

**Title:** High mortality over 12 years of follow up in people admitted to provincial custody in Ontario

**Authors:** Fiona G. Kouyoumdjian,<sup>1</sup> Lori Kiefer,<sup>2</sup> Wendy Wobeser,<sup>3</sup> Stephen W. Hwang<sup>1</sup>

**Institutional affiliations:** <sup>1</sup>Centre for Research on Inner City Health, St. Michael's Hospital, Toronto, Ontario, Canada, <sup>2</sup>Ontario Ministry of Community Safety and Correctional Services, Toronto, Ontario, Canada, <sup>3</sup>Faculty of Medicine, Queen's University, Kingston, Ontario

**Corresponding author:** Fiona G. Kouyoumdjian, kouyoumdjiaf@smh.ca

**Word count:** 2752

**Abstract word count:** 272

### **Abstract**

*Background:* Persons who experience incarceration have poor health. No study in Canada has examined mortality rates both in custody and after release.

*Methods:* We linked data on adults admitted to provincial custody in Ontario in 2000 with administrative data on deaths between 2000 and 2012. We examined rates and causes of mortality, and compared them to the general population using indirect adjustment for age.

*Results:* Of 49,470 persons, 97.4% were linked to health administrative data. In the follow up period, 8.6% of cohort members died at a mean age of 47.5 years. The crude mortality rate was 7.1 per 1,000 persons years. The standardized mortality ratio (SMR) was 4.0 (95% CI 3.9, 4.1) overall and 1.9 (95% CI 1.5, 2.4) in provincial custody. Most common causes of death were injury (38.2% of all deaths) including overdose (13.6%) and suicide and self-inflicted injury (8.2%), diseases of the circulatory system (15.8%) including ischemic heart disease (10.1%), and cancer (14.5%). In the month after release, the SMR was over 5 overall and 56.0 (95% CI 15.3, 143.4) for overdose. Life expectancy for cohort members was 7 and 9 years less than for the average Canadian man and woman.

*Interpretation:* The mortality rate in this cohort is very high. Efforts should be made to reduce the significant gap in mortality between people who experience incarceration and those who do not. Time in custody could serve as an opportunity to intervene to decrease risk and to link with programs and services in the community.

### **Background**

Worldwide, more than 11 million people are incarcerated at any given time,<sup>1</sup> and an estimated 30 million people move through the prison system annually.<sup>2</sup> In Canada, there are over 250,000 admissions to correctional facilities each year,<sup>3</sup> and about 40,000 people in correctional facilities on any given day.<sup>1</sup> This translates into an estimated 1 in 250 people who experience incarceration in Canada each year.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

International research reveals that people who experience incarceration have poor health compared with the general population, including higher rates of mental illness, substance use disorders, infectious diseases, and injury.<sup>4</sup> An emerging literature identifies ways to improve health in this population, both in custody and after release,<sup>5</sup> and empirical and theoretical evidence suggest that such interventions could benefit all of society, by decreasing health care costs,<sup>6</sup> improving health in the general population,<sup>6-11</sup> improving public safety,<sup>6</sup> and decreasing re-incarceration.<sup>6,12,13</sup>

In Canada, there is a lack of data on many indicators of health for people who experience incarceration.<sup>14</sup> Regarding mortality in particular, several reports have examined deaths in custody, and have noted high rates of death, including due to homicide, suicide, and overdose.<sup>15-20</sup> However, no study has looked at mortality after release, although the post-release period has been identified across international studies as very risky for death.<sup>21-36</sup>

We aimed to define mortality rates and causes of death in custody and after release in people who were admitted to provincial custody in Ontario in 2000, and to compare these data with data for the general population.

## Methods

*Cohort:* The provincial custody cohort was all persons admitted in 2000 to a provincial correctional facility for adults in Ontario, whether remanded (*i.e.* detained and not yet sentenced) or incarcerated (*i.e.* sentenced); in this paper we use the term incarcerated to represent both these groups. We obtained demographic data, health card numbers, and information on death while under supervision from the Ontario Ministry of Community Safety and Correctional Services (MCSCS).

*Data linkage:* These data were transferred to the Institute for Clinical and Evaluative Sciences (ICES), an independent, non-profit organization funded by the Ontario Ministry of Health and Long-Term Care. We linked eligible persons in the cohort to individuals in the Registered Persons Database (RPDB), which is a roster of all persons eligible for the Ontario Health Insurance Plan (OHIP). Through the RPDB, we accessed a unique encrypted health card number (IKN), which is used to identify individuals across health care databases. We used deterministic linkage for persons with a health card number provided by MCSCS, and probabilistic linkage for persons with no health card number provided by MCSCS.<sup>37</sup>

Data on mortality are from the Ontario Registrar General Death database. Cause of death was classified at ICES during the period of follow up using the International Classification of Diseases (ICD)-9.

*Outcome:* We accessed data on deaths from the time of first admission to provincial custody in 2000 until the end of 2012. We classified a person as having died in provincial custody if the reason for release from custody was death, or if the date of death provided by the MCSCS and in the RPDB was during the period in custody. We defined death while not in provincial custody as a death in the RPDB while the person was not in provincial custody or death in the MCSCS dataset while the person was under

community supervision, as long as the person had no admissions to custody after that date. No death was defined as no death recorded in either MCSCS or RPDB datasets, or no death in MCSCS and death in RPDB but in custody subsequent to date of death listed in the RPDB. We categorized cause of death into broad categories using ICD-9 Chapters, deaths due to specific preventable diseases of interest, and certain risk factors,<sup>38</sup> with specific ICD-9 and ICD-10 codes provided in Appendix A.

*Analyses:* We calculated person years of observation as the total years from the date of first admission to custody in 2000 to the end of 2012, or to the date of death in those who died during this period. We calculated crude mortality rates for demographic characteristics, while in custody, and for specific time periods after release. We used indirect standardization to adjust for age distribution in comparing mortality rates in this cohort with mortality rates for the Ontario population when available, or else for the Canadian population, using data for 2006 as the midpoint of the period of follow up, including by sex, cause, period after release, and whether in provincial custody. We used life tables<sup>39</sup> to calculate life expectancy. Analyses were conducted in SAS, Stata, and Excel.

*Study approval:* We obtained approval for the study from the Ontario Ministry for Community Safety and Correctional Services and the St. Michael's Hospital Research Ethics Board.

## Results

There were 49,470 persons admitted to provincial custody in Ontario in 2000. Of those, 40,593 were linked deterministically to 71,935 valid IKNs, and 8,071 were linked probabilistically to an IKN. There was overlap in persons and IKNs identified in the probabilistic and deterministic linkage, such that the total number of persons matched was 48,277 and there were 79,619 unique combinations of persons and IKNs. For 145 combinations of persons and IKNs, the sex in the IKN differed from the sex specified by the MCSCS, and these records were removed from the dataset leaving 48,229 persons. We excluded persons for whom the data suggested a linkage error, *i.e.* those with OHIP billings after the date of death (n=38), persons for whom the date of death in the RPDB was before January 1, 2000 (n=11), and those who were in custody after the date of death in the RPDB (n=14). This left 48,166 persons in the cohort, which is 97.4% of the initial sample. Of these, 44,849 had one IKN, 2,850 had two IKNs, 393 had three IKNs, 53 had four IKNs, 17 had five IKNs and 4 had six IKNs. A flow diagram of inclusion in the final sample is available as online Appendix B.

Characteristics of persons in the final cohort are shown in Table 1. More than 90% of cohort members were men (n=43,419), and the median age was 32 for men and 33 for women. Over 69% identified their race as White, 12% as Black, and 7% as Aboriginal. Almost 30% were in the lowest neighbourhood income quintile. One third had only one admission to provincial custody during the follow up period, one third had between two and four admissions, and one third had five or more admissions. Almost 11% of men and 5.6% of women were transferred to a federal facility at some point during the follow up period. Just over 18% spent less than one week in provincial custody over the follow up

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

period, while more than 29% spent between one week and three months and over 52% spent more than three months in provincial custody.

Confidential

Table 1. Characteristics and rates of death between 2000 and 2012 in persons admitted to provincial correctional facilities in Ontario in 2000

Characteristic		Men			Women		
		N (%of men)	person years (PYs)	mortality rate per 1,000 PYs	N (% of women)	person years (PYs)	mortality rate per 1,000 PYs
All		43,419 (100)	522,742.3	7.1	4,747 (100)	57,260.9	7.3
Age at baseline	15-19	4,054 (9.3)	50,046.6	2.6	411 (8.7)	5,095.6	1.8
	20-24	8,257 (19.0)	101,957.8	2.7	752 (15.8)	9,273.0	2.6
	25-29	6,349 (14.6)	77,710.5	4.0	684 (14.4)	8,389.9	4.2
	30-34	6,942 (16.0)	84,628.7	4.9	878 (18.5)	10,695.1	5.9
	35-39	6,936 (16.0)	83,512.4	7.2	901 (19.0)	10,734.8	9.0
	40-44	5,009 (11.5)	59,340.1	10.5	567 (11.9)	6,711.4	11.3
	45-49	2,805 (6.5)	32,486.1	14.4	306 (6.4)	3,521.9	16.5
	50-54	1,565 (3.6)	17,658.8	18.7	117 (2.5)	1,350.2	17.8
	55-59	771 (1.8)	8,274.2	28.5	74 (1.6)	851.3	17.6
	60-64	395 (0.9)	3,967.5	40.1	32 (0.7)	360.2	25.0
	65-69	206 (0.5)	1,965.9	50.4	21 (0.4)	231.8	25.9
	70-74	85 (0.2)	793.4	51.7	4 (0.1)	45.5	43.9
	75-79	37 (0.1)	331.2	54.3	0 (0.0)	-	-
	80-84	5 (0.0)	34.4	116.3	0 (0.0)	-	-
85-89	2 (0.0)	22.3	44.9	0 (0.0)	-	-	
90+	1 (0.0)	12.4	0.0	0 (0.0)	-	-	
Race	Aboriginal	3,005 (6.9)	35,972.0	8.4	460 (9.7)	5,468.6	9.0
	Black	5,374 (12.4)	66,137.4	3.1	596 (12.6)	7,367.3	2.0
	Declined to specify	47 (0.1)	583.4	1.7	3 (0.1)	37.0	0.0
	East Asian	545 (1.3)	6,682.8	3.7	35 (0.7)	435.2	0.0
	Hispanic	392 (0.9)	4,817.7	2.9	28 (0.6)	347.0	2.9
	Other	1,431 (3.3)	17,625.6	3.1	124 (2.6)	1,527.1	2.6

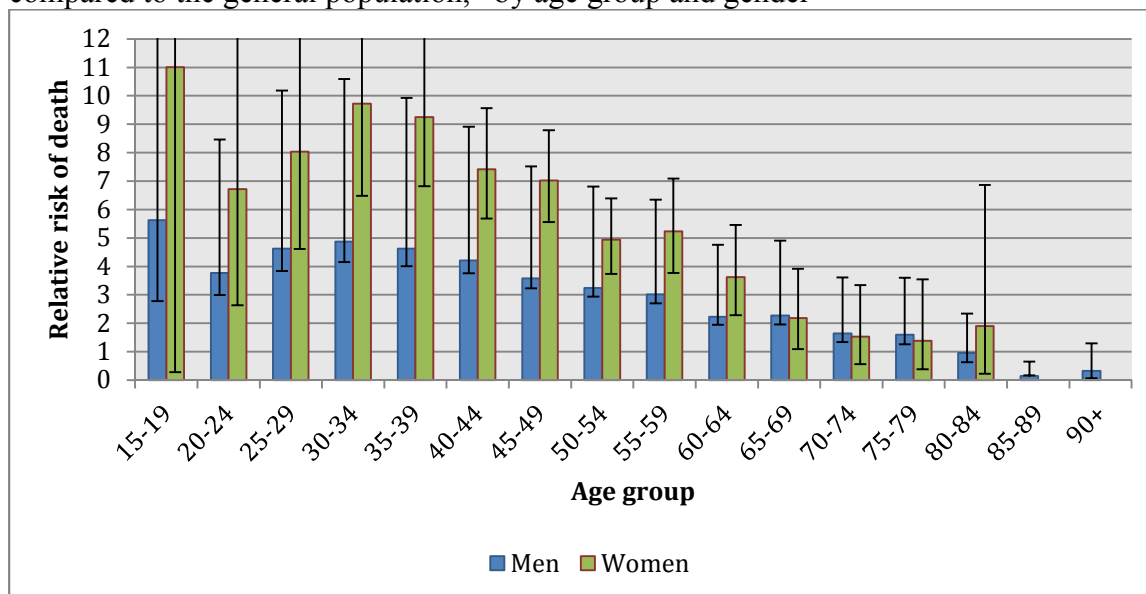
1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49

	South Asian	897 (2.1)	10,922.4	4.6	54 (1.1)	665.2	3.0
	South East Asian	725 (1.7)	8,872.6	4.2	70 (1.5)	877.1	1.1
	Unknown	454 (1.0)	5,470.4	5.3	72 (1.5)	869.1	9.2
	West Asian/Arab	572 (1.3)	7,100.6	2.3	26 (0.5)	324.3	0.0
	White	29,977 (69.0)	358,557.4	8.3	3,279 (69.1)	39,342.8	8.6
Neighbourhood income quintile	missing	7,862 (18.1)	96,907.8	3.3	910 (19.2)	11,200.8	3.9
	1	13,336 (30.7)	159,367.3	8.3	1,693 (35.7)	20,362.9	7.6
	2	8,381 (19.3)	100,458.6	7.9	858 (18.1)	10,302.9	8.7
	3	5,892 (13.6)	70,743.8	7.4	573 (12.1)	6,920.5	7.4
	4	4,674 (10.8)	56,102.0	7.8	393 (8.3)	4,698.7	8.7
	5	3,274 (7.5)	39,162.8	8.1	320 (6.7)	3,775.0	10.1
Admissions to provincial custody 2000-2012	1	14,238 (32.8)	169,333.2	7.8	1,885 (39.7)	22,714.8	5.9
	2-4	14,678 (33.8)	175,775.7	7.6	1,392 (29.3)	16,653.5	8.0
	5+	14,503 (33.4)	177,633.4	5.9	1,470 (31.0)	17,892.6	8.3
Transferred to federal facility 2000-2012	no	38,680 (89.1)	464,590.0	7.4	4,480 (94.4)	53,968.8	7.5
	yes	4,739 (10.9)	58,152.2	4.8	267 (5.6)	3,292.1	3.3
Total time in provincial custody 2000-2012	<1 week	8,006 (18.4)	95,893.8	6.5	1,358 (28.6)	16,406.6	5.4
	1 week- <1 month	5,676 (13.1)	67,742.7	7.8	863 (18.2)	10,251.7	8.5
	1 month- <3 months	6,971 (16.1)	82,747.9	8.6	787 (16.6)	9,436.5	8.5
	3 months- <6 months	6,072 (14.0)	72,872.6	7.6	628 (13.2)	7,479.5	10.0
	6 months- <1 year	6,132 (14.1)	73,685.2	7.9	534 (11.2)	6,514.6	7.8
	1 year- <2 years	5,384 (12.4)	65,483.8	6.8	395 (8.3)	4,895.8	5.5
	2 years- <3 years	2,445 (5.6)	30,188.5	4.9	114 (2.4)	1,430.7	4.9
≥3 years	2,733 (6.3)	34,127.7	3.5	68 (1.4)	845.4	3.5	

A total of 4126 people (8.6%) died during the follow up period from 2000 to 2012: 418 women (8.8%) and 3708 men (8.5%). The crude mortality rate was 7.1 per 1,000 persons years: 7.1 for men and 7.3 for women, and the mean age at death was 47.5 years. Seventy-four persons (0.2%) died in custody, for a crude mortality rate of 2.0 per 1,000 person years.

The risk of death was significantly higher for cohort members than for the general population in Ontario for men between age groups 15-19 and 75-79 and for women between age groups 20-24 and 65-69, as shown in Figure 1.

Figure 1. Relative risk of death in persons admitted to provincial custody in 2000 compared to the general population,\* by age group and gender



\*Death rates in provincial custody cohort between 2000 and 2012 and in Ontario population aged 15 and older in 2006. §95% confidence intervals shown with vertical lines.

Standardized to the Ontario age distribution, the mortality ratio (SMR) for cohort members was 4.0 (95% CI 3.9, 4.1) overall: 1.9 (95% CI 1.5, 2.4) in provincial custody and 4.1 (95% CI 3.9, 4.2) while not in provincial custody. The SMR was 3.2 (95% CI 3.1, 3.3) for men and 5.6 (95% CI 5.1, 6.2) for women.

Regarding causes of death, a qualitative examination of causes of deaths revealed a similar distribution of deaths by each cause for men and women. More than one third (n=1575) of deaths were due to injury and poisoning, including 13.6% due to overdose (n=563) and 8.2% due to suicide and self-inflicted injury (n=340), as shown in Table 2. More than one in seven deaths was caused by neoplasms (n=600), and over one in 10 by ischemic heart disease (n=416). Over 2% of deaths were from each of viral hepatitis (n=87) and HIV (n=96), respectively. In provincial custody, 18.9% of 74 deaths (n=14) were due to overdose, 24.3% (n=18) to suicide and self-inflicted injury, 13.5% (n=10) to

cardiovascular disease, 6.8% (n=5) had no known cause of death, and 8.1% (n=6) were attributed to symptoms, signs, and ill-defined conditions.

Compared to the population of Canada, the SMR was significantly elevated across almost all categories of disease, *i.e.* by ICD-9 Chapter (see Table 2). Regarding specific preventable causes of death, the SMR was greater than 8 for each of HIV and viral hepatitis. The SMR was not significantly increased for colorectal, breast or cervical cancer. The SMR was greater than two for all chronic diseases that we examined, *i.e.* for diabetes, epilepsy, cerebrovascular disease, hypertensive disease, and ischemic heart disease. Regarding types of injury, the SMR was 4.3 for suicide and self-inflicted injury, and very high for each of homicide: 14.8, legal intervention: 37.0, overdose: 20.3, and events of undetermined intent (*i.e.* events for which it is unclear whether they were accidentally or purposefully inflicted): 8.7.

Table 2. Observed and expected\* deaths between 2000 and 2012 for persons admitted to provincial correctional facilities in Ontario in 2000, by ICD-9 chapter and for selected preventable causes of death

Cause of death	observed deaths, n	expected deaths, n	SMR	95% CI	mean age at death
All deaths†	4126	1037	4.0	3.9, 4.1	47.5
Cause unknown	130	-	-	-	43.4
By ICD-9 chapter					
1. Infectious and parasitic diseases	224	30.2	7.4	6.5, 8.5	48.2
HIV	96	11.4	8.5	6.9, 10.3	43.3
sepsis	24	7.5	3.2	2.1, 4.8	56.3
viral hepatitis	87	6.4	13.5	10.8, 16.7	51.1
2. Neoplasms	600	380.3	1.6	1.5, 1.7	56.1
breast‡	7	7.5	0.9	0.4, 1.9	54.7
cervix‡	4	1.1	3.6	1.0, 9.3	41.0
colon, rectum and anus	37	35.9	1.0	0.7, 1.4	60.8
3. Endocrine, nutritional and metabolic diseases, and immunity disorders	120	39.2	3.1	2.5, 3.7	52.4
diabetes	90	27.3	3.3	2.7, 4.1	53.3
4. Diseases of the blood and blood-forming organs	2	3.9	0.5	0.1, 1.9	44.5
5. Mental disorders	174	20.5	8.5	7.3, 9.9	47.5
6. Diseases of the nervous system and sense organs	61	36.3	1.7	1.3, 2.2	49.2
epilepsy	19	3.7	5.2	3.1, 8.1	46.3
7. Diseases of the circulatory system	653	212.9	3.1	2.8, 3.3	54.3
cerebrovascular disease	80	32.1	2.5	2.0, 3.1	54.8
hypertensive disease	15	5.1	3.0	1.7, 4.9	52.1
ischemic heart disease	416	123.6	3.4	3.1, 3.7	55.7
8. Diseases of the respiratory system	135	46.5	2.9	2.4, 3.4	56.4



pneumonia	39	12.5	3.1	2.2, 4.3	55.1
9. Diseases of the digestive system	303	48.3	6.3	5.6, 7.0	51.5
10. Diseases of the genitourinary system	18	11.4	1.6	0.9, 2.5	57.7
12. Diseases of the skin and subcutaneous tissue	3	1.0	3.1	0.6, 9.0	59.3
13. Diseases of the musculoskeletal system and connective tissue	2	6.9	0.3	0.0, 1.1	62.5
14. Congenital anomalies	1	7.2	0.1	0, 0.8	50.0
16. Symptoms, signs, and ill-defined conditions	123	32.6	3.8	3.1, 4.5	43.0
17. Injury and poisoning	1575	226.4	7.0	6.6, 7.3	39.9
accidental falls	59	8.8	6.7	5.1, 8.7	50.2
events of undetermined intent	132	15.2	8.7	7.3, 10.3	40.5
excessive cold	11	1.3	8.6	4.3, 15.4	47.3
homicide	169	11.4	14.8	12.7, 17.2	33.2
legal intervention	10	0.3	37.0	17.8, 68.1	34.0
overdose	563	27.7	20.3	18.7, 22.1	41.4
suicide and self-inflicted injury	340	78.4	4.3	3.9, 4.8	39.4
By risk factor§					
alcohol-related diseases	243	6.1	40.0	35.2, 45.4	51.8
drug-related diseases	58	4.0	14.5	11.0, 18.7	42.5
smoking-related diseases	337	52.5	6.4	5.8, 7.1	57.9

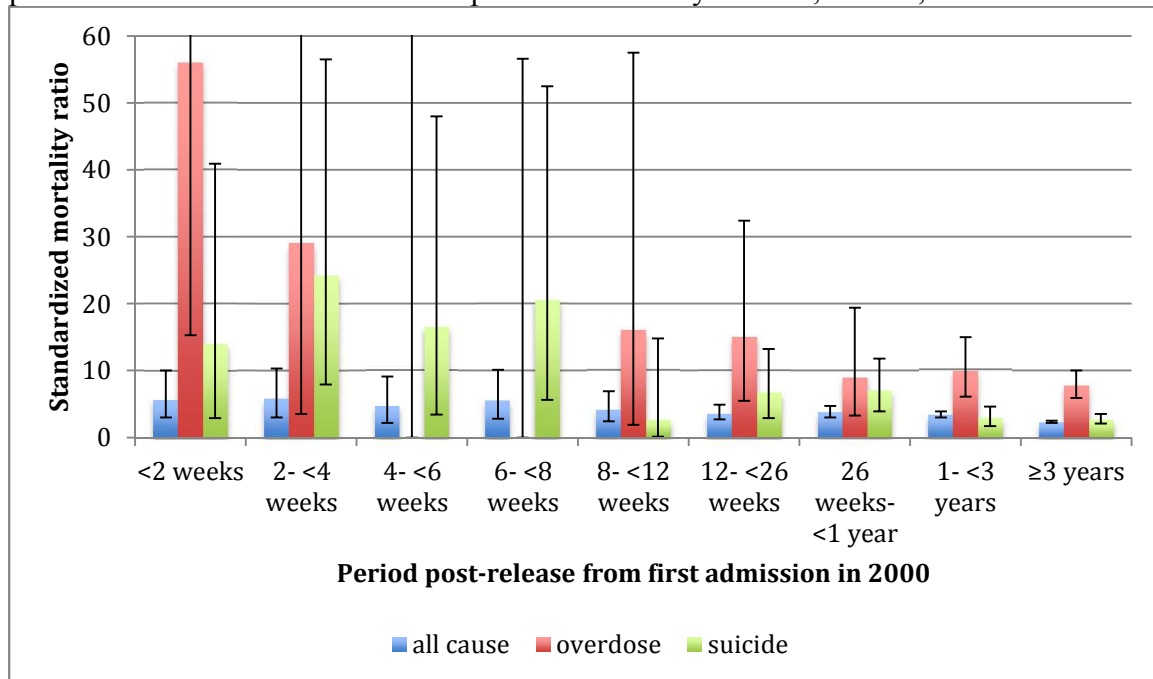
\*Expected rates are adjusted for age, and we used age groups of 5 years for persons 15 and older in Canada in 2006, unless otherwise specified. †Standardized to the Ontario population in 2006. ‡Includes women only. §These are diseases that are attributable in whole or in part to the risk factor as defined by Statistics Canada,<sup>38</sup> and these data include persons aged 25 and older only. ||For some strata, number of deaths was too low to report, *i.e.* <5, so we assumed the maximum number of 4 expected deaths to provide the most conservative estimate of the SMR.

Considering certain behavioural risk factors in persons 25 years old and older, the SMR was 40.0 for alcohol-related diseases, 14.5 for drug-related diseases, and 6.4 for deaths due to smoking-related diseases, as shown in Table 2.

Looking at deaths by time period subsequent to the first release from provincial custody, the crude mortality rate from all causes did not differ significantly over time. In contrast, for overdose and suicide, the rate was higher in the weeks after release than later in the post-release period, at 2.3 deaths due to overdose per 1,000 person years in the first two weeks after release compared to 0.4 per 1,000 after 26 weeks post-release, and 2.3 deaths per 1,000 due to suicide in the first four weeks post-release compared to 0.4 per 1,000 after 52 weeks post-release. As shown in Figure 2, the standardized mortality ratios decreased from the immediate post-release period to later periods post-release for deaths due to all causes, overdose, and suicide, respectively. The SMR for deaths in the first month post-release was over five, a large proportion of which is due to deaths from

overdose, with SMRs of 56.0 (95% CI 15.3, 143.4) in the first two weeks and 29.0 (95% CI 3.5, 104.8) between weeks two and four post-release, and deaths from suicide, with SMRs of 14.0 (95% CI 2.9, 40.9) in the first two weeks and 24.2 (95% CI 7.9, 56.5) in weeks two to four post-release.

Figure 2. Standardized mortality ratio for all causes, overdose, and suicide, by period post-release from first admission to provincial custody in 2000,\* N=46,442



\*Excludes 960 persons who were transferred to federal custody. †Standardized to the Canadian population in 2000. §95% confidence intervals shown with vertical lines.

Life expectancy contingent on survival to age 25 was 74 years for women and 71 years for men.

### Interpretation

This is the first Canadian study to examine long-term mortality in people who have experienced incarceration, and reveals a high death rate in this young cohort. Eight point six percent of persons died over the 12 year follow up period, with a crude rate of 7.1 deaths per 1,000 person years and a mean age at death of 47.5 years. The standardized mortality was four times higher for this cohort than for the general population, and almost twice as high while in custody. Many of the deaths are due to preventable and treatable causes, including 13.6% of deaths due to overdose, 10.1% to ischemic heart disease, and 8.2% to suicide and self-inflicted injury. The life expectancy of men and women in this cohort is about 7 and 9 years less than the life expectancy for the average Canadian man and woman.<sup>40</sup>

The high mortality rate in this cohort is consistent with the findings of recent studies from other countries.<sup>2,29,30</sup> In particular, many studies have identified that people who experience incarceration are at greater risk of overdose, especially in the weeks after

1  
2  
3 release,<sup>2,29,41</sup> suggesting a role for interventions including diversion programs for persons  
4 with addictions, training in overdose prevention and distribution of naloxone prior to  
5 release, access to opioid substitution therapies and drug treatment programs, and  
6 appropriate use of prescribed opioids.<sup>29,42</sup> Other studies have also noted high rates of  
7 death due to HIV and hepatitis C,<sup>29,30</sup> each of which caused 2% of deaths in this cohort.  
8 That notwithstanding, the increased risk of death due to almost all causes and behavioural  
9 risk factors (see Table 2) compared to the general population indicates that upstream and  
10 broad interventions are also needed for this population,<sup>5</sup> for example programs focused  
11 on behavioural factors such as smoking and alcohol use,<sup>43</sup> release planning and the  
12 provision of case management at the time of release,<sup>44</sup> and improving linkage with and  
13 access to primary care.<sup>45</sup> Recognizing that competing causes of death likely contribute to  
14 an underestimate of the risk of death for any specific cause examined, such interventions  
15 have the potential to narrow the large gap in mortality between persons who experience  
16 incarceration and the general population.  
17  
18  
19

20  
21 This study has several noteworthy strengths and limitations. This is the first Canadian  
22 study to define mortality rates after release, which is important to understanding the  
23 overall risk of mortality for this population and to defining windows of risk and  
24 opportunity. The cohort is large, which allowed us to identify causes of death that occur  
25 less frequently and are amenable to intervention, such as bloodborne infections.<sup>5</sup> Since  
26 almost all persons who are admitted to federal custody are first admitted to provincial  
27 custody in Canada, estimates of overall mortality rates (though not mortality rates post-  
28 release or in custody), include persons who were transferred to federal custody. The long  
29 period of follow up allows examination of rates of mortality by time in custody and over  
30 periods of time after release. We achieved a very high rate of linkage of data from the  
31 MCSCS with health administrative databases, with over 80% of cohort members linked  
32 deterministically using provincial health card numbers and 97.4% linked overall.  
33  
34  
35

36 Regarding limitations, there may have been errors in data linkage despite the use of a  
37 validated procedure for probabilistic linkage.<sup>37</sup> Linkage to data on persons who were not  
38 members of the cohort would likely underestimate the absolute and relative mortality in  
39 this cohort, assuming death rates are higher in cohort members. A significant number of  
40 persons in the MCSCS dataset had more than one OHIP number across admissions,  
41 contributing about 6.9% of the final sample having more than one IKN. This may be due  
42 to multiple aliases,<sup>46</sup> to losing identification or not having identification at the time of  
43 admission to custody, or to clerical errors in data entry at admission to custody. If aliases  
44 represent persons having multiple identities that are not shared with other persons, then  
45 inclusion of multiple IKNs would not affect outcome classification, whereas if aliases are  
46 identities that are shared with others, the inclusion of multiple IKNs could lead to an  
47 overestimate of deaths; we do not think this would significantly impact the results.  
48 Further, we did not capture deaths in cohort members that occurred outside of Ontario,  
49 which would likely lead to an underestimate of deaths in this cohort.<sup>2</sup> We did not  
50 ascertain the date of release from federal custody in persons who were transferred to  
51 federal facilities, and therefore we could not determine the total post-release mortality.  
52 Finally, we did not have data on health status, risk behaviours, or criminological history,  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 and these data would allow a more nuanced assessment of the distribution of risk across a  
4 heterogeneous population.  
5  
6

7 Though being in custody is a temporary state, it is conceivable that spending any time in  
8 custody may serve as a flag for a high risk of adverse health outcomes such as death. This  
9 perspective leads to two considerations: persons who have spent any time in custody  
10 should be recognized as being at high risk of death, and time in custody should be viewed  
11 an opportunity to identify risk and to intervene to mitigate risk. Though in Canada the  
12 median length of time in provincial or territorial custody is only days to weeks,<sup>3</sup> most  
13 people in this cohort spent more than three months in custody over the period of follow  
14 up; this large amount of time could be used to provide or link with programs and services  
15 to improve health.<sup>5</sup> We suggest a greater focus in Canada on defining health status and  
16 improving health in people who experience incarceration, with potential benefits for the  
17 whole population.<sup>6</sup>  
18  
19

20  
21 **Competing interests:** None  
22

### 23 **Acknowledgements:**

24 We are grateful to Kathy Underhill at the Ontario Ministry of Community Safety and  
25 Correctional Services for assembling the dataset, and to Alejandro Gonzalez and  
26 Alexander Kopp at the Institute for Clinical and Evaluative Sciences for data analyses.  
27  
28

29 This study was funded by a 2013 University of Toronto Postgraduate Research Award to  
30 Fiona Kouyoumdjian. It was also supported by the Centre for Research on Inner City  
31 Health (CRICH), which is part of the Li Ka Shing Knowledge Institute of St. Michael's  
32 Hospital. Fiona Kouyoumdjian receives salary support from a Canadian Institutes for  
33 Health Research Fellowship. The opinions, results, and conclusions are those of the  
34 authors and are independent from the funding and supporting agencies.  
35  
36

### 37 **References**

- 38  
39 1. Walmsley R. *World prison population list, 10th edition*. London: King's College  
40 London International Centre for Prison Studies;2013.  
41 2. Kinner SA, Forsyth S, Williams G. Systematic review of record linkage studies of  
42 mortality in ex-prisoners: why (good) methods matter. *Addiction*. 2013;108:38-  
43 49.  
44 3. Perrault S. Admissions to adult correctional services in Canada, 2011/2012. 2014;  
45 <http://www.statcan.gc.ca/pub/85-002-x/2014001/article/11918-eng.htm - a2>.  
46 Accessed December 14, 2014.  
47 4. Fazel S, Baillargeon J. The health of prisoners. *Lancet*. 2011;377:956-65.  
48 5. Kouyoumdjian F, McIsaac KE, Liauw J, Green S, Karachiwalla F, Siu W,  
49 Burkholder K, Binswanger I, Kiefer L, Kinner SA, Korchinski M, Matheson FI,  
50 Young P, Hwang SW A systematic review of randomized controlled trials of  
51 interventions to improve the health of persons during imprisonment and in the  
52 year after release. *American Journal of Public Health*. 2015;105:13-33.  
53 6. Kinner S, Wang EA. The case for improving the health of ex-prisoners. *American*  
54 *Journal of Public Health*. 2014;104:1352-5.  
55  
56  
57  
58  
59  
60

- 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16
  - 17
  - 18
  - 19
  - 20
  - 21
  - 22
  - 23
  - 24
  - 25
  - 26
  - 27
  - 28
  - 29
  - 30
  - 31
  - 32
  - 33
  - 34
  - 35
  - 36
  - 37
  - 38
  - 39
  - 40
  - 41
  - 42
  - 43
  - 44
  - 45
  - 46
  - 47
  - 48
  - 49
  - 50
  - 51
  - 52
  - 53
  - 54
  - 55
  - 56
  - 57
  - 58
  - 59
  - 60
7. Lee H, Wildeman C, Wang EA, Matusko N, Jackson JS. A heavy burden: the cardiovascular health consequences of having a family member incarcerated. *Am J Public Health*. 2014;104:421-7.
8. Wildeman C. Despair by association? The mental health of mothers with children by recently incarcerated fathers. *American Sociological Review*. 2012;77:216-43.
9. Green KE, Ensminger, M.E., Robertson, J.A., Juon, H.-S. Impact of adult sons' incarceration on African American mothers' psychological distress. *Journal of Marriage and Family*. 2006;68 430-41.
10. Wildeman C, Andersen SH, Lee H, Karlson KB. Parental incarceration and child mortality in Denmark. *Am J Public Health*. 2014;104:428-33.
11. Thomas JC, Torrone E. Incarceration as forced migration: effects on selected community health outcomes. *Am J Public Health*. 2006;96:1762-5.
12. Freudenberg N, Daniels J, Crum M, Perkins T, Richie BE. Coming home from jail: the social and health consequences of community reentry for women, male adolescents, and their families and communities. *Am J Public Health*. 2005;95:1725-36.
13. Fu JJ, Herme M, Wickersham JA, et al. Understanding the revolving door: individual and structural-level predictors of recidivism among individuals with HIV leaving jail. *AIDS and behavior*. 2013;17 Suppl 2:S145-55.
14. Kouyoumdjian FG, Schuler A, Hwang SW, Matheson FI. Research on the health of people who experience detention or incarceration in Canada: a scoping review. *BMC public health*. 2015;15:419.
15. Wobeser WL, Datema J, Bechard B, Ford P. Causes of death among people in custody in Ontario, 1990-1999. *CMAJ*. 2002;167:1109-13.
16. Gabor T. *Deaths in Custody*: Office of the Correctional Investigator;2007.
17. Office of the Correctional Investigator. Annual Report of the Office of the Correctional Investigator 2011-20122012.
18. British Columbia Coroners Service. Deaths of Inmates of Correctional Facilities in British Columbia, 2004-2011.
19. Sapers H. Annual Report of the Correctional Investigator: 2013-2014. 2014; <http://www.oci-bec.gc.ca/cnt/rpt/pdf/annrpt/annrpt20132014-eng.pdf>. Accessed November 25, 2014.
20. Antonowicz D, Winterdyk, J. A review of deaths in custody in three Canadian provinces. *Canadian Journal of Criminology and Criminal Justice*. 2014:85-103.
21. Pratt D, Piper M, Appleby L, Webb R, Shaw J. Suicide in recently released prisoners: a population-based cohort study. *Lancet*. 2006;368:119-23.
22. Binswanger IA, Stern MF, Deyo RA, et al. Release from prison--a high risk of death for former inmates. *N Engl J Med*. 2007;356:157-65.
23. Bird SM, Hutchinson SJ. Male drugs-related deaths in the fortnight after release from prison: Scotland, 1996-99. *Addiction*. 2003;98:185-90.
24. Verger P, Rotily M, Prudhomme J, Bird S. High mortality rates among inmates during the year following their discharge from a French prison. *J Forensic Sci*. 2003;48:614-6.
25. Harding-Pink D. Mortality following release from prison. *Med Sci Law*. 1990;30:12-6.

- 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16
  - 17
  - 18
  - 19
  - 20
  - 21
  - 22
  - 23
  - 24
  - 25
  - 26
  - 27
  - 28
  - 29
  - 30
  - 31
  - 32
  - 33
  - 34
  - 35
  - 36
  - 37
  - 38
  - 39
  - 40
  - 41
  - 42
  - 43
  - 44
  - 45
  - 46
  - 47
  - 48
  - 49
  - 50
  - 51
  - 52
  - 53
  - 54
  - 55
  - 56
  - 57
  - 58
  - 59
  - 60
26. Seymour A, Oliver JS, Black M. Drug-related deaths among recently released prisoners in the Strathclyde Region of Scotland. *J Forensic Sci.* 2000;45:649-54.
27. Krinsky CS, Lathrop SL, Brown P, Nolte KB. Drugs, detention, and death: a study of the mortality of recently released prisoners. *Am J Forensic Med Pathol.* 2009;30:6-9.
28. Farrell M, Marsden J. Acute risk of drug-related death among newly released prisoners in England and Wales. *Addiction.* 2008;103:251-5.
29. Binswanger IA, Blatchford PJ, Mueller SR, Stern MF. Mortality after prison release: opioid overdose and other causes of death, risk factors, and time trends from 1999 to 2009. *Annals of internal medicine.* 2013;159:592-600.
30. Spaulding AC, Seals RM, McCallum VA, Perez SD, Brzozowski AK, Steenland NK. Prisoner survival inside and outside of the institution: implications for health-care planning. *Am J Epidemiol.* 2011;173:479-87.
31. Rosen DL, Schoenbach VJ, Wohl DA. All-cause and cause-specific mortality among men released from state prison, 1980-2005. *Am J Public Health.* 2008;98:2278-84.
32. Kariminia A, Butler T, Corben S, et al. Extreme cause-specific mortality in a cohort of adult prisoners--1988 to 2002: a data-linkage study. *Int J Epidemiol.* 2007;36:310-6.
33. Joukamaa M. The mortality of released Finnish prisoners; a 7 year follow-up study of the WATTU project. *Forensic Sci Int.* 1998;96:11-9.
34. Stewart LM, Henderson CJ, Hobbs MS, Ridout SC, Knuiman MW. Risk of death in prisoners after release from jail. *Aust N Z J Public Health.* 2004;28:32-6.
35. Sailas ES, Feodoroff B, Lindberg NC, Virkkunen ME, Sund R, Wahlbeck K. The mortality of young offenders sentenced to prison and its association with psychiatric disorders: a register study. *Eur J Public Health.* 2006;16:193-7.
36. Chen CY, Wu PN, Su LW, Chou YJ, Lin KM. Three-year mortality and predictors after release: a longitudinal study of the first-time drug offenders in Taiwan. *Addiction.* 2010;105:920-7.
37. Chong N. IARC Technical Reports No. 32: Automated Data Collection in Cancer Registration: Computerized record linkage in cancer registries. In: International Agency for Research on Cancer, ed. Lyon, France: World Health Organization,; 1998.
38. Statistics Canada. Appendix Table B. ICD-9 and ICD-10 codes for causes of death. 2013; <http://www.statcan.gc.ca/pub/82-003-x/2013007/article/11852/tbl/appb-eng.htm>. Accessed June 24, 2015.
39. Rowland DT. *Demographic methods and concepts*. New York: Oxford University Press; 2003.
40. Statistics Canada. Table 109-5401. Life expectancy at various ages, by population group and sex, Canada, occasional (years), CANSIM2011.
41. Madadi P, Hildebrandt D, Lauwers AE, Koren G. Characteristics of opioid-users whose death was related to opioid-toxicity: a population-based study in Ontario, Canada. *PloS one.* 2013;8:e60600.
42. Strang J, Bird SM, Parmar MK. Take-home emergency naloxone to prevent heroin overdose deaths after prison release: rationale and practicalities for the N-

- 1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60
- ALIVE randomized trial. *Journal of urban health : bulletin of the New York Academy of Medicine*. 2013;90:983-96.
43. Clarke JG, Stein LAR, Martin RA, et al. Forced smoking abstinence: Not enough for smoking cessation. *JAMA Internal Medicine*. 2013;173:789-94.
44. Kinner SA, Lennox N, Williams GM, et al. Randomised controlled trial of a service brokerage intervention for ex-prisoners in Australia. *Contemporary clinical trials*. 2013;36:198-206.
45. Wang EA, Hong CS, Shavit S, Sanders R, Kessell E, Kushel MB. Engaging individuals recently released from prison into primary care: A randomized trial. *American Journal of Public Health*. 2012;102:e22-e9.
46. Martin RE, Hislop TG, Grams GD, Moravan V, Calam B. Beware of multiple names in database linkage research: prevalence of aliases in female prison population. *BMJ*. 2005;331:335-6.

Confidential

## Appendix A. Categorization of causes of death in ICD-9 and ICD-10

Cause of death by ICD-9 chapter	ICD-9	ICD-10
1. Infectious and parasitic diseases	001-139	A00-B99
HIV	42	B20-B24
sepsis	38	A40-A41
viral hepatitis	70	B15-B19
2. Neoplasms	140-239	C00-C97
breast*	174	C50
cervix*	180	C53
colon, rectum and anus	153-154	C18-C21
3. Endocrine, nutritional and metabolic diseases, and immunity disorders	240-279	E00-E90
diabetes	250	E10-E14
4. Diseases of the blood and blood-forming organs	280-289	D50-D89
5. Mental disorders	290-319	F00-F99
6. Diseases of the nervous system and sense organs	320-389	G00-G99
epilepsy	345	G40
7. Diseases of the circulatory system	390-459	I00-I99
cerebrovascular disease	430-438	I60-I69
hypertensive disease	401-405	I10-I15
ischemic heart disease	410-414	I20-I25
8. Diseases of the respiratory system	460-519	J00-J99
pneumonia	480-486	J11.0, J12-J16, J18
9. Diseases of the digestive system	520-579	K00-K93
10. Diseases of the genitourinary system	580-629	N00-N99
12. Diseases of the skin and subcutaneous tissue	680-709	L00-L99
13. Diseases of the musculoskeletal system and connective tissue	710-739	M00-M99
14. Congenital anomalies	740-759	Q00-Q99
16. Symptoms, signs, and ill-defined conditions	780-799	R00-R99
17. Injury and poisoning	E800-E999	V01-Y89
accidental falls	E880-E888	W00-W19
events of undetermined intent	E980-E999	Y10-Y34
excessive cold	E901	X31
homicide	E960-E969	X85-Y09
legal intervention	E970-E978	Y35
overdose	E8500-E8629	X40-X49
suicide and self-inflicted injury	E950-E959	X60-X84
By risk factor <sup>1</sup>		
alcohol-related diseases	291, 303, 305.0, 425.5,	F10, I426, K70, K85,

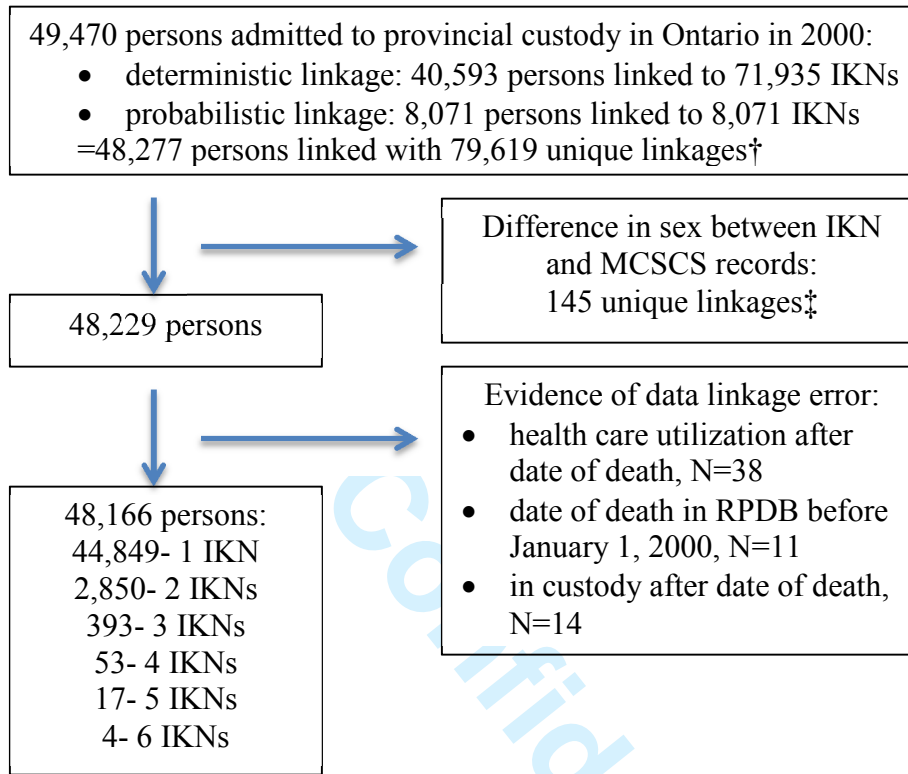


	571.0-571.3, 577.0-577.1, 860	K86.0, X45
drug-related diseases	292, 304, 305.2-305.9, 850-858, 950.0-950.5, 980.0, 980.5, 962.0	F11-F16, F18, F19, X40-X44, X60-X64 X85, Y10-Y14
smoking-related diseases	140-150, 161- 163, 165, 490- 494, 496	C00-C15, C30- C34, C39, J40- J44, J47

\*in women

Confidential

Appendix B. Flow diagram of inclusion in final sample of persons admitted to provincial custody in Ontario in 2000\*



\*IKN is a unique encrypted health card number. MCSCS is the Ontario Ministry of Community Safety and Correctional Services. †Number of persons and number of IKNs do not sum because of overlap in persons and IKNs from deterministic and probabilistic linkage. ‡This number represents the number of combinations of persons and IKNs.

### References

1. Statistics Canada. Appendix Table B. ICD-9 and ICD-10 codes for causes of death. 2013 [cited 2015 June 24]; Available from: <http://www.statcan.gc.ca/pub/82-003-x/2013007/article/11852/tbl/appb-eng.htm>