

Research Article

Comparing Polysubstance and Single-class Toxicity Deaths in Newfoundland & Labrador, Canada

Cindy Whitten^{1,*} , Syed Zaigham Raza¹ , Allyson Summers¹, Nash Denic²

¹Department of Research and Innovation, Newfoundland and Labrador Health Services, St. John's, Canada

²Department of Justice and Public Safety, Office of the Chief Medical Examiner, St. John's, Canada

Abstract

Objective: This study examined differences in demographic and substance profile trends between single-class and polysubstance drug toxicity deaths in Newfoundland and Labrador, Canada, between 2018 and 2024. **Methods:** The present study employed a retrospective chart review in which information was collected from death investigation charts of individuals who died from acute drug toxicity in Newfoundland and Labrador between 2018 and 2024. Data relating to demographics and toxicology of decedents was gathered from the Office of the Chief Medical Examiner. **Results:** 403 individuals died from acute drug toxicity in NL between 2018 and 2024. Of these, 293 deaths (72.7%) were determined accidental. Among accidental deaths, 160 deaths (55%) were caused by polysubstance toxicity and 133 deaths (45%) were caused by single-substance toxicity. Sex differences were more pronounced among females, who died more often from polysubstance than single-class deaths. Males died from single-class toxicity more often in the last three years of the study. Cocaine was the most implicated substance across toxicity types, and stimulant-opioid was the most common class combination contributing to polysubstance deaths. Geographical analysis implicates cocaine and ethanol across regions, across toxicity type. **Conclusion:** Accidental drug toxicity deaths continue to rise in Newfoundland & Labrador, across polysubstance and single-class toxicity. Complex patterns among sex distributions across toxicity type warrant further research. The heavy presence of cocaine, ethanol, and zopiclone, and the relatively low presence of non-pharmaceutical opioids in toxicology was in contrast to other jurisdictions in Canada and warrants attention from policy-makers and harm reduction service providers. Regional data from this small Canadian province is crucial in tailoring interventions for people who use drugs in the province.

Keywords

Acute Drug Toxicity, Substance Use, Polysubstance, Toxicology, Public Health, Death Investigation

1. Introduction

Deaths from acute drug toxicity continue to be a major public health concern in Canada [1, 2]. While opioids account for most drug toxicity deaths, most opioid toxicity deaths in recent years also involved at least one substance from other drug classes such as stimulants and benzodiazepines [1, 3, 4].

Indeed, the majority of acute toxicity deaths across Canadian jurisdictions (i.e., provinces and territories) have involved a combination of substances from different classes in recent years - a phenomenon termed polysubstance (or polydrug) toxicity [3, 5, 6]. Drug toxicity research has traditionally

*Corresponding author: cindy.whitten@nlhealthservices.ca (Cindy Whitten)

Received: 8 September 2025; **Accepted:** 17 September 2025; **Published:** 17 October 2025



Copyright: © The Author(s), 2025. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

focused on single substance classes, such as opioid toxicity, as polysubstance toxicity presents analytical complexity and has not been a driver of toxicity deaths until recently [7-10]. An exclusive focus on single substance class toxicity potentially overlooks deaths and overdoses involving substances from multiple classes. As a result, the potential increase in toxicity when combining substances from different classes is understudied, and differences in characteristics of individuals who died from polysubstance toxicity compared to single-class toxicity remain unexplored. In previous work, we addressed this gap and shared data related to polysubstance toxicity deaths in the Canadian province of Newfoundland & Labrador (NL) - a small province that is often underrepresented in national data [6]. We found that a majority (59%) of all toxicity deaths during the 6-year study period (2018-2023) were caused by polysubstance exposure.

The risk of acute toxicity or other negative health outcomes from polysubstance exposure varies based on the reason behind exposure. Polysubstance use refers to intentional co-use of substances from more than one drug class. Individuals may intentionally seek substances belonging to different substance classes to enhance the effects of a given substance, counteract the effects of another substance, or mimic the effects of an unattainable substance [7, 8, 11]. Of concern, individuals may also be exposed to polysubstances unintentionally due to rising contamination and adulteration of the drug supply for various commonly used substances, such as cocaine [3, 5].

Among Canadians who died of polysubstance toxicity between 2014 and 2017, the most prevalent combination of drug classes contributing to death was stimulants and opioids [3]. These findings are consistent with data from a national community urinalysis and self-report project, which indicates that the illicit stimulant supply contains unexpected illicit opioids and benzodiazepines [3, 5, 12]. Stimulant-opioid combinations double the risk of fatal overdose compared to opioid toxicity and may lead to greater abuse potential by enhancing the effects of the desired substance and creating greater dependence [13, 14]. In our previous investigation, we found that stimulants-opioids comprised the most common class combination contributing to death among polysubstance deaths in NL between 2018 and 2023 [6]. However, while stimulants and opioids are a potent combination in polysubstance toxicity cases, the two drug classes are also heavily implicated in single-class poisonings (i.e., stimulants only or opioids only) [15]. The lack of research comparing demographics and substance profiles across single-class and polysubstance toxicity represents a gap in knowledge that needs to be addressed before a comprehensive drug toxicity policy and programming framework can be established in a given region.

General risk factors for drug toxicity deaths in Canada have been described in previous studies [16-18]. Youth are at increased risk for negative effects of substance use, including fatal overdose [16, 18]. Stimulant use among adolescents has increased substantially in recent years, mirroring the increase

in prescribed stimulants for attention-deficit/hyperactivity disorder [16, 17, 19]. Problematic use of opioids is also higher in young Canadians, as well as among those with lower socioeconomic status and poorer mental health [20], and the main demographic for opioid use has shifted from patients prescribed opiate analgesics to individuals poisoned unintentionally due to a contaminated illicit drug supply [1]. While demographics and risk factors for fatal toxicity have been described in a variety of single-substance and polysubstance cohorts, the differences between these cohorts remains understudied. Among the sparse studies directly comparing the populations that use single-class substances or polysubstances, only broad-level conclusions have been established, such as that polysubstance users are more likely to be male, be smokers, have more comorbid mental health issues, and utilize more health services [21, 22]. The existing literature also focuses exclusively on substance use habits and risk factors and does not extend to toxicity deaths. A deeper understanding of differences between polysubstance and single-class toxicity can potentially provide key insights to help guide policy, programming, and community solutions to the drug toxicity crisis. Considering that a large portion of toxicity deaths in NL between 2018 and 2023 were single-class (41%), we argue that a comparison of demographics and substances implicated in death across the two toxicity categories is warranted.

Our current study's objectives were to compare the demographics of decedents and substances and classes implicated in death between single-class and polysubstance toxicity deaths in NL between 2018 and 2024. Differences across age groups and sex are presented, as well as differences in substances and drug classes implicated in each type of toxicity death. We also report the most common substances involved in both toxicity types geographically, according to health zone, and discuss the findings in context of wider Canadian literature on substance use and harms.

2. Methods

2.1. Study Design and Data Collection

The present study employed a retrospective chart review design in which the population was composed of all individuals who died from acute drug toxicity in Newfoundland and Labrador between January 1st, 2018 and December 31st, 2024. The cause and manner of death are determined by the investigating pathologist and confirmed by the chief medical examiner for the province according to best practices in forensic pathology. The determination of manner of death is informed by several factors, such as intentionality (e.g., evidence of suicidal ideation, presence of suicide note, etc.), mental health history, and reports from witnesses and loved ones. While we report the manner breakdown of all acute drug toxicity deaths, we focus most analyses on the 'accidental' manner of death because those cases reflect unintentional

tional poisoning, which underlies the Canadian drug toxicity epidemic that motivates this study.

Variables of interest were gathered from paper and electronic records of all drug toxicity deaths in NL between 2018 and 2024 from the Office of the Chief Medical Examiner (OCME). In accordance with ethical approval from the Health Research Ethics Board of NL (File #2023.104), data collected about decedents included demographics (i.e., age and sex), time and place of death, and substances (and quantities) found in toxicology reports. All cases were reviewed by a medical examiner, in the presence of the research team, to confirm cause and manner of death, and determine which substance(s) contributed directly to death.

2.2. Toxicity Type Classification

Substance classes were assigned to substances contributing to toxicity among all toxicity deaths. Classes were determined based on substance grouping frameworks in relevant literature, usually informed by a combination of the perceived effects of the drug, the mode of attaining the drug, and licit/illicit nature of the drug. The presence of licit, pharmaceutical drugs among contributing substances warrants their inclusion in analyses alongside illicit, recreational drugs. We do not equate exposure to pharmaceutical drugs and recreational drugs, but the presence of pharmaceutical drugs in the sample indicates they are contributing to polysubstance deaths, and thus meaningfully inform the research question. Deaths were classified as resulting from polysubstance toxicity if they met two criteria: more than one substance contributed to death and the contributing substances belonged to two or more distinct substance families (e.g., a stimulant and opioid; cocaine and fentanyl). Consequently, single-class cases were defined as cases in which one or more substances from the same substance class contributed to death (e.g., two stimulants; cocaine and methamphetamine).

2.3. Statistical Analysis

Descriptive statistics (counts, rates, measures of central tendency, etc.) were used to characterize the demographics of the decedents in our sample, stratified by toxicity type (i.e., single-substance or polysubstance toxicity). For age-adjusted mortality rate (AAMR), population estimates by age were acquired from official figures published by NL’s Department of Finance [23]. To test whether annual proportions of sin-

gle-class deaths and polysubstance deaths changed across the study period, we utilized the chi-square (X^2) test. In one instance (annual proportion of female deaths across type), we utilized Fisher’s exact test instead, due to some cell values being lower than 5. Geographical data are presented on a standard provincial health zone map provided by Newfoundland and Labrador Health Services; Health zones were amalgamated into the same authority by the end of the study period, but represent distinct health authorities at the beginning of the study period - the administrative switch took place between 2020 and 2023. Descriptive statistics and statistical tests were calculated and computed using R Statistical Software (v4.3.3) [24], within the development environment of RStudio (v2024.4.2.764) [25]. Data wrangling, grouping, and calculations were performed using the dplyr (v1.1.4) [26] and tidyr (v1.3.1) [27] R packages. Statistical tests were performed using the rstatix R package (v0.7.2) [28]. UpSet plots were generated using the ComplexUpset package (v1.3.3) [29].

3. Results

3.1. Characteristics of Deaths over the Study Period

According to provincial death investigation records from the Office of the Chief Medical Examiner, 403 individuals died from acute drug toxicity in NL between 2018 and 2024. Of these, 293 deaths (73%) were classified as accidental, while 78 (19%) were deemed suicides; the manner of death was undetermined for 32 deaths (8%) (Table 1). Among accidental deaths, 160 deaths (55%) were caused by polysubstance toxicity while 133 deaths (45%) were caused by toxicity from substances belonging to a single class (Table 1). 204 males died from accidental toxicity compared to 89 females. Proportionally, females died more from polysubstance toxicity (57 deaths; 64% of female deaths) than males (103 deaths; 51% of male deaths). Male deaths from accidental single-class toxicity (101 deaths) outnumbered female deaths (32 deaths) by a factor of 3. Among accidental toxicity deaths, polysubstance deaths outnumbered single-class deaths among all age groups except 50-59 year olds, and the difference was more pronounced for younger age groups (<40 years old) (Table 2).

Table 1. Counts and sociodemographic breakdown of single-class and polysubstance toxicity deaths in NL (2018-2024). Counts for single-class and polysubstance toxicity deaths, stratified by sex, and manner of death. Percentages are calculated within each row; percentages may not add up to 100% due to rounding.

	Single-class N (%)	Polysubstance N (%)	Overall N
Total Deaths			

	Single-class N (%)	Polysubstance N (%)	Overall N
Count	169 (42)	234 (58)	403
Sex			
Female	36 (30)	84 (70)	120
Male	93 (47)	103 (53)	196
Manner of Death			
Accident	133 (45)	160 (55)	293
Suicide	24 (31)	54 (69)	78
Undetermined	12 (38)	20 (63)	32

Table 2. Age breakdown of accidental single-class and polysubstance toxicity deaths in NL (2018-2024). The counts presented refer to acute drug toxicity deaths that were deemed accidental by medical examiners.

Age group	Single-class	Polysubstance
0-19	2	4
20-29	21	27
30-39	24	50
40-49	27	39
50-59	41	23
60-69	16	17
70-79	2	0

3.2. Annual Trends in Accidental Deaths

Annual accidental acute drug toxicity deaths increased 129% over the study period, from 31 in 2018 to 71 in 2024. Accidental polysubstance deaths comprised more young people than single-class deaths through the study period - there were comparatively more polysubstance deaths for each age group under 50 years old. Over that period, polysubstance deaths increased 106%, from 18 in 2018 to 37 in 2024; Single-class toxicity deaths increased 161%, from 13 to 34 (Table 3). Among females, accidental polysubstance deaths increased 117% from 6 deaths to 13 deaths while the number of annual accidental single-class toxicity deaths remained the same (7 deaths). Among males, accidental polysubstance deaths increased from 12 to 24 (a 200% increase), while single-class deaths increased from 6 to 27 (350%). We did not find evidence of trend differences in annual death counts between accidental polysubstance and single-class deaths across both sexes ($\chi^2 = 9.42$, $df = 6$, $p = 0.15$), among females ($\chi^2 = 7.47$, $df = 6$, $p = 0.28$), or

among males ($\chi^2 = 9.34$, $df = 6$, $p = 0.16$). The annual mortality rate also did not differ in trend across polysubstance and single-class toxicity ($\chi^2 = 1.78$, $df = 6$, $p = 0.94$) (Table 3).

3.3. Most Common Substances and Classes

Among accidental toxicity deaths, stimulants and opioids contributed most often to death across single-class and polysubstance deaths - 85% of accidental deaths involved a stimulant, an opioid, or both. Among single-class deaths, stimulants were the most common contributing class (51% of single-class deaths), followed by alcohol and opioids (21% of single-class deaths each) (Figure 1A). Among accidental polysubstance deaths, the most common combination was stimulants-opioids (28% of polysubstance deaths), followed by opioids-benzodiazepines and opioids-sedatives (Figure 1B).

Among accidental single-class deaths, cocaine most commonly contributed to death (61 deaths; 46% of single-class deaths), followed by ethanol (25 deaths; 19% of single-class deaths) (Figure 1C). Opioids also contributed commonly to single-class deaths, with fentanyl and methadone contributing to 9 deaths each, and oxycodone to 7 deaths. Among polysubstance deaths, cocaine also contributed most commonly to death - it was involved in 160 deaths (51% of polysubstance deaths) (Figure 1D). Methadone contributed to 43 deaths (27%) and zopiclone to 32 deaths (20%), followed by opioids such as fentanyl (31 deaths; 19%) and morphine (26 deaths, 16%).

To avoid statistical overrepresentation of populous urban regions within the province, we report a geographical breakdown - at the level of administrative health zone - of the most common substances that contributed to death (Figure 2). Cocaine and ethanol most frequently contributed to death across regions, across type of toxicity (i.e., single-class vs polysubstance).

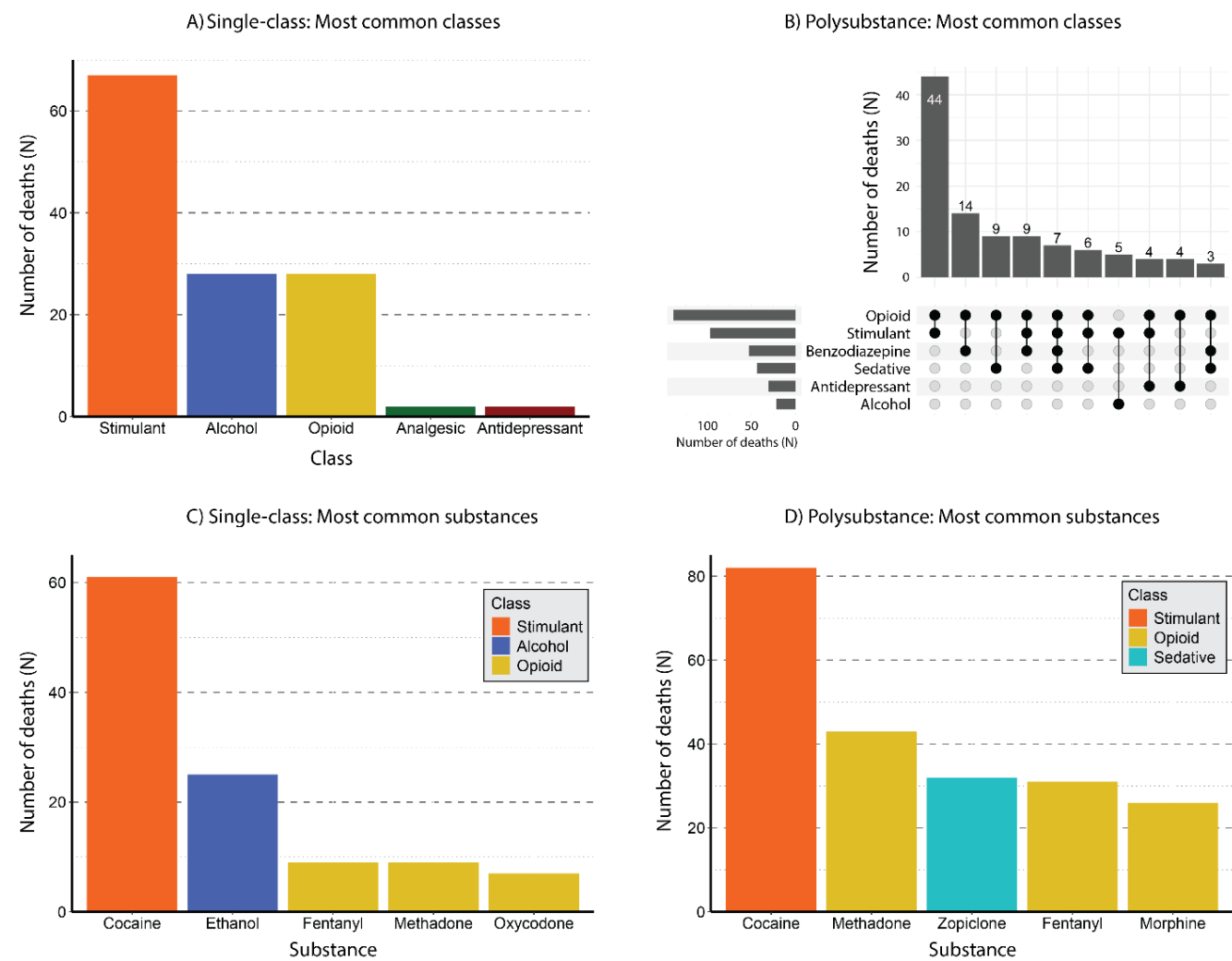


Figure 1. Most common substances and classes involved in single-class and polysubstance toxicity deaths in NL (2018-2024). A) The most common classes contributing to single-class deaths over the study period; Each death is represented once in this plot, classes are coloured for consistency with substance plots. B) UpSet plot showing the most common class combinations implicated in polysubstance deaths. Filled circles and lines connecting them indicate the class combination, height of vertical bars corresponds to number of deaths in which that combination was implicated. Vertical bars represent each death uniquely; horizontal bars overlap in representation of death (i.e., one death may contribute to multiple bars). C) The most common substances contributing to single-class deaths. D) The most common substances contributing to polysubstance deaths.

Table 3. Annual counts of accidental single-class and polysubstance toxicity deaths in NL (2018-2024). Yearly overall counts, age-adjusted mortality rates, and sex counts for single-class and polysubstance deaths are presented. Difference in counts, mortality rates, and sex counts across toxicity type was determined using chi-square tests; Fisher's exact test was used for female counts due to low cell count ($N < 5$).

	2018	2019	2020	2021	2022	2023	2024	p-value (χ^2)
Total								
Single-class	13	10	6	22	18	30	34	0.15
Polysubstance	18	13	22	16	19	35	37	
AAMR*								
Single-class	2.46	1.89	1.14	4.17	3.39	5.57	6.24	0.94
Polysubstance	3.41	2.46	4.18	3.04	3.58	6.49	6.79	
Sex - Female								
Single-class	7	1	1	7	3	6	7	0.29**

	2018	2019	2020	2021	2022	2023	2024	p-value (χ^2)
Polysubstance	6	2	7	5	9	15	13	0.16
Sex - Male								
Single-class	6	9	5	15	15	24	27	
Polysubstance	12	11	15	11	10	20	24	

*AAMR = Age-adjusted Mortality Rate
** p-value corresponds to Fisher’s exact test for this row

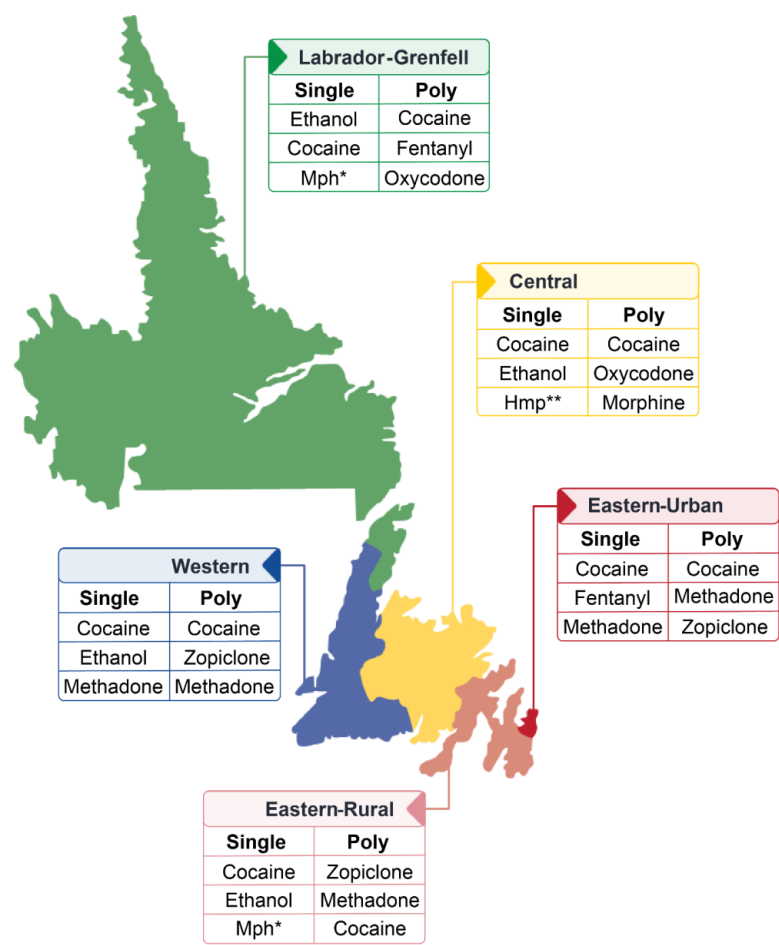


Figure 2. Most frequent substances contributing to single-class and polysubstance deaths in NL by health zone. The top 3 most common substances that contributed to death in each health zone are presented for single-class and polysubstance deaths. Substances with longer names are abbreviated for readability: *Mph = methamphetamine; **Hmp = hydromorphone. This map was modified from the official zone map of Newfoundland and Labrador Health Services. Please note that zones represented independent health authorities before official amalgamation in the first half of 2023.

4. Discussion

There were 403 drug toxicity deaths in Newfoundland and Labrador between 2018 and 2024. Accidental deaths comprised a majority of drug toxicity deaths (293 deaths; 73%) and increased by 129% over the 7-year study period. Over the same period, the population of NL remained relatively stable,

increasing by a mere 3.2% [23]. Notably, the number of accidental toxicity deaths increased from 2023 to 2024, a period over which Canadian toxicity deaths decreased [30]. Newfoundland & Labrador was one of three Canadian jurisdictions where toxicity deaths increased from 2023 to 2024 - alongside Quebec and Northwest Territories [30]. The reason behind the difference in trends from most of Canada is unclear and further research is needed to explain this discrepancy. One

potential reason behind this trend may be that stimulant deaths made up a larger portion of deaths in NL than other jurisdictions, while harm reduction efforts in Canada are more tailored to opioids, which drive toxicity deaths in other regions [2, 31, 32].

In our data, polysubstance toxicity was more common than single-class toxicity as it accounted for 54% (n=160) of accidental toxicity deaths between 2018 and 2024. This is consistent with what is observed nationally and in other Canadian jurisdictions with polysubstance toxicity comprising a majority of deaths federally and in provinces and territories [1, 3]. Our findings show that, over the entire study period, polysubstance toxicity deaths outnumbered single-class deaths across the sexes. Among females, there were more polysubstance deaths in all but the first year of the study, with the gap widening over the study period. This finding contradicts literature comparing single-class and polysubstance use, which found that males were more likely to take part in polysubstance use [21]. In the absence of literature examining sex differences across polysubstance and single-class substance use, we speculate that the higher rates of polysubstance death in females may be related to the COVID-19 pandemic and rates of mental illness and substance-use increasing more among females [33-35]. This hypothesis is in line with recent research from France, where the increase in female use of psychotropic medication was greater than among males [36]. The COVID-19 pandemic, which began in 2020 in Canada, coincides with a sharp rise in proportion of polysubstance deaths among females in our sample.

Male single-class toxicity deaths increasingly outnumbered polysubstance deaths from 2021 to 2024. Similar to the trend among females, this finding contradicts existing literature and further research into substance use behaviour across the sexes is needed to determine why the pattern of more single-class toxicity deaths among males is emerging in NL. Existing literature suggests that males are generally at a higher risk for substance use disorders, but it's unclear why polysubstance exposure affects more females proportionally [37-39]. The lack of specific literature addressing this pattern further emphasizes the need for continuation of research within the framing of single-class versus polysubstance exposure.

In our study, polysubstance and single-class deaths implicated cocaine as the most common contributing substance. This finding is in contrast to larger provinces in Canada, where fentanyl and other opioids are most implicated, and stimulant deaths involve large contributions from methamphetamine and other stimulants (i.e., not cocaine) [31, 32, 40]. We also found key differences from other provinces among opioids implicated in toxicity deaths. For instance, in our 7-year sample, we found far fewer cases of toxicity deaths involving non-pharmaceutical opioids (e.g., fentanyl) than other Canadian jurisdictions. Larger provinces such as BC, Alberta and Ontario have reported presence of non-pharmaceutical opioids in upwards of 80% of annual toxicity deaths in recent years, whereas cocaine was the main

driver in Newfoundland & Labrador [31, 32, 40]. Additionally, polysubstance deaths over our study period implicated pharmaceutical substances such as methadone (an opioid agonist used in opioid dependence treatment), and zopiclone (a non-benzodiazepine sleeping aid), which suggests that pharmaceutical substances play a much larger role in polysubstance deaths in NL than other Canadian jurisdictions. This finding affirms the need to enhance management of patients' pharmaceutical prescriptions by extending existing prescription monitoring programs—which are opioid-focused—to opioid agonists and commonly prescribed sedatives such as zopiclone.

We conducted a geographical analysis - by health service zone - of the most frequent substances contributing to death. While the substances implicated between the two toxicity types differed across regions, cocaine and ethanol most often contributed to death across regions and across polysubstance and single-class deaths. It is unclear why cocaine is so heavily implicated in our toxicity sample in the absence of other literature focused on cocaine use and stimulant use disorder in the province. The status of St. John's, Newfoundland & Labrador as an international port may partially underlie the cocaine problem, as port cities have been implicated in issues around curbing cocaine smuggling [41, 42]. Addressing stimulant use presents a unique challenge due to the lack of stimulant-specific harm reduction resources. While emerging medications have been shown to be promising in the treatment of cocaine addiction, there is a lack of evidence supporting treatment, and none have been approved for use in Canada [43, 44]. The federal minister of health requested an increase in access to safer stimulant use in the country in 2020. To our knowledge, BC has been the only province that has taken action in prescribing psychostimulants to individuals at high risk [45]. As mentioned earlier, harm reduction initiatives in Canada have mainly focused on opioids; stimulant-specific harm reduction strategies, such as stimulant replacement therapy or a safe legal supply warrant further exploration.

The heavy presence of ethanol, especially in rural regions of NL, may be related to the shifting of the burden of alcohol poisoning and heavy drinking to rural areas across North America in recent years [46, 47]. Recent government reports show that heavy drinking continues to increase in NL - which is already above the national average - reinforcing national trends [47, 48]. Strengthening of education and safe-use programs around heavy drinking and stimulant use are recommended as initial steps in addressing the frequent contribution of cocaine and ethanol to toxicity deaths across Newfoundland & Labrador. Much of NL is rural and could benefit from improved access to alternative recreational activities, mirroring the Icelandic model for substance use prevention which improved substance use in areas that exhibit similar geographical isolation [49].

Our findings further emphasize the need to direct policy initiatives, programming, and harm reduction services to problems unique to small, rural regions such as Newfound-

land & Labrador. The relatively low amounts of illicit opioids and other adulterants in our sample imply that polysubstance exposure reflects intentional co-use of substances - at least among toxicity deaths. This is in contrast to the hypothesized issue in much of the rest of Canada, which centers on an adulterated illicit drug supply. Given this information, it is important for point-of-care workers in the substance harms fields to communicate the potential for toxic drug combinations and safe use amounts to individuals who use drugs in the province. Further, there is a need for improved prescription practices and monitoring when assessing the safety of prescribed medication, such as zopiclone, in the face of potential polysubstance use by patients.

Limitations of this study are centered on the robustness of the data. Case files from the OCME contain limited data on a decedent's medical history. As such, associations between mental and physical health history, substance use, and toxicity could not be determined. Additionally, with the lack of information surrounding prescriptions the intent of the exposure could not be determined. Furthermore, and importantly, association between social determinants of health and drug toxicity could not be established given the limitations of the data. Lastly, while we can make educated guesses about drug supply adulteration based on adulterants established in other Canadian jurisdictions, new adulterants are constantly emerging across Canada and the profile of adulterants may differ across regions, presenting challenges in determining the cause of polysubstance exposure from coroner's data.

5. Conclusion

The present study found that accidental drug toxicity deaths increased 129% in Newfoundland & Labrador from 2018 to 2024. The increase in deaths persisted across toxicity categories (i.e., polysubstance and single-class toxicity). We found females and young people (<40 years old) died more often from polysubstance toxicity, while males and 50-59 year olds were more likely to die from single-class toxicity. Cocaine was most heavily implicated among deaths in both toxicity categories, and stimulant-opioid was the most common drug class combination involved in polysubstance deaths. Our findings offer insight into patterns among toxicity deaths in NL that are in contrast with findings from other Canadian jurisdictions and warrant further research. These insights serve as a foundation for evidence-based health policy and practice, promoting safer drug use and reducing preventable deaths.

Abbreviations

NL	Newfoundland and Labrador
OCME	Office of the Chief Medical Examiner

Author Contributions

Cindy Whitten: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Syed Raza: Conceptualization, Data curation, Investigation, Methodology, Software, Validation, Writing - original draft, Writing - review & editing

Allyson Summers: Data curation, Methodology, Writing - original draft, Writing - review & editing

Nash Denic: Conceptualization, Supervision, Writing - review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Fischer B. The continuous opioid death crisis in Canada: changing characteristics and implications for path options forward. *Lancet Reg Health - Am* 2023; 19: 100437. <https://doi.org/10.1016/j.lana.2023.100437>
- [2] CCENDU Bulletin: An Update on Stimulant Use and Related Harms in Canada and the United States n.d.
- [3] Konefal S, Sher A, Maloney-Hall B, Young M, Kent P, Biggar E. Polysubstance use poisoning deaths in Canada: an analysis of trends from 2014 to 2017 using mortality data. *BMC Public Health* 2022; 22: 269. <https://doi.org/10.1186/s12889-022-12678-z>
- [4] Belzak L, Halverson J. Evidence synthesis - The opioid crisis in Canada: a national perspective. *Health Promot Chronic Dis Prev Can* 2018; 38: 224-33. <https://doi.org/10.24095/hpcdp.38.6.02>
- [5] Street A. Community Urinalysis and Self-Report Project: Cross-Canada Report on the Use of Drugs from the Unregulated Supply, 2019-2021 Data 2021.
- [6] Raza SZ, Whitten C, Randell S, Sparkes B, Denic N. Polysubstance toxicity deaths in Newfoundland and Labrador: a retrospective study. *J Public Health* 2025; 47: 114-22. <https://doi.org/10.1093/pubmed/fdaf001>
- [7] Liu Y, Guazzelli Williamson V, Setlow B, Cottler LB, Knackstedt LA. The importance of considering polysubstance use: lessons from cocaine research. *Drug Alcohol Depend* 2018; 192: 16-28. <https://doi.org/10.1016/j.drugalcdep.2018.07.025>
- [8] Boileau-Falardeau M, Contreras G, Gariépy G, Laprise C. Patterns and motivations of polysubstance use: a rapid review of the qualitative evidence. *Health Promot Chronic Dis Prev Can Res Policy Pract* 2022; 42: 47-59. <https://doi.org/10.24095/hpcdp.42.2.01>
- [9] Network P-CPH. Special Advisory Committee on the Epidemic of Opioid Overdoses - Pan-Canadian Public Health Network 2022. <https://www.phn-rsp.ca/en/about/opioids-overdose-crisis.html#a2>

- [10] TEDS 2004-2014 National Admissions to Substance Abuse Treatment Services n.d.
- [11] Beliveau CM, McMahan VM, Arenander J, Angst MS, Kushel M, Torres A, et al. Stimulant use for Self-Management of Pain among Safety-Net Patients with Chronic Non-Cancer Pain. *Subst Abuse* 2022; 43: 179-86.
<https://doi.org/10.1080/08897077.2021.1903654>
- [12] Canadian Center on Substance Use and Addiction. Community urinalysis and self-report project: Overall cross-Canada trends in substance use, 2021-2023. 2024.
- [13] Palis H, Xavier C, Dobrer S, Desai R, Sedgemore K, Scow M, et al. Concurrent use of opioids and stimulants and risk of fatal overdose: A cohort study. *BMC Public Health* 2022; 22: 1-10.
<https://doi.org/10.1186/s12889-022-14506-w>
- [14] Maguire DR, Minervini V. Chapter One - Interactions between opioids and stimulants: Behavioral pharmacology of abuse-related effects. In: Li J-X, editor. *Adv. Pharmacol.*, vol. 93, Academic Press; 2022, p. 1-33.
<https://doi.org/10.1016/bs.apha.2021.10.002>
- [15] Whitten, C, Dalton, K, Randell, S, Ibrahim, K, Denic, N. Population-based Drug Toxicity Death Rate in Newfoundland.. : *Canadian Journal of Addiction* n.d.
<https://doi.org/10.1097/CXA.0000000000000213>
- [16] Chang GY-S, VanSteeleand A, McKenzie K, Kouyoumdjian F. Accidental substance-related acute toxicity deaths among youth in Canada: a descriptive analysis of a national chart review study of coroner and medical examiner data. *Health Promot Chronic Dis Prev Can* 2024; 44: 77-88.
<https://doi.org/10.24095/hpcdp.44.3.02>
- [17] Lim JK, Earlywine JJ, Bagley SM, Marshall BDL, Hadland SE. Polysubstance Involvement in Opioid Overdose Deaths in Adolescents and Young Adults, 1999-2018. *JAMA Pediatr* 2021; 175: 194-6.
<https://doi.org/10.1001/jamapediatrics.2020.5035>
- [18] Public Health Agency of Canada. The Chief Public Health Officer's Report on the State of Public Health in Canada 2018: Preventing Problematic Substance Use in Youth 2018.
<https://www.canada.ca/en/public-health/corporate/publication/s/chief-public-health-officer-reports-state-public-health-canada/2018-preventing-problematic-substance-use-youth.html>
- [19] LaBossier NJ, Hadland SE. Stimulant Misuse Among Youth. *Curr Probl Pediatr Adolesc Health Care* 2022; 52: 101265.
<https://doi.org/10.1016/j.cpped.2022.101265>
- [20] Carrière G, Garner R, Sanmartin C. Significant factors associated with problematic use of opioid pain relief medications among the household population, Canada, 2018. *Health Rep* 2021; 32: 13-26.
<https://doi.org/10.25318/82-003-x202101200002-eng>
- [21] Bhalla IP, Stefanovics EA, Rosenheck RA. Clinical Epidemiology of Single Versus Multiple Substance Use Disorders: Polysubstance Use Disorder. *Med Care* 2017; 55: S24-32.
<https://doi.org/10.1097/MLR.0000000000000731>
- [22] Bassiony M, Seleem D. Drug-related problems among polysubstance and monosubstance users: a cross-sectional study. *J Subst Use* 2020; 25: 392-7.
<https://doi.org/10.1080/14659891.2020.1720326>
- [23] Newfoundland & Labrador Statistics Agency (2024). Population by Age Group and Gender Newfoundland and Labrador, 1971-2024 2024.
https://stats.gov.nl.ca/Statistics/Topics/population/PDF/PopAgeSex_BS.PDF
- [24] R Core Team. RStudio: Integrated Development Environment for R. Posit Software, PBC, Boston, MA 2024.
<https://www.r-project.org/> (accessed October 17, 2024).
- [25] Posit team. Posit team. Posit 2024. <https://www.posit.co/> (accessed October 17, 2024).
- [26] Wickham H, François R, Henry L, Müller K, Vaughan D, Software P, et al. *dplyr: A Grammar of Data Manipulation* 2023.
- [27] Wickham H, Vaughan D, Girlich M, Ushey K, Software P, PBC. *tidyr: Tidy Messy Data* 2024.
- [28] Kassambara A. *rstatix: Pipe-Friendly Framework for Basic Statistical Tests* 2023.
- [29] Michał Krassowski, Arts M, Lagger C, Max. *krassowski/complex-upset: v1.3.5* 2022.
<https://doi.org/10.5281/ZENODO.3700590>
- [30] Reported drug toxicity deaths dropped in parts of Canada in 2024 - But what's behind the numbers? CATIE - Can Source HIV Hepat C Inf 2025.
<https://www.catie.ca/prevention-in-focus/reported-drug-toxicity-deaths-dropped-in-parts-of-canada-in-2024-but-whats>
- [31] Alberta Ministry of Mental Health and Addiction. SAS® Visual Analytics. Alta Subst Use Surveill Syst 2024.
https://healthanalytics.alberta.ca/SASVisualAnalytics/?reportUri=%2Freports%2Freports%2F1bbb695d-14b1-4346-b66e-d401a40f53e6§ionIndex=0&sso_guest=true&reportViewOnly=true&reportContextBar=false&sas-welcome=false (accessed October 16, 2024).
- [32] British Columbia Corners Service. Unregulated Drug Poisoning Emergency Dashboard n.d.
<http://www.bccdc.ca/health-professionals/data-reports/substance-use-harm-reduction-dashboard> (accessed October 16, 2024).
- [33] Government of Canada SC. Mental disorders and access to mental health care 2023.
<https://www150.statcan.gc.ca/n1/pub/75-006-x/2023001/article/00011-eng.htm>
- [34] Dharma C, Al-Jaishi AA, Collins E, Orchard C, Amankwah N, Lang JJ, et al. Assessing the impact of the COVID-19 pandemic on the mental health-related hospitalization rate of youth in Canada: an interrupted time series analysis. *Health Promot Chronic Dis Prev Can* 2024; 44: 417-30.
<https://doi.org/10.24095/hpcdp.44.10.02>
- [35] Nguyen T, Buxton JA. Pathways between COVID-19 public health responses and increasing overdose risks: A rapid review and conceptual framework. *Int J Drug Policy* 2021; 93: 103236.
<https://doi.org/10.1016/j.drugpo.2021.103236>

- [36] Lamer A, Saint-Dizier C, Levailant M, Hamel-Broza J-F, Ayed E, Chazard E, et al. Prolonged increase in psychotropic drug use among young women following the COVID-19 pandemic: a French nationwide retrospective study. *BMC Med* 2024; 22: 274. <https://doi.org/10.1186/s12916-024-03496-8>
- [37] Riecher-Rössler A. Sex and gender differences in mental disorders. *Lancet Psychiatry* 2017; 4: 8-9. [https://doi.org/10.1016/S2215-0366\(16\)30348-0](https://doi.org/10.1016/S2215-0366(16)30348-0)
- [38] Boyd A, Van de Velde S, Vilagut G, de Graaf R, O'Neill S, Florescu S, et al. Gender differences in mental disorders and suicidality in Europe: results from a large cross-sectional population-based study. *J Affect Disord* 2015; 173: 245-54. <https://doi.org/10.1016/j.jad.2014.11.002>
- [39] MacKenzie MB, Fowler KF. Social anxiety disorder in the Canadian population: exploring gender differences in socio-demographic profile. *J Anxiety Disord* 2013; 27: 427-34. <https://doi.org/10.1016/j.janxdis.2013.05.006>
- [40] Gomes T, Leece P, Iacono A, Yang J, Kolla G, Cheng C, et al. Characteristics of substance-related toxicity deaths in Ontario: Stimulant, opioid, benzodiazepine, and alcohol-related deaths. 2023. <https://doi.org/10.31027/ODPRN.2023.03>
- [41] Sergi A. Cocaine and the port: Utopias of security, urban relations, and displacement of policing efforts in the port of Piraeus. *Eur J Criminol* 2024; 21: 329-49. <https://doi.org/10.1177/14773708231182782>
- [42] Roks R, Bisschop L, Staring R. Getting a foot in the door. Spaces of cocaine trafficking in the Port of Rotterdam. *Trends Organ Crime* 2021; 24: 171-88. <https://doi.org/10.1007/s12117-020-09394-8>
- [43] Palis H, MacDonald S, Jun J, Oviedo-Joekes E. Use of sustained release dextroamphetamine for the treatment of stimulant use disorder in the setting of injectable opioid agonist treatment in Canada: a case report. *Harm Reduct J* 2021; 18: 1-8. <https://doi.org/10.1186/s12954-021-00500-9>
- [44] Kampman KM. The treatment of cocaine use disorder. *Sci Adv* 2019; 5: eaax1532. <https://doi.org/10.1126/sciadv.aax1532>
- [45] Nosyk B, Slaunwhite A, Urbanoski K, Hongdilokkul N, Palis H, Lock K, et al. Evaluation of risk mitigation measures for people with substance use disorders to address the dual public health crises of COVID-19 and overdose in British Columbia: a mixed-method study protocol. *BMJ Open* 2021; 11: e048353. <https://doi.org/10.1136/bmjopen-2020-048353>
- [46] Spencer MR, Curtin SC, Hedegaard H. Rates of Alcohol-induced Deaths Among Adults Aged 25 and Over in Urban and Rural Areas: United States, 2000-2018. *NCHS Data Brief* 2020: 1-8
- [47] Government of Canada SC. Heavy Drinking, 2018 2019. <https://www150.statcan.gc.ca/n1/pub/82-625-x/2019001/article/00007-eng.htm>
- [48] Health Canada. Canadian Alcohol and Drugs Survey (CADS): summary of results for 2019 2021. <https://www.canada.ca/en/health-canada/services/canadian-alcohol-drugs-survey/2019-summary.html>
- [49] Sigfusdottir ID, Thorlindsson T, Kristjansson AL, Roe KM, Allegrante JP. Substance use prevention for adolescents: the Icelandic Model. *Health Promot Int* 2008; 24: 16-25. <https://doi.org/10.1093/heapro/dan038>