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Excess deaths during the COVID-19 pandemic in Alberta, Canada

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A B S T R A C T

Objectives: To determine if there was excess mortality in Alberta, Canada during the coronavirus disease 2019 (COVID-19) pandemic, to confirm if excess mortality affected all age groups equally, and to determine what proportions of excess deaths were directly related to COVID-19 and non-pharmaceutical drug poisoning.
Methods: Weekly all-cause data used to estimate excess mortality were modelled against the pre-pandemic period (January 2015–February 2020). Age-adjusted weekly mortality rates for March 2020 to December 2021 were compared with the preceding 5 years.
Results: From March 2020 to December 2021, there was an 11% excess mortality rate, corresponding to an average of 265 monthly excess deaths (maximum >30%). COVID-19-related deaths (n=3202) accounted for 54.9% of total excess deaths (n=5833) that occurred in the 22-month period. The increase in all-cause excess deaths was proportionately higher, and with significantly greater numbers, in younger age groups. Significant increases in monthly drug poisoning deaths occurred from March 2020 to April 2021, with a total of 1819 deaths. Eight hundred and 25 excess drug poisoning deaths, representing 25.4% of total all-cause excess deaths, occurred, mainly among those aged 25–60 years. Overall, 54.9% of all excess deaths were directly related to COVID-19 and 25.4% were related to drug poisoning.
Conclusions: There was a significant increase in all-cause mortality during the COVID-19 pandemic. Although older adults are more likely to die of COVID-19, a massive increase in non-COVID-19-related mortality was observed among younger people. These factors should be considered in public policy decisions on epidemic/pandemic management.

Introduction

Following the emergence of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) in December 2019, with high case fatality rates reported in China (3.8–14.6% from 1 to 17 January 2020), the international public health community reacted promptly by implementing a suite of major non-pharmaceutical interventions (Mi et al., 2020). In the Western world, these measures were initially accepted as necessary, but scepticism emerged over time (Melnick and Ioannidis, 2020) and some questioned whether drastic measures that led to economic losses, adverse mental health outcomes and infringement on personal liberties were proportional to disease severity (Bowcott, 2020). In some jurisdictions, health services, such as elective surgeries, were deferred to prepare the health system to manage potential surges in hospitalizations and intensive care unit (ICU) admissions (CIHI, 2020). Fear of coronavirus disease 2019 (COVID-19) deterred some patients from accessing vital medical services. For example, more than 40% of American adults chose not to access medical care due to concerns about the risk of contracting COVID-19 in healthcare settings (Czeisler et al., 2020). The same effect has been found in the Canadian health system, including Alberta, where overall emergency department visits decreased by 35% [incidence rate ratio (IRR) 0.65, P<0.001), and surgical and medical admissions through emergency departments decreased by 18% (IRR 0.82, P<0.001) and 14% (IRR 0.86, P<0.001), respectively (Rennert-May et al., 2021).

Although policy makers are subjected to a daily onslaught of massive amounts of data and advice from scientists, modellers, economists, disaster management professionals and legal experts, public health decision making usually relies on case numbers, test positivity rates, clinical severity of disease, hospital admissions, ICU admissions and case fatality rates. Comparing absolute numbers of deaths or mortality rates across different jurisdictions can be problematic as the numbers can be biased due to differences in case definitions, SARS-CoV-2 testing criteria, and reporting of deaths as being ‘due’ to COVID-19 as opposed to

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'with' COVID-19. To assess the real impact of the COVID-19 pandemic, all-cause mortality, which compares mortality over a given period with the historical baseline, is emerging as a reliable, objective and gold standard metric (Simonsen and Viboud, 2021; Weinberger et al., 2021; Lee et al., 2022; McGrail, 2022). With the exception of a few countries, such as Australia, Singapore, Iceland and Norway, excess mortality was documented in most jurisdictions impacted by the COVID-19 pandemic (COVID-19 Excess Mortality Collaborators, 2022). Although it was initially unclear whether the excess mortality rate was solely attributable to COVID-19, recent reports are confirming major mortality impacts during the pandemic. For example, based on US data collected from August 2014 to April 2021, Lee et al. (2022) reported higher excess mortality for diabetes, heart disease, Alzheimer's disease, cerebrovascular disease, accidents and injuries, drug overdoses, and assaults and homicides during the pandemic. Likewise, DiGennaro et al. (2021) found significant excess drug overdose mortality during the pandemic. In Canada, deaths due to opioid poisoning increased significantly during the pandemic. Increased toxicity of non-pharmaceutical drugs in Alberta, particularly fentanyl, contributed to the increased number of accidental drug poisoning deaths in 2021 (Public Health Agency of Canada, 2022).

This study aimed to confirm whether the COVID-19 pandemic was accompanied by excess all-cause mortality in Alberta, Canada, to determine which age groups were most impacted, and to tease out subtle factors driving the mortality trends.

Methods

Mortality data were obtained from the Alberta Vital Statistics database, accessed through Alberta Health Services, Data and Analytics. The Vital Statistics database tracks all births and deaths in the province of Alberta, and is maintained by Service Alberta. Population estimates were obtained from the Alberta Population Health Statistics database, which contains estimates for the population of Alberta stratified by various attributes including sex, age and postal code, and is derived from the Provincial Registry which tracks registration with the Alberta Health Care Insurance Plan. Deaths related to COVID-19 were obtained from the Communicable Disease Outbreak Management system, which is used for contact tracing and follow-up of people with confirmed COVID-19. Deaths were considered to be related to COVID-19 if the cause of death was recorded as being 'from the disease' or the disease 'contributed to the death (secondary cause)'. In addition, publicly available data from Alberta's substance use surveillance system (Alberta Health-A, 2022) were used to look at the number of deaths associated with substance abuse by age and sex in the same time frame.

All-cause deaths were summarized weekly between 2015 and 2021, and stratified by pre-specified 10-year age groups. Weekly data were used to estimate excess mortality using an overdispersed Poisson model, where expected mortality was based on the pre-pandemic period (January 2015–February 2020). Total cumulative excess mortality between March 2020 and December 2021 was estimated, as well as the proportion of the increase relative to expected mortality, overall and for each age group. All statistical analyses were conducted using SAS Version 9.4 (Cary, NC, USA) and R Version 4.1.2 (Vienna, Austria), including the excessmort package for estimation of excess mortality (Acosta and Irizarry, 2022).

Results

The province of Alberta has a population of approximately 4.4 million people, and an observed COVID-19 case rate of 8411 per 100,000 people in Alberta from 15 March 2020 to 31 December 2021 (Alberta Health-B, 2022). As can be seen in Figure 1, significant excess deaths were observed compared with expected deaths for the 22-month period from March 2020 to December 2021. In Alberta, the first COVID-19-associated fatality was reported in early March 2020. From March 2020 to December 2021, the estimated total excess deaths was 5833 [95% confidence interval (CI) 5373–6293], which equates to an average of approximately 265 excess deaths per month. The highest excess mortality relative to the expected death rate occurred in late 2020 and late 2021, with maximum weekly increases of 33.1% (95% CI 27.4–28.8%) for the week ending 24 September 2021 and 30.4% (95% CI 25.6–35.3%) for the week ending 25 December 2020 (Figure 2). There were only three periods where a significant increase in excess mortality was not observed: (i) prior to the week ending 20 March 2020; (ii) between the weeks ending 8 May 2020 and 10 July 2020; and (iii) between the weeks ending 12 February 2021 and 9 April 2021 (Figure 2). COVID-19-related deaths (n=3202) accounted for 5.7% of all deaths since March 2020 (n=56,010), but 54.9% of the total excess deaths (n=5833) that occurred over the 22-month period. There was strong correlation between the weekly estimated excess deaths and COVID-19-related deaths (Pearson correlation, r=0.75).

The analysis of weekly data stratified by age group suggests that there was no significant excess mortality in the 0–9-years age group and generally very little excess mortality in the younger age groups. The older age groups followed the pattern observed in the overall population, with peaks in late 2020 and late 2021; however, the 30–39-years age group showed steadily increasing excess mortality throughout the pandemic (Figure 3). Alberta data show that most COVID-19 deaths were in the older age groups, notably in those aged >80 years.

Based on Alberta substance use surveillance system data (Alberta Health-A, 2022), there was an increase in the number of deaths associated with non-pharmaceutical drug poisoning. The surveillance group found that totals of 1379 and 1818 deaths in 2020 and 2021, respectively, were attributed to drug poisoning related to any substance (opioids, methamphetamines, cocaine, alcohol, benzodiazepines or other). These numbers correspond to an excess of 534 and 946 drug poisoning deaths in 2020 and 2021, respectively, compared with the mean of 825 drug poisoning deaths in each of the four preceding years. The 1480 excess drug poisoning deaths account for 59% of the 2514 non-COVID-19 imputed excess deaths and 25.4% of the total all-cause excess deaths between March 2020 and December 2021, and occurred primarily in those aged 25–60 years. Of the 1545 non-pharmaceutical opioid drug poisoning deaths in 2021, the highest proportion of deaths occurred in young men aged 25–44 years (41.4%, n=639) (Alberta Health-A, 2022). Overall, 80.3% of all-cause excess mortality can be accounted for by COVID-19-related deaths (54.9%) and drug poisoning deaths (25.4%) (Figure 4). The remaining 19.7% of excess deaths are likely due to a constellation of factors including, but not limited to, delay in accessing urgent and critical medical care, suboptimal chronic disease follow-up, and potential adverse outcomes associated with delay in some surgeries.

Discussion

Despite both the death rate (75/100,000) and the overall case fatality rate (0.8%) being lower in Alberta than in more heavily populated Canadian provinces such as Ontario and Quebec, all-cause excess mortality was higher in Alberta (McGrail, 2022). The present study confirmed that the COVID-19 pandemic was associated with excess mortality in Alberta, and permits deeper exploration of possible reasons. Importantly, nearly half of the excess deaths in the study period did not appear to be COVID-19-related. Given the robust infectious disease surveillance infrastructure in Alberta, it is unlikely that the 43.1% of excess deaths attributed to non-COVID-19 causes were exclusively due to under-reporting, although it is possible that some COVID-19 deaths may have been attributed to other underlying co-morbidities.

In recent months, several papers have been published documenting potential associations between non-COVID-19 imputed excess mortality and diabetes, Alzheimer's disease, cerebrovascular disease (Glei, 2022) and heart disease (Brant et al., 2020), which are possibly due to avoidance or inaccessibility of health care (Czeisler et al., 2020). Furthermore, recent data have shown an increase in homicides (Kegler et al., 2022), suicides (Kaggwa et al., 2022; Orellana and de Souza, 2022; Rogalska

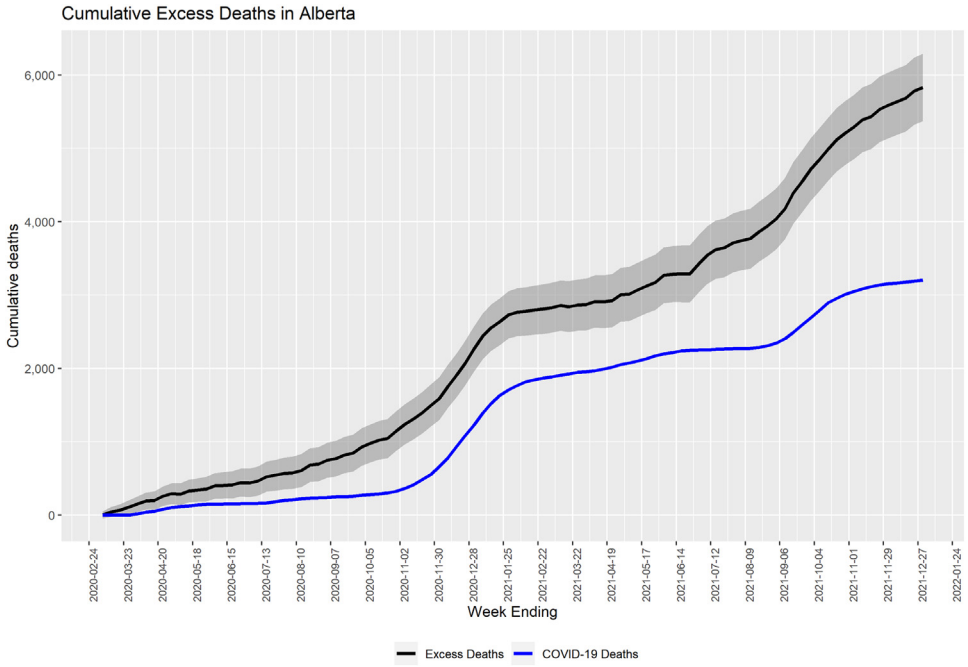

Figure 1. Cumulative number of coronavirus-disease-2019-related deaths and total excess deaths from March 2020 to December 2021.

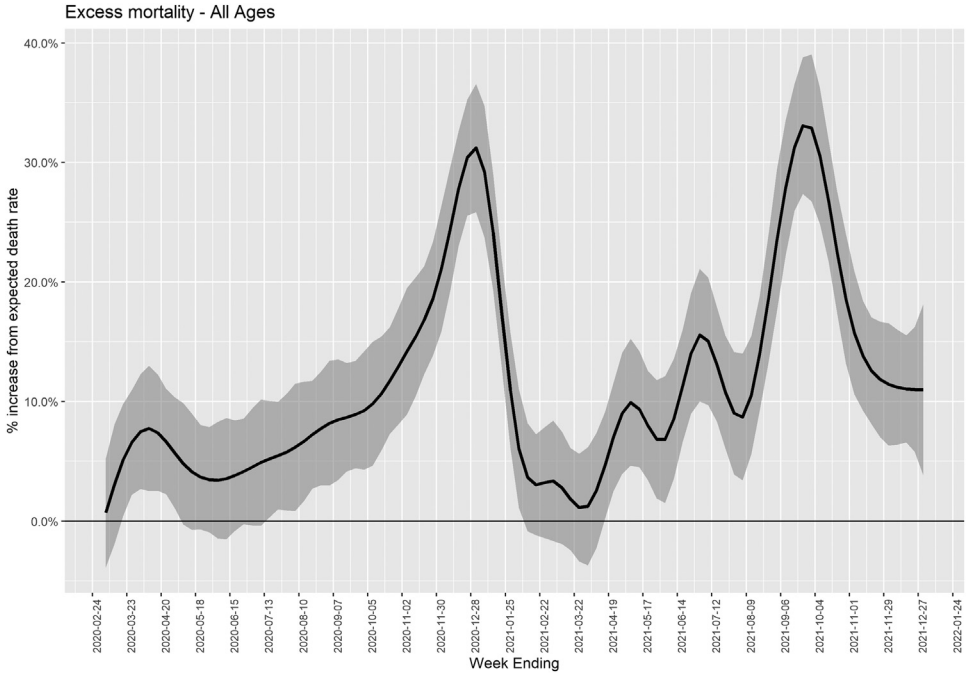

Figure 2. Excess mortality across all ages from March 2020 to December 2021.

and Syrkiewicz-Świtała, 2022) and drug poisoning deaths (Faust et al., 2021; Mason et al., 2021; Hawkins and Phan, 2022; Schleihauf and Bowes, 2022) in other jurisdictions during the pandemic. Alberta has a robust surveillance system for drug poisoning deaths (Alberta Health Services-A, 2022), which was used to verify an increase in the number of drug poisoning deaths from March 2020 to December 2021 (Figure 4). Much of this increase can be attributed to increased toxicity of the non-pharmaceutical drug supply, especially in the last 6 months of 2021. For example, the Supervised Consumption Service in Calgary, Alberta reported that the average number of daily client visits decreased significantly as public health measures affected site capacity. In December 2019, there were an average of 210.9 visits per day, compared with 100 in December 2021. The proportion of overdoses per number of times that drugs were consumed increased from 1.22% in December 2019 to 7.95% in 2021, reflecting this increased drug supply toxicity (Alberta Health Services-B, 2022)

There are limitations to what can be surmised from the available data. The overall mortality rates are highly accurate, but monthly and yearly fluctuations can impact any precise estimates of excess deaths. Importantly, discerning between deaths attributable to acute COVID-19 infection and non-COVID-19-related deaths requires that testing is available, broadly applied and accurately reported. This example can be seen clearly in Eastern Europe and Latin America in the first wave of COVID-19, where high rates of excess mortality were observed prior to the widespread availability of testing (Ritchie et al., 2020), resulting in a large gap between COVID-19-attributable deaths and the overall in-

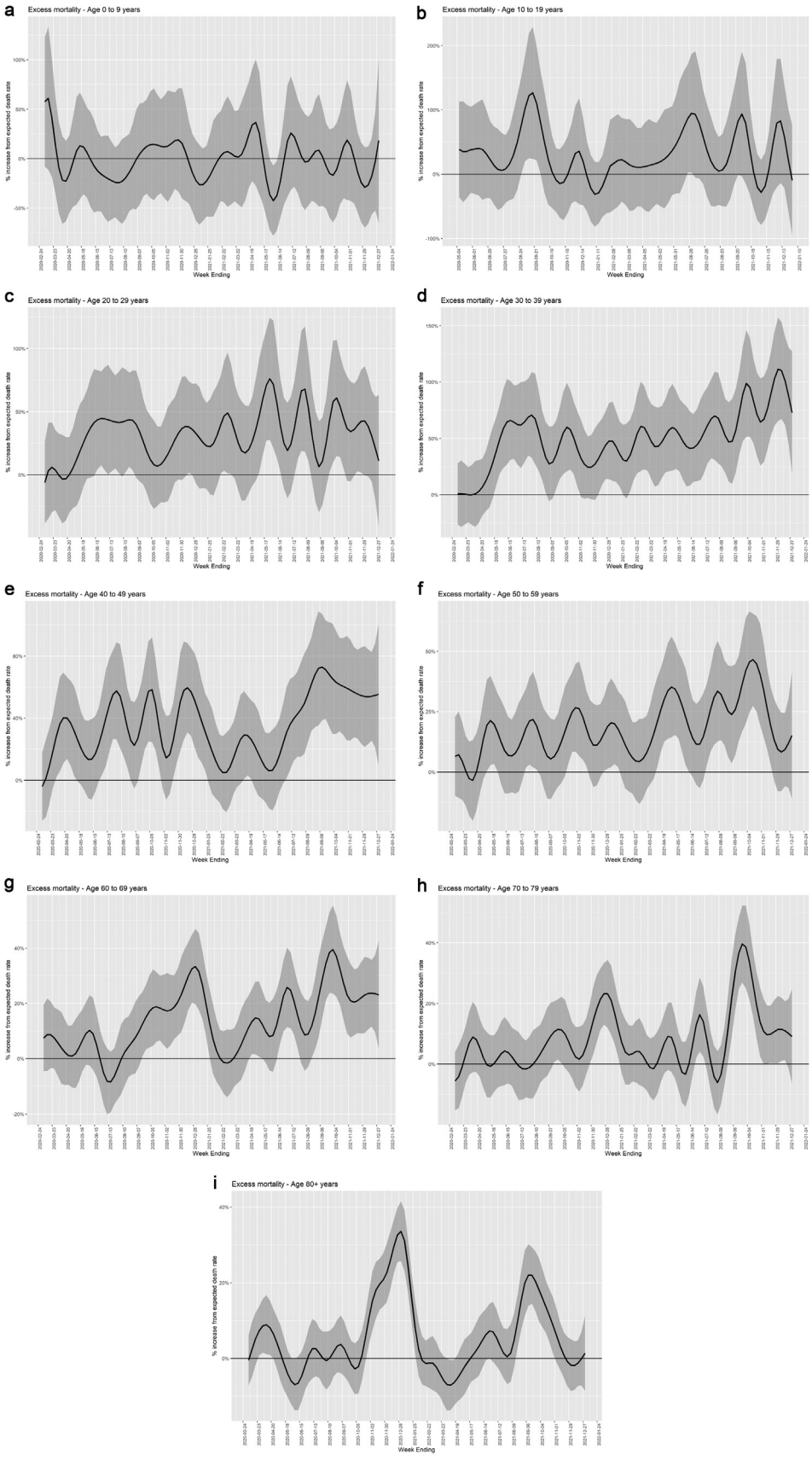

Figure 3. Excess mortality by 10-year age groups.

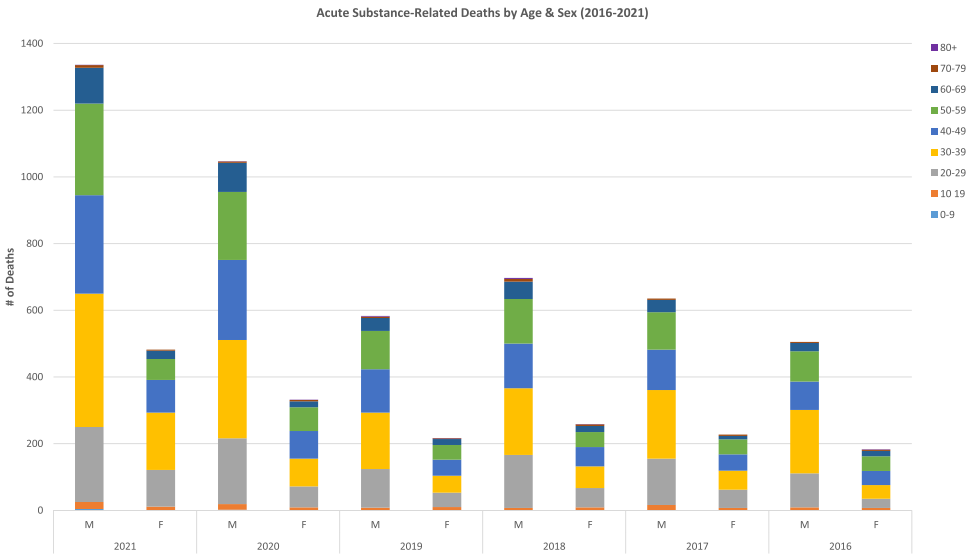

Figure 4. Drug poisoning deaths by age group and sex from 2016 to 2021.

creased number of deaths observed compared with the number of deaths expected. Access to testing was readily available at no cost and with minimal eligibility restrictions to the individual as part of Alberta's publicly funded healthcare system. With a testing rate of 111,059 per 100,000 population, Alberta had one of the highest per-capita testing rates in the country (Public Health Agency of Canada, 2021). However, there may well have been differences in testing rates across age/sex strata (Sundaram et al., 2021). Implementation of public health measures to control the spread of COVID-19 may reduce mortality rates below expected levels (and underestimate excess mortality) through reductions of other communicable diseases (e.g. influenza), work-related accidents and road traffic fatalities, or may increase mortality, for example, due to substance use and mental-health-related deaths (Moriarty et al., 2021). A deeper exploration of cause of death and contributing factors would help to clarify how these factors may contribute to changes in observed mortality. Although standardized definitions were applied throughout, some misclassification of either COVID-19 or non-COVID-19 deaths is still possible. It is unlikely that COVID-related deaths were missed prior to the first recognized case in the province on 5 March 2020 (Kanji et al., 2021).

Conclusion

This cross-sectional study confirmed earlier findings in other jurisdictions that the COVID-19 pandemic led to substantial excess mortality, and highlights the differences in effect across age groups. Relative death rates were disproportionately higher among young Albertans between 20 and 59 years of age, which was not linked directly to confirmed COVID-19. Analysis of official acute drug poisoning death data during the pandemic strongly suggests that the latter made a substantial contribution to total non-COVID-19 deaths during the study period. It is important to understand the contributions and inter-relations of medical, social and economic factors to explain the high number of non-COVID-19-related excess deaths in order to make policy decisions during future pandemics. This work highlights the importance of looking beyond case counts and case fatality rates in understanding the effects of a pandemic in society.

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Conflict of interest statement

None declared.

Ethical approval

Ethical approval for this study was obtained from the Health Research Ethics Board of the University of Alberta, Canada (Pro00112035).

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