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At-a-glance

A comparison of the characteristics of accidental substance-related acute toxicity deaths in Canada across life stages, 2016–2017

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Part of our "Accidental overdose mortality" theme series.

Abstract

The acute toxicity (sometimes called "overdose" or "poisoning") crisis has affected Canadians across all stages of life, including youth, adults and older adults. Our biological risks and exposures to substances change as we age. Based on a national chart review study of coroner and medical examiner data on acute toxicity deaths in 2016 and 2017, this analysis compares the burden of deaths and circumstances of death, locations of acute toxicity event and death, health history and substances contributing to death of people, by sex and life stage.

Keywords: *substance use, acute toxicity deaths, youth, adults, older adults, Canada*

Highlights

- This analysis reveals key differences in the characteristics of acute toxicity deaths by sex and life stage, and suggests potential intervention points for each group.
- Many people across demographics were alone while using substances before the acute toxicity event, and many were alone when they died. Youth, particularly female youth, more often died in circumstances where someone might have been available to help by calling 911 or administering first aid and naloxone.
- For the people who were in contact with health care prior to their death, about one-quarter (24%–28%) of adults and older adults sought assistance for reasons related to pain. Youth more often sought assistance for a nonfatal acute toxicity event (13%–14%) or for mental health (particularly female youth, 21%) than people in other life stages.
- Multiple substances contributed to most deaths, and both pharmaceutical and nonpharmaceutical substances were common causes of death for all life stages and sexes. There are demographic differences in the specific substances contributing to death.

Introduction

The acute toxicity (sometimes called "overdose" or "poisoning") crisis has affected Canadians from all walks of life and of all ages—children, youth, adults including older adults have died. At the population level, our biological risks from substance use change as we age: our brains are not fully developed until our mid-20s;[1] over time we can accumulate more diseases and disorders;[2] and eventually our metabolism and ability to process substances slows down.[3] Our exposures to substances also evolve with age: first exposures to nonmedical substance use are often in our youth;[4] peer pressure to engage in nonmedical substance use changes over time;[4] and we are more likely to have multiple prescriptions in later life.[5]

In this analysis, we compare characteristics of acute toxicity deaths across life stages for youth, adults and older adults. This analysis serves as an important baseline at the beginning of the acute toxicity crisis that can be used to measure change. It is intended to bridge previously published in-depth reports on youth[6] and older adults,[7] and compares broader life stages rather than the 5- or 10-year age groupings other reports use based on the same dataset.[8,9]

Methods

This study was reviewed and approved by the Public Health Agency of Canada Research Ethics Board (REB 2018-027P), the University of Manitoba Health Research Ethics Board (HS22710) and the Newfoundland and Labrador Health Research Ethics Board (20200153).

For the purposes of this study, life stages are defined as youth (aged 12 to 24 years),

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adults (aged 25 to 59 years) and older adults (aged 60 plus years). Substances include alcohol, pharmaceutical and non-pharmaceutical drugs and chemicals not approved for human consumption (e.g. illegal drugs, nonpharmaceutical inhalants, industrial or household chemicals, or veterinary drugs). Based on a national retrospective chart review study of coroner and medical examiner data on all substance-related acute toxicity deaths from 1 January 2016 to 31 December 2017,[8,10] we calculated the burden of accidental substance-related acute toxicity deaths and characteristics of people who died by sex and life stage. Table 1 lists the variables used in the analysis and their descriptions.

Burden is based on the number of deaths, mortality rate and proportionate mortality ratio due to accidental substance-related acute toxicity. Mortality rates were calculated with population counts from the 2016 Census[11] as the denominator. To calculate the proportionate mortality ratios attributable to substance-related acute toxicity, we used data from Statistics Canada on all-cause accidental mortality counts by demographic group for the denominators. We included all-cause deaths with ICD-10 codes V01–V99 (transport accidents), W00–X59 (other external causes of accidental injury), Y85 (sequelae of transport accidents) and Y86 (sequelae of other accidents).

We also analyzed the circumstances of death, locations of the acute toxicity event and death, health history and substances contributing to death of people who died of accidental acute toxicity, by sex at birth and life stage, using the variables described in Table 1. We calculated the proportions of each group that had a given characteristic, and conducted Pearson chi-square tests to assess statistical differences across life stages and sex ($p < 0.05$). As information on the variables of interest are not always recorded in death investigation files, the results represent only the minimum proportions of people who had a given characteristic.

To protect privacy, all counts are randomly rounded to base 3 (i.e. values had different chances of being rounded to nearest multiples of 3) and counts less than 10 are suppressed.[10] Since table totals were also independently rounded to base 3, the sum of values do not always equal the total. Proportions and mortality rates are calculated with rounded counts.

Results

Each of these demographic groups has been affected by the acute toxicity crisis in different ways. Acute toxicity accounted for 41% to 60% of all accidental deaths for youth and adults (Table 2). The mortality rate due to accidental acute toxicity was much higher for male adults (30 deaths per 100 000 population) than the other demographic groups (2.8–9.5 deaths per 100 000 population). Among the people who died of accidental acute toxicity, contacts with health care, circumstances of death and substances contributing to death varied by life stage and sex.

Circumstances of accidental acute toxicity deaths

- Older adults were less often using substances in the presence of others prior to their death (12%–14% vs. 16%–28%).
- Older adults were more often already dead when found compared with youth and adults (38%–39% vs. 19%–29%).
- Many people were found in or near a bed (24% to 39%) where their acute toxicity event could have been misinterpreted as sleep. Females were more often found in or near a bed.
- Among people who were reported to show signs of opioid toxicity before death, naloxone was less often administered to older adults (counts and proportions suppressed due to small numbers).
- For all life stages, the most frequent location for the acute toxicity event leading to death was the individual's personal residence (59%–87%). Of those who had their acute toxicity event in their personal residence, older adults more commonly lived alone (31%–32% vs. 16% or less).
- Though less common across all life stages, youth and adults were more often at the home of another person compared to older adults (14%–16% and 9%–10%, respectively, vs. 5% or less).
- Most people died where the acute toxicity event happened (68%–84%). Female youth were most often transported to hospital before death (26%), and male older adults were least often transported to hospital (10%).

Health history and previous contacts with the health system of people who died of accidental acute toxicity

- Most people who died had a history of substance use (excluding alcohol). This was less common for female older adults (55%) than other demographic groups (71%–83%).
- Female older adults also had a history of substance use disorders (excluding alcohol) less frequently than other demographic groups (10% vs. 18%–22%).
- The frequency of alcohol use disorders increased with age (5%–6% among youth to 12%–15% among older adults).
- Male youth (42%) and female older adults (43%) had a history of chronic (daily) substance use less often than other demographic groups (48%–59%).
- Having a history of depression or depressive symptoms and of anxiety disorders was more frequent among females than males (29%–39% and 19%–22%, respectively, vs. 19%–22% and 11%–14%, respectively).
- Contact with health care services (inpatient or outpatient) in the year prior to death was more common with increased age (58%–61% for youth to 80%–91% for older adults).
- For the people who were in contact with health care prior to their death, there were no demographic differences in seeking care for substance use and/or addictions. About one-quarter (24%–28%) of adults and older adults sought assistance for reasons related to pain. Youth more often sought assistance for a nonfatal acute toxicity event (13%–14%) or for mental health (particularly female youth, 21%) than people in other life stages.

Substances causing accidental acute toxicity deaths

- A pharmaceutical substance contributed to death most often among female older adults (63% vs. 28%–46%).

TABLE 1
Variables used to describe the burden of substance-related acute toxicity deaths and the characteristics of people who died, by sex and life stage, Canada, 2016–2017

Variable	Description
Burden	
Number of accidental acute toxicity deaths	A count of accidental substance-related acute toxicity deaths.
Mortality rate due to accidental acute toxicity per 100 000 population	The number of deaths for every 100 000 people in that population. Controls for differences in the number of people that fall into each demographic category.
Proportionate mortality ratio due to accidental acute toxicity	The proportion of all-cause accidental mortality that is due to accidental acute toxicity.
Circumstances of death	
Was using substances in the presence of others	The person who died consumed substances in the presence of others prior to the fatal acute toxicity event, i.e. the substance use was witnessed.
Deceased when found	There was no known witness to the fatal acute toxicity event and no intervention was possible when the person who died was found.
Found in or near a bed	The person who died was in or near where they could have been thought to be sleeping. A perception that the person was sleeping, and not unconscious, could have delayed a response.
Had signs of opioid toxicity	A bystander or first responder who witnessed the fatal acute toxicity event observed one or more signs of opioid toxicity. These include snoring/gurgling, difficulty breathing, pinpoint pupils, unconsciousness or unresponsiveness, or blue lips/fingernails/face. As toxicology information is not immediately available, bystanders and first responders use toxidromes, or symptoms of toxicity, to determine the substance(s) causing the acute toxicity and how to respond.
Naloxone was given	The count as well as the proportion of those with signs of opioid toxicity who were given naloxone, an antidote for opioid toxicity. This includes naloxone given by bystanders, EMS, police, fire, hospital staff or others.
Place of acute toxicity event	The fatal acute toxicity event occurred in the home of the person who died, in the home of another person or in another location.
Lived alone	Of those whose fatal acute toxicity event occurred in their own home, those who lived alone. Those who lived alone may have been less likely to have someone nearby to help.
Place of death	Whether the person was transported from the location of the acute toxicity event to a hospital or another location before they died, or if they died in the same place as the acute toxicity event.
Health history [a]	
History of substance use (excluding alcohol)	The death investigation file includes information that the person had a history of substance use, excluding the use of alcohol or the use of pharmaceuticals as prescribed to them.
History of substance use disorder (excluding alcohol)	The death investigation file explicitly states that the person had a substance use disorder.
History of alcohol use disorder	The death investigation file explicitly states that the person had an alcohol use disorder.
History of chronic (daily) substance use	The death investigation file mentions that the person used substances chronically (i.e. daily).
Lifetime history of a nonfatal acute toxicity event	The death investigation file includes a record of a previous nonfatal acute toxicity event (overdose).
History of depression or depressive symptoms	The death investigation file includes information that the person had a depressive disorder or depressive symptoms.
History of anxiety disorder	The death investigation file includes information that the person had an anxiety disorder.
Contact with health care in the previous year	The person had contact with health care services in the year prior to their death. This could be outpatient or inpatient services.
Sought assistance for…	For those who had contact with health care services in the year prior to their death, the death investigation file describes a specific reason the person sought health care services, e.g. pain, a nonfatal acute toxicity event, substance use and/or addictions, or mental health.

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TABLE 1 (continued)
Variables used to describe the burden of substance-related acute toxicity deaths and the characteristics of people who died, by sex and life stage, Canada, 2016–2017

Variable	Description
Substances contributing to death	
Origin of substances contributing to death	Origins of substances are categorized into: • nonpharmaceutical ("street drugs" and substances not intended for human use, e.g. industrial or household chemicals or veterinary medications); • pharmaceutical (produced for human use by a regulated pharmaceutical manufacturer); • ethanol (originating in the alcoholic beverage industry or home-distilled alcohol and does not fall under the other origin categories), or • unknown (insufficient evidence to determine the origin of the substance). A substance can have multiple origins. Deaths due solely to prescribed substances or alcohol were not available from British Columbia.
At least one of the pharmaceutical drugs was prescribed	Of the people who had at least one pharmaceutical drug contribute to their death, those who had been prescribed at least one of these drugs.
Substances most often contributing to death	Specific substances that contributed to at least 10% of deaths for one of the demographic groups.
Multiple toxicity, no substances specified	Deaths with a cause of death describing multiple substances contributing to the death, but not listing the specific contributing substances.
Multiple substances contributed to death	Deaths where more than one substance was identified as a contributor to the death.

Abbreviation: EMS, emergency medical services.

[a] Abstractors included any information about health history in the file, including medical records or statements from family or friends. The conditions reported may not have been clinically diagnosed.

- A nonpharmaceutical substance contributed to death most often among youth and male adults (72%–74%).
- Youth had a prescription for pharmaceutical drugs that contributed to their deaths less often than other groups (16%–18% vs. 40%–66%).
- Multiple substances contributed to most deaths (55%–72%).
- The most common substances contributing to death in youth were similar for both sexes (fentanyl, cocaine, methamphetamine, ethanol [alcohol] and amphetamine), but there were sex differences for the other age groups. For example, fentanyl contributed to a greater proportion of male adult deaths (53%) than female adult deaths (36%) and to male older adult deaths (32%) than female older adult deaths (16%).
- Fentanyl was a cause of more than half of fatal acute toxicity events of youth (55%–57%) and male adults (53%).

Discussion

This analysis reveals key differences in the characteristics of acute toxicity deaths by sex and life stage and suggests potential intervention points for each group. Many people who died of acute toxicity had contact with health care in the year prior to their death. These encounters with the health care system provide earlier opportunities to identify and address the risk of a fatal acute toxicity event as well as unmet health and social needs that may contribute to substance use. About one in four adults and older adults were in contact with health care for reasons related to pain. Such contacts create an opportunity for discussions regarding pain management, including safe use of pain medications, seeking relief from other substances, and other available treatment options and services to help alleviate pain.

Youth, particularly female youth, more often died in circumstances where someone might have been available to help by calling 911 or administering first aid and naloxone (Table 2). It is important that potential witnesses to acute toxicity events be able to recognize and respond to the emergency, and have the right tools to help (e.g. a naloxone kit, a phone to call 911). Many people across demographics were alone while using substances before the acute toxicity event, and many were alone when they died. Removing the stigma of substance use is important so that those who are using substances alone can find greater safety with others. Supporting connections to laypeople trained in overdose prevention or formalized supervised consumption services could help prevent these deaths.

Multiple substances contributed to most deaths, and both pharmaceutical and nonpharmaceutical substances were common causes of death for all life stages and sexes (Table 2). When a pharmaceutical substance contributed to death, many people, and particularly older adults and female adults, had been prescribed the substance that caused their death. The involvement of multiple substances in an acute toxicity event is the norm, and the potential combined harms of substances are an important consideration for prescribing practices (e.g. management of multiple prescriptions), patient education, harm reduction programs, drug checking services and drug alerts.

In this study, we were unable to differentiate between whether the multiple substances involved were intentionally or unintentionally consumed. Initiatives to address the toxic drug supply would benefit all demographics, as would a harm reduction approach to prescribing that emphasizes patient education about the risks of their prescription drugs, their risks in combination with other substances and the risks of diversion.[12,13]

TABLE 2
Burden, circumstances of death, documented health history and substances contributing to the deaths of people who died of accidental acute toxicity, by sex and life stage, Canada, 2016–2017

	Youth (12–24 years)		Adults (25–59 years)		Older adults (≥60 years)	
	Female	Male	Female	Male	Female	Male
Total accidental acute toxicity deaths	**N = 207**	**N = 525**	**N = 1563**	**N = 4896**	**N = 246**	**N = 462**
Mortality rate due to accidental acute toxicity, per 100000 population	3.9	9.5	9.2	30	2.8	6.0
Proportionate mortality ratio, %	42	41	59	60	3.1	5.9
Circumstances of death, % (n)						
Was using substances in the presence of others*	28 (57)	19 (102)	20 (315)	16 (783)	12 (30)	14 (63)
Deceased when found*	19 (39)	24 (126)	28 (435)	29 (1419)	39 (96)	38 (177)
Found in or near a bed*	35 (72)	30 (156)	35 (543)	24 (1191)	39 (96)	24 (111)
Had signs of opioid toxicity[a]	36 (75)	30 (159)	33 (519)	26 (1263)	27 (66)	21 (96)
Naloxone was given*	40 (30)	34 (54)	22 (114)	28 (357)	Suppressed	Suppressed
Place of acute toxicity event*, % (n)						
Personal residence	59 (123)	61 (321)	70 (1092)	62 (3021)	87 (213)	77 (354)
Lived alone	Suppressed	7 (23)	16 (179)	15 (465)	32 (69)	31 (111)
Home of another person	16 (33)	14 (75)	10 (162)	9 (453)	Suppressed	5 (21)
Other	23 (48)	25 (129)	20 (309)	29 (1419)	10 (24)	18 (84)
Place of death*, % (n)						
Same as place of acute toxicity event	68 (141)	71 (375)	71 (1113)	76 (3735)	78 (192)	84 (390)
Hospital [b]	26 (54)	22 (114)	22 (339)	17 (825)	17 (42)	10 (48)
Other	6 (12)	7 (39)	7 (111)	7 (333)	5 (12)	5 (24)
Health history, % (n)						
History of substance use (excluding alcohol)*	83 (171)	81 (426)	78 (1215)	83 (4083)	55 (135)	71 (330)
History of substance use disorder (excluding alcohol)*	20 (42)	20 (105)	22 (339)	20 (966)	10 (24)	18 (81)
History of alcohol use disorder*	6 (12)	5 (27)	9 (135)	9 (426)	12 (30)	15 (69)
History of chronic (daily) substance use*	48 (99)	42 (219)	50 (783)	54 (2646)	43 (105)	59 (273)
Lifetime history of a nonfatal acute toxicity event	17 (36)	17 (87)	15 (234)	12 (585)	15 (36)	9 (42)
History of depression or depressive symptoms*	29 (60)	19 (99)	33 (516)	20 (963)	39 (96)	19 (90)
History of anxiety disorder*	22 (45)	14 (72)	19 (300)	11 (528)	21 (51)	11 (51)
Contact with health care in the previous year*, % (n)	**61 (126)**	**58 (306)**	**80 (1254)**	**66 (3249)**	**91 (225)**	**80 (369)**
Sought assistance for pain*	14 (18)	17 (51)	26 (321)	25 (810)	24 (54)	28 (105)
Sought assistance for a nonfatal acute toxicity event*	14 (18)	13 (39)	7 (90)	8 (249)	7 (15)	7 (24)
Sought assistance for substance use and/or addictions	19 (24)	17 (51)	13 (165)	14 (444)	9 (21)	9 (33)
Sought assistance for mental health*	21 (27)	14 (42)	13 (165)	11 (342)	11 (24)	6 (21)
Origin of substances contributing to death[c], % (n)						
At least 1 nonpharmaceutical*	72 (150)	73 (384)	55 (861)	74 (3624)	18 (45)	55 (255)
At least 1 pharmaceutical*	32 (66)	29 (150)	46 (720)	28 (1347)	63 (156)	40 (186)
At least 1 of the pharmaceutical drugs was prescribed*	18 (12)	16 (24)	56 (402)	40 (537)	66 (99)	56 (102)
Substances most often contributing to death, % (n)						
Fentanyl*	57 (117)	55 (291)	36 (555)	53 (2562)	16 (39)	32 (150)
Cocaine*	28 (57)	30 (156)	30 (474)	39 (1887)	10 (24)	36 (165)
Methamphetamine*	22 (45)	17 (87)	22 (339)	24 (1170)	5 (12)	11 (51)
Ethanol (alcohol)*	16 (33)	15 (81)	21 (330)	23 (1107)	18 (45)	26 (120)
Amphetamine*,[d]	13 (27)	11 (57)	7 (117)	14 (678)	Suppressed	6 (30)
Morphine[d]	12 (24)	14 (72)	14 (219)	14 (696)	11 (27)	17 (78)

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TABLE 2 (continued)
Burden, circumstances of death, documented health history and substances contributing to the deaths of people who died of accidental acute toxicity, by sex and life stage, Canada, 2016–2017

	Youth (12–24 years)		Adults (25–59 years)		Older adults (≥60 years)	
	Female	Male	Female	Male	Female	Male
Alprazolam*	10 (21)	10 (51)	2 (27)	2 (78)	Suppressed	Suppressed
Diacetylmorphine (heroin)*	6 (12)	12 (63)	6 (99)	12 (606)	Suppressed	6 (30)
Methadone*	6 (12)	7 (36)	11 (168)	8 (378)	5 (12)	8 (39)
Multiple toxicity, no substances specified*	Suppressed	3 (18)	8 (120)	4 (201)	15 (36)	6 (27)
Oxycodone*	Suppressed	6 (30)	7 (114)	5 (258)	12 (30)	6 (30)
Multiple substances contributed to death	68 (141)	64 (336)	72 (1122)	71 (3480)	55 (135)	64 (297)

Sources: National chart review study of substance-related acute toxicity deaths (2016 to 2017)[8,10]; 2016 Census.[11]

Notes: Deaths due solely to prescribed substances or alcohol were not available from British Columbia and all numbers in this table may be underestimates. The denominator for each group is from the 2016 Census.[11] The all-cause mortality counts by demographic group used to calculate the proportion of the mortality rate for all causes due to acute toxicity were provided by Statistics Canada. All accidental deaths include ICD-10 codes V01–V99, W00–W99, X00–X59, Y85 and Y86.

To protect privacy, counts from the national chart review study of substance-related acute toxicity deaths were randomly rounded to base 3, and proportions and rates were based on randomized counts. Counts <10 and the proportions and rates based on counts <10 are suppressed. Test statistics and exact *p* values are not shown to protect the random rounding.

[a] Signs of opioid toxicity include snoring/gurgling, difficulty breathing, pinpoint pupils, unconscious or unresponsive, or blue lips/fingernails/face.

[b] The "hospital" category includes only the people who were transported to hospital from another location. If an acute toxicity event leading to death occurred in a hospital and the person died in hospital it was categorized as "same as place of acute toxicity event." Less than 1% of fatal acute toxicity events occurred in a hospital. Notably, most of the fatal acute toxicity events that occurred in hospitals were among male adults (33 of 45 events, not shown).

[c] Origins of substances are categorized into: nonpharmaceutical ("street drugs" and substances not intended for human use, e.g. industrial or household chemicals or veterinary medications); pharmaceutical (produced for human use by a regulated pharmaceutical manufacturer); ethanol (originating in the alcoholic beverage industry or home-distilled alcohol, neither of which belong in the other origin categories); or unknown (insufficient evidence to determine the origin of the substance). A substance can have multiple origins.

[d] Amphetamine and morphine are active metabolites of other substances that may have contributed to death. Amphetamine is a metabolite of methamphetamine and morphine is a metabolite of heroin. The presence of these substances in toxicology testing may be because the parent substance was consumed rather than the substance itself.

* $p < 0.05$.

Strengths and limitations

A chart review of death investigation data allowed for more detailed analysis of patterns in substance-related acute toxicity deaths for different demographic groups. This is particularly true for the circumstances surrounding the death, as there is limited contextual information captured in other reporting systems.

Death investigation protocols vary across the country, and information about these variables is not always consistently available in death investigation files. Age, sex and manner of death were complete for all records, but for other characteristics, these are the minimum proportions of people who died of substance-related acute toxicity that had a given characteristic, and may underestimate the true number.

Conclusion

Acute toxicity is a major cause of accidental deaths among youth and adults in Canada, and entirely preventable. Contextual information from coroner and medical examiner files, even where some of the information we seek is missing, reveals patterns and potential opportunities to prevent further acute toxicity deaths for specific demographic groups, including through focused interventions across the life course. These patterns may have changed since the study period of 2016 to 2017, particularly during the COVID-19 pandemic, but these results serve as an important baseline to measure the impacts of interventions implemented in the intervening years.

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Conflicts of interest

The authors report no conflicts of interest.

Authors' contributions and statement

GC: Conceptualization, data curation, formal analysis, writing – original draft, writing – review & editing.

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References

1. Johnson SB, Blum RW, Giedd JN. Adolescent maturity and the brain: the promise and pitfalls of neuroscience research in adolescent health policy. J Adolesc Health. 2009;45(3): 216-21. https://doi.org/10.1016/j.jadohealth.2009.05.016

2. Boss GR, Seegmiller JE. Age-Related physiological changes and their clinical significance. West J Med. 1981; 135(6):434-40.

3. Klein-Schwartz W, Oderda GM. Poisoning in the elderly. Drugs Aging. 1991;1(1):67-89. https://doi.org/10.2165/00002512-199101010-00008

4. Keyzers A, Lee SK, Dworkin J. Peer pressure and substance use in emerging adulthood: a latent profile analysis. Subst Use Misuse. 2020;55(10): 1716-23. https://doi.org/10.1080/10826084.2020.1759642

5. Huang AR, Mallet L. Prescribing opioids in older people. Maturitas. 2013; 74(2):123-9. https://doi.org/10.1016/j.maturitas.2012.11.002

6. Chang YS, VanSteelandt A, McKenzie K, Kouyoumdjian F. Substance-related acute toxicity deaths among Canadian youth: a descriptive analysis of a national chart review study of coroner and medical examiner data. Health Promot Chronic Dis Prev Can. 2024; 44(3):77-88. https://doi.org/10.24095/hpcdp.44.3.02

7. Ha H, Burt J, Randell S, VanSteelandt A. Accidental substance-related acute toxicity deaths in older adults in 2016 and 2017: a national chart review study. Health Promot Chronic Dis Prev Can. 2024;44(3):89-100. https://doi.org/10.24095/hpcdp.44.3.03

8. Public Health Agency of Canada. Substance-related acute toxicity deaths in Canada from 2016 to 2017: a review of coroner and medical examiner files. Ottawa (ON): PHAC; 2022. 114 p. Available from: https://www.canada.ca/content/dam/hc-sc/documents/services/opioids/data-surveillance-research/substance-related-acute-toxicity-deaths-canada-2016-2017-review-coroner-medical-examiner-files/substance-related-acute-toxicity-deaths-canada-2016-2017-review-coroner-medical-examiner-files.pdf

9. Baddeliyanage R, Enns A, VanSteelandt A, Abele B, Kouyoumdjian F, Schleihauf E, et al. Substance-related acute toxicity deaths by area-based characteristics: a descriptive analysis of a national chart review study of coroner and medical examiner data. Int J Ment Health Addiction. 2024. https://doi.org/10.1007/s11469-024-01259-3

10. Rotondo J, VanSteelandt A, Kouyoumdjian F, Bowes MJ, Kakkar T, Jones G, et al. Substance-related acute toxicity deaths in Canada from 2016 to 2017: protocol for a retrospective chart review study of coroner and medical examiner files. JMIR Public Health Surveill. 2024:49981. https://doi.org/10.2196/49981

11. Statistics Canada. Age (in single years), average age and median age and gender: Canada, provinces and territories, census divisions and census subdivisions: Table 98-10-0022-01 [Internet]. Ottawa (ON): Statistics Canada; 2022 Apr 27 [cited 2022 Oct 04]. https://doi.org/10.25318/9810002201-eng

12. Drucker E, Anderson, K, Haemmig R, Heimer R, Small D, Walley A, et al. Treating addictions: harm reduction in clinical care and prevention. J Bioeth Inq. 2016;13:239-49. https://doi.org/10.1007/s11673-016-9720-6

13. Hawk KF, Vaca FE, D'Onofrio G. Reducing fatal opioid overdose: prevention, treatment and harm reduction strategies. Yale J Biol Med. 2015; 88(3):235-45.