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ABSTRACT

Background

Canada's drug toxicity crisis has burdened some populations disproportionately. This study identifies populations facing higher (or lower) rates of acute toxicity death (ATD) relative to a comparison group, using integrated Canadian Census Health and Environment Cohort data.

Methods

This national prospective cohort study linked census long-form questionnaire respondents to Canadian Vital Statistics Deaths to identify ATDs occurring within five years of the 2016 Census (from May 10, 2016, to May 9, 2021). Age-standardized mortality rates (ASMRs) and ratios relative to a reference population group were compiled for Canada overall, by sex, and by select socioeconomic characteristics.

Results

Approximately 0.05% of Canada's household population experienced an ATD during the follow-up period. The national ASMR of 10.7 per 100,000 person-years varied by population group. The highest ASMRs related to lowest educational attainment, household income quintile, and unemployment. Among employed people, highest ASMRs occurred for workers in trades, transport, equipment operators, and related occupations (19.0 per 100,000 person-years) or in occupations in manufacturing and utilities (15.3 per 100,000 person-years). People who spent between 50% to under 100% of their household total income on housing had the highest ASMR (27.9) compared with people spending less than 15% of their total household income on housing. Lower ASMRs also occurred for racialized people and immigrants.

Conclusion

This study's results generally align with previous studies, while also identifying new details about which disaggregated population groups experienced higher ATD rates. These findings can support intervention programs and policies tailored for populations facing greater ATD risk and enable future monitoring of progress towards equitable outcomes.

Keywords

Overdose crisis; opioids; substances; substance-related; record-linkage.

AUTHORS

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What is already known on this subject?

- Critically high numbers of poisoning-related deaths, also known as acute toxicity deaths (ATDs), occur every year in Canada with the number of deaths attributed to accidental drug poisonings having increased dramatically since 2016, and accounted for at least 2.3% of all deaths in Canada in 2023.
- Some personal, contextual information about ATD decedents from Canada's coroner and medical examiner charts for 2016/2017 was previously reported by others, such as that at least 24% of decedents commonly lived alone or that at least 20% lived with family, yet more comprehensive national information regarding the socioeconomic characteristics of people who experienced an ATD in Canada has remained limited.

What does this study add?

- ATD rates varied significantly within each socioeconomic characteristic, with lower ASMRs among individuals having higher levels of education, higher household income, employment, or among people spending less than 15% of total household income on housing or living in a dwelling owned by someone in the household rather than renting.
- While ATD rates were generally higher in males compared with females, in most cases, resulting mirrored patterns of rate ratios suggest similar social determinants of health relate to greater ATD risk for both sexes.
- Lower rates of ATDs also occurred for the racialized population and immigrants (particularly those who arrived within 10 years before the 2016 Census).

Critically high numbers of poisoning-related deaths, also known as acute toxicity deaths (ATDs), occur every year in Canada, with the number of such deaths having increased over time (Figure 1). Acute toxicity deaths increased sharply in 2017, with an average of 8,260 ATDs per year occurring between 2020 and 2023.[1] In 2023, more than a quarter of ATDs were caused by the consumption of narcotics (such as opioids) and hallucinogens (27.3%), while more than half (58.9%) were caused by the consumption of other and unspecified drugs, medicaments, and biological substances. In that same year, ATDs accounted for 2.5% of all deaths in Canada (Figure 1). Meanwhile, life expectancy in Canada decreased for three consecutive years (2020 to 2022)[2], with some of this decline attributed to COVID-19 and to accidental drug poisoning deaths.[1,3]

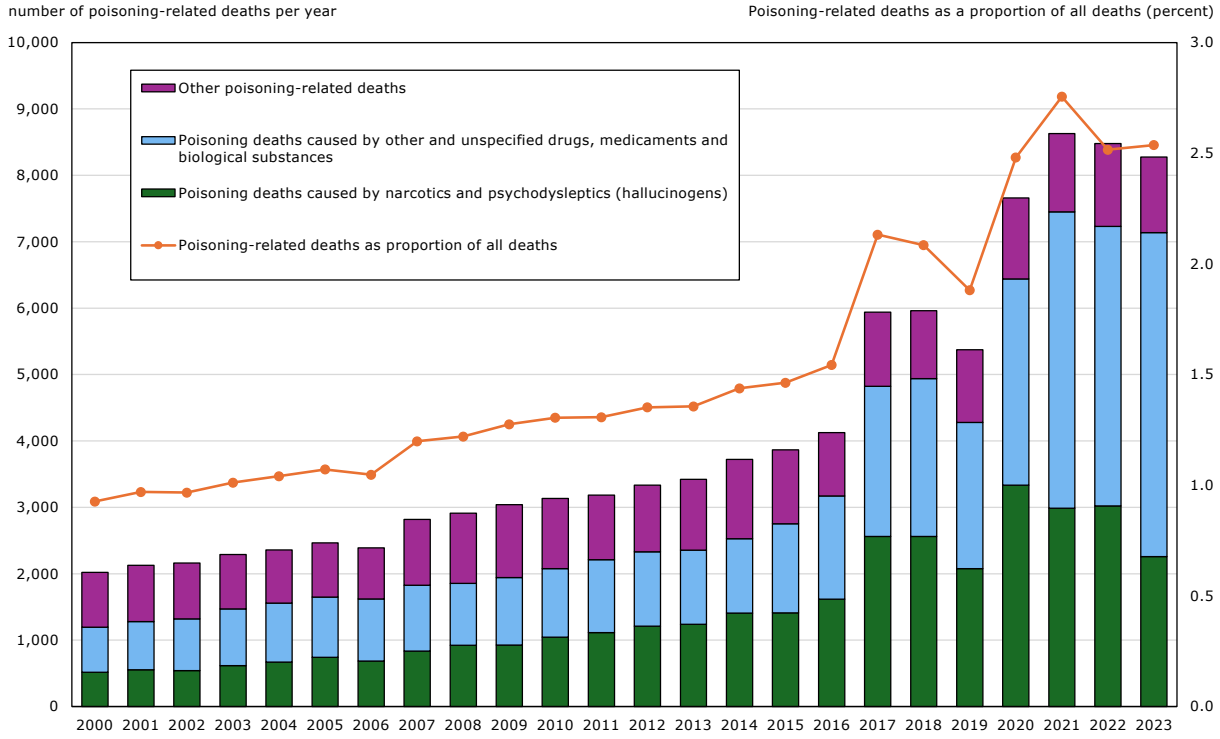
While much is known about the age, sex, and geographic location of people dying of acute toxicities in Canada, national-level information about decedents' socioeconomic characteristics remains limited despite well-known links between factors such as education, income, and housing, that operate as determinants of health.[4,5] This information is often missing or incomplete in vital statistics registries and coroner and medical examiner data. Such information gaps impede the monitoring of changes to the prevalence of ATDs among population groups who may be disproportionately impacted.[6,7]

Previous work has considered the area-based socioeconomic characteristics and circumstances of people who died of acute toxicity nationally and sub-nationally.[6,7,8,9,10] However, area-based measures carry limitations, including lesser sensitivity. Therefore, knowing more about the individual-level circumstances and characteristics of the people who experienced ATDs may help support future interventions to reduce substance-related harms and enable more comprehensive equity-framed monitoring of progress in population health.

Individual-level socioeconomic circumstances of people who experienced opioid overdoses, a subset of ATDs, have been examined only for select regions of Canada, such as British Columbia[11,12,13] or Ontario.[14,15] Such individual-level information is still needed nationally to inform policy and health promotion programming aimed at preventing ATDs. This study seeks to provide new national information about population groups in Canada that have disproportionately higher ATD rates by using linked census and Canadian Vital Statistics Death (CVSD) data. Granular descriptors are provided by the 2016 Canadian Census Health Environment Cohort (CanCHEC)[16,17], to reveal new reliable insights into socioeconomic factors that relate to greater or lesser incidence of ATD.

The present study extends previous work[6,9,18,19] by using individual or household-level information rather than aggregated area-based (i.e., "ecological") data to consider associations between various socioeconomic characteristics and ATD that is defined using a broader range of substances (see Appendix A) to that used previously by others. Other research on sociodemographic factors and social determinants associated with overdose deaths has used a similarly wide range of International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) codes.[20,21] The objective of this project was to investigate and describe rates of

Figure 1
Poisoning-related deaths in Canada by year, count by category and proportion of all deaths



Notes: "Poisoning deaths caused by narcotics and psychodysleptics (hallucinogens)" includes deaths with International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) codes X42, X62, and Y12. "Poisoning deaths caused by other and unspecified drugs, medicaments and biological substances" includes deaths with ICD-10 codes X44, X64, and Y14. "Other poisoning-related deaths" includes all other poisoning-related ICD-10 codes (i.e., X40, X41, X43, X45 to X49, X60, X61, X63, X65 to X69, Y10, Y11, Y13, and Y15 to Y19).
Source: Statistics Canada. Table 13-10-0156-01 Deaths, by cause, Chapter XX: External causes of morbidity and mortality (V01 to Y89).
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ATD among the national household population according to a person's age, sex, and socioeconomic characteristics.

Data and methods

This prospective cohort study used Statistics Canada's 2016 CanCHEC cohort, a linkage of 2016 Census long-form questionnaire respondents (i.e., 25% of the private household population) to a variety of administrative data sources, including to the CVSD database.[16,22] The CanCHEC linkages were approved as governed by Statistics Canada's policy Directive on Microdata Linkage.[23] The CanCHECs were constructed using Statistics Canada's Social Data Linkage Environment (SDLE).[24] The SDLE helps create linked population data files for social analysis through linkage 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 generalized record linkage software that supports deterministic and probabilistic linkage. Mortality records were linked to the DRD using a probabilistic approach based on surname, given names, birthdate, and geography (province, city, and postal code). SDLE linkage results showed that 99.0% of mortality records between 2016 and 2021 (this study's reference period) and 97.6% of eligible 2016 Census records were successfully linked to the DRD. The 2016 CanCHEC sample consists of over 8.4 million records.[16]

Acute toxicity deaths

Acute toxicity deaths (ATDs) were identified based on the ICD-10 codes for the underlying cause of death. ATDs were defined as those that were caused by poisoning by or exposure to noxious substances, including accidents (X40 to X49), suicides (X60 to X69), and events of undetermined intent (Y10 to Y19). Using a definition based on the underlying cause of death is consistent with other reporting from Statistics Canada covering all deaths in Canada by causes of deaths.[1,3] Other research on sociodemographic factors and social determinants associated with overdose deaths has used a similarly wide range of ICD-10 codes.[19,20] It is noteworthy that since 89% of this study's defined ATDs were attributable to codes for drugs (X40 to X44, Y60 to Y64, Y10 to Y14; see Appendix A for ICD-10 code frequencies), using any narrower a case definition focused on drug poisonings would have produced similar results.

Table 1

Crude[1] and age-adjusted[2] person-year rates of acute toxicity death, by demographic, socioeconomic characteristics,Canada, May 10, 2016, to May 9, 2021

	Crude person-year rate			Age-standardized person-year rate					
	Rate[1] per 100,000			Rate[2] per 100,000			Rate ratio		
		95% confidence interval			95% confidence interval			95% confidence interval	
	rate	from	to	rate	from	to	ratio	from	to
Canada total									
Canada	11.0	10.5	11.4	10.7	10.3	11.2	...	...	...
Age groups									
0 to 19 years	1.3	1.0	1.7	...	...	...	...	...	...
20 to 29 years†	13.6	12.3	14.9	...	...	...	...	...	...
30 to 39 years	16.5	15.1	18.0	...	...	...	...	...	...
40 to 49 years	16.4	15.0	17.8	...	...	...	...	...	...
50 to 59 years	16.5	15.1	17.8	...	...	...	...	...	...
60 to 69 years	10.7	9.6	11.9	...	...	...	...	...	...
70 years or older	5.4	4.6	6.3	...	...	...	...	...	...
Population groups									
Racialized groups	4.3	3.8	4.8	4.2	3.7	4.7	0.4	0.3	0.4
Non-racialized population (non-Indigenous group)†	11.5	10.9	12.0	11.2	10.6	11.7	...	...	...
Immigrant status and immigration admission category									
Immigrants and non-permanent residents	5.4	4.8	6.0	4.6	4.0	5.1	0.4	0.3	0.4
Economic immigrants (principal applicants)	2.0	1.0	2.9	1.6	0.7	2.5	0.1	0.1	0.2
Economic immigrants (secondary applicants)	3.0	1.9	4.1	2.6	1.5	3.8	0.2	0.1	0.3
Immigrant sponsored by family	6.6	5.2	7.9	4.9	3.8	6.0	0.4	0.3	0.5
Refugees	7.2	4.9	9.6	5.9	4.0	7.8	0.5	0.3	0.6
Non-permanent residents	x	x	x	x	x	x	x	x	x
Immigrants who landed before 1980	8.3	6.8	9.8	9.1	7.1	11.2	0.7	0.6	0.9
Other immigrants	x	x	x	x	x	x	x	x	x
Non-immigrants†	12.7	12.1	13.2	13.0	12.4	13.6	...	...	...
Among Immigrants, period of immigration									
Arrived within 10 years before census	2.4	1.6	3.2	2.0	1.2	2.8	0.4	0.2	0.5
Arrived more than 10 years before census†	6.7	6.0	7.5	5.7	4.9	6.5	...	...	...
Males total									
Canada	14.9	14.2	15.6	14.6	13.9	15.3	...	...	...
Age groups									
0 to 19 years	1.6	1.0	2.1	...	...	...	...	...	...
20 to 29 years†	18.6	16.6	20.6	...	...	...	...	...	...
30 to 39 years	24.5	22.1	26.9	...	...	...	...	...	...
40 to 49 years	22.2	19.8	24.5	...	...	...	...	...	...
50 to 59 years	22.1	19.9	24.2	...	...	...	...	...	...
60 to 69 years	13.3	11.4	15.2	...	...	...	...	...	...
70 years or older	7.5	6.1	8.9	...	...	...	...	...	...
Population groups									
Racialized groups	7.1	6.1	8.0	6.9	5.9	7.9	0.5	0.4	0.5
Non-racialized population (non-Indigenous group)†	15.6	14.8	16.5	15.3	14.5	16.1	...	...	...
Immigrant status and immigration admission category									
Immigrants and non-permanent residents	8.7	7.7	9.8	7.4	6.4	8.4	0.4	0.4	0.5
Economic immigrants (principal applicants)	x	x	x	x	x	x	x	x	x
Economic immigrants (secondary applicants)	5.6	3.3	8.0	4.3	2.2	6.4	0.3	0.2	0.4
Immigrant sponsored by family	13.2	10.3	16.1	9.9	7.7	12.2	0.6	0.5	0.7
Refugees	x	x	x	x	x	x	x	x	x
Non-permanent residents	x	x	x	x	x	x	x	x	x
Immigrants who landed before 1980	12.2	9.5	14.8	12.9	9.4	16.4	0.8	0.6	1.0
Other immigrants	x	x	x	x	x	x	x	x	x
Non-immigrants†	16.7	15.9	17.6	17.1	16.3	18.0	...	...	...
Among Immigrants, period of immigration									
Arrived within 10 years before census	x	x	x	x	x	x	x	x	x
Arrived more than 10 years before census†	x	x	x	x	x	x	...	...	...
Females total									
Canada	7.2	6.7	7.7	7.0	6.5	7.5	...	...	...
Age groups									
0 to 19 years	1.1	0.6	1.5	...	...	...	...	...	...
20 to 29 years†	8.4	6.9	10.0	...	...	...	...	...	...
30 to 39 years	8.9	7.3	10.4	...	...	...	...	...	...
40 to 49 years	10.8	9.2	12.4	...	...	...	...	...	...
50 to 59 years	11.1	9.6	12.6	...	...	...	...	...	...
60 to 69 years	8.3	7.0	9.7	...	...	...	...	...	...
70 years or older	3.8	2.8	4.8	...	...	...	...	...	...
Population groups									
Racialized groups	1.7	1.3	2.2	1.7	1.2	2.2	0.2	0.2	0.3
Non-racialized population (non-Indigenous group)†	7.4	6.7	8.0	7.1	6.5	7.7	...	...	...
Immigrant status and immigration admission category									
Immigrants and non-permanent residents	2.4	1.8	3.1	2.0	1.5	2.5	0.2	0.2	0.3
Economic immigrants (principal applicants)	x	x	x	x	x	x	x	x	x
Economic immigrants (secondary applicants)	1.2	0.4	1.9	1.4	0.2	2.6	0.2	0.1	0.4
Immigrant sponsored by family	2.0	0.9	3.2	1.4	0.6	2.3	0.2	0.1	0.3
Refugees	x	x	x	x	x	x	x	x	x
Non-permanent residents	x	x	x	x	x	x	x	x	x
Immigrants who landed before 1980	4.8	3.1	6.5	5.6	3.0	8.2	0.6	0.4	1.0
Other immigrants	x	x	x	x	x	x	x	x	x
Non-immigrants†	8.7	8.1	9.3	8.9	8.2	9.5	...	...	...
Among Immigrants, period of immigration									
Arrived within 10 years before census	x	x	x	x	x	x	x	x	x
Arrived more than 10 years before census†	x	x	x	x	x	x	...	...	...

... not applicable

† reference category

x suppressed to meet the confidentiality requirements of the *Statistics Act* .

1. Crude rate figures are based upon unrounded denominators and numerators rounded to base 5.

2. Mortality rates have been standardized to the total population age structure (both sexes combined) of the 2016 Census.

Notes: The 2019 to 2021 death data are considered preliminary. Data for Yukon were not available from December 31, 2016, thereon at the time of this analysis, therefore rates may be slightly underestimated.

Source: 2016 Canadian Census Health Environment Cohort (CanCHEC); 2016 Census long-form respondents linked to the Canadian Vital Statistics Deaths Database (CVSD); Statistics Canada.

At the time of this study, deaths in the CVSD for 2019 through 2021 were considered preliminary. Additionally, death data for Yukon were unavailable from 2017 onwards at the time of this analysis. Residents of Yukon made up 0.1% of Canada's population in 2016.

Individual characteristics

Rates of ATD were examined over a series of demographic and socioeconomic characteristics. Details of these factors are given in Appendix B, essentially covering demographic, ethnographic, educational attainment, employment, occupation, household income, connections by household living arrangements, and core housing indicators.

Methods

Age-standardized mortality rates (ASMRs) of ATDs were compiled over person-years at risk per 100,000 population within the study period (May 10, 2016, to May 9, 2021, inclusively). Person-years at risk were adjusted for deaths by any cause within the study period (i.e., after their date of death decedents' years at risk were removed from the denominator for rate calculations). The age structure of the national population (both sexes combined) from the 2016 Census of Population was used for age standardization[25] Ten-year age bands enabled greater comparability of results published by others using different data.[19] Rate ratios (RRs) of ASMRs are given relative to a reference category group for each characteristic. In the present analysis, ASMRs with non-overlapping confidence intervals (CIs) are deemed significantly different, as are RRs with CIs that do not include 1.

In accordance with the CanCHECs release guidelines, numerators in crude rates were random-rounded to base 5: no rounding was applied in age-standardized rates. Survey weights were used to represent Canada's total household population in 2016 and included adjustments for non-linkage. Replicate weights were used to adjust variance estimation (i.e., 100 replicate weights, Fay adjustment of 2). Rates were suppressed if underlying weighted (non-zero) counts represented fewer than 10 individuals to protect respondents' confidentiality and privacy, and for quality assurance if the ratio's coefficient of variation exceeded 0.35. All presented analyses used SAS-callable SUDAAN and SAS Enterprise Guide Version 8.3.

Results

An estimated 0.05% of Canada's total household population experienced an ATD within five years since the 2016 Census. The national ATD ASMR was 10.7 per 100,000 person-years. The ASMR for males was 14.6 per 100,000 person-years and for females 7.0 per 100,000 person-years (Table 1).

The national ATD age-specific crude rates were greatest among people aged 30 to 59 years ranging from 16.4 to 16.5 per 100,000 person-years, with rates typically decreasing with age thereafter (Table 1). At ages 30 to 39, the crude rate for males was nearly three times higher (RR=2.8) than that for females: for all other age groups (20 years or older), the male crude rate was about twice higher than the corresponding rate among females.

Racialized population groups

The ASMR among racialized people (Table 1) was significantly lower than that among non-racialized, non-Indigenous people (RR=0.4). This pattern held for both males (RR=0.5) and females (RR=0.2).

Migration status, admission category, and period of arrival

Overall, the ASMR was lower among immigrants or non-permanent residents as a group (RR=0.4) than among non-immigrants. The ASMR for male immigrants and non-permanent residents was half that (RR=0.4) of non-immigrant males. Female immigrants and non-permanent residents had a significantly lower ASMR (RR=0.2) compared with non-immigrant females.

Disaggregating according to immigrants' admission category showed that rates for all admission categories were significantly lower compared with non-immigrants. Information to classify immigrants who landed in Canada before 1980 by admission categories is not available. Therefore, immigrants who arrived before 1980 are in a separate category. The ASMR for immigrants who landed before 1980 was just above that for immigrants and non-permanent residents altogether, but lower than the rate found among non-immigrants (RR=0.7). The ASMR for people admitted to Canada as refugees was half that of non-immigrants (RR=0.5). Notably, refugees experienced higher ASMRs than principal or secondary applicant immigrants whose admission into Canada was granted via an economic program's criteria. Individuals who arrived by family sponsorship likewise had elevated rates compared to other immigrants, but again, overall, immigrants' and non-permanent residents' ASMRs were still significantly lower for all admission categories compared with that for non-immigrants. Owing to low event counts, the sex-specific ATD rates for refugees and economic immigrants (principal applicants) were suppressed to protect confidentiality and to ensure reliability of reported estimates, as were overall rates for non-permanent residents and "other immigrants" (e.g., 'not elsewhere classified" within immigrants).

Rates of ATD also varied by period of immigration. Immigrants who arrived in Canada more recently, i.e., within 10 years before the 2016 Census, had a lower ASMR (RR=0.4) than did immigrants who landed in Canada more than 10 years prior to the 2016 Census.

After-tax total household income quintile

When considering after-tax household income level, there was a nearly five-fold difference in ATD ASMRs between those in the lowest 20% (i.e., first quintile; 26.1) and people in the highest 20% (5.6; Table 2). Compared with individuals in the second household income quintile, the ASMR was more than twice higher (RR=2.4) among people in the lowest household income quintile (Table 2). ASMRs decreased with increasing income.

Table 2

Crude[1] and age-adjusted[2] person-year rates of acute toxicity death by income, education, and employment characteristics, Canada, May 10, 2016, to May 9, 2021

	Crude person-year rate			Age-standardized person-year rate					
	Rate[1] per 100,000			Rate[2] per 100,000			Rate ratio		
		95% confidence interval			95% confidence interval			95% confidence interval	
	rate	from	to	rate	from	to	ratio	from	to
Canada total									
Canada	11.0	10.5	11.4	10.7	10.3	11.2	...	...	...
Income quintile: Adjusted after-tax income of household for all persons									
Quintile 1 (lowest)	23.7	22.5	24.8	26.1	24.4	27.9	2.4	2.1	2.6
2†	10.5	9.9	11.2	11.1	10.1	12.1	...	...	...
3	8.1	7.5	8.6	8.0	7.2	8.8	0.7	0.6	0.8
4	7.0	6.5	7.6	6.6	5.9	7.4	0.6	0.5	0.7
Quintile 5 (highest)	6.2	5.6	6.7	5.6	4.9	6.4	0.5	0.4	0.6
Educational attainment: Highest certificate, diploma or degree									
No certificate, diploma, or degree	22.6	20.9	24.3	31.3	28.8	33.8	3.4	3.0	3.9
Secondary (high) school diploma or equivalency certificate	15.3	14.2	16.3	15.5	14.3	16.6	1.7	1.5	1.9
Apprenticeship or trade certificate or diploma	17.3	15.5	19.0	15.9	14.2	17.5	1.7	1.5	2.0
College, CEGEP, or other non-university certificate or diploma†	10.4	9.4	11.3	9.2	8.3	10.1	...	...	...
University certificate or diploma below bachelor level	9.4	7.1	11.7	8.6	6.4	10.7	0.9	0.7	1.2
University certificate or diploma at bachelor's level or above	4.4	3.8	5.0	4.1	3.5	4.6	0.5	0.4	0.5
Aged younger than 15 years[3]	0.7	0.5	1.0	1.1	0.7	1.5	0.1	0.1	0.2
Labour force status									
Employed†	8.5	7.9	9.1	7.6	7.0	8.2	...	...	...
Unemployed	27.6	24.0	31.2	24.3	21.0	27.7	3.2	2.7	3.7
Not in the labour force	19.2	18.1	20.4	31.5	29.3	33.6	4.1	3.7	4.6
Occupation groups NOC 2016									
Management occupations	5.7	4.5	7.0	5.1	3.8	6.3	0.5	0.4	0.6
Business, finance and administration occupations	5.5	4.5	6.5	5.2	4.0	6.3	0.5	0.4	0.6
Natural and applied sciences and related occupations	5.2	3.7	6.6	4.0	2.9	5.1	0.4	0.3	0.5
Health occupations	6.6	4.6	8.6	9.1	1.0	17.2	0.9	0.4	2.1
Occupations in education, law, social, community and government services	4.6	3.6	5.5	5.0	3.2	6.9	0.5	0.3	0.7
Occupations in art, culture, recreation and sport	4.9	3.1	6.7	4.7	2.9	6.5	0.5	0.3	0.7
Sales and service occupations†	11.2	10.0	12.4	10.4	9.1	11.6	...	...	...
Trades, transport and equipment operators and related occupations	21.8	19.7	23.9	19.0	16.9	21.2	1.8	1.6	2.1
Natural resources, agriculture and related production occupations	16.7	12.4	21.1	15.6	11.3	19.8	1.5	1.1	2.0
Occupations in manufacturing and utilities	15.8	12.5	19.1	15.3	11.3	19.2	1.5	1.1	2.0
Males total									
Canada	14.9	14.4	15.4	14.6	13.9	15.3	...	...	...
Income quintile: Adjusted after-tax income of household for all persons									
Quintile 1 (lowest)	30.5	28.7	32.2	33.7	31.0	36.4	2.1	1.8	2.4
2†	15.2	14.0	16.3	16.1	14.4	17.8	...	...	...
3	11.6	10.6	12.6	11.6	10.1	13.0	0.7	0.6	0.9
4	10.5	9.6	11.5	9.9	8.7	11.1	0.6	0.5	0.7
Quintile 5 (highest)	8.6	7.7	9.5	7.8	6.6	9.0	0.5	0.4	0.6
Educational attainment: Highest certificate, diploma or degree									
No certificate, diploma, or degree	30.1	27.5	32.6	38.6	35.2	42.1	3.2	2.7	3.7
Secondary (high) school diploma or equivalency certificate	21.7	20.0	23.5	21.0	19.3	22.8	1.7	1.5	2.0
Apprenticeship or trade certificate or diploma	19.8	17.5	22.2	18.3	16.1	20.5	1.5	1.3	1.8
College, CEGEP, or other non-university certificate or diploma†	13.8	12.0	15.5	12.2	10.6	13.8	...	...	...
University certificate or diploma below bachelor level	13.3	9.0	17.7	11.6	7.7	15.6	1.0	0.7	1.4
University certificate or diploma at bachelor's level or above	5.7	4.7	6.7	5.1	4.2	6.1	0.4	0.3	0.5
Aged younger than 15 years[3]	0.8	0.4	1.2	1.3	0.6	1.9	0.1	0.1	0.2
Labour force status									
Employed†	12.3	11.4	13.3	11.0	10.0	11.9	...	...	...
Unemployed	36.8	31.3	42.4	32.8	27.6	38.1	3.0	2.5	3.6
Not in the labour force	26.5	24.6	28.4	50.9	46.5	55.4	4.6	4.1	5.2
Occupation groups NOC 2016									
Management occupations	7.3	5.4	9.1	6.9	4.9	8.9	0.4	0.3	0.6
Business, finance and administration occupations	8.7	6.4	11.0	7.6	5.5	9.7	0.5	0.4	0.7
Natural and applied sciences and related occupations	x	x	x	x	x	x	x	x	x
Health occupations	9.7	4.9	14.5	9.2	4.0	14.3	0.6	0.3	1.0
Occupations in education, law, social, community and government services	6.4	4.4	8.5	5.5	3.5	7.5	0.3	0.2	0.5
Occupations in art, culture, recreation and sport	x	x	x	x	x	x	x	x	x
Sales and service occupations†	16.7	14.5	18.9	16.0	13.7	18.3	...	...	...
Trades, transport and equipment operators and related occupations	22.3	20.0	24.5	19.5	17.2	21.8	1.2	1.0	1.5
Natural resources, agriculture and related production occupations	x	x	x	x	x	x	x	x	x
Occupations in manufacturing and utilities	19.4	15.2	23.6	18.6	13.6	23.6	1.2	0.9	1.6

... not applicable

† reference category

x suppressed to meet the confidentiality requirements of the *Statistics Act* .

1. Crude rate figures are based upon unrounded denominators and numerators rounded to base 5.

2. Mortality rates have been standardized to the total population age structure (both sexes combined) of the 2016 Census.

3. For respondents aged 15 years or older, educational attainment was classified into one of the categories shown; otherwise the person was categorized as "aged younger than 15 years.

Notes: The 2019 to 2021 death data are considered preliminary. Data for Yukon were not available from December 31, 2016, thereon at the time of this analysis, therefore rates may be slightly underestimated.

Sources: Statistics Canada, 2016 Canadian Census Health Environment Cohort (CanCHEC); 2016 Census long-form respondents linked to the Canadian Vital Statistics Deaths Database (CVSD).

Table 2

Crude[1] and age-adjusted[2] person-year rates of acute toxicity death by income, education, and employment characteristics, Canada, May 10, 2016, to May 9, 2021 (continue)

	Crude person-year rate			Age-standardized person-year rate					
	Rate[1] per 100,000			Rate[2] per 100,000			Rate ratio		
		95% confidence interval			95% confidence interval			95% confidence interval	
	rate	from	to	rate	from	to	ratio	from	to
Females total									
Canada	7.2	6.7	7.7	7.0	6.5	7.5	...	...	...
Income quintile: Adjusted after-tax income of household for all persons									
Quintile 1 (lowest)	17.8	16.5	19.1	19.7	17.7	21.7	3.0	2.5	3.7
2†	6.2	5.5	6.9	6.5	5.4	7.5	...	...	...
3	4.6	4.0	5.2	4.6	3.8	5.4	0.7	0.6	0.9
4	3.5	3.0	4.0	3.3	2.6	4.0	0.5	0.4	0.7
Quintile 5 (highest)	3.6	3.1	4.2	3.4	2.7	4.1	0.5	0.4	0.7
Educational attainment: Highest certificate, diploma or degree									
No certificate, diploma, or degree	14.8	12.9	16.7	22.2	19.0	25.3	3.1	2.6	3.8
Secondary (high) school diploma or equivalency certificate	9.2	8.0	10.3	9.6	8.2	11.0	1.4	1.1	1.7
Apprenticeship or trade certificate or diploma	11.8	9.2	14.5	10.7	8.3	13.2	1.5	1.2	2.0
College, CEGEP, or other non-university certificate or diploma†	7.9	6.7	9.1	7.1	6.0	8.1	...	...	...
University certificate or diploma below bachelor level	6.8	4.2	9.4	6.4	3.9	8.9	0.9	0.6	1.4
University certificate or diploma at bachelor's level or above	3.3	2.6	4.0	3.2	2.5	3.9	0.5	0.4	0.6
Aged younger than 15 years[3]	0.6	0.3	1.0	0.9	0.4	1.4	0.1	0.1	0.2
Labour force status									
Employed†	4.3	3.8	4.9	3.9	3.3	4.6	...	...	...
Unemployed	15.8	12.2	19.4	14.2	10.7	17.7	3.6	2.7	4.9
Not in the labour force	13.9	12.6	15.1	20.9	19.0	22.9	5.4	4.5	6.4
Occupation groups NOC 2016									
Management occupations	3.1	1.8	4.4	2.4	1.3	3.4	0.4	0.3	0.6
Business, finance and administration occupations	4.1	3.2	5.1	4.2	2.8	5.7	0.7	0.5	1.0
Natural and applied sciences and related occupations	x	x	x	x	x	x	x	x	x
Health occupations	5.8	3.8	7.8	9.1	0.0	19.5	1.5	0.5	4.7
Occupations in education, law, social, community and government services	3.7	2.6	4.8	4.7	2.2	7.2	0.8	0.4	1.3
Occupations in art, culture, recreation and sport	x	x	x	x	x	x	x	x	x
Sales and service occupations†	7.1	5.9	8.4	6.1	5.0	7.2	...	...	...
Trades, transport and equipment operators and related occupations	15.0	7.7	22.2	12.3	6.4	18.2	2.0	1.2	3.4
Natural resources, agriculture and related production occupations	x	x	x	x	x	x	x	x	x
Occupations in manufacturing and utilities	7.3	3.5	11.1	6.3	2.9	9.6	1.0	0.6	1.8

... not applicable

† reference category

x suppressed to meet the confidentiality requirements of the *Statistics Act* .

1. Crude rate figures are based upon unrounded denominators and numerators rounded to base 5.

2. Mortality rates have been standardized to the total population age structure (both sexes combined) of the 2016 Census.

3. For respondents aged 15 years or older, educational attainment was classified into one of the categories shown; otherwise the person was categorized as "aged younger than 15 years.

Notes: The 2019 to 2021 death data are considered preliminary. Data for Yukon were not available from December 31, 2016, thereon at the time of this analysis, therefore rates may be slightly underestimated.

Sources: Statistics Canada, 2016 Canadian Census Health Environment Cohort (CanCHEC); 2016 Census long-form respondents linked to the Canadian Vital Statistics Deaths Database (CVSD).

Educational attainment: Highest certificate, diploma, or degree

Nationally, the ASMR was 3.4 times higher among people without a secondary-level education, and nearly two times higher (RR=1.7) for those with a secondary (high) school diploma or equivalent or an apprenticeship or trade certificate or diploma, as compared with people who held a college, CEGEP, or other non-university certificate or diploma (Table 2). Attainment of university certification or diploma above the bachelor level was associated with lower ASMRs (RR=0.5) by the same comparison.

Employment

Compared with individuals who were employed during the week before the census, the ASMR was significantly higher among people aged 15 years or older who were not in the labour force, i.e., individuals who were neither employed nor unemployed (Table 2; RR=4.1) and among the unemployed (RR=3.2). The higher rate among people who were not in the labour force was observed among men (RR=4.6) and among women (RR=5.4).

Occupation group

Among employed people, ASMRs were examined by occupation sector (Table 2). People working in sales and service occupations had an ASMR that was close to the national rate (ASMR = 10.4) and were selected as the reference groups for comparisons across occupational sectors. Compared with those working in sales and service occupations, ASMRs were one and a half to nearly two times higher for people working in trades, transport and equipment operators and related occupations (RR=1.8), natural resources, agriculture and related production occupations (RR=1.5) or occupations in manufacturing and utilities (RR=1.5). Conversely, ASMRs were lower for those employed in all other occupation sectors reported, except for health occupations (RR=0.9; CIs from 0.4 to 2.1).

Living arrangements

Household living arrangements describe with whom, if anyone, the person lives (see Appendix B). Compared with people living with a spouse (married or common-law), the ASMR was halved for non-adult children (i.e., younger than age 20) living in a couple household (RR=0.5), while the ASMR was higher than the reference group for (non-adult) children living in a one-parent household (RR=1.4) or in other living arrangements

(RR=1.6). ASMRs were significantly elevated for most other living arrangement categories as compared with the reference group (Table 3). The rates were around five times higher among adult (i.e., age 20 or older) children living in a one-parent household (RR=5.7) or couple household (RR=5.2), among people living alone (RR=4.7) and people living with (unrelated) others, such as roommates (RR=4.7).

Home tenure

Home ownership was strongly related to lower ASMRs. People who rented their home experienced an ASMR three times higher (RR=3.1; Table 3) than that among people who lived in a private dwelling owned by someone in the household. The ASMR among renters was nearly three times higher for males (RR=2.7) and four times higher for females (RR=4.3) compared with the rates for home owners (Table 3).

Housing suitability

Nationally, people living in housing of unsuitable quality experienced a similar ASMR to people living in housing of suitable quality; the rates were not significantly different (RR=1.1; CIs from 1.0 to 1.3). This was also the case for housing suitability rates within each sex.

Housing affordability

Nationally, ASMRs showed a strong positive gradient with housing affordability (i.e., the proportion of total income spent on housing). Compared with the ASMR among those who spent less than 15% of their total household income on housing, ASMRs were significantly elevated as affordability decreased (i.e., housing represented a greater proportion of household income). For example (Table 3), the ATD ASMR was higher (RR=1.3) among people whose housing costs were from 15% to less than 30% of their total income, also among people whose housing costs represented 30% to less than 50% of their total income (RR=2.4), and for people whose housing costs were 50% to less than 100% of their total household income (RR=3.8). For those whose housing costs equalled or exceeded their total household income, the ASMR was lower at a rate of 20.3 than that of the previous housing affordability category, but was still nearly three times higher (RR=2.8) than that among people whose housing costs were less than 15% of their total household income.

Discussion

This study provides new national information on demographic, ethnographic, and socioeconomic factors associated with ATDs in Canada between 2016 and 2021. By using individual and household-level information, this study's results more fully characterize the people who died of acute drug toxicity and underscore that certain population groups were disproportionately affected. This study found that ATD rates varied across almost every factor examined, which represented demographic, household living arrangement, housing, employment, income and education domains. Nationally, the following characteristics measured at the time of the 2016 Census were identified as risk factors for ATD:

- being male
- being between 30 to 59 years of age (inclusively)
- not having completed secondary education (i.e., no certificate, diploma or degree)
- being unemployed or not in the work force
- working in trades, transport and equipment operators and related occupations; natural resources, agriculture or related production occupations; or in manufacturing and utilities occupations, if employed
- having a total household income in the lowest income quintile
- being in a non-racialized population group
- being a non-immigrant
- immigrating to Canada more than 10 years before the census, among immigrants
- being an adult (age 20 years or older) child living in a one-parent or couple household, an adult living alone, or an adult living with (unrelated) others (e.g., with roommates)
- spending 15% or more of one's total household income on housing
- not owning one's home.

This study's new national results resemble patterns of associations between socioeconomic factors and ATDs reported by others previously using different methods and data sources[11,12,14] including national results based on coroner and medical examiner data.[19] However, there are some notable differences between that 2022 Public Health Agency of Canada[19] study and the results presented here that may be owing to differences to study design, i.e., the chart review reported retrospective percentages of ATD decedents vs. this study's prospective overall population outcome design.

This study's new results help address other long-standing information gaps about ATD rates by individuals' immigration status and period of immigration. Results are consistent with the "healthy immigrant effect,"[26] which posits that immigrants have better health status relative to Canadian-born individuals upon arrival. Other work has shown that this effect generally diminishes as the time since immigration increases, whereby the health of immigrants tends to converge to that of the Canadian-born population over time.[27,28,29] The patterns shown in the present study are consistent with the healthy immigrant effect and its waning, in that immigrants had significantly lower rates of ATDs relative to non-immigrants, particularly among recent

Table 3

Crude[1] and age-adjusted[2] person-year rates of acute toxicity death by housing characteristics, Canada, May 10, 2016, to May 9, 2021

	Crude person-year rate			Age-standardized person-year rate					
	Rate[1] per 100,000			Rate[2] per 100,000			Rate ratio		
		95% confidence interval			95% confidence interval			95% confidence interval	
	rate	from	to	rate	from	to	ratio	from	to
Canada total									
Canada	11.0	10.5	11.4	10.7	10.3	11.2	...	...	...
Household living arrangements									
Married spouse or common-law partner (with or without children)†	6.4	5.9	6.8	6.6	6.0	7.2	...	...	...
Parent in a one-parent household	19.2	16.6	21.9	19.3	16.2	22.5	2.9	2.4	3.5
Adult child in a couple household	18.7	16.4	21.0	34.6	22.6	46.5	5.2	3.7	7.5
Adult child in a one-parent household	35.3	30.8	39.8	37.4	30.7	44.1	5.7	4.7	6.9
Person living alone	27.6	25.4	29.7	31.3	28.7	33.8	4.7	4.2	5.4
Person living with others	26.6	23.5	29.7	30.7	27.0	34.3	4.7	4.0	5.4
Non-adult child of a couple	1.7	1.3	2.1	3.5	2.6	4.5	0.5	0.4	0.7
Non-adult child in a one-parent household	5.8	4.2	7.4	9.3	6.6	12.1	1.4	1.0	1.9
Non-adult child with other living arrangements	15.0	7.8	22.1	10.3	5.4	15.3	1.6	1.0	2.5
Tenure of housing									
Owned by a member of the household†	7.0	6.6	7.5	7.0	6.6	7.4	...	...	...
Rented	21.3	20.0	22.5	21.7	20.4	23.1	3.1	2.8	3.4
Housing suitability									
Suitable†	10.9	10.4	11.4	10.6	10.1	11.1	...	...	...
Not suitable	12.0	10.3	13.6	12.0	10.1	13.9	1.1	1.0	1.3
Classification of shelter-cost-to-income ratio by groups									
Less than 15%†	7.4	6.9	7.9	7.3	6.8	7.8	...	...	...
15% to less than 30%	9.6	8.9	10.3	9.6	8.8	10.3	1.3	1.2	1.5
30% to less than 50%	16.6	14.9	18.4	17.2	15.3	19.0	2.4	2.1	2.7
50% to less than 100%	27.9	24.4	31.4	27.9	24.4	31.5	3.8	3.3	4.4
100% or more	22.5	19.0	25.9	20.3	17.2	23.4	2.8	2.4	3.3
Males total									
Canada	14.9	14.2	15.6	14.6	13.9	15.3	...	...	...
Household living arrangements									
Married spouse or common-law partner (with or without children)†	8.5	7.8	9.3	9.4	8.3	10.6	...	...	...
Parent in a one-parent household	30.3	23.7	36.8	30.1	22.1	38.2	3.2	2.4	4.3
Adult child in a couple household	26.0	22.6	29.4	47.8	27.6	67.9	5.1	3.3	7.8
Adult child in a one-parent household	49.8	42.8	56.8	53.2	43.1	63.3	5.7	4.5	7.1
Person living alone	39.8	35.9	43.6	39.8	35.8	43.8	4.2	3.6	4.9
Person living with others	35.5	30.5	40.6	39.1	33.4	44.9	4.2	3.5	5.0
Non-adult child of a couple	x	x	x	x	x	x	x	x	x
Non-adult child in a one-parent household	7.7	5.0	10.3	12.5	7.8	17.1	1.3	0.9	2.0
Non-adult child with other living arrangements	x	x	x	x	x	x	x	x	x
Tenure of housing									
Owned by a member of the household†	10.2	9.5	10.9	10.3	9.5	11.0	...	...	...
Rented	27.5	25.6	29.3	27.7	25.7	29.8	2.7	2.4	3.0
Housing suitability									
Suitable†	14.8	14.0	15.6	14.5	13.7	15.2	...	...	...
Not suitable	15.5	12.7	18.3	15.9	12.7	19.0	1.1	0.9	1.4
Classification of shelter-cost-to-income ratio by groups									
Less than 15%†	10.4	9.6	11.3	10.4	9.5	11.2	...	...	...
15% to less than 30%	13.5	12.4	14.6	13.5	12.4	14.6	1.3	1.2	1.5
30% to less than 50%	22.1	19.5	24.8	22.9	20.1	25.7	2.2	1.9	2.6
50% to less than 100%	36.3	30.8	41.9	36.3	30.7	41.9	3.5	2.9	4.2
100% or more	28.8	22.1	35.6	25.9	19.8	32.0	2.5	2.0	3.2
Females total									
Canada	7.2	6.7	7.7	7.0	6.5	7.5	...	...	...
Household living arrangements									
Married spouse or common-law partner (with or without children)†	4.2	3.7	4.7	4.2	3.6	4.8	...	...	...
Parent in a one-parent household	16.3	13.5	19.1	16.8	13.6	20.1	4.0	3.2	5.1
Adult child in a couple household	8.8	6.2	11.3	14.3	7.0	21.6	3.4	2.0	5.7
Adult child in a one-parent household	14.5	10.0	18.9	12.6	7.9	17.3	3.0	2.0	4.5
Person living alone	17.2	14.8	19.6	21.9	18.6	25.1	5.2	4.3	6.4
Person living with others	17.3	14.0	20.5	21.4	16.9	25.8	5.1	4.0	6.5
Non-adult child of a couple	x	x	x	x	x	x	x	x	x
Non-adult child in a one-parent household	3.8	2.1	5.5	5.8	2.9	8.8	1.4	0.8	2.3
Non-adult child with other living arrangements	x	x	x	x	x	x	x	x	x
Tenure of housing									
Owned by a member of the household†	3.9	3.5	4.3	3.8	3.4	4.2	...	...	...
Rented	15.5	14.1	16.9	16.2	14.6	17.7	4.3	3.7	4.9
Housing suitability									
Suitable†	7.0	6.5	7.6	6.8	6.3	7.3	...	...	...
Not suitable	8.6	6.8	10.5	8.5	6.5	10.5	1.3	1.0	1.6
Classification of shelter-cost-to-income ratio by groups									
Less than 15%†	4.3	3.8	4.9	4.1	3.6	4.6	...	...	...
15% to less than 30%	5.8	5.1	6.5	5.9	5.1	6.6	1.4	1.2	1.7
30% to less than 50%	11.9	9.9	13.9	12.2	10.2	14.3	3.0	2.4	3.7
50% to less than 100%	20.6	17.4	23.9	20.9	17.5	24.2	5.1	4.2	6.2
100% or more	15.9	11.6	20.2	14.8	10.8	18.9	3.6	2.7	4.9

... not applicable

† reference category

x suppressed to meet the confidentiality requirements of the *Statistics Act* .

1. Crude rate figures are based upon unrounded denominators and numerators rounded to base 5.

2. Mortality rates have been standardized to the total population age structure (both sexes combined) of the 2016 Census.

Notes: The 2019 to 2021 death data are considered preliminary. Data for Yukon were not available from December 31, 2016, thereon at the time of this analysis, therefore rates may be slightly underestimated.

Source: 2016 Canadian Census Health Environment Cohort (CanCHEC); 2016 Census long-form respondents linked to the Canadian Vital Statistics Deaths Database (CVSD); Statistics Canada.

immigrants (i.e., within 10 years before the 2016 Census). It has been previously reported that new immigrants to Canada have a different socioeconomic profile than their Canadian-born peers, partly owing to immigration policy.[30] A strength of the present study is that ATDs were able to be reported according to immigrants' admission category and by sex. The present study showed lower ASMRs among immigrants across every admission category compared with non-immigrants (Table 1). Others have noted though that the relationship between immigrants' admission category and health may vary depending on migrants' country of origin.[26] Furthermore, associations between potentially protective factors, such as higher education, employment, and income, may operate differently for immigrants than for Canadian-born individuals.[31] These points warrant additional analysis of ATDS with disaggregation and intersectional analyses of correlated factors.

The present study also revealed that individuals in racialized populations experienced significantly lower ASMRs relative to the non-Indigenous, non-racialized population. These findings are consistent with that of others who reported higher rates of fatal overdoses among White people compared with racialized people in the United States.[32,33,34,35] However, both recent[36,37] and historical[37] examinations have shown that the rate of opioid-involved overdose deaths in the United States have been steeper among racialized groups, such as Indigenous and Black population groups, compared with non-racialized groups. Also, surveillance data for Ontario suggests higher rates for lower-income racialized people.[38,39] Therefore, more work is needed to further disaggregate the potential heterogeneity of ATD rates across different racial groups.

Several U.S. studies and others in Canada have found associations between housing vulnerability and overdose deaths.[40,41,42,43] In the present study, people who experienced greater housing vulnerability had elevated ASMRs compared with those spending less of their income on housing. These results may provide another reason to address unaffordable housing (i.e., spent 30% or more of household total income on shelter costs), which could point housing policy-developers to particular populations having greater ATD risk. However, it should be noted that this study included only individuals who were housed. Individuals living in institutional settings or those who were unhoused at the time of the census were excluded. Others' work has shown that such excluded populations experience disproportionately higher burden of ATDs in Canada.[43]

In the present study, some living arrangements showed ATD patterns that align with previously acknowledged risks and protective factors.[44] Adults living with a spouse or common-law partner were at lower risk for ATD, while adults in other living arrangements (e.g., living alone, living with relatives or with roommates) were at elevated risk. The impacts of loneliness and social marginalization on health and wellbeing, including among people who use substances[45], have shown that having fewer social contacts is associated with poorer health outcomes[46], including mortality.[47,48] Furthermore, some living arrangements offer fewer opportunities for others to intervene during an overdose event. Mechanisms underlying living arrangements, social connections, and overdoses represent a current research gap.[32]

This study's results mirror previous jurisdiction-specific research that used other integrated, individual-level information that had come from sources other than the census to examine associations between opioid-related deaths and characteristics such as income, and industry of employment.[11,12,14] The present study was designed to consider each socioeconomic and demographic risk factor individually (while accounting for age and sex differences); however, many of these risk factors are correlated with one another. Future work could assess the combined effect of these multiple risk factors in a single model to determine which factors are the strongest drivers of ATD risk. Future work could also take an intersectional approach to better understand the interplay between multiple risk or protective factors, for example, to distinguish intersections between being an immigrant, landing year, and employment, or among racialized sub-populations in relation to lower ATD rates. Additionally, several CanCHECs could be used to evaluate trends in ATDs among subpopulation groups, to determine whether disparities have widened or narrowed over time. This could be especially important as the demographics of the Canadian population change over time.[49]

Some other limitations may affect the generalizability of the presented results and should be acknowledged. First, death data for the years 2019 to 2021, which were linked to the 2016 CanCHEC in this study, are considered preliminary. As such, some ATDs may not have been included because the cause of death was still pending investigation by a coroner or medical examiner. Furthermore, the follow-up period was not adjusted for people living in Yukon, despite deaths data not being available in the CVSD from 2017 thereon at the time of analysis. This means that mortality rates reported in the current study are an underestimate relative to any future reports with more complete death data. Next, only the private household dwelling population receives the census long-form questionnaire. The institutionalized population (e.g., incarcerated people), people living in collective dwellings (e.g., long-term care or residential care facilities), and people not enumerated (e.g., unhoused people) were not included in the study cohort. Therefore, caution is warranted before generalizing results to the entire population of Canada. Also, other than aging the cohort and adjusting time at risk of death across the five-year study periods, no other adjustments were made to account for changes to Canada's population composition or individual risk factors, such as changes to proportions of landed immigrants or to a person's employment over time. Therefore, generalizing these results to years other than those included in this study should be done cautiously. Lastly, information about specific types of substances involved in reported deaths, or manner of death, may be available in

future work using these data but were not included in the present report.

Interpretation

The significantly greater ATD prevalence for certain groups in Canada's population that this study details suggests that having specific characteristics places an individual at greater risk of ATD within this study's reference period. The ATD variation shown in this study can serve as a foundation for future intersectional modelling that might clarify mechanisms underlying reported associations to better inform more specific strategies aiming to reduce ATDs. Going forward, this new national information that is based on linked pre-existing data sources could be used to contribute further insights to the nature of differences in ATD rates across population groups and over time.

Appendix A

Distribution of total[1] identified acute toxicity death cases experienced among the 2016 Canadian Census Health Environment cohort within five years from the 2016 Census enumeration date, May 10, 2016, to May 9, 2021, by underlying cause of death

Underlying cause of death based on International Statistical Classification of Diseases and Related Health Problems, Tenth Revision[2] codes.		Total (Both sexes)				Males				Females			
Causes of death[3] by poisoning and exposure to:	ICD-10	Estimate[1]	%	LCI	UCI	Estimate[1]	%	LCI	UCI	Estimate[1]	%	LCI	UCI
Non-opioid analgesics, antipyretics and antirheumatics	X40, X60, Y10	280	1.5	1.3	1.7	110	0.9	0.7	1.1	170	2.7	2.3	3.1
Antiepileptics, sedative-hypnotic, antiparkinsonism, psychotropic drugs, not elsewhere classified	X41, X61, Y11	1,590	8.5	8.1	8.9	860	6.9	6.5	7.4	725	11.7	10.9	12.5
Narcotics, and psychodysleptics [hallucinogens], not elsewhere classified	X42, X62, Y12	7,340	39.4	38.7	40.1	5,375	43.3	42.4	44.2	1,965	31.7	30.5	32.9
Other and unspecified drugs, medicaments and biological substances	X44, X64, Y14	7,365	39.6	38.9	40.3	4,520	36.4	35.6	37.3	2,840	45.8	44.6	47.0
Alcohol	X45, X65, Y15	855	4.6	4.3	4.9	590	4.8	4.4	5.1	260	4.2	3.7	4.7
Carbon monoxide and other gases and vapours	X47, X67, Y17	1,015	5.5	5.1	5.8	830	6.7	6.2	7.1	185	3.0	2.6	3.4
Grouped other [4]	X43, X63, Y13, X46, X66, Y16, X48, X68, Y18, X49, X69, Y19	165	0.9	0.8	1.0	115	0.9	0.8	1.1	45	0.7	0.5	0.9

1. Estimates (counts, proportions) are based upon weighted values, randomly rounded to base 5.

2. World Health Organization (WHO), International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10), ICD-10 Version:2019 (https://icd.who.int/browse10/2019/en)

3. All manners of death (Accidental; Intentional; Undetermined) combined.

4. Grouped other includes: Other drugs acting on the autonomic nervous system (X43, X63, Y13); Organic solvents and halogenated hydrocarbons and their vapours (X46, X66, Y16); Pesticides (X48, X68, Y18); and Other and unspecified chemicals and noxious substances (X49, X69, Y19).

Notes: LCI = lower confidence interval; UCI = upper confidence interval; CV = coefficient of variation. The 2019 to 2021 death data are considered preliminary. Data for Yukon were not available after December 31, 2016; therefore estimates are slightly underestimated.

Sources: Statistics Canada, 2016 Canadian Census Health Environment Cohort (CanCHEC); 2016 Census long-form respondents linked to the Canadian Vital Statistics Deaths Database (CVSD) .

Appendix B

Examined covariates provided by the 2016 Census long-form questionnaire

Table or Appendix	Categories
Table 1	
Sex	Male; Female
Age group	0 to 19 years; 20 to 29; 30 to 39; 40 to 49; 50 to 59; 60 to 69; 70 or years or older.
Population groups	Population group refers to the population group or groups to which the person belongs. These are the groups used on questionnaires that collect data on the visible minority population for employment equity purposes. The *Employment Equity Act* defines visible minorities as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour." Individuals who self-identify as Indigenous are not asked the population group questions on the census. Therefore, self-identified Indigenous people are excluded from this covariate. For this study, racialized populaton groups include responses of South Asian, Chinese, Black, Filipino, Latin American, Arab, Southeast Asian, West Asian, Korean or Japanese, "visible minorities not included elsewhere," as well as "multiple visual identity." The non-racialized population group includes responses of White. For this study, two categories of population groups were used: racialized groups; non-racialized population. Racialized groups include those who reported being South Asian, Chinese, Black, Filipino, Latin American, Arab, Southeast Asian, West Asian, Korean or Japanese, "visible minorities not included elsewhere," well as "multiple visual identity." The non-racialized population includes those who reported being White.
Immigrant status	Immigrant status refers to whether the person is a non-immigrant, an immigrant or a non-permanent resident. Immigrants include people who are, or who have ever been, landed immigrants or permanent residents. Such people have been granted the right to live in Canada permanently by immigration authorities. Immigrants who have obtained Canadian citizenship by naturalization are included in this category. In the 2016 Census of Population, immigrants include those who landed in Canada on or before May 10, 2016.
Among immigrants, immigration admission category	Admission category refers to the name of the immigration program or group of programs under which an immigrant has been granted, for the first time, the right to live in Canada permanently by immigration authorities. The following six admission categories and applicant types pertain to immigrants who landed in Canada between January 1, 1980, and May 10, 2016: economic immigrants (principal applicants); economic immigrants (secondary applicants); immigrant sponsored by family; refugees; non-permanent residents; and other immigrants, for example, immigrants who may not have qualified in any program but have been granted, on an exceptional basis, permanent resident status based on humanitarian and compassionate considerations or for public policy reasons. Immigrants who landed in Canada before 1980 were classified as "immigrants who landed before 1980."
Among immigrants, period of immigration	Period of immigration refers to the period in which the immigrant first obtained landed immigrant or permanent resident status. This is derived from "year of immigration," which refers to the year in which the immigrant first obtained landed immigrant or permanent resident status. This factor applies only to immigrants (i.e., excludes non-permanent residents). Immigrants who landed before 1980 are in the "immigrated more than 10 years ago" category.
Table 2	
Total household income quintile	This used total adjusted after-tax income of all people in the household. Based upon information provided by respondents, total income refers to the sum of certain incomes (in cash and, in some circumstances, in kind) of the household during a specified reference period. The after-tax adjusted total household income takes the number of people in the household into account. For this study quintile thresholds used the distribution of the calculated total household person-adjusted after-tax income of the national 2016 Canadian Census Health and Environment Cohort. For this study, Quintile 1 refers to the lowest quintile; Quintile 5 refers to the highest quintile.
Educational attainment: Highest certificate, diploma, or degree	Highest certificate, diploma, or degree is the classification used in the census to measure the broader concept of educational attainment.This variable refers to the highest level of education that the respondent has successfully completed and is derived from the educational qualifications questions, which asked for all certificates, diplomas, and degrees to be reported. For respondents aged 15 years or older, educational attainment was classified into one of the following categories: no certificate, diploma, or degree; secondary (high) school diploma or equivalency certificate; apprenticeship or trade certificate or diploma; college, CEGEP, or other non-university certificate or diploma; university certificate or diploma below bachelor's level; university certificate or diploma at bachelor's level or above; otherwise the person was categorized as "aged younger than 15 years."
Labour force status (among those aged 15 years and older)	Labour force status refers to whether a person was employed, unemployed, or not in the labour force (i.e., being available and looking for work) during the reference period. Early enumeration was conducted in remote, isolated parts of the provinces and territories in February, March, and April 2016. When enumeration has taken place before May 2016, the reference date used is the date on which the household was enumerated.This concept (labour force status) is applicable only to individuals aged 15 years or older. This study reports results for these three categories: employed, unemployed, and not in the labour force. Employed people include those who (a) did any work at all at a job or business, that is, paid work in the context of an employer–employee relationship, or self-employment during the week of Sunday, May 1 to Saturday, May 7, 2016; (b) did unpaid family work, which is defined as unpaid work contributing directly to the operation of a farm, business, or professional practice owned and operated by a related member of the same household; or (c) had a job but were not at work because of factors such as their own illness or disability, personal or family responsibilities, vacation, or a labour dispute. This (c) category excludes persons not at work because they were on lay-off or between casual jobs, and those who did not then have a job (even if they had a job to start at a future date); Unemployed people included those who, during the week of Sunday, May 1 to Saturday, May 7, 2016, were without paid work or without self-employment work and were available for work and either: (a) had actively looked for paid work in the past four weeks; (b) were on temporary lay-off and expected to return to their job; or (c) had definite arrangements to start a new job in four weeks or less. Not in the labour force includes people who, during the week of Sunday, May 1 to Saturday, May 7, 2016, were neither employed nor unemployed.
Occupation group (among the employed; based on the National Occupation Classification (NOC) 2016	Occupation category is based on the National Occupational Classification (NOC) 2016, "occupation" refers to the kind of work performed in a job, a job being all the tasks carried out by a particular worker to complete their duties. An occupation is a set of jobs that are sufficiently similar in work performed. Among respondents who reported that they were employed, individuals were classified into one of these 10 mutually exclusive occupation categories: management occupations; business, finance and administration occupations; natural and applied sciences and related occupations; health occupations; occupations in education, law, social, community and government services; occupations in art, culture, recreation and sport; sales and service occupations; trades, transport and equipment operators and related occupations; natural resources, agriculture and related production occupations; and occupations in manufacturing and utilities.
Table 3	
Household living arrangements	Household living arrangements refer to whether the person lives with another person or people and, if so, whether they are related to that person or those people. Categories used in this study include married spouse or common-law partner (with or without children), parent in one-parent household, adult (aged 20 years or older) child in a couple household, non-adult (younger than age 20) child in a couple household, adult child in a one-parent household, non-adult child (younger than 20 years) in a one-parent household, person living alone, person living with others, or non-adult child (younger than age 20) with other living arrangements.
Tenure of housing	Tenure refers to whether the household owns or rents their private dwelling. The private dwelling may be situated on rented or leased land or be part of a condominium. A household is considered to own their dwelling if some member of the household owns the dwelling even if it is not fully paid for, for example, if there is a mortgage or some other claim on it. A household is considered to rent their dwelling if no member of the household owns the dwelling. For historical and statutory reasons, shelter occupancy on Indian reserves or settlements does not lend itself to the usual classification by standard tenure categories. Therefore, a special category, band housing, was created for census purposes. For this study, results are reported for these two mutually exclusive categories: owned by a member of the household or rented.
Housing suitability	Housing suitability refers to whether a private household is living in suitable accommodations according to the National Occupancy Standard (NOS); that is, whether the dwelling has enough bedrooms for the size and composition of the household. A household is deemed to be living in suitable accommodations if its dwelling has enough bedrooms, as calculated using the NOS. Housing suitability and the NOS on which it is based were developed by Canada Mortgage and Housing Corporation through consultations with provincial housing agencies. For this study, respondents' housing was deemed either suitable or not suitable.
Classification of shelter-cost-to-income ratio by groups	Shelter-cost-to-income ratio refers to the proportion of average total income of a household that is spent on shelter costs. In 1986, the Canada Mortgage and Housing Corporation and the provinces agreed to measure housing affordability based on whether the household spent 30% or more of its average monthly total income on shelter costs. This study used the following standard Statistics Canada classification structure to represent the individuals' proportion of average total income of their household that is spent on shelter costs as one of these categories: less than 15%, 15% to less than 30%, 30% to less than 50%, 50% to less than 100%, or 100% or more.

Source: Statistics Canada. Dictionary, Census of Population, 2016. Complete A to Z index. 2016. (https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/az1-eng.cfm)

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