Opioid toxicity deaths in Indigenous people who experienced incarceration in Ontario, Canada 2015–2020: a whole population retrospective cohort study

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Summary

Background While Indigenous people are overrepresented in Canada's prisons and in the toxic drug supply crisis, we lack data on the harms related to opioids for Indigenous people with experiences of incarceration. We aimed to examine opioid toxicity deaths in Indigenous peoples who experienced incarceration and to compare opioid toxicity mortality rates with rates for people with no incarceration.

Methods This retrospective cohort study linked correctional data for all people who were incarcerated in provincial correctional facilities and coronial data for all people who died from opioid toxicity in Ontario, Canada between 2015 and 2020. We calculated opioid mortality rates for Indigenous people who experienced incarceration and for people who did not experience incarceration using publicly available population data and calculated age-standardized mortality rates for Indigenous and non-Indigenous people who experienced incarceration compared with people who did not experience incarceration.

Findings Of 14,885 Indigenous people who experienced incarceration, 2% (N = 242) died from opioid toxicity in custody or post-release, representing 2.9% of all opioid toxicity deaths in Ontario during this period. The crude opioid toxicity mortality rate per 100 person-years was 0.53 for Indigenous females and 0.36 for Indigenous males who experienced incarceration, compared with 0.0060 for females and 0.0132 for males who did not experience incarceration. Rates of opioid toxicity death were highest in the month post-release for Indigenous people who experienced incarceration, at 1.13 per 100 person-years. Standardized for age and compared with people with no incarceration, the mortality ratio was 81.0 (95% CI 62.1–100.0) for Indigenous females who experienced incarceration and 23.6 (95% CI 20.1–27.1) for Indigenous males who experienced incarceration. The SMRs for Indigenous and non-Indigenous females who experienced incarceration were not significantly different, at 81.0 compared with 76.4, and were significantly different for Indigenous and non-Indigenous males who experienced incarceration, at 23.6 compared with 28.5.

Interpretation This whole-population study identified a substantial and inequitable burden of opioid toxicity death for Indigenous people who experienced incarceration, similar to the burden for non-Indigenous people who experienced incarceration. The large burden is particularly concerning in the context of the overrepresentation of Indigenous people in correctional facilities. Focus is warranted to prevent substance use harms for Indigenous people, including through community- and custody-based interventions to support health.

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Keywords: Opioid toxicity; Indigenous peoples; Incarceration; Prisons; Opioid crisis

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Research in context

Evidence before this study

We searched OVID MEDLINE(R) from 1946 and Embase from 1974 to May 13, 2024 for studies on opioid toxicity mortality in custody or post-release for Indigenous people who experienced incarceration. We used no language limitations and used the following search terms (Prisoners/or Prisoners/or Prisons/or (prisoner* or incarcerat* or inmate* or prison* or jail* or inmate* or incarcerat* or imprison* or remand* or sentence* or detain* or detention or offen* or custod*).kw,tw.) AND (drug overdose.kw,tw. or exp Drug Overdose/) AND (exp Indigenous Peoples/OR (Indigenous or Metis or First Nation* or Inuit or Native* or Tribe* or Aborig*).kw,tw.). We did not identify any relevant studies.

Added value of this study

This is the first known population-based study to investigate opioid toxicity mortality among Indigenous people with experiences of incarceration in Canada or internationally. We identified very high absolute and relative opioid toxicity death rates compared with people who didn't experience incarceration, which were similar to rates for non-Indigenous people who experienced incarceration.

Implications of all the available evidence

There is a high, inequitable burden of opioid toxicity mortality for Indigenous people who experience incarceration, both in custody and post-release. In the context of the over-incarceration of people who are Indigenous in Ontario, there is an urgent need for interventions to support population health to prevent opioid toxicity deaths.

Introduction

Across North America, Indigenous people have been disproportionately harmed in the ongoing drug toxicity crisis.[1,2] In British Columbia, Canada, First Nations people were 6 times more likely to die from drug toxicity in 2023 than others in the general population,[3] and in Ontario, Canada, First Nations people were 7 times more likely to die from opioid toxicity in 2021 than non-First Nations people.[4] The devastating legacy of colonization, systemic racism, and ongoing structural and interpersonal violence, including child removal and incarceration, contribute to increased vulnerability to harms related to drug use among Indigenous people.[5,6]

In Canada, there were a total of 42,494 opioid toxicity deaths between January 2016 and September 2023.[7] The continuous toll of deaths—averaging 22 opioid-related deaths per day during the first half of 2023[7]– has resulted in the stagnation of life expectancy.[8] Similar to patterns observed in the United States,[9] unintentional poisonings now constitute a leading cause of accidental death in Canada.[10]

Canada's 'war on drugs' and the criminalization of drug use disproportionately impact Indigenous as well as Black communities,[11] contributing to the mass incarceration; over 30% of the federal prison population is Indigenous, despite representing only 5% of the total Canadian population,[12] and Indigenous people are overrepresented by a factor of 9 in provincial correctional facilities in five provinces.[13] Multiple, interrelated factors contribute to the over-incarceration of Indigenous people in Canada, including colonialism and historical and intergenerational trauma.[13,14] Indigenous people in Canada face significant challenges upon incarceration: they are more likely to be assessed for and placed in a maximum security facility, to have a higher number of reported self-harm incidents, and to spend more time in segregation, and they are less likely to be granted parole.[15,16]

For people who experience incarceration in North America, death due to opioid toxicity is a predominant driver of increased mortality rates both during incarceration and upon release from prison.[17,18] Compared to the rest of the population, people who experience incarceration face considerable health and social inequities including histories of mental illness, homelessness, and barriers to accessing health care, which impact risks of fatal and non-fatal drug toxicity events.[19–21] Indigenous people have identified the need to address the opioid toxicity crisis,[22,23] especially as it relates to Indigenous people who are incarcerated.[22,24]

With the continued overrepresentation of Indigenous people in Canada's prisons and in the drug toxicity crisis, there is a need for population-based evidence on the rate and timing of opioid toxicity death among Indigenous people who experience incarceration. Information on the number of opioid toxicity deaths and characteristics of those who have died could support a case for a specific focus on the needs of Indigenous people who experience or are at risk of incarceration, and inform coordinated responses to prevent deaths and other harms. In this context, we aimed to describe opioid toxicity deaths in Indigenous people who experienced incarceration in Ontario, both in custody and post-release and to compare opioid toxicity mortality rates with rates for people with no incarceration.

Methods

In this retrospective cohort study, we accessed data from the Ontario Ministry of the Solicitor General for people aged 18 and older who were detained or incarcerated in

an Ontario provincial correctional facility for adults between January 1, 2015 and December 31, 2020.[19] The Ministry operates correctional institutions in Ontario for adults on remand (awaiting trial or sentencing), or sentenced to less than two years in custody, and oversees and delivers health care in these facilities. People sentenced to two years or more in custody are transferred to federal penitentiaries. We also accessed data in 2022 from the Office of the Chief Coroner of Ontario for all opioid toxicity deaths between January 1, 2015 and December 31, 2020. In Ontario, there is a legal obligation to report to a coroner any death from opioid toxicity, which includes sudden and unexpected deaths where an opioid was identified in post-mortem toxicology and was determined to have directly contributed to the death, either alone or in combination with other substances. We linked the correctional and coronial data deterministically or else probabilistically (for data not linked deterministically) using name, date of birth and sex, using Link Plus version 2.0.[25]

We use the term "people who experienced incarceration" to describe people who experienced incarceration in an Ontario provincial correctional facility at any time between 2015 and 2020, recognizing that for most of the follow-up period, people were in the community post-release and not in custody, and that some people were detained rather than incarcerated.

We considered Indigenous people who experienced incarceration as the *exposed* group, i.e. based on both Indigenous identity and incarceration. We accessed data on Indigenous identity and race from the correctional dataset, and these data were self-reported on each custodial admission. We did not access data from the coronial dataset on race or Indigenous identity, though these data may be collected during a death investigation, as we consider self-reported data to be more appropriate, consistent with the United Nations Declaration on the Rights of Indigenous Peoples, which specifies the right to "determine their own identity or membership in accordance with their customs and traditions."[26] We categorized people as Indigenous if they ever reported they were Indigenous and never reported they were not Indigenous in response to the Indigenous identity question, or if they did not have a response to the Indigenous identity question and ever reported they were Indigenous or Aboriginal in response to the race question. We categorized all other people who experienced incarceration as non-Indigenous, and we considered non-Indigenous people who experienced incarceration as a second *exposed* group (i.e. also exposed to incarceration). We considered all people in the Ontario population who did not experience incarceration during the study period as the *unexposed* group. We accessed data on population sizes by age and sex using publicly available census data.[27]

Our primary outcome was death from opioid toxicity, based on report to a coroner (as above). We identified deaths in people who experienced incarceration based on linkage between the correctional and coronial datasets, and if there was no linkage for a death, we categorized the death as occurring in a person who did not experience incarceration.

We described baseline characteristics for Indigenous and non-Indigenous people who experienced incarceration using correctional data and for people who did not experience incarceration using census data. We did not have access to data on gender. For Indigenous people who experienced incarceration who died from opioid toxicity, we calculated the number, percentage, and rates of opioid toxicity death by period in custody and post-release, and we described sociodemographic and correctional data such as age, marital status, length of most recent incarceration, and cumulative time in custody and number of incarcerations during the study period. We calculated rates of opioid toxicity death using person time as the total days of follow-up, given variable periods of follow-up. For people who experienced incarceration, we calculated person time as the time from the date of their first admission to custody during the study period to the end of the study or known death (as we did not have access to data on death due to causes other than opioid toxicity for people who did not die in custody), whether they remained in custody or were released to the community. We examined deaths and rates of death overall and relative to period in custody using all admissions and all post-release periods during the study period. For people who did not experience incarceration, we assumed they contributed one person year per calendar year, and people who experienced incarceration contributed person-time to the unexposed group prior to their first admission during the study period.

We calculated age-standardized mortality ratios (SMRs) for people who experienced incarceration compared with people with no incarceration during this period. We calculated the expected number of opioid toxicity deaths using all opioid toxicity deaths for people aged 18 and over who did not experience incarceration and the mean age- and sex-specific Ontario population over the study period, based on Statistics Canada Census data for age and sex,[27] which were interpolated to estimate the populations from 2015 to 2020. We applied the rate of opioid toxicity death for people who did not experience incarceration to the total person years in each age-sex group of people who experienced incarceration to obtain the expected number of deaths for each age-sex group, and then summed the expected deaths across age groups to get a total expected number. We divided the actual number of deaths (i.e. observed deaths) by the expected number of deaths for each age-sex group to get the SMR, and we calculated 95%

confidence intervals (CI) for the SMRs. Analyses were performed in SAS version 10.0.

Ethical considerations

In the context of the Canadian Truth and Reconciliation Commission's (TRC's) *Calls to Action*,[24] and recognizing the imperative and challenges of "how to ethically engage Indigenous communities and Indigenous knowledge systems"[28] at the institutional and interpersonal levels, we developed this project as a form of "*reconciliation indigenization*,"[28] in which relationships continued to develop through the project as community partnerships with Indigenous communities, organizations, and academics. We partnered with a National Indigenous Organization: the Native Women's Associated of Canada, represented by co-author Hollie Sabourin, and we documented their interest and partnership in a letter that specified that we would collaborate regarding analyses, interpretation and framing of study findings, and plans for knowledge dissemination.

We also engaged in knowledge exchange with Indigenous people with relevant lived experiences, including three Elders and three other people with lived experience of incarceration and substance use, to help contextualize and interpret the study findings. We conducted in-person or online meetings with the experts with lived experiences, in which we presented and discussed key findings, and experts with lived experience also contributed to manuscript review and revision. We provided culturally appropriate honoraria for these experts: $150 for Indigenous Elders and $30 per hour for others. The project is guided by principles of Indigenous research ethics such as accounting for spirit and wholistic health, respecting the diversity among Indigenous people, community capacity building, and reciprocal knowledge translation.

The study was approved by the Ontario Ministry of the Solicitor General, the Office of the Chief Coroner of Ontario, and the Hamilton Integrated Research Ethics Board (study #5878). Consistent with Canadian standards for research involving humans,[29] we did not obtain individual consent for the secondary use of these correctional and coronial administrative data, as it would have been impracticable.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Between 2015 and 2020, a total of 129,152 people experienced incarceration in provincial correctional facilities in Ontario. Of those, 14,885 people (11.5%) reported Indigenous identity (Table 1).

In total, 242 Indigenous people who experienced incarceration between 2015 and 2020 died from opioid toxicity (2%), including 70 females and 172 males; this represents 2.9% of all 8460 people (and 2.9% of all 8402 adults aged 18 and older) who died from opioid toxicity in Ontario during this period. For those who died, the median length of time in custody across all admissions between 2015 and 2020 was 52.2 days for females and 98.3 days for males, and the median length for the most recent incarceration was 12.1 days for females and 23.0 days for males (Table 2).

For Indigenous people who experienced incarceration and died from opioid toxicity (Table 3), 0 females and 7 males died in custody, for an overall rate of 0.10 deaths per 100 person-years. In the 30 days post-release, 10 Indigenous females and 27 Indigenous males died, for a rate of 1.13 per 100 person-years overall, which was the highest rate across all periods examined. Though the rates were lower for periods after 30 days post-release, the majority of people (78%) died at more than 30 days post-release.

The crude opioid toxicity mortality rate per 100 person-years was 0.53 for Indigenous females who experienced incarceration and 0.36 for Indigenous males who experienced incarceration, 0.50 for non-Indigenous females who experienced incarceration and 0.43 for non-Indigenous males who experienced incarceration, and 0.0060 for females who did not

	Indigenous people who experienced incarceration		Non-Indigenous people who experienced incarceration		People who did not experience incarceration[a]	
	F	M	F	M	F	M
N	3487	11,336	14,659	99,290	5,511,294	5,107,016
Age[b]						
18–24	955 (27.4%)	2899 (25.6%)	3230 (22.0%)	20,977 (21.1%)	604,181 (10.9%)	630,981 (12.2%)
25–39	1871 (53.7%)	5516 (48.7%)	7113 (48.5%)	43,900 (44.2%)	1,294,431 (23.4%)	1,222,402 (23.5%)
40–49	489 (14.0%)	1906 (16.8%)	2680 (18.3%)	18,473 (18.6%)	939,967 (17.1%)	874,205 (17.1%)
50+	172 (4.9%)	1015 (9.0%)	1636 (11.2%)	15,940 (16.1%)	2,672,716 (48.6%)	2,379,429 (47.3%)

[a]Total population numbers differ from sum across categories due to rounding. [b]Age on first admission or January 1, 2015 for people who experienced incarceration, or on July 1, 2015 for people who did not experience incarceration.

Table 1: **Baseline data for Indigenous people who experienced incarceration, non-Indigenous people who experienced incarceration, and people who did not experience incarceration in provincial correctional facilities in Ontario, 2015–2020, by sex.**

experience incarceration and 0.0132 for males who did not experience incarceration (Table 4).

Adjusted for age and sex, Indigenous people who experienced incarceration were 29.7 [CI 26.3, 33.1] times more likely to die from opioid toxicity than people with no history of incarceration. Adjusted for age, Indigenous females who experienced incarceration were 81.0 [CI 62.1, 100.0] times more likely to die from opioid toxicity than females with no experience of incarceration during this period, and Indigenous males who experienced incarceration were 23.6 [CI 20.1, 27.1] times more likely to die from opioid toxicity than males with no experience of incarceration during this period, as shown in Table 3 and Fig. 1. The SMRs were of a similar magnitude for Indigenous and non-Indigenous females who experienced incarceration, at 81.0 compared with 76.4, and for Indigenous and non-Indigenous males who experienced incarceration, at 23.6 compared with 28.5; the difference in the SMRs for Indigenous and non-Indigenous males who experienced incarceration was statistically significant.

	Females	Males	Total
Deaths, n/N (%)	70/3487 (2)	172/11,336 (2)	242/14,885 (2)
Age, n (%)[a]			
18–24	14 (20)	28 (16)	42 (17)
25–39	41 (59)	95 (55)	136 (56)
40–49	11 (16)	32 (19)	43 (18)
50+	4 (6)	17 (10)	21 (9)
Marital status[b]			
Married[c]	17 (24)	28 (16.3)	45 (18.6)
Single	53 (76)	144 (83.7)	197 (81.4)
Total time in custody 2015–2020			
Mean (SD)	142.3 (206.8)	230.0 (290.8)	204.6 (271.7)
Median (IQR)	52.2 (8.9–164.9)	98.3 (26.9–348.3)	77.1 (17.7–304.4)
Most recent incarceration length-days			
Mean (SD)	63.9 (130.4)	75.2 (129.9)	71.9 (129.9)
Median (IQR)	12.1 (2.8–45.1)	23.0 (5.0–84.4)	77.1 (17.7–304.4)
Incarceration episodes 2015–2020			
Mean (SD)	3.9 (4.0)	4.4 (4.2)	4.2 (4.2)
Median (IQR)	2 (1–6)	3 (1–6)	3 (1–6)
Follow-up- years[c]			
Mean (SD)	2.9 (1.6)	3.2 (1.7)	3.1 (1.7)
Median (IQR)	2.9 (1.6–4.3)	3.3 (1.8–4.6)	3.1 (1.8–4.5)

[a]On first admission or as of January 1, 2015. [b]Married includes people who reported being married or in a common law relationship, and single includes those who reported they were single, separated, divorced or widowed. [c]On first admission or as of January 1, 2015 to end of study or death.

Table 2: **Sociodemographic characteristics, correctional data, and follow up for Indigenous people who experienced incarceration in provincial correctional facilities in Ontario and died from opioid toxicity, 2015–2020, by sex.**

Discussion

This study examined mortality from opioid toxicity for 14,885 Indigenous people who experienced incarceration in provincial correctional facilities in Ontario between 2015 and 2020. We found that almost 2% of all Indigenous people who experienced incarceration, or 242 people, died from opioid toxicity over this six-year time period, which represents almost 3% of all 8460 opioid toxicity deaths in the province. Indigenous people who experienced incarceration were 29.7 times more likely to die from opioid toxicity than people with no history of incarceration, after adjusting for sex and age, with SMRs of 81.0 for Indigenous females who experienced incarceration and 23.6 for Indigenous males who experienced incarceration, showing the disproportionately high burden of opioid toxicity death in this population. The opioid toxicity mortality rates were similar overall for Indigenous and non-Indigenous people who experienced incarceration. For Indigenous people, the risk of death from opioid toxicity was highest in the month post-release, with 37 deaths and a death rate of 1.13 per 100 person-years, though of those who died, more than three-quarters (78%) died after 30 days post-release.

Our hypothesis that the burden of opioid toxicity would be high for Indigenous people who experienced incarceration, in absolute terms and relative to others who did not experience incarceration, was correct. We

	Females, N = 70		Males, N = 172		Total, N = 242	
	rate (n/100 PYs)	n (% of deaths)	rate (n/100 PYs)	n (% of deaths)	rate (n/100 PYs)	n (% of deaths)
In custody	0	0	0.12	7 (4%)	0.10	7 (3%)
In community post-release						
0–30 days	1.41	10 (14%)	1.06	27 (16%)	1.13	37 (15%)
31–90 days	0.87	10 (14%)	0.64	26 (15%)	0.69	36 (15%)
91–365 days	0.58	20 (29%)	0.35	40 (23%)	0.40	60 (25%)
>1 year	0.44	29 (41%)	0.32	64 (37%)	0.35	93 (38%)
Other[a]	1.60	1 (1%)	0.12	8 (5%)	0.95	9 (4%)

[a]These people were released from provincial custody to a federal correctional facility or to another institution, so it is not known if they were still incarcerated or had been released to the community when they died.

Table 3: **Rates of death from opioid toxicity for Indigenous people who experienced incarceration in provincial correctional facilities in Ontario, 2015–2020, by sex and period in custody or post-release.**

	Indigenous people who experienced incarceration		Non-Indigenous people who experienced incarceration 2015–2020		People who did not experience incarceration	
	Females N = 3487	Males N = 11,336	Females N = 14,659	Males N = 99,290	Females N = 5,511,294	Males N = 5,107,016
Deaths[a]						
Total	70	172	274	1682	2044	4149
Person years of follow up						
Total	13,283	47,498	55,150	389,899	34,026,804	31,354,655
Mortality rate (deaths/100 person years)						
18–24	0.38	0.23	0.36	0.31	0.0044	0.0090
25–39	0.58	0.41	0.61	0.50	0.0075	0.0191
40–49	0.59	0.41	0.51	0.49	0.0074	0.0167
50+	0.63	0.43	0.28	0.32	0.0052	0.0100
Total	0.53	0.36	0.50	0.43	0.0060	0.0132
Mortality ratios (95% CI)						
18–24	85.0 (40.5–129.5)	25.2 (15.9–34.6)	81.1 (57.1–105.0)	34.8 (30.5–39.0)	Ref	Ref
25–39	77.5 (53.8–101.3)	21.3 (17.0–25.5)	82.2 (69.5–94.9)	26.3 (24.5–28.0)	Ref	Ref
40–49	79.8 (32.7–127.0)	24.3 (15.9–32.8)	68.2 (50.0–86.4)	29.3 (26.2–32.3)	Ref	Ref
50+	123.1 (2.5–243.7)	42.8 (22.5–63.2)	53.4 (28.0–78.8)	31.6 (27.1–36.0)	Ref	Ref
Total, age-standardized (SMR)	81.0 (62.1–100.0)	23.6 (20.1–27.1)[b]	76.4 (68.8–84.0)	28.5 (27.3–29.7)	Ref	Ref
Total, age-sex standardized SMR	29.7 (26.3–33.1)		31.3 (30.1–32.5)		Ref	

[a]Given stratification by sex, the number of deaths in people who experienced incarceration excludes those in people with missing sex (n = 2) and who self-reported their sex as trans (n = 9), and the number of deaths in people who didn't experience incarceration also excludes people younger than 18 who died from opioid toxicity (n = 58). [b]The SMR for Indigenous males who experienced incarceration was statistically significantly lower than the SMR for non-Indigenous males who experienced incarceration.

Table 4: **Opioid toxicity deaths and death rates by sex for Indigenous people who experienced incarceration, all other people who experienced incarceration, and people with no incarceration in provincial correctional facilities in Ontario, 2015–2020, and mortality ratios compared with people with no incarceration.**

also expected that for people who experienced incarceration, Indigenous people would be at higher risk of opioid toxicity death than non-Indigenous people, given whole population evidence from several North American studies showing Indigenous people were at higher risk than non-Indigenous people.[1–4] However, rates were similarly high for Indigenous and non-Indigenous people who experienced incarceration. Additional research would be valuable to elucidate mechanisms that increase the risk of opioid toxicity death, which

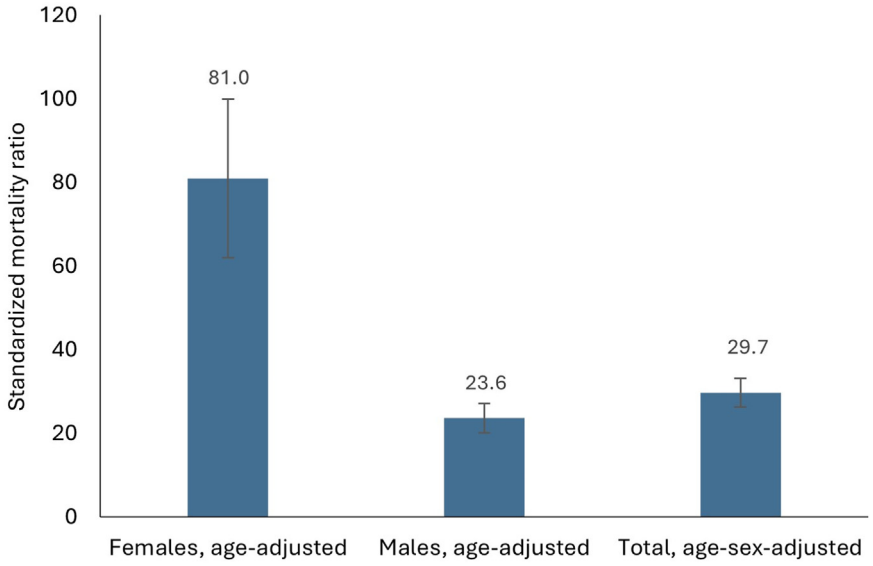

Fig. 1: Standardized mortality ratios for opioid toxicity death for Indigenous people who experienced incarceration in provincial correctional facilities in Ontario, 2015–2020, compared with people with no incarceration, by sex.

likely reflect structural barriers to health that may be more common for Indigenous people in Canada, and how incarceration modifies these risks for both Indigenous and non-Indigenous people. We also note that in the context of the substantial over-incarceration of Indigenous people in Canada.[12,13] Indigenous people who experience incarceration having the same mortality rate as non-Indigenous people who experience incarceration indicate an inequitable burden of opioid toxicity death associated with incarceration for Indigenous people who experience incarceration.

To our knowledge, this is the first population-based study to investigate opioid toxicity mortality among Indigenous people with experiences of incarceration in Canada or internationally. Our findings are consistent with prior evidence of a high burden of opioid toxicity mortality for people who experience incarceration overall,[30,31] and particularly high risk in the weeks post-release,[17,32–34] and reveal that this burden extends to Indigenous females and Indigenous males who experience incarceration. Our results are also consistent with Australian research on Indigenous people who experienced incarceration which showed a high burden of all-cause mortality and substance-related mortality post-release.[35–37] Given this context, we expect that our findings regarding the increased burden of opioid toxicity mortality for Indigenous people may be generalizable to Indigenous populations in other countries.

Experts with lived experience who participated in knowledge exchange for the current study attributed the higher risk of substance-use related death upon release to a lack of access to wraparound community-based services and release planning, and underscored the importance of varied options for supportive, culturally-based programming in custody and the community, and for strengthening social and community relationships. They acknowledged that while some addiction programs do exist in custody, they may not be accessible (particularly during the COVID-19 pandemic) and may not include Indigenous, culturally-based programming. They emphasized how substance use treatment and programming that is rooted in cultural teachings and practices—beyond a superficial level—can serve as an important support for people in custody, and that these supports should be available in custody and upon release.

We note that while the risks were highest in the month post-release, the fact that most people who died from opioid toxicity died after 30 days post-release (78%) reflects ongoing high levels of risk in this population and that while incarceration may contribute to increased risk in the immediate post-release period, the experience of incarceration likely serves both as a marker of risk as well as a risk factor for opioid toxicity death.

We also found that for people who experienced incarceration, while there was a higher absolute number of deaths among Indigenous males, opioid toxicity death rates were higher for Indigenous females than for Indigenous males. The very high opioid toxicity death rates for Indigenous females call attention to the gendered ways in which historical and ongoing settler colonial violence has been enacted in Canada. The National Inquiry into Missing and Murdered Indigenous Women and Girls identified several pathways that maintain this violence, including social and economic marginalization and inter-and multi-generational trauma,[38] which may require a focus on determinants of health such as housing, income, and racism in relation to the high rates of opioid toxicity deaths among Indigenous females upon release. Experts with lived experience who participated in knowledge exchange for this study described the need for culturally-safe Indigenous programming in custody that facilitates healing from trauma and loss of connection to culture. They associated the high rates of death for Indigenous females with the specific challenges they face when they are released with little connection to the community and few resources, financial or otherwise. Given that females who are mothers were also likely the primary caregivers of their children prior to incarceration, the experts highlighted the importance of substance use and healing programming that does not shame or stigmatize parents for drug use.

Our study has several strengths and limitations. We used whole population data for a six-year period. We used self-reported data on Indigenous identity, but there may be variation in how correctional staff collected data, and Indigenous people may not report their Indigenous identity on admission. Indigenous people may not identify with the term "Indigenous," which was formally adopted by the federal government of Canada within the last decade, may not know whether it is appropriate to claim Indigenous identity as a status or identity from a legal or social perspective, or may be concerned about discrimination.[39] The misclassification of people who are Indigenous as non-Indigenous would underestimate the absolute and relative burden of opioid toxicity death for people who are Indigenous who experienced incarceration, and would likely lead to mortality rates for the two exposed groups appearing more similar than they truly are. While our data linkage strategy employed best practices, we may have incorrectly linked some records and missed other linkages, and missed linkages may be more common in this population due to the use of aliases.[40] Given our use of correctional and coronial administrative data, we lack information on Indigenous-specific factors to understand upstream and downstream mechanisms of risk and opportunities to intervene in custody and in the community. Additional data would be valuable regarding access to treatment and harm reduction services, unmet health needs, and whether people participated in correctional programming or had a case management or release plan. In

addition, we did not access data on circumstances of death that may identify prevention opportunities such as polysubstance use (including alcohol), use of opioid alone, and use of naloxone. We also lack data on other causes of death, which would lead to overestimation of the total person-time at risk for people who experience incarceration, and contribute to conservative bias, i.e. lower absolute rates of opioid toxicity mortality and lower relative rates of relative opioid toxicity mortality, given higher mortality rates from causes other than opioids for people who experience incarceration. Due to small population sizes, especially for females, we recognize that some rates may be unstable, e.g. for specific age groups. In addition, we decided to not examine trends over time in these analyses due to considerations of power, and we acknowledge the increase in opioid toxicity mortality risk over the study period for people who experience incarceration.[19] As we did not have access to self-reported Indigenous identity data for people who did not experience incarceration and died from opioid toxicity, we were not able to compare data for Indigenous people who did and did not experience incarceration. However, given that the focus of this study is on describing the burden of opioid toxicity death in people who are Indigenous and experienced incarceration to support a focus on population health, rather than explaining the mechanisms of risk, the comparator group of people who did not experience incarceration remains valid to illustrate the substantial and inequitable burden of opioid toxicity mortality for Indigenous people who experience incarceration. Finally, we acknowledge the heterogeneity of the Indigenous and non-Indigenous groups in terms of identity and experiences of racialization and stigma for people in each group, and in terms of risks of opioid-related harms.

Our findings demonstrate the need for multi-level and multi-sectoral evidence-informed approaches to address the devastating—and preventable—impacts of the toxic drug supply crisis for Indigenous people who experience incarceration, including primary prevention, treatment, and harm reduction strategies.[41] At the population level, decriminalization and supporting access to alternatives to the unregulated street supply of drugs for people who use drugs through safer supply programs are important elements of a public health-informed response. In addition, and in recognition of the harms associated with incarceration, diversion from incarceration paired with access to comprehensive health and social services supports including Indigenous-led culturally-safe trauma and addictions recovery services are necessary responses at the community level.[38]

While methadone and buprenorphine/naloxone were available in provincial correctional facilities during the period under study,[41] challenges with care access and quality in custody and a lack of systematic processes to support continuity of treatment on release presented barriers to treatment. For Indigenous people who use drugs and have histories of incarceration, intersecting forms of marginalization present significant barriers to accessing care, including racism and discrimination in the health care and correctional systems as well as trauma resulting from historical and ongoing colonial violence.[42] Incorporating principles of Indigenous harm reduction into existing harm reduction programs through a holistic understanding of the impacts of colonialism holds the potential to facilitate more equitable and inclusive programming.[5] Echoing calls put forth by the National Inquiry into Missing and Murdered Indigenous Women and Girls and Truth and Reconciliation Commission, people experiencing incarceration need consistent access to Indigenous community- and peer-led harm reduction supports and mental health services both in custody and in community settings upon release. Engaging with Indigenous people who have lived experience of incarceration and drug use to inform the development, implementation and evaluation of such programs is critical to ensure the appropriateness of programs and services for the communities they intend to serve.

As the toxic drug supply crisis continues to lead to the preventable deaths of thousands of people in Canada each year and the number of Indigenous people in Canada's prison systems grows at an alarming rate,[43] our findings emphasise the urgent need for preventive, responsive, and comprehensive interventions across multiple levels. Undertaking these interventions requires a holistic approach that attends to the realities of Indigenous life and livelihood and recognizes that the imperative to address harms from drug use is intextricably linked with the imperative to meaningfully address the harms of colonialism. Additional collaborative work and qualitative research would be valuable to elucidate mechanisms of risk, identify effective and acceptable opportunities for intervention, and support the implementation of solutions.

Contributors

FGK and AB designed the study, and FGK acquired the data and was responsible for the decision to submit the manuscript for publication. RC did the statistical analysis, and RC and FGK accessed and verified the data. All authors had access to all the data in the manuscript, and contributed to interpretation of the data. TB, NO and FGK wrote the first draft of the report. All authors reviewed the draft critically for important intellectual content, approved the final version to be published, and had final responsibility for the decision to submit for publication.

Data sharing statement

Legal data sharing agreements prohibit the investigators from making the dataset publicly available (even if deidentified). The data that the authors linked are in the custody of the Ontario Ministry of the Solicitor General and the Office of the Chief Coroner of Ontario, and are subject to statutory confidentiality requirements. In order to access the linked dataset, any interested persons would need to obtain permission from the Ministry of the Solicitor General and from the Office of the Chief Coroner), and should contact the project Principal Investigator, Dr. Fiona Kouyoumdjian (kouyouf@mcmaster.ca) who could facilitate communication with the appropriate parties and the Hamilton

Integrated Research Ethics Board. The study protocol is also available by contacting the corresponding author.

Declaration of interests

We declare no competing interests.

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