Mortality Rate: 152 per 100,000 person-years; 95 % CI: 131–177). Psychostimulants were involved in 20.4 % of all-cause mortality and 61.4 % of overdose mortality (n = 176). Opioids were the second most prevalent substance reported (Mortality Rate: 138 per 100,000 person-years; 95 % CI: 118–161) and were involved in 18.4 % of all-cause mortality and 60.6 % of overdose mortality (n = 159). Of opioid-related deaths, heroin was the most prevalent substance reported (n = 121) with a heroin-related mortality rate of 106 deaths per 100,000 person-years (95 % CI: 88–126), and synthetic opioid-related mortality (which includes fentanyl) was 15 deaths per 100,000 person-years (95 % CI: 9–24). Overdose was the underlying cause of death in 95.0 % of

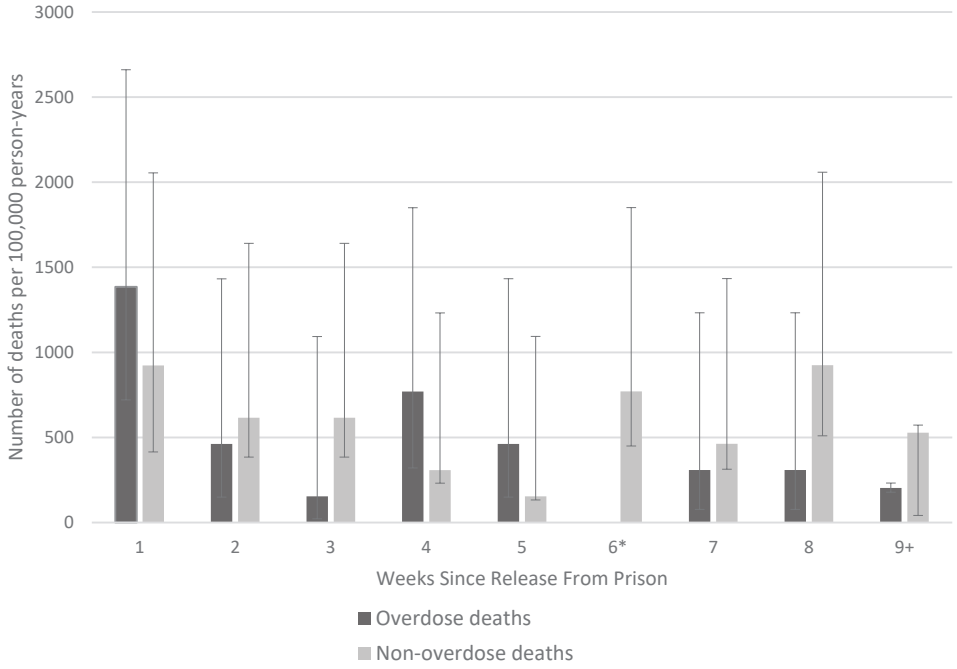

Fig. 1. Mortality rates by week since prison release for overdose and non-overdose deaths. *Note: There were no overdose deaths in Week 6 post-release for this cohort.

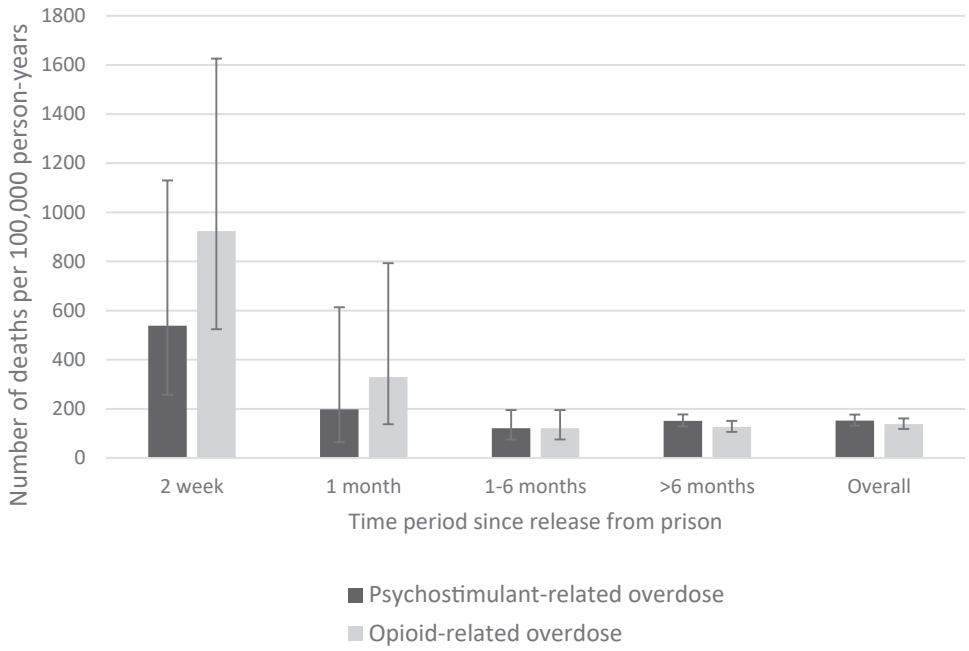

Fig. 2. Mortality rates and 95 % confidence intervals for psychostimulant- and opioid-related deaths by time period since release from prison.

opioid-related mortality (n = 151) and 86.9 % of psychostimulant-related mortality (n = 153).

Substance combinations associated with mortality are shown in Table 3, and 62.3 % of substance-related mortality involved poly-substance use (n = 172). Aside from mortality involving unspecified drugs, the combination of opioids and psychostimulants was the most common substance combination and was involved in 30.1 % of substance-related mortality (n = 83).

The period immediately after release was deadliest for persons released from prison. A week after release, the mortality rate from overdose (1384 deaths per 100,000 person-years, 95 % CI: 720–2661) was greater than the mortality rate from non-overdose causes (923 deaths per 100,000 person-years, 95 % CI: 415–2055) (Fig. 1). Opioid-related mortality rates were higher than psychostimulant-related mortality rates within two weeks and one month since release (Fig. 2), though psychostimulant-related mortality was greater overall and for time beyond six months after release.

In adjusted analyses (Table 4), the strongest risk factors for all-cause, non-overdose, and overdose mortality were being age 45 years and older at most recent release, male gender, having previous incarcerations, and having a drug-related conviction. Mortality risk was more than two-fold greater within the study time frame for persons aged 45 years and older

Table 4
Multivariate models of potential risk factors for mortality after prison release for all-cause, non-overdose, and overdose mortality.

Adjusted Hazard Ratios (HR)			
Variable Age at most recent release	All-cause mortality Adjusted HR (95 % CI)	Non-overdose mortality Adjusted HR (95 % CI)	Overdose mortality Adjusted HR (95 % CI)
18–24 years	1.0 (reference)	1.0 (reference)	1.0 (reference)
25–34 years	1.13 (0.84–1.51)	0.98 (0.70–1.37)	1.59 (0.90–2.81)
35–44 years	1.26 (0.94–1.70)	1.08 (0.76–1.54)	1.82 (1.02–3.24)
45–54 years	2.20 (1.64–2.96)	2.08 (1.48–2.94)	2.59 (1.44–4.64)
55–64 years	4.08 (2.98–5.57)	4.53 (3.18–6.46)	2.69 (1.37–5.26)
65 + years	8.37 (5.62–12.47)	10.56 (6.88–16.20)	0.87 (0.11–6.61)
Gender			
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)
Female	0.68 (0.53–0.86)	0.63 (0.46–0.85)	0.78 (0.51–1.18)
Race			
White	1.0 (reference)	1.0 (reference)	1.0 (reference)
Black	0.93 (0.77–1.13)	1.01 (0.81–1.25)	0.76 (0.52–1.11)
Other	0.91 (0.72–1.15)	0.91 (0.69–1.22)	0.90 (0.58–1.38)
Number of incarcerations prior to latest release (range 0–17)			
0	1.0 (reference)	1.0 (reference)	1.0 (reference)
1–2	1.34 (1.14–1.57)	1.29 (1.07–1.56)	1.48 (1.10–1.99)
> 2	1.44 (1.19–1.75)	1.38 (1.10–1.73)	1.63 (1.14–2.34)
Drug-related conviction for most recent incarceration			
No	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.16 (1.00–1.33)	1.05 (0.89–1.25)	1.43 (1.09–1.87)
Release year			
2014	1.0 (reference)	1.0 (reference)	1.0 (reference)
2015	1.06 (0.88–1.29)	1.09 (0.87–1.38)	0.99 (0.70–1.40)
2016	1.01 (0.82–1.23)	1.14 (0.90–1.44)	0.73 (0.50–1.08)
2017	0.82 (0.66–1.03)	0.90 (0.69–1.18)	0.67 (0.44–1.02)
2018	0.82 (0.66–1.07)	0.87 (0.66–1.17)	0.77 (0.51–1.17)

compared to persons aged 18–24 years old. Overdose mortality, however, was comparatively lower for people 65 years and older, though this reduced risk was not significant.

Compared to men, women had a 32 % reduced risk for all-cause mortality (HR 0.68; 95 % CI: 0.53–0.86), a 37 % reduced risk of non-overdose mortality (HR 0.63; 95 % CI: 0.46–0.87), and a 22 % decreased, though not significantly reduced, risk of overdose mortality (HR 0.78; 95 % CI: 0.51–1.18). Compared to releases with non-drug-related convictions, drug-related conviction was associated with an increased risk of death for all-cause mortality (HR 1.16; 95 % CI: 1.00–1.33) and overdose mortality (HR 1.43; 95 % CI: 1.09–1.87). People with more than two prior incarcerations had an increased risk of all-cause mortality (HR 1.44; 95 % CI: 1.19–1.75), non-overdose mortality (HR 1.38; 95 % CI: 1.10–1.73), and overdose mortality (HR 1.63; 95 % CI: 1.14–2.34) compared to people with no previous incarcerations.

Table A1
ICD-10 code descriptions of drug overdose and substance-related causes of death. This coding is based on Disease Flags for specific drugs attributed to causes of death from the Washington State Death File 2017 Data Users' Guide.

Cause of Death	Description
Drug Overdose	Drug overdose: underlying cause of death codes X40-X44 (unintentional drug overdose), X60-X64 (suicide drug overdose), X85 (assault/homicide drug overdose), Y10-Y14 (drug overdose of undetermined intent)
Opioid	Opioid (unspecified) overdose: multiple cause of death codes T40.0–T40.4
Heroin	Heroin overdose: multiple cause of death code T40.1
Natural Semisynthetic Opioid	Natural and semisynthetic opioid (codeine, morphine) overdose: multiple cause code T40.2
Methadone	Methadone overdose: multiple cause code T40.3
Synthetic Opioid	Synthetic opioid (including fentanyl, excluding methadone) overdose: multiple cause code T40.4
Prescription Opioid	Prescription drug overdose: multiple cause code T40.2-T40.4
Cocaine	Cocaine overdose: multiple cause code T40.5
Other and unspecified narcotics	Other and unspecified narcotic overdose: multiple cause code T40.6
Benzodiazepines	Benzodiazepine overdose: multiple cause of death code T42.4
Psychostimulant	Psychostimulant overdose: multiple cause code T43.6
Alcohol	Alcohol overdose: X45, Y15, T51.0, T51.1, T51.9

4. Discussion

Overdose was the most common cause of mortality for people released from Washington State prisons between 2014 and 2018, with psychostimulants and opioids contributing substantially to substance-related mortality. While all-cause mortality after prison release changed little in the past decades in Washington State, overdose mortality notably increased among people released from Washington State prisons. This study estimated a post-release overdose mortality rate of 216 deaths per 100,000 person-years (95 % CI: 190–244), compared to a previous Washington State study's estimate of 167 deaths per 100,000 person-years (95 % CI: 153–181) for persons released between 1999 and 2009 (Binswanger et al., 2013). Also, overdose mortality rates were substantially greater for people recently released from prison than the general population. Between 2015 and 2017, the age-adjusted overdose mortality rate was 16 deaths per 100,000 person-years (95 % CI: 15–16) for the Washington State population (Health, 2021).

Opioid-related mortality rates among formerly incarcerated people also increased to higher levels than were previously found (Binswanger et al., 2013), with opioid overdose mortality primarily attributed to heroin. Fentanyl was increasingly associated with overdose deaths in the U.S. during our study period (Jalal et al., 2018), and while we did not calculate fentanyl-specific mortality, mortality after release for synthetic opioids in North Carolina was 21.4 deaths per 100,000 person-years (Ranapurwala et al., 2018), comparable to our finding of 15 deaths per 100,000 person-years for synthetic opioid-related mortality. Furthermore, in this cohort, psychostimulants eclipsed opioids as the most prevalent substance contributing to substance-related mortality after release from prison. The rise in overdose mortality for the formerly incarcerated population tracks growth in overdose mortality among the U.S. population (Jalal et al., 2018), especially for psychostimulant and heroin-related mortality. In Washington State, from 2009 to 2019, psychostimulant-related mortality increased four-fold and heroin-related mortality tripled for the Washington State population at large (Health, 2021).

Several studies on post-incarceration mortality recognize the acute risk of opioid overdose after release (Binswanger et al., 2013; Merrall et al., 2010; Mital et al., 2020; Ranapurwala et al., 2018), and the rise in

Table A2
Washington State Revised Code of Washington (RCW) criminal codes used by the Washington State Department of Corrections to identify drug-related convictions.

	RCW Criminal Codes
1	Willfully disobeys order to remain outside "protected against drug trafficking area" (school area subsequent violation)
2	Ephedrine sales - other than licensee
3	Violation of the uniform controlled substance act
4	Possession of marijuana
5	Violation uniform narcotic drug act
6	Violation uniform narcotic drug act
7	Possession of marijuana
8	Poison in milk or food product
9	Placing poison or other harmful object or substance in food, drinks, medicine or water
10	Sale of dangerous drug
11	Illegally obtaining legend drug
12	Forged prescription (legend drug)
13	Possession of legend drug with intent to sell or deliver
14	Sale, delivery, or possession of legend drug without a prescription or order
15	Illegal issuance of legend drug prescription
16	Possession of steroids in excess of 200 tablets or eight 2cc bottles, without a valid prescription
17	Sale or receipt of precursor drugs
18	Unlawful delivery of substance with intent to use
19	Drugs-manufacture, deliver, possess w/intent to deliver
20	Drugs-manufacture, deliver, possess w/intent to deliver - meth
21	Manufacture, deliver, or possess with intent to deliver narcotics from in schedule I or II which is a narcotic drug or flunitrazepam
22	Delivery or possession with intent to deliver amphetamine, including its salts, isomers, and salts of isomers, or methamphetamine, including its salts, isomers, and salts of isomers
23	Manufacture, deliver, or possess with intent to deliver narcotics from schedule I,II, or III
24	Manufacture, deliver, or possess with intent to deliver narcotics from schedule IV, except flunitrazepam
25	Manufacture, deliver, or possess with intent to deliver narcotics from schedule V
26	Violation of uniform controlled substance act - 20 yr.
27	Violation of uniform controlled substance act - 10 yr.
28	Violation of uniform controlled substance act - 5 yr.
29	Violation of uniform controlled substance act - under 18
30	Create, deliver, or possess a counterfeit controlled substance - schedule I or II narcotic
31	Create, deliver, or possess a counterfeit controlled substance - methamphetamine
32	Create, deliver, or possess a counterfeit controlled substance from schedule I, II, or III
33	Create, deliver, or possess a counterfeit controlled substance - from schedule IV, except flunitrazepam
34	Create, deliver, or possess a counterfeit controlled substance from schedule V
35	Delivery of material in lieu of a controlled substance
36	Possession of controlled substance
37	Involving a minor in drug dealing
38	Dispense controlled substance violation
39	Maintaining a dwelling for controlled substances
40	Dispensing violation (VUCSA)
41	Controlled substance abuse fraud
42	Utter false or forged prescription
43	Forged prescription for a controlled substance
44	VUCSA deliver to a minor
45	Over 18 and deliver to someone under 18
46	Over 18 and deliver to someone under 18- and 3-years junior
47	Drug possession
48	Selling heroin for profit
49	Selling for profit (controlled or counterfeit) any controlled substance
50	Controlled substance label violation
51	Controlled substance label violation
52	Possession of ephedrine, pseudoephedrine or anhydrous ammonia with intent to manufacture methamphetamine
53	Medical marijuana fraud record
54	Medical marijuana fraudulent records
55	Manufacture, distribute, or possess with intent to distribute imitation controlled substance
56	Manufacture, distribute, or possess with intent to distribute imitation controlled substance
57	Delivery of imitation controlled substance by person 18 or over to person under 1
58	Unlawful use of building for drug purposes
59	Unlawful fortification of building for drug purposes
60	Unlawful use of fortified building
61	Sale of dangerous drugs
62	Bringing narcotics, liquor, or weapons into institution or grounds
63	Possession of controlled substance by prisoners
64	Possession of controlled substance in prison by non-prisoner 2
65	Drug offense (from out of state)
66	Possession of controlled substance, alcohol, marijuana, other intoxicant, cell phone or other form of electronic telecommunications device.

Note: Codes used by the Washington State DOC records system to determine if a sentence was a drug-related conviction may have changed over time.

psychostimulant-related and heroin-specific overdose mortality after release from prison observed in this study are concerning. The psychostimulant-related mortality rate was 152 deaths per 100,000 person-years (95 % CI: 131–177) in the present cohort compared to 41 deaths per 100,000 person-years (95 % CI: 34–48) for the 1999–2009 cohort. To our knowledge, this is the first study on post-incarceration mortality to observe psychostimulants as the predominant substance contributing to mortality after prison release.

This research also corroborated previous findings on the elevated risk of opioid- and psychostimulant-related mortality in the first weeks and months after release (Calcaterra et al., 2012; Mital et al., 2020; Ranapurwala et al., 2018). For this recent cohort of formerly incarcerated persons, opioid-related and psychostimulant-related mortality rates were highest in the first two weeks after release. Furthermore, detection of multiple drugs in combination–common in substance-related causes of death–was more prevalent in this study compared to the previous findings (Binswanger et al., 2013). In this study, thirty percent of psychostimulant-related mortality also involved opioids. This equates to a 10-fold increase in the recent decade for the mortality rate involving both psychostimulants and opioids (Binswanger et al., 2013).

These updated findings on post-incarceration mortality emphasize the need for continued surveillance of mortality trends in populations who experience incarceration as well as a continued focus on prevention and treatment of health problems, particularly for substance use disorders. Identification of substance use before or during incarceration may improve access to substance use disorder treatment and ultimately improve health outcomes. A meta-analysis of the effectiveness of treatments for opioid use in prisons and jails found that uptake of these therapies while incarcerated increased participation in substance use treatment and reduced opioid use after release (Moore et al., 2019). A more recent study found that, after release, pharmacy service use increased and emergency department use decreased among people provided with medications for opioid use disorder while incarcerated (Howell et al., 2021); and there is growing evidence that providing medications for substance use disorder treatment (e.g., methadone, buprenorphine, naltrexone), after release reduces post-incarceration overdose mortality (Green et al., 2018). Greater investment in prevention and treatment of drug overdose is paramount in addressing the high post-release mortality rates observed in this at-risk population.

Interventions focused on overdose prevention, particularly for psychostimulant and heroin use, could greatly reduce post-release mortality among formerly incarcerated persons. Reintegration is stressful, and many formerly incarcerated people face discrimination, wage stagnation and low-income jobs (Massoglia and Remster, 2019). Several studies on incarceration as a social determinant of health highlight the ongoing consequences of incarceration including poor health, poor social support, and the use of drugs as self-medication (Massoglia and Remster, 2019; Western and Simes, 2019; Wildeman and Wang, 2017). In addition to providing substance use disorder treatment, interventions reducing mortality post-release would benefit from addressing

structural barriers, such as improving access to health care, improving follow-up of overdose prevention services after release (Mital et al., 2020), preventing the poverty that is more prevalent among people who experience incarceration (Massoglia and Remster, 2019), and offering opportunities for education and social support.

The findings in this study were specific to Washington State, and more research in areas of the U.S. which experience disparate drug use and overdose epidemics could help identify risk factors for overdose mortality and inform interventions tailored to those populations. These findings may also correlate with trends in substances attributed to non-fatal overdose, which is elevated for the formerly incarcerated population (Keen et al., 2020). They could also inform interventions focused on particular types of drug use. Future research could assess the interaction between substance use and other causes of death, as well as other types and stages of incarceration, (e.g., after release from jail or during probation). A recent study found that the highest overdose mortality rates after prison release were observed while people were on parole, though risk of overdose mortality continued for many years thereafter (Binswanger et al., 2020). More nuanced assessment of substance use disorder treatments and overdose mortality – before, during, and after prison and jail release – may aid intervention efforts to reduce mortality for at-risk persons after incarceration.

4.1. Limitations

This study aimed to update previous studies of post-release mortality statistics for people released from Washington State prisons; however, there were several methodological differences compared to previous studies (Binswanger et al., 2007, 2013). Notably, this study relied on Washington State death records rather than the National Death Index to match persons released from prison to decedents. Out-of-state deaths of Washington residents are included in the Washington State death records (Washington State Death File, Data Users' Guide, 2017, 2018), though some mortality of non-Washington residents may be missing from our analyses. In previous studies, 85 % of deaths of persons formerly incarcerated in Washington State occurred in Washington (Binswanger et al., 2007).

This study used a deterministic method linking prison release records to Washington State death records. Deterministic linkage may have led to undercounting of post-release mortality if, for example, name changes over time resulted in missed matches. Thus, mortality rates in this study may be underestimated due to both missing out-of-state deaths in the Washington State death records and missed matches with death records. Even if this is the case, mortality rates increased compared to previous studies, especially for overdose and substance-related mortality (Binswanger et al., 2013). Additionally, while much of the inclusion criteria in this study remained the same compared to previous studies, people on compassionate leave due to illness who were excluded in previous studies (i.e., extraordinary medical parole) were included in this study since that release information was not available.

Drug-related conviction was broadly defined and was an imperfect proxy for substance use. While this determination could be helpful in identifying and directing interventions for people at risk after release, it does not necessarily capture the population with a history of or at risk of substance use disorders. Also, the drug-related conviction variable may not identify people who participate in or need substance use disorder treatment before, during, or after incarceration.

Additionally, while in-prison substance use disorder treatment may be associated with drug overdose mortality after release, we were unable to analyze in-prison mental health and substance use disorder treatment. Reporting and treatment of mental health and substance use disorder therapies varies across prison facilities in Washington State making it difficult to associate diagnoses and in-prison mental health and substance abuse treatment with post-incarceration health outcomes. Reliable records on in-prison mental health and substance abuse treatment are needed and could improve analyses of risk factors associated with post-release mortality.

5. Conclusion

Mortality after release from prison remains high, and drug overdose mortality rates in this study were higher than previously estimated. Psychostimulants overtook opioids as the top contributor to substance-related mortality compared to previous studies in Washington State. Though, both psychostimulants and opioids were notable contributors to mortality, particularly immediately after release. Interventions addressing substance use during and after incarceration are needed to stem increasing overdose mortality after release. Continued surveillance of mortality after prison release may provide updated information on contributors to mortality and may help to track the progress of interventions preventing drug overdose in this at-risk population.

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CRediT authorship contribution statement

AO performed data management, data analysis, and results and manuscript preparation. JS contributed to data analysis and draft editing. DFK planned the project and obtained project funding, consulted on data analysis, and contributed to draft editing. All authors approved the final manuscript for submission.

Conflict of Interest

The authors have no declarations of competing interest to report.

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Appendix

(See here Appendix Tables A1,A2).

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