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# Mortality and morbidity related to fire, burns and carbon monoxide poisoning among First Nations people, Métis and Inuit: Findings from the 2011 Canadian Census Health and Environment Cohort



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## Correction notice

The report was updated on March 25, 2021 to replace estimates for the non-Indigenous population in Figure 8. The previous version of the figure incorrectly contained total population estimates instead of the non-Indigenous estimates.



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# **Mortality and morbidity related to fire, burns and carbon monoxide poisoning among First Nations people, Métis and Inuit: Findings from the 2011 Canadian Census Health and Environment Cohort**

Mohan B. Kumar, Centre for Indigenous Statistics and Partnerships, Statistics Canada

## Acknowledgments

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## Overview of the study

Fire-related mortality and morbidity has previously been demonstrated to be significantly higher among Indigenous people in Canada. However, several gaps in literature remain. This report examines age-standardized mortality and hospitalization rates relating to fire, burns and carbon monoxide poisoning among First Nations people, Métis and Inuit and compares it to rates among non-Indigenous people, living in private households.

- The fire-related mortality rate was 1.6, 0.6 and 5.3 deaths per 100,000 person-years at risk among First Nations people, Métis and Inuit, respectively. In comparison, it was 0.3 among non-Indigenous people.
- The hospitalization rate from injuries associated with fires was 7.5, 2.8 and 8.8 hospitalizations per 100,000 person-years at risk. The rate among non-Indigenous people was 1.7.
- The mortality rate for burns was 1.0 death per 100,000 person-years at risk among First Nations people and 0.2 among non-Indigenous people.
- The hospitalization rate for burns was 13.9, 5.0, 13.5 hospitalizations per 100,000 person-years at risk. The rate among non-Indigenous people was 4.3.
- CO mortality rate was 0.5 deaths per 100,000 person-years at risk among First Nations people, 0.7 among Métis and 0.6 among non-Indigenous people.
- The study indicates that disparities continue to exist among First Nations people, Métis and Inuit and non-Indigenous people. Contributing factors, which are not examined in the study, such as inadequate housing, lack of smoke detectors, underfunding for fire services on Indigenous communities, poverty, lack of legislation mandating adherence to building and fire codes on reserve need to be considered in interpreting the disparities in mortality and morbidity.

## Introduction

Fire-related mortality has previously been shown to be significantly higher among First Nations people than among non-Indigenous people.<sup>1</sup> For example, the fire-related mortality rate among Registered Indians in British Columbia was nine times higher than among the general British Columbia population. This was observed consistently from year to year between 1991 and 2001. The rates in this population were particularly high among children and seniors aged 65 years and older.

Between 2007 and 2011, among all Indigenous people in British Columbia, the rate of residential fire mortality was four times higher than among non-Indigenous people.<sup>2</sup> Moreover, Indigenous people who died from fires were 20 years younger than non-Indigenous people, and four in ten of them died in fires on First Nations reserves. Across Canada, the mortality rate from fires in First Nations communities was estimated to be 10.4 times that of the Canada-wide rate.<sup>3</sup>

Fire-related morbidity, as measured by the rate of acute-care hospitalization from injuries relating to burns, has been shown to be higher in areas with high percentage of First Nations people and Métis compared with areas with low percentage of Indigenous people.<sup>4,5</sup> Among children under ten years old, the rate of hospitalization from fire was higher in areas with high percentage of First Nations people and Métis.<sup>3,5</sup> The rates were also elevated among youth (10-19 years) in areas with higher percentage of First Nations people. Similarly, higher rates were observed among adult men and women in areas of high proportions of First Nations people, Métis and Inuit.<sup>4</sup> However, because these studies used an ecological approach, results may not be representative of First Nations people, Métis and Inuit living across Canada.<sup>4</sup>

Many factors contribute to the higher fire-related mortality among Indigenous people. These include inadequate housing, housing without smoke detectors, underfunding for fire services in Indigenous communities resulting in lack of fire halls and inadequate firefighting equipment as well as lack of legislation to require adherence to building and fire codes on reserve.<sup>6,7</sup> First Nations people living on reserve and Inuit living in Inuit Nunangat are more likely to live in houses in need of major repairs.<sup>8</sup> Higher incidence of poverty can also be linked to higher risk of fire-related casualty among Indigenous people.<sup>9</sup> Contextual analysis of fire-related deaths among Status Indians in British Columbia suggested an association with alcohol consumption, lit cigarettes or use of electric heaters near flammable materials, use of faulty electric heaters, unattended cooking oil on stoves, etc.<sup>1</sup>

Development of programs to enhance availability and use of smoke alarms, home safety checks, school programs, training of local fire fighters,<sup>10</sup> adequate funding for fire services, adoption of national building and fire codes on reserves and legislation enforcing the national fire code, and creation of a national First Nations fire marshal's office<sup>11</sup> have been recommended to address the higher rates of fire-related mortality and morbidity.

While previous studies have investigated fire-related mortality and morbidity among Indigenous people, several information gaps remain. There is a lack of estimates relating to Métis and Inuit. Furthermore, many previous studies have focussed on one or few jurisdictions. As a result, few national-level estimates are available for First Nations people, Métis and Inuit. Beyond this, there is a lack of statistics around carbon monoxide (CO) poisoning among First Nations people, Métis and Inuit.

The aim of this study is to generate mortality and morbidity rates relating to fires, burns and CO poisonings among First Nations people, Métis and Inuit and compare these estimates to those among non-Indigenous people in Canada. The study also examines variations in rates by sex, age group, province and territory where possible. The study uses the 2011 Canadian Census Health and Environment Cohort (CanCHEC) database, a

unique population-based linked dataset that follows the household population enumerated in the 2011 National Household Survey (NHS) for different health outcomes such as mortality, cancer, and hospitalizations between 2011 and 2018.

The section *Data sources and methodology*, at the end of the report, includes detailed information on the data source, study cohorts and variables. It also presents and discusses important limitations which should be considered when interpreting the findings.

## Results

### Mortality rates relating to fires, burns and carbon monoxide poisoning among First Nations people, Métis and Inuit

The age-standardized fire-related mortality rate was significantly higher<sup>a</sup> among First Nations people and Inuit than among non-Indigenous people living in private dwellings in Canada. The rate was 1.6 deaths per 100,000 person-years at risk among First Nations people, while the corresponding figure was 5.3 among Inuit (figure 1). In comparison, the rate was 0.3 among non-Indigenous people. Although the mortality rate estimate among Métis (0.6) was higher than the non-Indigenous rate, they were not statistically significantly different from one another.

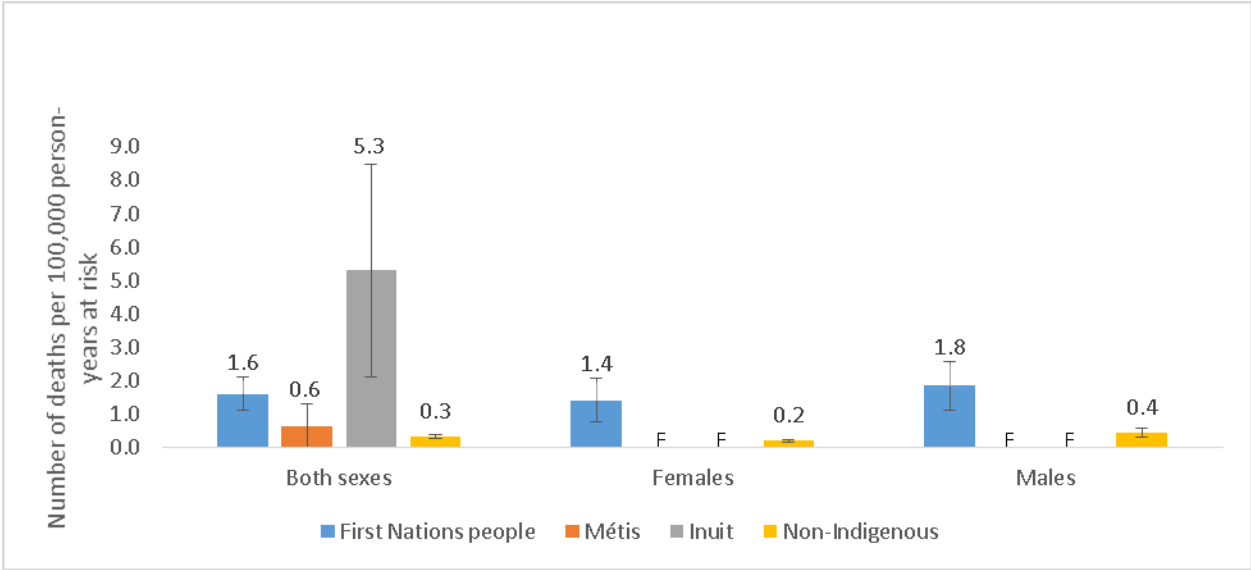
The rate ratio (RR) was 5.2 for First Nations people indicating that the mortality rate from all fires was five times higher in this population compared with the non-Indigenous population. Among Inuit, the rate ratio was 17.3. Mortality rates were relatively similar for First Nations males and females. Estimates for Métis and Inuit males and females were too unreliable to be published.

Given the rarity of fire-related deaths and the relatively small Indigenous populations, the rates presented in this report are based on small number of deaths, resulting in large confidence intervals (displayed as error bars on each column of the figures) for First Nations people, Métis and Inuit. These larger confidence intervals limit some comparisons between population groups.

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<sup>a</sup> Statistically significant differences in rates were identified using 95% confidence intervals.

**Figure 1. Age-standardized fire-related mortality rates (ASMR or number of deaths per 100,000 person-years at risk) among First Nations people, Métis, Inuit and non-Indigenous people, by sex, household population aged 1 year or older, Canada, 2011-2018**



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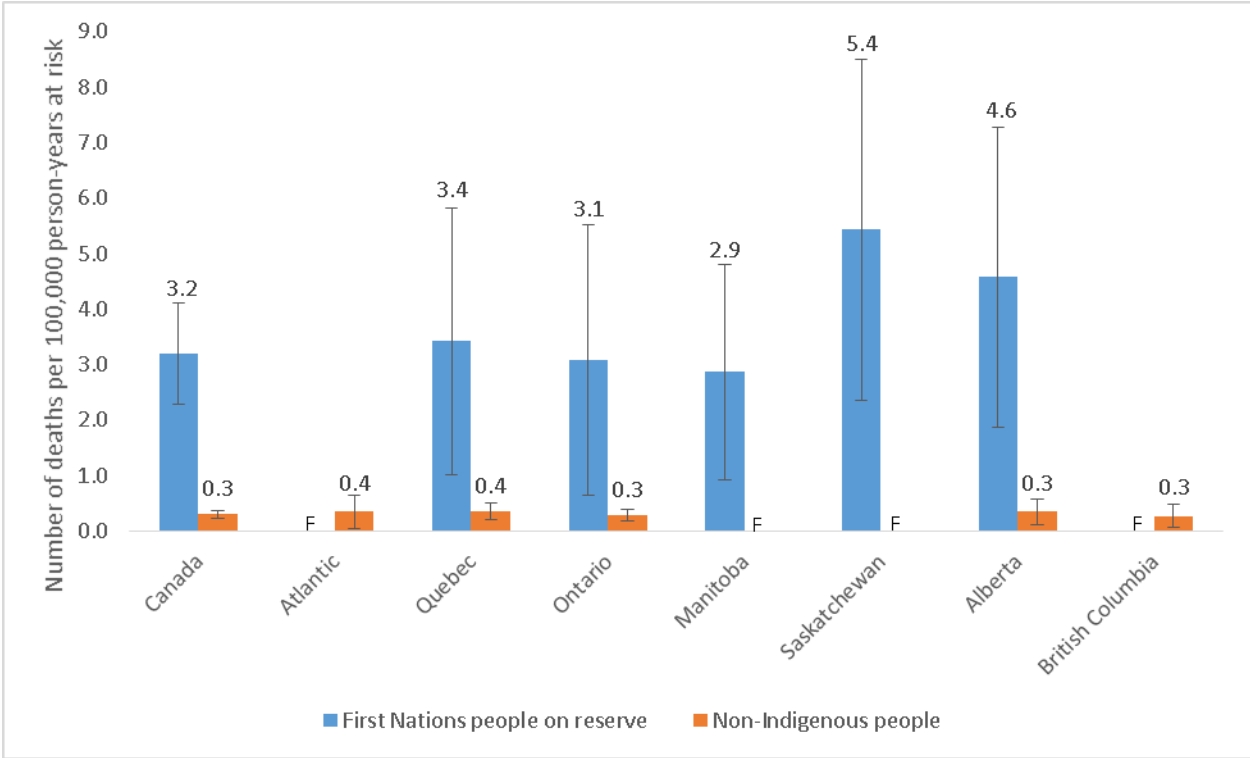
Notes: 7.6 years of follow-up period: May 10, 2011 to December 31, 2018

Excluded from data: institutional population at time of census collection (e.g. nursing homes, jails), population living in collective households (e.g. motels, hotels, rooming houses), persons not enumerated by the 2011 National Household Survey.

Source: Statistics Canada, 2011 Canadian Census Health and Environment Cohort integrating the 2011 National Household Survey with Canadian Vital Statistics Database (2011-2018).

For Canada as a whole, the age-standardized fire-related mortality rate among First Nations people living on reserve was 3.2 deaths per 100,000 person-years at risk, over 10 times higher (RR=10.5) than the rate among non-Indigenous people in Canada (figure 2). Fire-related mortality rate among First Nations people was five times higher on reserve than off reserve (0.6). Although rates in First Nations reserves varied by province, differences were not statistically significant.

**Figure 2. Age-standardized fire-related mortality rates (ASMR or number of deaths per 100,000 person-years at risk) among First Nations people living on reserve and non-Indigenous people, by province, household population aged 1 year or older, Canada, 2011-2018**



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Notes: 7.6 years of follow-up period: May 10, 2011 to December 31, 2018

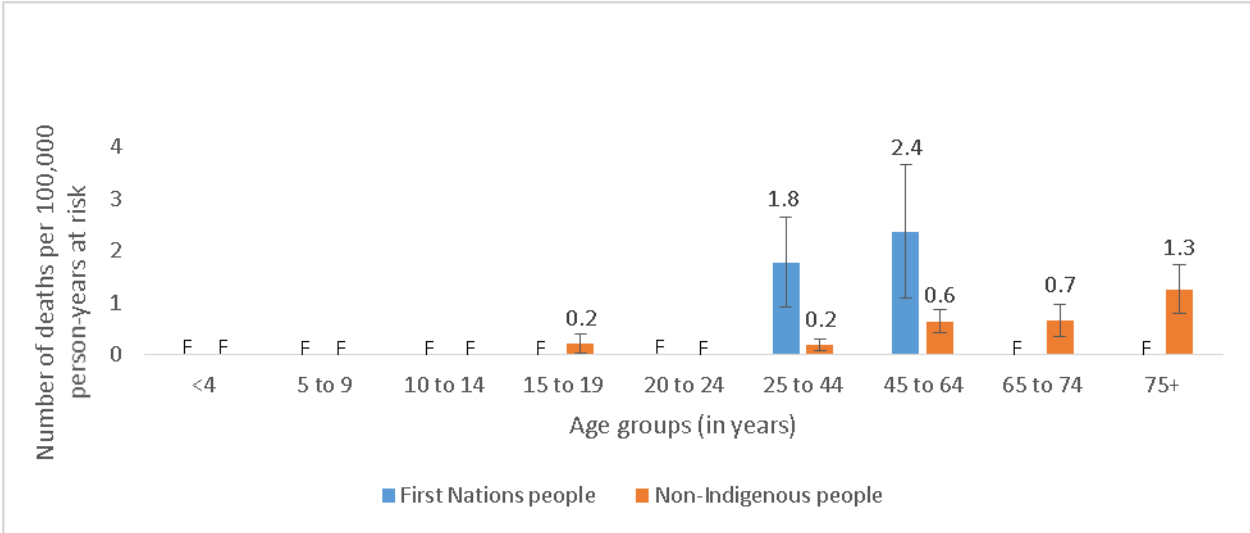
Excluded from data: institutional population at time of census collection (e.g. nursing homes, jails), population living in collective households (e.g. motels, hotels, rooming houses), persons not enumerated by the 2011 National Household Survey.

Source: Statistics Canada, 2011 Canadian Census Health and Environment Cohort integrating the 2011 National Household Survey with Canadian Vital Statistics Database (2011-2018).

Due to sample size limitations, age-specific mortality rates could only be compared for First Nations and non-Indigenous people and for two age groups. In each of these age groups, rates among First Nations people were significantly higher than among non-Indigenous people. Among adults aged 25 to 44, the rates were 1.8 and 0.2 for First Nations and non-Indigenous people, respectively. The corresponding rates among adults aged 45 to 64 were 2.4 and 0.6 (figure 3).

These results indicate that the fire-related mortality rate among First Nations was nearly ten times higher than among non-Indigenous people (RR=9.7) in the younger age group and nearly four times higher (RR=3.7) in the older age group.

**Figure 3. Age-specific fire-related mortality rates (number of deaths per 100,000 person-years at risk) among First Nations people and non-Indigenous people, by province, household population aged 1 year or older, Canada, 2011-2018**



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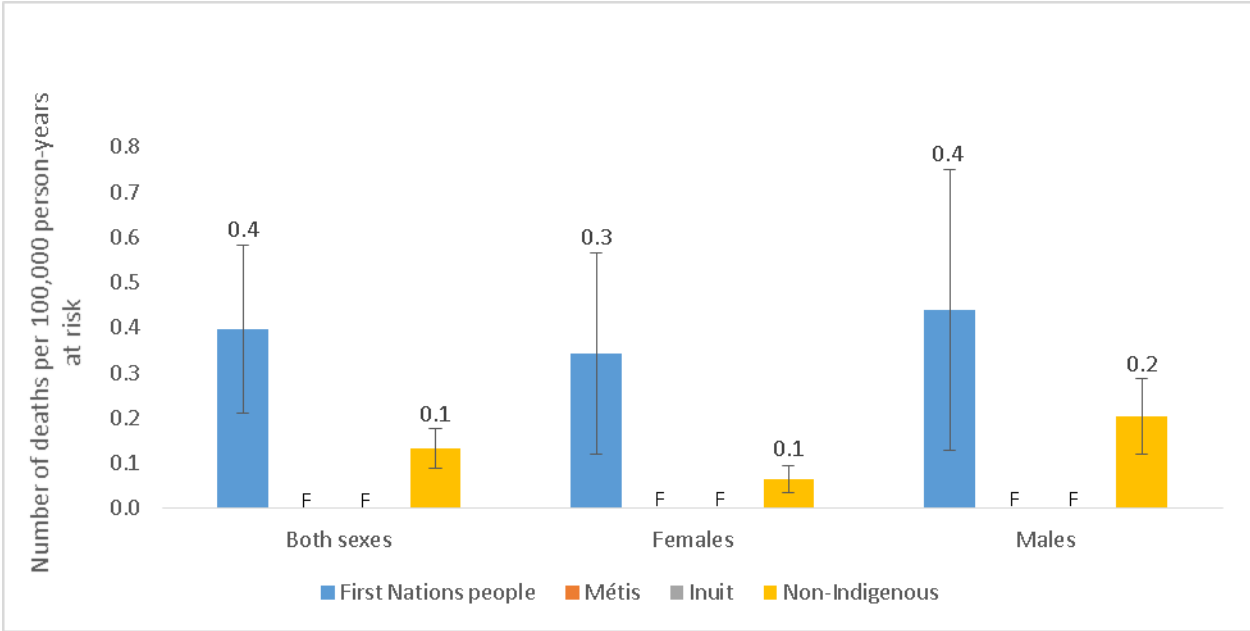
Notes: 7.6 years of follow-up period: May 10, 2011 to December 31, 2018

Excluded from data: institutional population at time of census collection (e.g. nursing homes, jails), population living in collective households (e.g. motels, hotels, rooming houses), persons not enumerated by the 2011 National Household Survey.

Source: Statistics Canada, 2011 Canadian Census Health and Environment Cohort integrating the 2011 National Household Survey with Canadian Vital Statistics Database (2011-2018).

While building or structural fires are a major source of fire-related deaths, other fires including ignition of highly flammable material, forest fires, camp fires, intentional self-harm, assault and undetermined intent can also cause deaths.<sup>12</sup> Among First Nations people, the age-standardized mortality rate related to these other fires (0.4 deaths per 100,000 person-years at risk) (figure 4) was lower than the corresponding mortality rate related to building or structural fires (1.2 deaths per 100,000 person-years at risk).

**Figure 4. Age-standardized other fires\*-related mortality rates (ASMR or number of deaths per 100,000 person-years at risk) among First Nations people, Métis, Inuit and non-Indigenous people, by sex, household population aged 1 year or older, Canada, 2011-2018**



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\* Other fires include ignition of highly flammable material, forest fires, camp fires, intentional self-harm, assault, undetermined intent, etc.

Notes: 7.6 years of follow-up period: May 10, 2011 to December 31, 2018

Excluded from data: institutional population at time of census collection (e.g. nursing homes, jails), population living in collective households (e.g. motels, hotels, rooming houses), persons not enumerated by the 2011 National Household Survey.

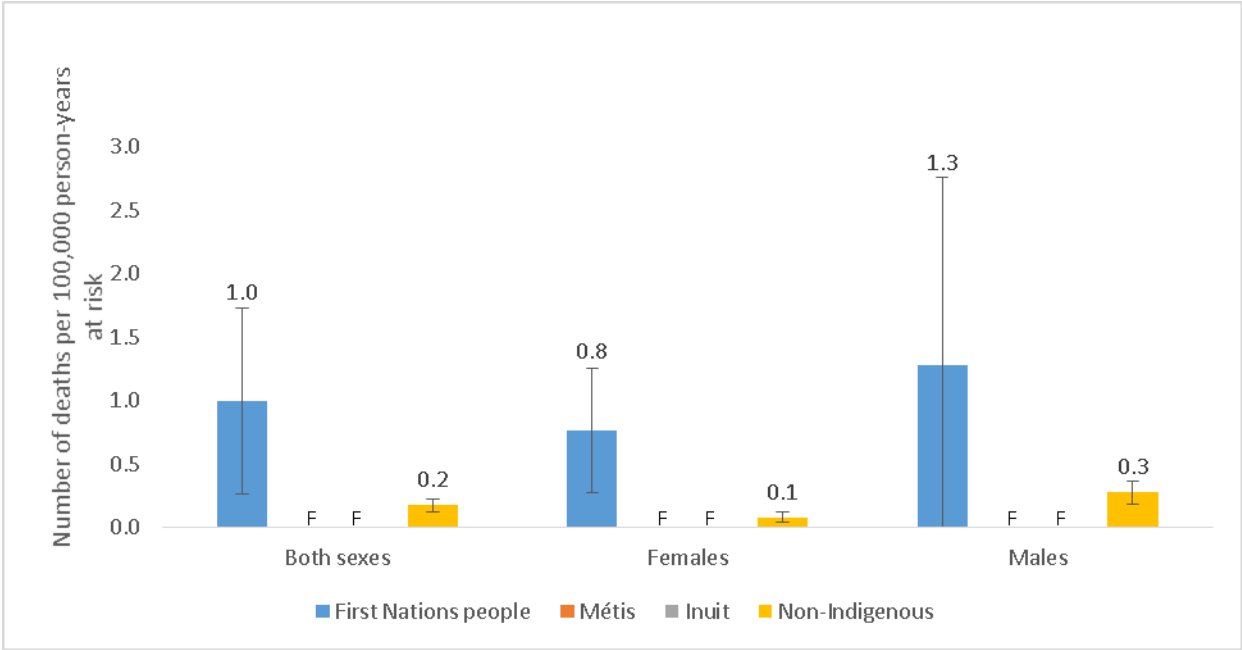
Source: Statistics Canada, 2011 Canadian Census Health and Environment Cohort integrating the 2011 National Household Survey with Canadian Vital Statistics Database (2011-2018).

**Mortality from burns and fire-related burns**

While burns are not the leading cause of death, they are a contributing factor in many fire-related deaths.<sup>13</sup> The age-standardized mortality rate for fire-related deaths where burns were a contributing factor was 0.6 deaths per 100,000 person-years at risk among First Nations people, more than six times higher than the corresponding rate among non-Indigenous people (0.1; RR=6.3). Similar disparities were observed for all burns, not just those involving fires (1.0 versus 0.2, respectively; figure 5). Because of sample size limitations, estimates for Métis and Inuit were considered too unreliable to be published.



**Figure 5. Age-standardized burns-related mortality rates (ASMR or number of deaths per 100,000 person-years at risk) among First Nations people, Métis, Inuit and non-Indigenous people, by sex, household population aged 1 year or older, Canada, 2011-2018**



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Notes: 7.6 years of follow-up period: May 10, 2011 to December 31, 2018

Excluded from data: institutional population at time of census collection (e.g. nursing homes, jails), population living in collective households (e.g. motels, hotels, rooming houses), persons not enumerated by the 2011 National Household Survey.

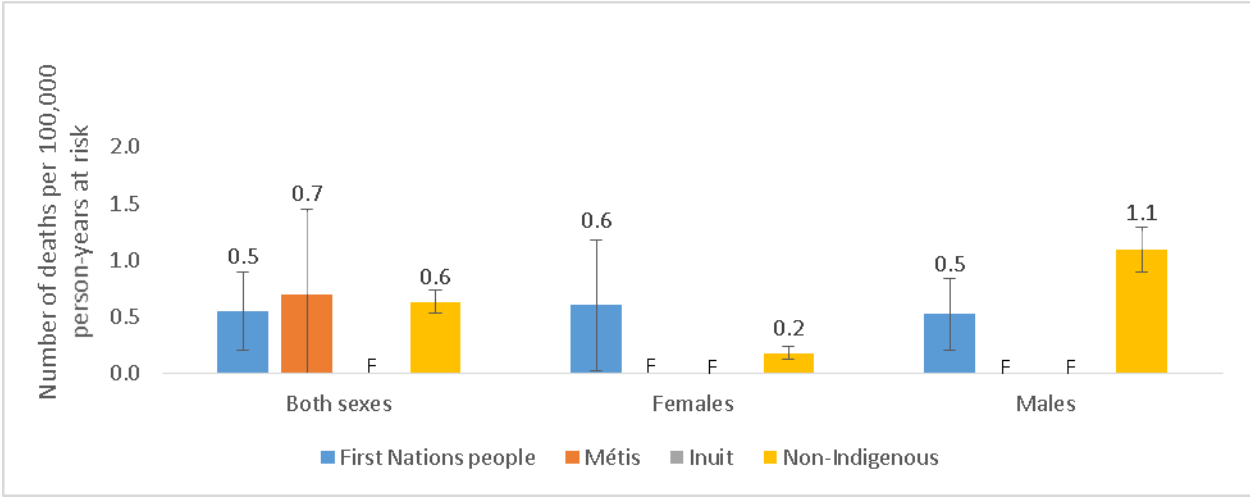
Source: Statistics Canada, 2011 Canadian Census Health and Environment Cohort integrating the 2011 National Household Survey with Canadian Vital Statistics Database (2011-2018).

The mortality rate for deaths from all burns among First Nations people living on reserve was 1.5 deaths per 100,000 person-years at risk. In Saskatchewan, where a publishable estimate was available, the rate was 2.8.

**Mortality from carbon monoxide poisoning**

Carbon monoxide (CO) poisoning results in more than 200 deaths per year in Canada.<sup>14</sup> CO poisoning mortality rates were not significantly different between First Nations people (0.5), Métis (0.7) and non-Indigenous people (0.6) (figure 6). The small number of deaths from CO poisoning prevented analysis by age group and examination of rates among First Nations people living on reserve.

**Figure 6. Age-standardized carbon monoxide poisoning-related mortality rates (ASMR or number of deaths per 100,000 person-years at risk) among First Nations people, Métis, Inuit and non-Indigenous people, by sex, household population aged 1 year or older, Canada, 2011-2018**



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Notes: 7.6 years of follow-up period: May 10, 2011 to December 31, 2018

Excluded from data: institutional population at time of census collection (e.g. nursing homes, jails), population living in collective households (e.g. motels, hotels, rooming houses), persons not enumerated by the 2011 National Household Survey.

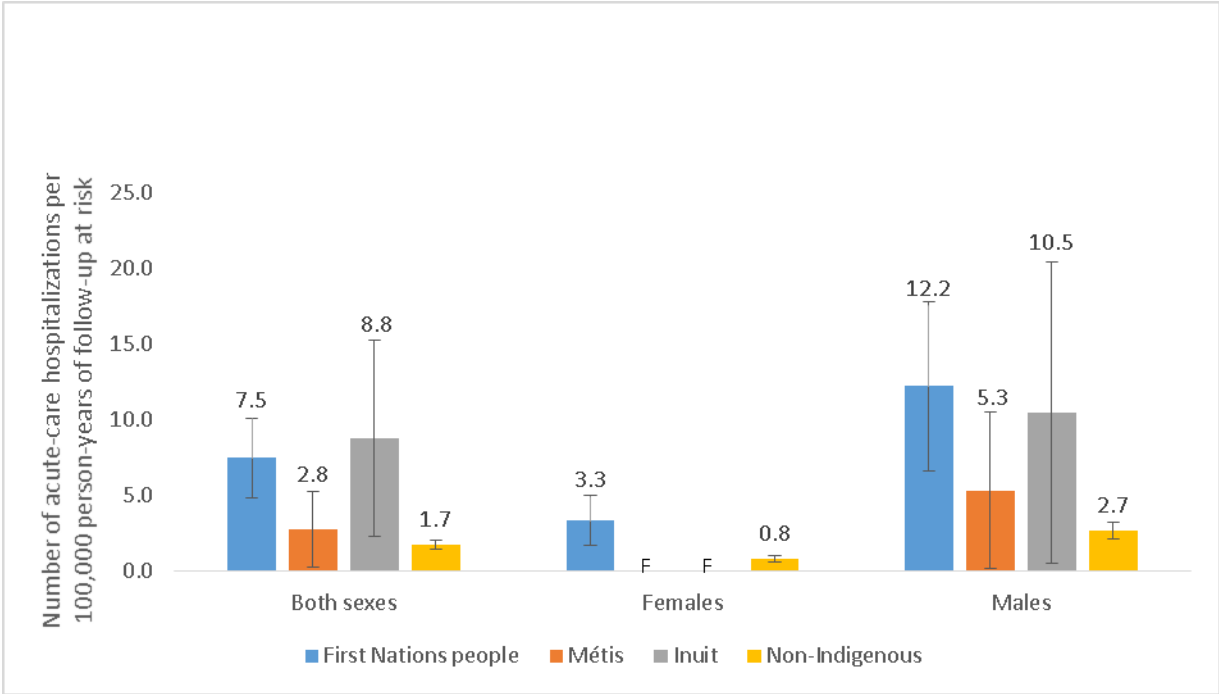
Source: Statistics Canada, 2011 Canadian Census Health and Environment Cohort integrating the 2011 National Household Survey with Canadian Vital Statistics Database (2011-2018).

**Fire, burns and CO related morbidity among First Nations people, Métis and Inuit**

Among First Nations people and Inuit living in private dwellings in Canada, excluding Quebec, the age-standardized hospitalization rate (ASHR) for all fire-related injuries was significantly higher than among non-Indigenous people. The ASHR was 7.5 acute-care hospitalizations per 100,000 person-years at risk among First Nations people, while the corresponding figure among Inuit was 8.8 (figure 7). In comparison, it was 1.7 among non-Indigenous people. Rates were, therefore, 4.3 and 5.1 times higher among First Nations people and Inuit, respectively, than among non-Indigenous people. The ASHR among Métis was 2.8. Although the point estimate was higher than the non-Indigenous one (1.7), they were not significantly different.

Age-standardized hospitalization rates were significantly higher among males than among females. For example, among First Nations males, it was 12.2 compared with 3.3 among females. Nonetheless, disparities with non-Indigenous people were similar by sex. It was over four fold higher among First Nations males (RR=4.1) and females (RR=4.5).

**Figure 7. Age-standardized hospitalization rates (ASHR or number of acute-care hospitalizations per 100,000 person-years at risk) for fire-related injuries among First Nations people, Métis, Inuit and non-Indigenous people, by sex, household population aged 1 year or older, Canada (excluding Quebec), 2011/12-2016/17**



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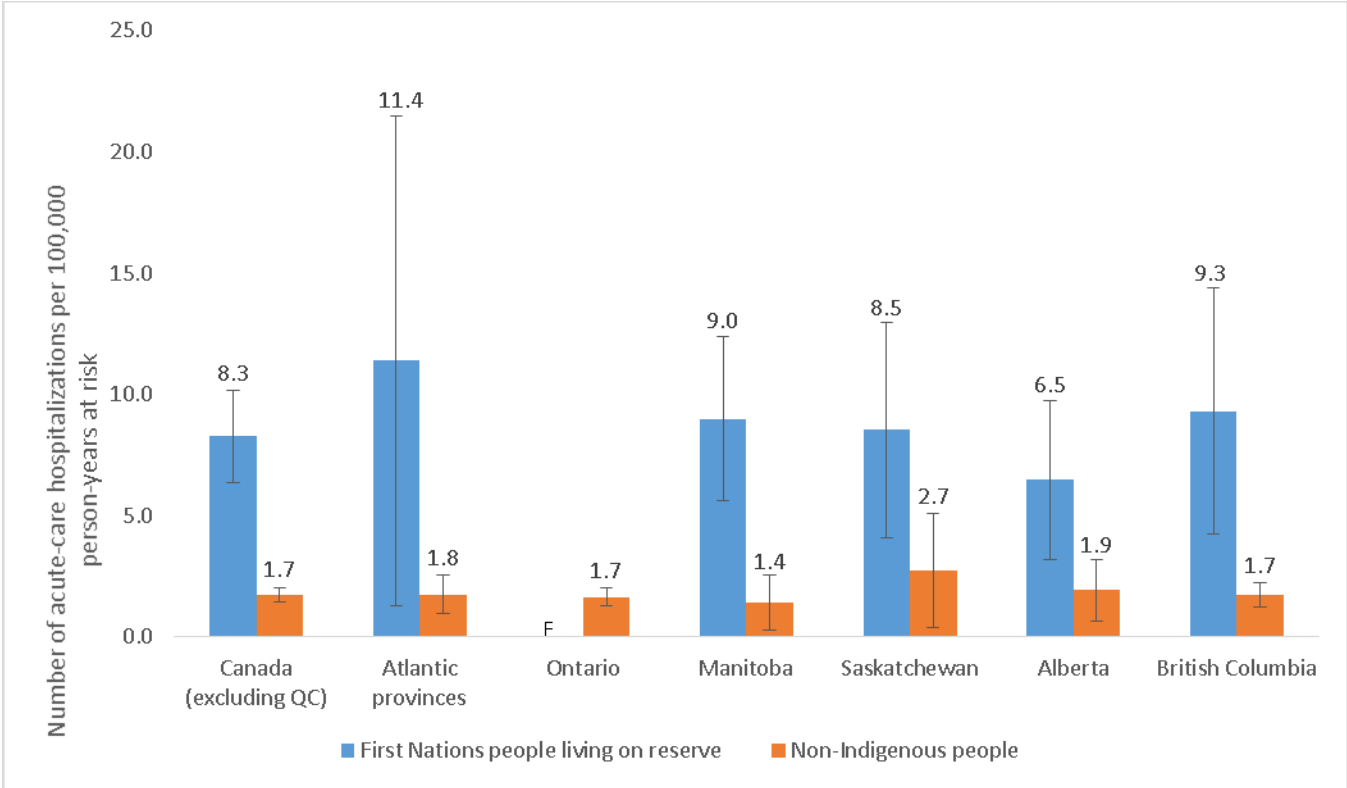
Notes: 5.9 years of follow-up period: May 10, 2011 to March 31, 2017

Excluded from data: institutional population at time of census collection (e.g. nursing homes, jails), population living in collective households (e.g. motels, hotels, rooming houses), persons not enumerated by the 2011 National Household Survey.

Source: Statistics Canada, 2011 Canadian Census Health and Environment Cohort integrating the 2011 National Household Survey with Discharge Abstract Database (2011/12-2016/17).

For Canada as a whole, the age-standardized fire-related hospitalization rate among First Nations people living on reserve was 8.3 hospitalizations per 100,000 person-years at risk, about five times higher (RR=4.7) than the rate among non-Indigenous people (figure 8). Although rates in First Nations reserves varied by province, they were not significantly different from one another.

**Figure 8. Age-standardized hospitalization rates (ASHR or number of acute-care hospitalizations per 100,000 person-years at risk) for fire-related injuries among First Nations people living on reserve and non-Indigenous people in Canada, by province and territory, household population aged 1 year or older, Canada (excluding Quebec), 2011/12-2016/17**



F: too unreliable to be published  
 Notes: 5.9 years of follow-up period: May 10, 2011 to March 31, 2017  
 Excluded from data: institutional population at time of census collection (e.g. nursing homes, jails), population living in collective households (e.g. motels, hotels, rooming houses), persons not enumerated by the 2011 National Household Survey.  
 Source: Statistics Canada, 2011 Canadian Census Health and Environment Cohort integrating the 2011 National Household Survey with Discharge Abstract Database (2011/12-2016/17).

Similar patterns were observed for burns associated with fires. The age-standardized hospitalization rate was 7.0 among First Nations people, 2.7 among Métis and 5.5 among Inuit. In comparison, the rate was 1.6 among non-Indigenous people. The rate ratios (RR) were therefore 4.5, 1.7 and 3.5 for First Nations people, Métis and Inuit, respectively.

As with all fire-related injuries, the rates among First Nations people were higher among males than among females. Rates for Métis and Inuit females were too unreliable to be published, and comparisons by sex were, therefore, not possible. The disparity in rates in relation to the non-Indigenous rate was similar for First Nations males (RR=4.4) and females (RR=4.8). Rates by province among First Nations people living on reserve were not statistically significantly different (data not shown).

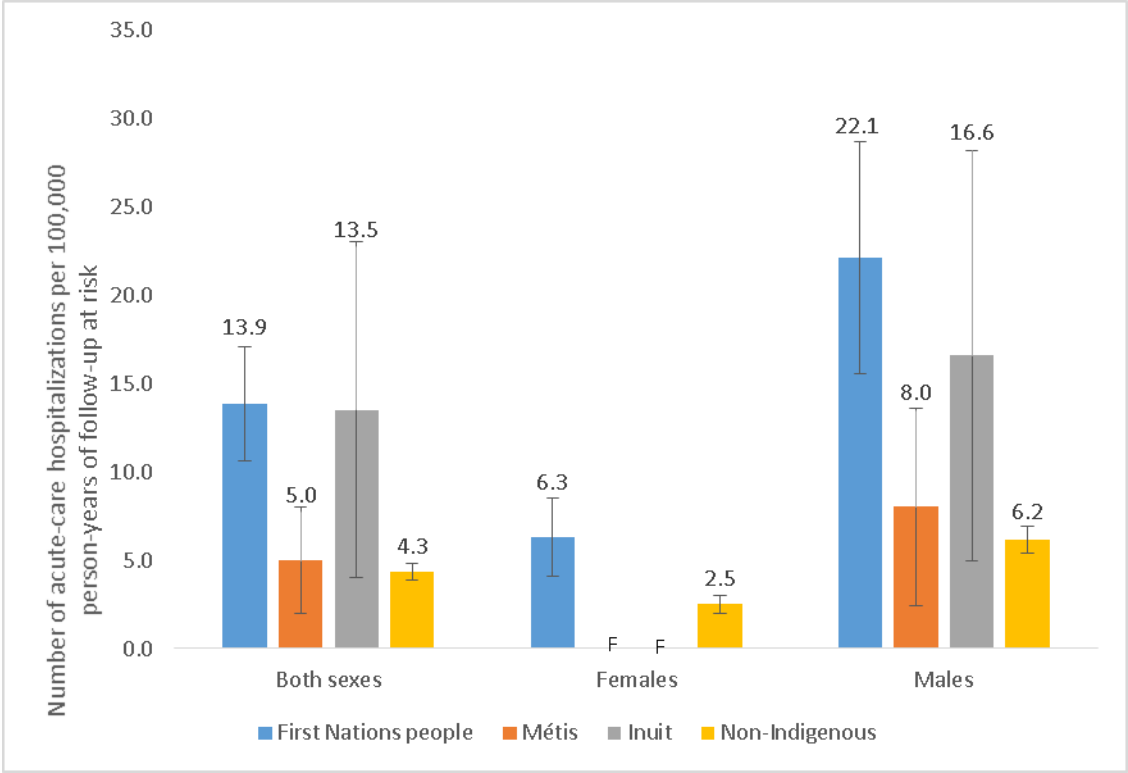
Rate of burns-related hospitalizations that were associated with building or structural fire were also significantly higher among First Nations people (0.9) than among non-Indigenous people (0.1). This was also the case for burns from other agents including ignition of highly flammable material. The age-standardized hospitalization

rate was 6.1 among First Nations people, 2.4 among Métis and 4.0 among Inuit. In comparison, the non-Indigenous rate was 1.5 resulting in rate ratios of 4.2, 1.7 and 2.7, respectively.

Similar to trends noted above, rates were higher among First Nations males (10.5) than among First Nations females (2.2). Still, the disparities with non-Indigenous people for the two sexes were not significantly different (3.5 for First Nations females and 4.6 for First Nations males).

These patterns were again observed for burns from all agents, not just fires. The all-burns age-standardized hospitalization rate was three times higher among First Nations people (13.9, RR=3.2) and Inuit (13.5, RR=3.1) when compared with non-Indigenous people (4.3) (figure 9). Among First Nations people, the rate was higher among males (22.1) than females (6.3) as among non-Indigenous males (6.2) and females (2.5). Disparities between rates of First Nations and non-Indigenous people was not significantly different among females (RR=2.5) and males (RR=3.6). Rates of burn-related hospitalization among on-reserve First Nations people by province were not statistically significantly different (data not shown).

**Figure 9. Age-standardized hospitalization rates (ASHR or number of acute-care hospitalizations per 100,000 person-years at risk) for all burns among First Nations people, Métis, Inuit and non-Indigenous people, by sex, household population aged 1 year or older, Canada (excluding Quebec), 2011/12-2016/17**



F: too unreliable to be published

Notes: 5.9 years of follow-up period: May 10, 2011 to March 31, 2017

Excluded from data: institutional population at time of census collection (e.g. nursing homes, jails), population living in collective households (e.g. motels, hotels, rooming houses), persons not enumerated by the 2011 National Household Survey.

Source: Statistics Canada, 2011 Canadian Census Health and Environment Cohort integrating the 2011 National Household Survey with Discharge Abstract Database (2011/12-2016/17).

## Carbon monoxide hospitalizations

Rates of hospitalization from carbon monoxide (CO) poisoning were not significantly different between First Nations people (0.6), Métis (2.9) and non-Indigenous people (0.9). Rates could not be published by age group or among First Nations people living on reserve because of sample size limitations.

## Conclusion

First Nations people and Inuit experience significantly higher rates of mortality and morbidity relating to fires and burns compared to rates among non-Indigenous people. The small number of deaths and hospitalizations relating to fires, burns and CO poisoning among Métis meant that mortality and morbidity estimates, while higher than non-Indigenous estimates, were not significantly different.

This is the first study, to our knowledge, to use one data source and methodology to examine rates of mortality and morbidity among the three Indigenous populations and compare them to those among the non-Indigenous population, nationally as well as regionally, where possible. The estimates reported here could serve as a baseline for future comparisons.

Limitations of the study should be considered when interpreting these findings, including the exclusion of institutional and collective dwelling population and those not enumerated, and the incomplete enumeration of 18 First Nations reserves in the 2011 National Household Survey.

## Data source and methodology

### Data

The 2011 Canadian Census Health and Environment Cohort (CanCHEC) used here is a population-based linked dataset that follows the non-institutional (household) population enumerated in the 2011 National Household Survey (NHS) for different health outcomes such as mortality, cancer, and hospitalizations. Briefly, record integration for the 2011 CanCHEC was carried out using Statistics Canada's Social Data Linkage Environment (SDLE).<sup>15</sup> The SDLE helps create linked population data files for social analysis through integration to the Derived Record Depository (DRD), a dynamic relational database containing only basic personal identifiers. Survey and administrative data are linked to the DRD using a generalized record integration software that supports deterministic and probabilistic integration.

The NHS was a voluntary survey, conducted in May 2011, of approximately 4.5 million (30%) private dwellings randomly selected from the 2011 Census of Population. The NHS covered all persons who usually live in Canada, including permanent and non-permanent residents, and individuals living on First Nations reserves, Métis settlements or Inuit communities. There were 18 incompletely enumerated First Nations reserves in the 2011 NHS. In 13 other communities, enumeration was delayed because of forest fires in Northern Ontario and occurred at a later date. The NHS excludes residents of institutions (for example, hospitals, nursing homes, penitentiaries) and collective dwellings (for example, work camps, hotels, shelters).<sup>15</sup>

Records for approximately 6.7 million NHS respondents were eligible for integration; 97% linked to the DRD using a probabilistic approach based on telephone number, surnames, given names, birthdate, and place of

residence. No differences in integration rates were found by collection mode, province, sex, or birth decade. To ensure representativeness of the linked cohort, weights were calculated to adjust for non-integration.<sup>15</sup>

The Discharge Abstract Database (DAD) contains demographic, administrative, and clinical data for all acute care (and some psychiatric, chronic rehabilitation, and day-surgery) hospital discharges for all provinces and territories, except Quebec.<sup>16</sup> Data are provided annually to Statistics Canada by the Canadian Institute for Health Information (CIHI). Hospital discharges that occurred from May 10, 2011 to March 31, 2017 were eligible for linkage (n = 23.5 million); 91% linked to the DRD using a deterministic approach based on birthdate, postal code, sex, and health insurance number. Analysis of linked versus non-linked DAD records found no evidence of bias, with similar distributions of individual-level characteristics (age, sex, province and territory of residence).<sup>17</sup>

The Canadian Vital Statistics Database (CVSD) contains information on all deaths in Canada. Data are obtained annually from provincial and territorial vital statistics registries.<sup>18</sup> Mortality records up to December 31, 2018 were eligible for linkage; 90% linked to the DRD using a probabilistic approach based on surname, given names, birthdate, and geography (province, city, postal code).<sup>19</sup>

Additional details about the linkage methodology are available in previous reports.<sup>20</sup> The linkage was conducted in accordance with the Policy on Record Linkage<sup>21</sup> and approved by Statistics Canada's Executive Management Board. Statistics Canada ensures respondent privacy during linkage and subsequent use of linked files. Only employees directly involved in the process have access to the identifying information (such as name and sex) required for linkage; they do not access health-related information. When linkage is completed, an analytical file is created from which identifying information has been removed. Analysts have access only to this de-identified file.

#### Study cohort

The study cohort for mortality analysis consisted of all NHS respondents who linked to the DRD (n=6,499,183). For morbidity analysis, it consists of all NHS respondents (excluding Québec residents) who linked to the DRD (n = 8,418,871). Injuries, burns, CO poisoning-related hospitalizations of cohort members between May 10, 2011 and March 31, 2017 were identified using a protocol following International Statistical Classification of Diseases and Related Health Problems—Canada, Tenth Revision (ICD-10-CA) codes. Deaths of study cohort members (all causes) between 2011 and 2017 were used to adjust the denominator for rate calculations.

#### Variables

Indigenous identity, age, sex, and province of residence variables available in the 2011 NHS dissemination dataset were used. A variable for on- and off-reserve areas of residence was generated using Standard Geographic Classification (SGC) codes. A binary variables for different causes of death and hospitalization were created using ICD-10 codes in the CVSD and the DAD. Generation of these and person-years at risk variables are described in the following section.

#### *ICD-10-CA codes for fires, burns and carbon monoxide poisoning*

For mortality rate estimation, fire-related deaths were identified using underlying external cause of death ICD-10-CA codes (Table 1). For burns-related deaths, record axis fields were used from the multiple cause-of-death files. These were used in conjugation with fire-related cause of death codes. For carbon monoxide poisoning deaths, both underlying external cause of death codes (suspected CO poisoning) and record axis fields were used.<sup>22</sup>

For hospitalization rate estimation, injury-, burns- and CO-related deaths were identified using codes in the most responsible diagnosis fields (Table 2). The “most responsible” diagnosis is the most significant diagnosed condition and/or the condition accounting for the longest length of stay. These were used in conjunction with the first external cause code for fires to identify fire-related injuries, burns and CO-poisoning.<sup>23</sup> Each hospital record contains up to 25 diagnoses coded according to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada (ICD-10-CA).



**Table 1. ICD-10-CA codes for fires, burns and carbon monoxide poisoning used in mortality rate estimation**

	Fire	Burns	CO
All fires	X00-X09, X76, X97, Y26		
All building/structural fires	X00, X02		
All other fires (include ignition of flammable material, forest fires, camp fires, intentional self-harm, assault, undetermined intent, etc.)	X01, X03-X08, X09, X76, X97, Y26		
All burns		T20-T32 (in multiple causes code)	
All burns related to building/structural fires		T20-T32 (in multiple causes code) if X00, X02 is underlying cause of death	
All burns related to other fires		T20-T32 (in multiple causes code) if X01, X03-X08, X09, X76, X97, Y26 is underlying cause of death	
Non-fire related burns		T20-T32 (in multiple causes code) without X00-X09, X76, X97, Y26 as underlying cause of death	
All CO poisonings			T58 or X47, X67, Y17 (in multiple causes)

**Table 2. ICD-10-CA codes for fires, burns and carbon monoxide poisoning used in acute-care hospitalization rate estimation**

Acute hospitalizations	ICD-10 codes
All injuries relating to fires	S00-T98 in most responsible diagnosis and first external cause of injury code of X00-X09, X76, X97, Y26
Burns	T20-T32 in most responsible diagnosis
All burns relating to fires	T20-T32 in most responsible diagnosis and first external cause of injury code of X00-X09, X76, X97, Y26
Burns relating to building /structural fires	T20-T32 in most responsible diagnosis and first external cause of injury code of X00, X02
Burns relating to other fires (ignition of flammable material, forest/camp fires, etc.)	T20-T32 in most responsible diagnosis and first external cause of injury code of X01, X03-X09
CO poisoning	T58 in most responsible diagnosis or first external cause of injury code X47, X67, Y17

## Estimation of weighted mortality and hospitalization rates

For mortality and hospitalization rate estimates, each person's time at risk of death was split into single years of follow-up, and within each year of follow-up, into durations before and after birth date. In the process, each person was aged on his or her birthday. This allows for the appropriate categorization into age groups for computing mortality rates. Weighted age-standardized mortality/hospitalization rates (ASMRs/ASHRs)<sup>24</sup> and their 95% confidence intervals were estimated. Those under the age of one were excluded from the analysis due to under-representation of this group in the linked dataset. Briefly, ASMRs/ASHRs were computed by dividing the count of cohort members who died/were hospitalized from fire, burns or CO poisoning in the follow-up period by the total person-years at risk. For each member of the cohort, person-years of follow-up were calculated as the number of days from the beginning of the study period to the date of death or end of study divided by 365.25. Age standardization was done with 5-year age groups using the 2011 total Indigenous population as the reference population, without Quebec for hospitalizations. Weighted age-specific mortality/hospitalization rates generated without age standardization were used for comparisons between age groups within an Indigenous group or between an Indigenous group and the non-Indigenous population. These rates were also used to compare mortality/hospitalization rates in the on- and off-reserve First Nations populations since their age structures were somewhat similar in 2011 (median age: 23.9 and 27.1 years, respectively).<sup>25</sup> Variance was calculated using 500 bootstrap weights.<sup>20</sup>

Age-standardized and age-specific mortality/hospitalization rates, expressed as the number of deaths/hospitalizations per 100,000 person-years at risk, were generated by sex, Indigenous identity and province and territory. Indigenous identity, as self-reported in the 2011 NHS Survey, included: First Nations, Métis, Inuit, multiple Indigenous identity, Indigenous identity responses not indicated elsewhere and non-Indigenous. However, in this paper, only estimates for single identity groups are presented. Geographic areas studied include province/territory, and on or off-reserve. Rate ratios, or the ratio of mortality/hospitalization rate among First Nations people, Métis or Inuit over mortality/hospitalization rate among non-Indigenous people were computed to examine the magnitude of disparity in the Indigenous group compared to the non-Indigenous population.

For mortality estimates, only estimates based on at least 5 deaths with a weighted sum of at least 10 are published. For hospitalization rates, only estimates based at least 5 hospitalizations with a weighted sum at least 10 with at least two contributing institutions and at least five contributing individuals with a weighted sum of at least 10 are published. Non-publishable estimates are presented as "F" in charts and tables.

## How to interpret estimates and confidence intervals

In charts and tables, publishable estimates are presented with 95% confidence intervals, which represent the variance associated with each estimate. Two estimates can be compared to see if they are statistically different from each other using the confidence intervals. For mortality and hospitalization rates, if the confidence intervals do not overlap, they are deemed to be significantly different from each other. For rate ratios, which compare estimates for an Indigenous group to the non-Indigenous group, if the confidence intervals do not include 1 in the range, they are deemed significant.

## Limitations

Several limitations of the analysis should be noted. Mortality rates presented in this article may underestimate the true rates because of (1) exclusion of the institutional population and population living in collective dwelling, (2) exclusion of persons not enumerated by the 2011 NHS including the homeless among whom Indigenous people are overrepresented,<sup>26</sup> (3) non-integration of some deaths/hospitalizations to the 2011 NHS, (4) potential integration error, and (5) potential misclassification of causes of death in the CVSD to avoid stigmatization or as a result of misclassification as an accident, or inability in ascribing a cause, etc. Furthermore, Indigenous identity in the Census was self-reported, which may have led to underestimation or overestimation of mortality/hospitalizations rates in some Indigenous groups. Also, 18 Indian reserves and Indian settlements were incompletely enumerated in the 2011 NHS,<sup>27</sup> which could have resulted in under- or over-estimation of mortality rates. Most of these reserves were in Quebec and Ontario, with the rest in Saskatchewan, Alberta and British Columbia. The former includes reserves with a large population e.g. Akwesasne (with a population of roughly 10,000 in 2020), Doncaster (~8000) and Pikangikum (~3000).<sup>27, 28</sup> Mortality rates for small areas and small subgroups of the population may experience substantial year-to-year random fluctuations since death is a relatively rare event, particularly death resulting from a fire, burns or CO poisoning.

## Evaluation of the validity of fire, burns and CO estimates

Estimates in the report were compared to published estimates where available. Fire-related mortality rate from the 2011 CanCHEC for the non-Indigenous population in Canada (0.3 deaths per 100,000 person-years at risk) is similar to previously published rates. Between 2011 and 2018, ASMR for the total population ranged from 0.4 to 0.6 per 100,000 population.<sup>29</sup> For hospitalizations, hospitalization rate for all fire-related injuries in British Columbia derived from the 2011 CanCHEC was 2.28 hospitalizations per 100,000 person-years at risk for the May 10, 2011-March 31, 2017 period. In comparison, the fire-related hospitalization rate provided by the BC Injury Research and Prevention Unit was 2.99 per 100,000 population for the 2012/13-2016/17 period.<sup>30</sup> CO hospitalization rate published here for the non-Indigenous population (0.9 hospitalizations per 100,000 person-years at risk) is similar to rates published elsewhere by province (ranging from 0.53 to 1.27 in provinces excluding Saskatchewan).<sup>14</sup> In interpreting these comparisons, it should be noted that the aforementioned published estimates are based on all deaths or hospitalizations in the respective jurisdictions while the CanCHEC rates are for the household population.

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## References

1. Gilbert M, Dawar M, Armour R. 2006. Fire-related deaths among Aboriginal people in British Columbia, 1991-2001. *Can J Public Health*. 97(4): 300-4.
2. Office of the Chief Coroner. 2012. Residential structure fire deaths in BC, 2007-2011. Burnaby, BC.
3. Canadian Mortgage and Housing Corporation. 2005. Fire experience, smoke alarms and sprinklers in Canadian houses: CMHC research to 2005. Ottawa, ON.

4. Finès P, Bougie E, Oliver LN, et al. 2013. Hospitalizations for unintentional injuries among Canadian adults in areas with a high percentage of Aboriginal-identity residents. *Chronic Dis Inj Can.* 33(4): 204-17.
5. Oliver LN, Kohen DE. 2012. Unintentional injury hospitalizations among children and youth in areas with a high percentage of Aboriginal identity residents: 2001/2002 to 2005/2006. *Health Rep.* 23(3): 7-15.
6. Winter J, Siekierska A. A First Nations solution to saving lives. *Toronto Star.* 2017.
7. Siekierska A, Winter J. Where are the girls? *Toronto Star.* 2017.
8. Statistics Canada. 2015. Aboriginal Statistics at a Glance: 2nd edition. Ottawa, ON.
9. Clare J, Kelly H. 2017. Fire and at risk populations in Canada. Analysis of the Canadian National Fire Information Database. Abbotsford, BC.
10. The Assembly of First Nations. 2006. Injury prevention for First Nations communities. Fact sheet. Ottawa, ON.
11. Siekierska A, Winter J. Fire and death in Canada's First Nations. *Toronto Star.* 2017.
12. British Columbia Vital Statistics Agency. Annual report. Selected vital statistics and health status indicators. British Columbia Vital Statistics Agency. Victoria, BC.
13. DiGuseppi C, Edwards P, Godward C, et al. 2000. Urban residential fire and flame injuries: a population based study. *Injury Prevention.* 6(4): 250-4.
14. Cohen I, Garis L, Rajabali F, et al. 2017. Carbon monoxide poisoning. Hospitalizations and deaths in Canada. BC Injury Prevention and Prevention Unit. Vancouver, BC.
15. Carrière G, Garner R, Sanmartin C. 2018. Social and economic characteristics of those experiencing hospitalizations due to opioid poisonings. *Health Reports.* 29(10): 23-8.
16. Canadian Institute for Health Information. Discharge Abstract Database (DAD) Metadata. Ottawa, ON.
17. Statistics Canada. 2018. Social Data Linkage Environment (SDLE) Methodology Report. Linkage between the DAD (Discharge Abstract Database, 1994 to 2016) and the SDLE Derived Record Depository (versions 13 and 14). Internal Report.
18. Statistics Canada. 2020. Canadian Vital Statistics Death Database.
19. Statistics Canada. 2017. Statistics Canada. Social Data Linkage Environment (SDLE) Methodology Report: Linkage between the Canadian Mortality Database (CMDB 2013-14) and the SDLE Derived Record Depository (version 12). Internal Report. Ottawa, ON.
20. Tjepkema M, Christidis T, Bushnik T, et al. 2019. Cohort profile: The Canadian Census Health and Environment Cohorts (CanCHECs). *Health Rep.* 30(12): 18-26.
21. Statistics Canada. 2011. Policy on record linkage. Ottawa, ON.
22. Iqbal S, Clower Jh Fau - King M, King M Fau - Bell J, et al. National carbon monoxide poisoning surveillance framework and recent estimates. (1468-2877 (Electronic)).
23. George MA, Jin A, Brussoni M, et al. 2015. Injury risk in British Columbia, Canada, 1986 to 2009: are Aboriginal children and youth over-represented? *Inj Epidemiol.* 2(1): 7.
24. Kumar MB, Tjepkema M. 2019. Suicide among First Nations people, Métis and Inuit (2011-2016): Findings from the 2011 Canadian Census Health and Environment Cohort (CanCHEC). Ottawa, ON.
25. Gionet L. 2009. First Nations people: Selected findings of the 2006 Census. Statistics Canada. Ottawa, Ontario.
26. Patrick C. 2014. Aboriginal homelessness in Canada: A literature review. *The Homeless Hub report series.* Canadian Homelessness Research Network Press. Toronto.
27. Statistics Canada. 2008. Incompletely enumerated Indian reserves and Indian settlements. Statistics Canada. Ottawa, Ontario.
28. Indigenous Services Canada. 2020. First Nations profile. [cited 2020 February 4]. Available from: <https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/SearchFN.aspx?lang=eng>.

29. Deaths and mortality rates (age standardization using the 2011 population), by selected grouped causes. 2020. Statistics Canada. Available from:  
<https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1310080001>.
30. Discharge Abstract Database, BC Ministry of Health. 2021. Data tables provided by: BC Injury Research and Prevention Unit.