**Where are we now? Retrospective study of non-natural deaths in Ontario: Effects of the COVID-19 pandemic and related public health measures - are we returning to baseline?**

Mackenzie Cullip[a] BHSc, Jeffrey S. Rosenthal[b] PhD, Richard Wells[a] MD DPhil, Jennifer M. Dmetrichuk[a,c,d] MBChB PhD

a. Office of the Chief Coroner-Ontario Forensic Pathology Services, Forensic Services and Coroner's Complex, 25 Morton Shulman Avenue, Toronto, Ontario M3M 0B1, Canada
b. Department of Statistical Sciences, University of Toronto, 9th Floor, Ontario Power Building, 700 University Avenue, Toronto, Ontario M5G 1Z5, Canada
c. Department of Laboratory Medicine and Pathobiology, University of Toronto, 1 King's College Circle, 6th Floor, Toronto, Ontario M5S 1A8, Canada
d. Corresponding author, jennifer.dmetrichuk@ontario.ca

## Introduction

As mask mandates, social distancing, and lockdowns dwindled globally, the curiosity surrounding the long-term impacts of COVID-19 and the amount of literature concerning non-natural deaths during the pandemic increased. Various countries and jurisdictions report differing trends when comparing pre-pandemic death data to that during or post-lockdown. Yet, few studies have presented the effects on death rates in 2022, during the return to our "new normal".[1–10]

The literature available before April 2021 (our previous study's literature search period) reported increased, decreased, and stable rates for suicide and homicide in different jurisdictions.[11–31] In contrast, all reporting regions experienced decreased motor vehicle collision fatalities and increased substance use deaths.[17,18,32–41] Some death trends were dependent on sex, age, or race, and fluctuated at various stages of the pandemic.[11,18,21,23,28,29]Additionally, multiple countries reported a sudden "pause" or decreased death rate(s) at the start of lockdown, with some rates returning to average or increasing later in the pandemic.[33,42,43]

An updated literature review in January 2024 found that motor vehicle and substance related fatalities trends were heterogeneous. Deaths involving motor vehicle collisions largely declined or were unchanged during lockdown,[1,2,44–62] aside from some regions in Ireland, UAE, USA, Estonia, Finland, Iceland, Latvia, Luxembourg, Montenegro, and Switzerland.[9,50,63–71] Studies on drug-related fatalities were available only from regions in the USA,[60–62,67–107] Iran,[5,76] Canada,[44,76,99,103,108–110] and the UK,[76,111,112] with most reporting increased deaths.

Studies reporting suicide rates comprised the majority of the literature with multiple countries describing increasing and decreasing trends across different geographic regions, populations, or lockdown periods.[7,45,46,48,60,69,70,72–76,113–151] Others noted no significant changes compared to previous years.[8,10,47,61,62,68,73,111,152–178] Several systematic reviews support these diverse findings.[130,169,170,172,179–183] Homicide rates decreased or were not influenced by lockdown in some

regions.[44–47,184] Alternatively, they increased in Bangladesh and the USA (excluding only San Francisco).[56,60,61,68–71,185,186]

Among these findings is the first iteration of our study.[44] When comparing manners of death and types of death across four provincially-defined 'lockdown' stages of the COVID-19 pandemic (March 17, 2020 to December 31, 2020) to the previous eleven years (March 17, 2009 to December 31, 2019), we found that homicide rates were unchanged, suicide rates decreased during the earliest stage, and drug-related fatalities increased during all lockdown stages. Motor vehicle collision associated fatalities appeared to decrease slightly in 2020, however we could not conclude this was a lockdown specific effect. The current paper serves to provide updated trends as more data becomes available, with a focus on potential "return to baseline" effects. To our knowledge, we are the first and largest study to completely report 2022 post-COVID-19 trends in all non-natural deaths, comparing pandemic and post-pandemic years.

The Office of the Chief Coroner and Ontario Forensic Pathology Service (OCC-OFPS) conduct provincial death investigations for all non-natural, sudden, or unexpected deaths as specified in the Coroners Act. The OCC-OFPS maintains death investigation data, including death type, manner of death, and cause of death, which is used to improve the health and safety of Ontario's population. Our analysis demonstrates the longer-term effects of the COVID-19 pandemic and associated public health measures, while highlighting the importance of timely mortality data.

**Methods**

The OCC-OFPS uses real-time cases management databases, the Coroner's Information System (CIS), and QuinC (post-2021), to organize data (manner of death and death type) for all death investigations in Ontario (approximately 20,000 per year). We pulled data at multiple time points during the course of this study to assess data quality and completeness. All death investigation data for January 1, 2009 to December 31, 2022 was retrieved (January 25, 2023), including the following data fields: case number, status of case (open/closed), sex, age, manner of death, environment (e.g. residence, motor vehicle, hospital), and type of death.

A total of 236,972 deaths were investigated in Ontario between 2009-2022 for which data was pulled from the CIS and QuinC (excluding 'unclear' deaths, see below). Of these, 96,173 had a manner of death that was homicide (n=2,957), suicide (n=19,248), or accident (n=73,968) and were included in the study. Deaths classified as natural (n=133,631), skeletal remains (n=711), or undetermined manner (n=6,457) were excluded. Cases resulting from Medical Assistance in Dying (MAiD) between June 17, 2016 - May 9, 2017 (n=437) were manually reviewed in the CIS, and the manner of death was assigned based on current practice.[44] As death factor coding in QuinC had minor variation from CIS, 80 randomly selected cases extracted from QuinC were manually checked (with 100% accuracy) to ensure unified death factor coding for our extraction.

For each manner of death and their associated death type (e.g. 'accident' and 'drug-related', or 'suicide' and 'drug-related'), crude rates were calculated per 100,000 Ontario yearly population as per Statistics Canada,[187] both for entire years and for specific date ranges that corresponded

to provincial lockdown periods: March 17 to May 18, 2020 (Stage 0), May 19 to June 11, 2020 (Stage 1), June 12 to July 16, 2020 (Stage 2), and July 17 to November 7, 2020 (Stage 3), and November 8 to December 31, 2020 (Stage 4). The end date of December 31st represents the end of the calendar year and pre-defined study period; it is not reflective of the end of the government mandated lockdown. The provincial lockdown periods were selected as originally published online by the Government of Ontario.[188] For drug-related accidental deaths, we also present corrected weekly time series counts for each year from 2018-2022 (with uncorrected raw counts as purple “”, and a quadratic curve shown in red). Further, the rates for 2019 ‘pre-pandemic’ (A), 2020-2021 ‘pandemic’ (B), and 2022 ‘post-pandemic’ (C) were compared, shown on the right side of the figures in purple.

*Statistical Analysis*

For each of the manner and factor categories, and each of the date ranges, we also present various statistical analyses of the corresponding death rates, as follows. To look for linear trends in the pre-pandemic years 2009–2021, we present (in red) the linear regression line and slope, together with the slope’s p-value and confidence interval. The combined 2009-2021 death rate is indicated with a green “–”. To gain a sense of whether the 2022 rate is substantially different from the 2009–2021 rate (i.e., is an outlier), we present the “Tukey’s fences” (in orange), i.e., four times the interquartile range of the pre-2022 values.

To measure more precisely whether the 2022 rate is substantially different from the 2009-2021 rate, we used a two-sample Poisson statistical test. We present (in green) the estimated ratio (“Ratio”) of the 2022 rate over the 2009-2021 rate, together with its 95% confidence interval and p-value. We also show the estimated difference (“Diff”) between the 2022 total count, and what that count would have been if the previous years’ rate had continued, together with its 95% confidence interval as well.

Separately, we also considered an “interrupted time series” (ITS) model, which is a linear regression of the death rates against both the year and an indicator variable for the special year 2022. The resulting “ITS” quantity uses the regression coefficient for the indicator variable to measure the ratio of the 2022 rate to what its expected value would be if the linear trend from 2009–2021 had continued. Its corresponding p-value and 95% confidence interval indicate the uncertainty of this ratio. The ITS thus compares the 2022 rate to the previous years in a way which also takes into account the previous years’ linear trend.

*Robustness Tests*

To check the robustness of the 2022 changes, we also consider other p-values, which compare the 2022 and 2009-2021 rates under different circumstances, as follows. First, we consider changing the comparison year range, from 2009-2021 to 2010-2021 and 2011-2021 and so on, to see if the 2022 rate still remains substantially different. We display (in brown) the value “robY” as (a) the largest of all the p-values over all choices of the comparison starting year (and show in brackets the starting year which gives the largest p-value), and also (b) the combined union (and

hence largest) of all the corresponding 95% confidence intervals. If the robY p-value is still small, and its combined confidence interval still does not approach the value 1, that means that the 2022 rate change is still substantial regardless of which of the comparison year ranges is used, thus demonstrating robustness of the change. Second, we consider different adjustments for cases whose manner or factor are “unclear”.

*Adjusting for “Unclear Cases”*

Some of the cases in the database are in a preliminary stage and may be subject to change at the time of case closure. We called a case “Unclear” if (a) it has missing death factor, and/or (b) it has missing manner, and/or (c) its manner is “Undetermined” and also its status is “Open”. The number of such cases is fairly small, but still not negligible.

Some of these Unclear Cases might later add to our categories. To estimate this effect, we performed a separate analysis comparing the latest (January 25, 2023) and earlier (August 25, 2020) data pulls. In the earlier pull, we identified all cases which were unclear at that time. We then examined each of these earlier-unclear cases in the latest pull. Some of them were still unclear and hence excluded. Of the remaining cases, the “correction multiplier” for each category is given by the number of cases resolved to that category divided by the total number of resolved cases. Then, for each death cause, we multiplied the appropriate correction multiplier by the number of corresponding unclear in the latest data pull. We then added that figure as a correction to the raw count. This provided a best estimate of the true death counts in each category and time period, and that best estimate was used to compute the rates shown (as blue circles) in the graphs. To indicate the uncertainty in this “unclear” correction, our graphs also show (in purple) vertical “uncertainty bars” which show 95% confidence intervals for the true rates based on this correction (specifically, the best estimate ± 1.96 times the correction standard deviation, bounded below by the observed raw count).

To check the robustness of this “unclear” correction, we then re-compute the p-value and confidence interval for the ratio of the 2022 rate compared to previous years where we take the previous years’ rates at either their lower or upper confidence interval endpoint, and simultaneously take the 2022 rate at either its lower or upper confidence interval endpoint. We then display (in brown) the value “robU” which is (a) the largest p-value over all of these endpoint choices, and also (b) the corresponding union (and hence largest) of all the corresponding 95% confidence intervals. If the robU p-value is still small, and its combined confidence interval still does not approach the value 1, that means that the 2022 rate change is still substantial over a wide range of possible resolutions of the unclear cases, thus again demonstrating robustness of the change.

Taken together, these p-values do quite a bit of robustness/sensitivity checking. If the various p-values are all small, and the combined (union) confidence interval still does not approach the value 1, then this means the 2022 change is substantial over a wide range of different comparison methods.

The results of our study are interpreted and reported using the American Statistical Association's (ASA) statement on statistical significance and p-values (i.e., it is recommended that p-values are interpreted as a spectrum). The ASA states that scientific conclusions and policy decisions should not only be based on whether a p-value passes a specific threshold (point 3 of the ASA Statement on Statistical Significance and p-Values).[189]

This study was approved by the University of Toronto Research Ethics Board (Protocol #00040433). Digital data sent off-site for statistical analysis (to JR) was anonymized and password protected. Confidentiality agreements were completed. A RECORD statement (REporting of studies Conducted using Observational Routinely-collected Data), which is an extension of STROBE guidelines (Strengthening the Reporting of Observational studies in Epidemiology) was completed.

**Results**

A total of 236,972 deaths were investigated in Ontario between 2009-2022. The number of homicides (n=2,957), suicides (n=19,248), and accidental deaths (n=73,968) were extracted from the CIS and QuinC database (total n=96,173). We compared 2022 crude rates (per 100,000 people) to previous 2009-2021 rates both on an annual basis, and for each distinct sub-annual date range (described above).

*Homicides*

The rate of homicides in Ontario continues to slightly trend upwards, as it has over the past decade (slope=0·036, 95% CI 0·0083-0·064; p=0·61; Figure 1). There was no major change in the rate of homicides during 2022 compared to 2009-2021 (RR 1·1, 95% CI 0·96-1·2; p=0·17; Figure 1) with an estimated annual effect of 22 more deaths in 2022 than expected. Further, there was no major change when comparing the rate of homicides in 2022 (post-pandemic 'C') versus 2020-2021 (pandemic 'B') (p = 0·7).

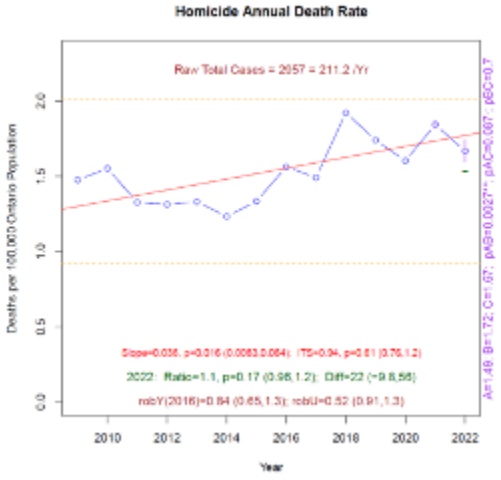


Figure 1. Annual Homicide Death Rates (per 100,000) in Ontario, 2009-2022.

*Suicides*

Although the overall suicide rate in 2022 remains less than estimated (RR 1·0, 95% CI 0·97-1·1; p=0·46; Figure 2a) when compared to 2009-2021, there is a slight recent increase in suicides when compared to the previous 2 lockdown years. That is, when comparing 2019 (pre-pandemic 'A') to 2020-2021 (pandemic 'B'), there was a drop in suicide rates during the pandemic years (p=0·0037). However in 2022 (post-pandemic 'C'), that drop is no longer seen when compared to 2019 (p=0·12). Of note, the increase is minor and is not substantially different when compared to the pandemic years (2020-2021 'B'; p=0·28).

We previously showed that during the first stage of the lockdown in 2020 (stage 0), that there was a decrease in the rate of suicides compared to recent years (estimated effect of 30 fewer deaths).[44] We now show in 2022, using the same dates as stage 0 for comparison, that the suicide rates may be trending towards baseline (RR 1·0, 95% CI 0·89-1·2; p=0·8; Figure 2b) with an estimated annual effect of 4 more deaths than expected.

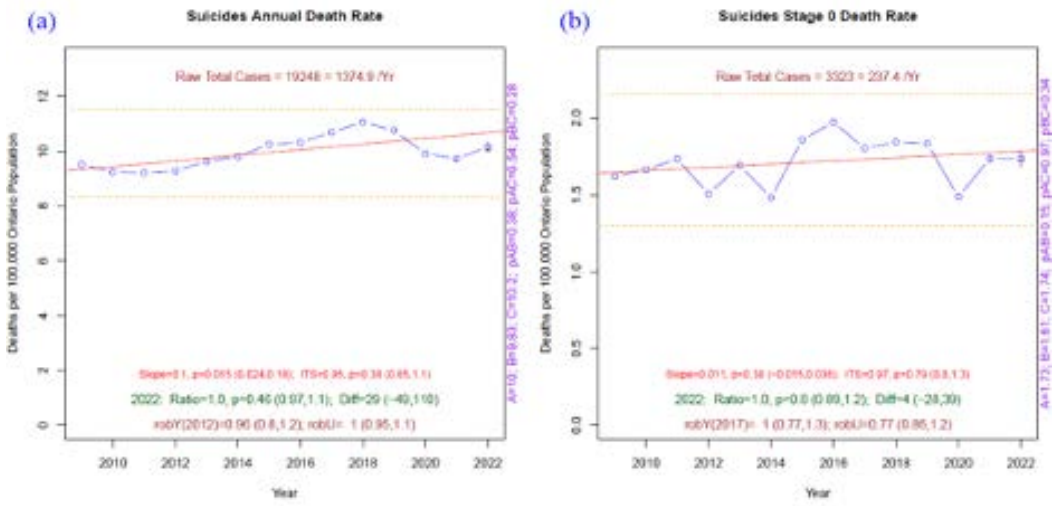


Figure 2. (a) Annual and (b) Stage 0 Suicide Death Rates (per 100,000) in Ontario, 2009-2022.

Furthermore, we previously showed that suicides by drug-related toxicity decreased in 2020 (54 fewer deaths) and in particular, during the first stage (stage 0) of the lockdown (15 fewer deaths) than expected.[44] In 2022, rates appear to be trending upward with 41 fewer deaths overall (Figure 3a, RR 0·83, 95% CI 0·72-0·96; p=0·011) and 4 fewer deaths in the 'stage 0' 2022 equivalent (Figure 3b, RR 0·91, CI 0·62-1·3; p=0·67). Overall, in 2022, the substantial drop in suicides by drug-related toxicity death that was seen during the pandemic (2019 'A' versus 2020-2021 'B'; p=0·0033) is no longer seen when comparing 2019 pre-pandemic 'A' to post-pandemic 2022 'C' to C' (p=0·066). However, of note, the increase in drug toxicity-related suicides in 2022 'C' is small and is not substantially different when compared to the pandemic years 'B' (p=0·46).

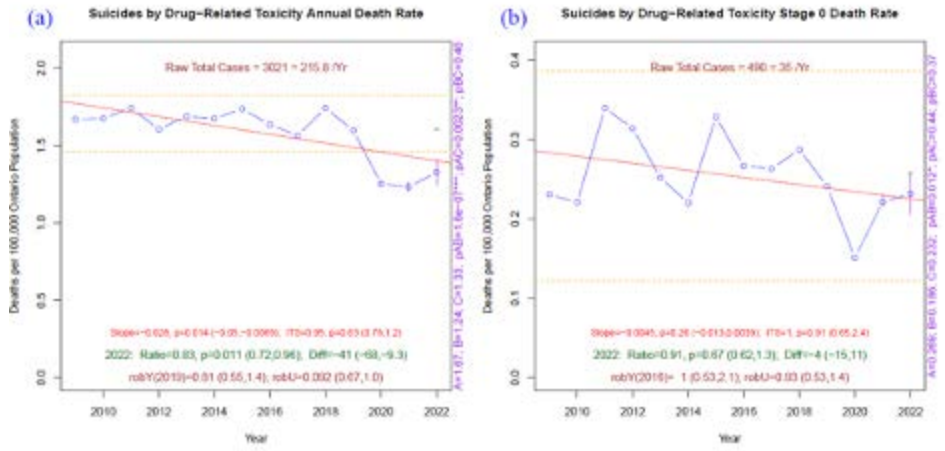


Figure 3. (a) Annual and (b) Stage 0 Suicide by Drug-Related Toxicity Death Rates (per 100,000) in Ontario, 2009-2022.

*Accident*

The rate of accidents in Ontario continues to slightly trend upwards over the past decade (slope=1·7, 95% CI 1·2-2·3; p<0·001; Figure 4). Overall, the rate of accidents during 2022 compared to 2009-2021 remains substantially elevated (RR 1·4, 95% CI 1·4-1·4; p=<0·001; Figure 4) with an estimated annual effect of 2312 more deaths in 2022 than expected.

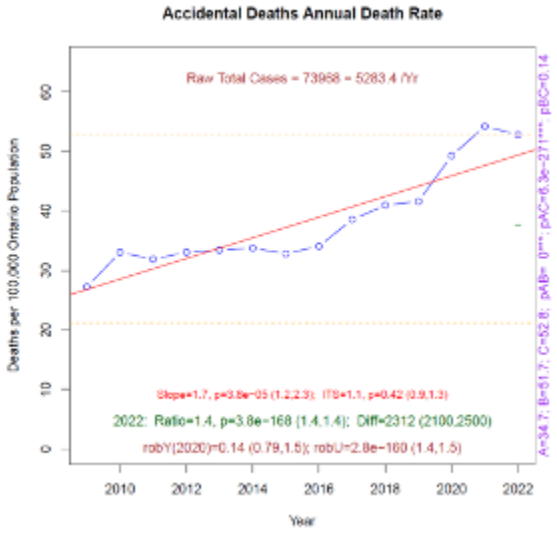


Figure 4. Annual Accidental Death Rates (per 100,000) in Ontario, 2009-2022.

When looking specifically at drug-related deaths, we previously showed an excess of 1,500 accidental drug-related deaths in 2020.[44] In 2022, while drug-related deaths still remain elevated (RR 1·8, 95% CI 1·8-1·9), p<0·001; estimated annual effect of 1132 excess deaths, they appear

to be trending slightly downwards (Figure 5). Furthermore, there is a substantial decrease in drug-related deaths in 2022 (‘C’) compared to the pandemic years 2020-2021(‘B’) (p<0·001).

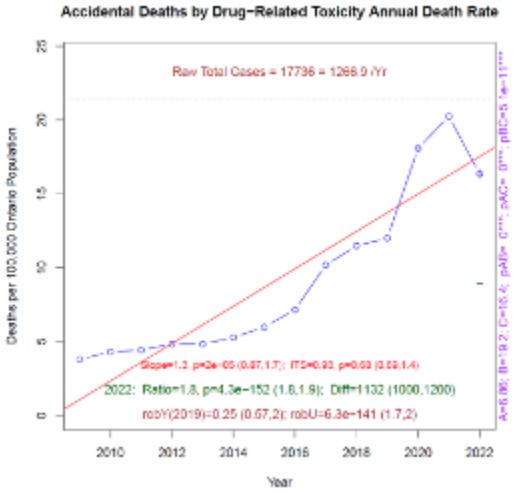


Figure 5. Annual Accidental Drug-Related Death Rates (per 100,000) in Ontario, 2009-2022.

This effect of a decrease in drug-related deaths in post-pandemic 2022 ‘C’ is seen at all equivalent timeframes during the lockdown (2020-2021 ‘B’) (stage 1 (p=0·034), stages 0 and 3-4 (p<0·001), stage 2 (p=0·089)) (Figure 6a-e).

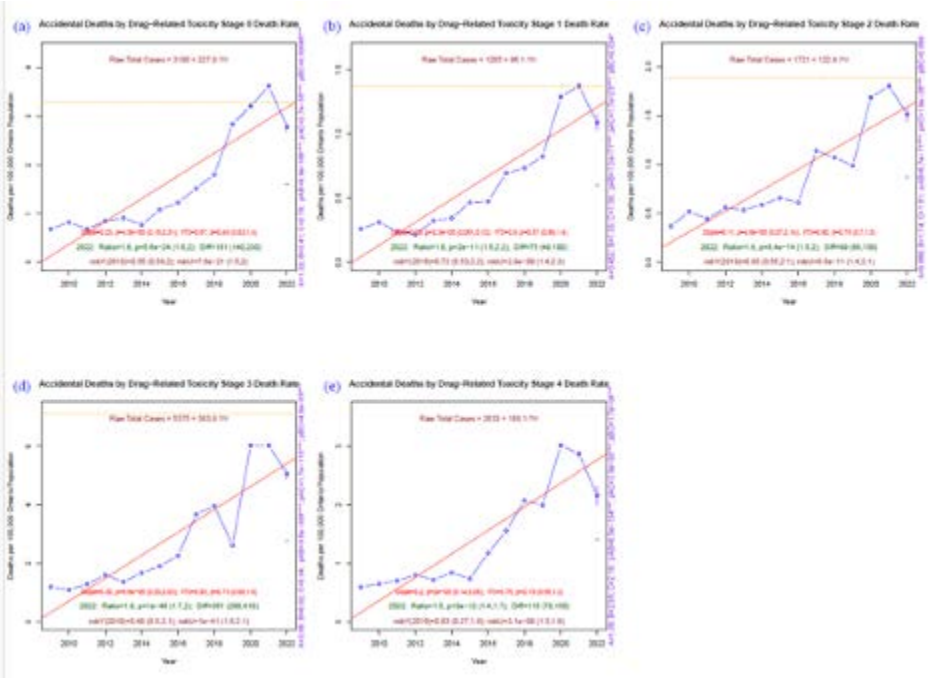

Figure 6. (a) Stage 0, (b) Stage 1, (c) Stage 2, (d) Stage 3, and (e) Stage 4 Accidental Drug-Related Death Rates (per 100,000) in Ontario, 2009-2022.

The decrease in drug-related deaths in 2022, is also demonstrated in a weekly time series plot showing the pandemic years (2020 and 2021) and post-pandemic year (2022) (Figure 7).

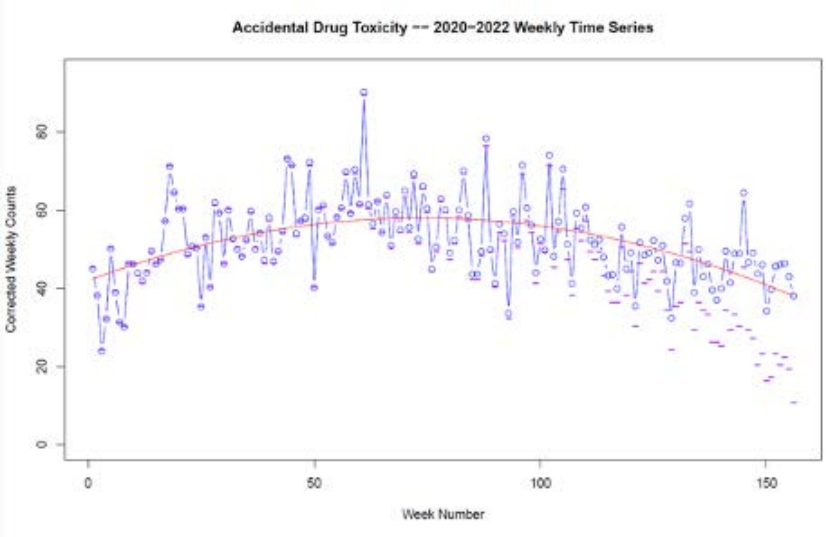


Figure 7. Weekly Accidental Drug-Related Death Rates in Ontario, 2020-2022.

Accidental drug death data may intersect with suicide data insofar as some suicides by drug overdose may be misclassified as accidental drug deaths. We thus also explored a composite self-injury mortality (SIM) model. Rockett *et al.* (2020) have proposed the use of this composite category that includes all suicides plus the accidental drug toxicity deaths.[190] We previously showed an estimated annual effect of 1628 more deaths in 2020.[44] In 2022, we show 398 fewer deaths than previously reported (estimated annual effect for 2022 = 1230) (RR 1·4, 95% CI 1·4-1·5), p<0·001) with a substantial decrease in deaths from 2022 'post-pandemic' 'C' compared to the pandemic years 2020-2021 'B' (p<0·001)(Figure 8).

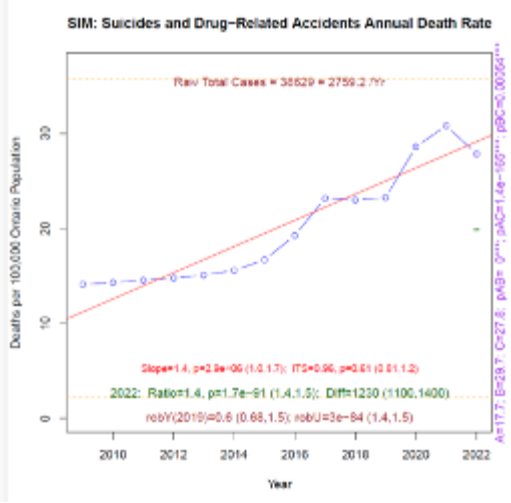


Figure 8. Annual Combined Suicide and Accidental Acute Drug-Related Death Rate (per 100,000) in Ontario, 2009-2022.

We previously showed that in 2020, motor vehicle collision-associated fatalities decreased slightly (estimated annual effect of 78 fewer deaths),[44] however in 2022, rates appear to be trending back to baseline (RR 0·93, 95% CI 0·85-1·0), p=0·061; estimated annual effect of 51 fewer deaths (i.e., an increase in 27 deaths versus expected) (Figure 9a). Overall, this trend is minor, with no substantial change in 2022 'post-pandemic' 'C' compared to the 'pandemic' years 2020-2021 'B' (p=0·53).

However, when looking at stage 0 in 2020, we previously showed a decrease of 21 accidental deaths attributed to motor vehicle collisions versus expected.[44] In 2022, when looking at the comparable time point, there was an increase of 11 deaths (i.e., an increase in 32 deaths versus expected), again, suggesting an increase to greater than baseline (Figure 9b).


Figure 9. (a) Annual and (b) Stage 0 Accidental Motor Vehicle Accident Death Rates (per 100,000) in Ontario, 2009-2022.

The main findings from our current study are summarized in a forest plot (Figure 10b) which displays the 2022 death rate ratios (i.e., the 2022 rate over the pre-2020 rate) and their respective p-values and confidence intervals. This can be visually compared to the same analysis from 2020 (Figure 10a), again demonstrating a slight reversal (towards baseline) of all previously demonstrated trends.

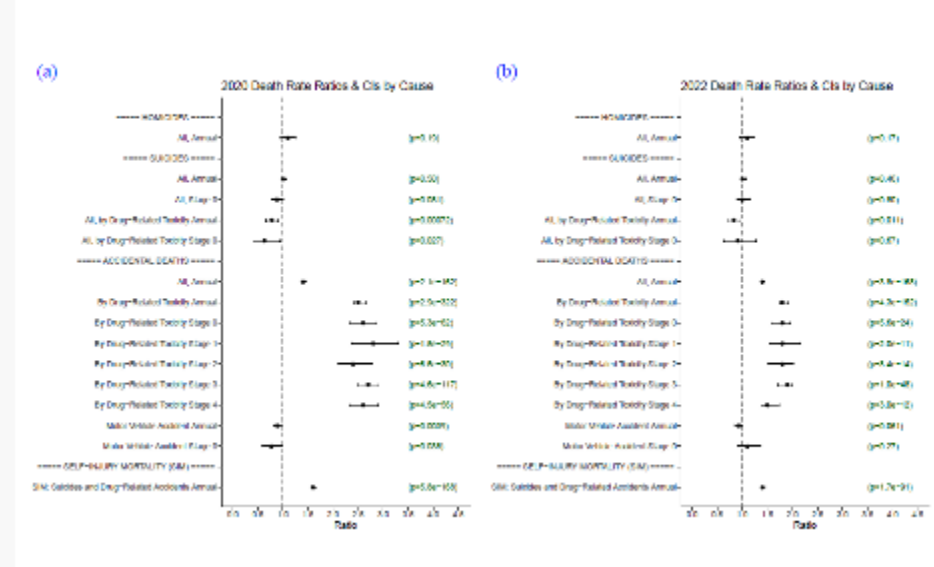


Figure 10. Death Rate Ratios and their Respective p-Values and Confidence Intervals by Death Type in (a) 2020 and (b) 2022.

## Discussion

The COVID-19 pandemic and the public health measures it necessitated were unlike anything this generation has previously witnessed. Its long-term implications are still being elucidated. An understanding of these impacts remains of interest to the public, media, academics, and government policy makers in order to inform future decisions.

We previously reported that homicide rates during the lockdown were largely unaffected in Ontario.[44] Further, we showed that suicide rates slightly decreased during Stage 0, compared to recent years.[44] In contrast, we reported a substantial increase in the rate of drug-related fatalities during all stages of the lockdown.[44] Lastly, we showed accidental motor vehicle collision-associated fatalities decreased slightly in 2020, although an effect attributed to the lockdown was not clearly evident when compared to recent years.[44]

Our current study of 96,173 deaths is, to our knowledge, is the largest worldwide which reports the longer-term effects (i.e., including the entire year of 2022) of the COVID-19 pandemic

(including removal of public health lockdown measures/restrictions) on all non-natural manners of death (suicide, homicide, accident). We currently show evidence of reversals of the previously reported pandemic-related trends. That is, the trends previously observed including a decrease in suicide rates, an increase in accidental drug-related deaths, and a slight decrease in motor-vehicle associated deaths, appear to be heading back to baseline. These results strengthen the evidence for a causal link between the pandemic and the changes seen in the 2020 data, and highlight the importance of death investigation systems in providing high quality and timely data to inform public health recommendations and may give early suggestion to an end of the pandemic-related effects on manners of death.

*Homicides*

Our data demonstrate that in Ontario, the rate of homicides continues to slightly trend upwards however there was no major change in the 2022 post-pandemic phase. Unfortunately, we are unable to compare this finding internationally as the literature has not reported post-pandemic trends beyond February 2022.[9]

During the pandemic, homicide rates decreased in China, England, Wales, and Greece and were unchanged in Mexico and Ontario, Canada.[44–47,184] Femicide also decreased in Turkey and was unchanged in Chile, while domestic homicides increased in Greece.[184,191,192] Additionally, homicides in Bangladesh increased during lockdown but decreased post-lockdown in 2021.[186]

In the USA, most publications reported increasing homicides throughout the pandemic,[60,61,68–71,185] particularly for black individuals,[72] by means of firearm,[62,67,193,194] and in less privileged neighborhoods.[195]

It is unclear why Ontario homicide rates appear to have been unaffected during and subsequent to the pandemic. It is likely that the varied findings between geographic areas are due in large part to region-specific stressors, economic, political, cultural and/or potential variability in the response of emergency medical services (e.g., police, ambulance, and/or hospital services). It remains important to continue to monitor trends not only in mortality, but also domestic violence to ensure public safety.

*Suicides*

Although the overall suicide rate in 2022 remains less than estimated, when compared to 2009-2021, there is a slight recent increase in suicides when compared to the previous two lockdown years. Although the increase is small, a trend towards baseline is evident. Further, in 2022, the substantial drop in suicides by drug-related toxicity death that was seen during the pandemic (2020-2021) is no longer observed, also suggesting a return to baseline.

Compared to all manners of death, suicide rates were the most extensively reported and had the greatest variation in trends in the literature. The most recent data are from 2022, although the majority of these studies report consistent trends across all years (i.e., remained steady or

continued to increase or decrease) rather than a return to baseline effect .[4,7–10] One exception is a study from France, which found suicides decreased during lockdown periods but increased in both youth and elderly age groups from mid-2021 to 2022.[6]

Many countries reported decreased suicide rates, especially early in the pandemic.[45,46,48,60,69,70,72–75,113–131,145,148] However, rates increased during the pandemic period in Poland, Spain, Northern Ireland, Hungary, Nepal, Jordan, Japan, Iran, Mexico, Russia, India (excluding New Delhi) and Suzhou, China,[7,73,76,130,132–144,146,147,149–151] while others reported no change.[8,10,47,61,62,68,73,111,152–178]

Additionally, multiple countries had heterogeneous findings both between studies and within studies (i.e., results varied between geographic region, age, and sex). In the USA, the vast majority of studies reported decreased or stable suicide rates, excluding increased youth suicides.[196,197] Similarly, in Brazil the only increases were seen in women, elderly persons, and those living in economically vulnerable areas.[4,117,198] Japan also reported that youth rates both peaked and returned to baseline in 2020 and that female suicides increased throughout the pandemic period.[43,141,142,148,199–203] Studies from Korea and Poland also reported increased suicides for women only.[204–206] Alternatively, Hungary saw male suicides increase while female rates remained steady.[207]

Lastly, trends also changed from pre- to post-lockdown or from year to year. In Mexico and Hungary, suicides increased during the 2020 but returned to expected rates by 2021.[208,209] Conversely, rates in Germany and Japan were lower during lockdown but increased after restrictions were lifted.[43,148,210–212]

Our observation that suicides in Ontario, particularly due to drug toxicity, initially decreased and then returned to baseline requires further study. It is possible that the initial factors that led to the initial pandemic-associated decrease in suicides have now been removed. That is, perhaps potential positive mental health impacts that accompanied the pandemic and lockdown restrictions, such as working from home and school closures, may no longer be available. This may highlight the relevance of stressors such as commuting/traffic, pressures, harassment, and bullying, which may have been mitigated by pandemic restrictions. Alternatively, it is possible the data reflect long-term mental health implications of the COVID-19 pandemic and related lockdowns (e.g., potential negative impacts on income, unemployment, and increased mental illness). Alternatively, protective factors[26] at the start of the pandemic such as bolstered mental health services, community and or financial supports, may no longer be available. These factors require elucidation, ongoing monitoring, and potential intervention.

*Accident*

The rate of accidents in Ontario continues to trend slightly upwards over the past decade.

When looking specifically at drug-related deaths, we previously showed an excess of 1,500 accidental drug-related deaths in 2020.[44] In 2022, while drug-related deaths still remain increased (estimated annual effect of 1132 excess deaths), they appear to be trending towards baseline.

Furthermore, there is a substantial decrease in drug related deaths in 2022 compared to the pandemic years (2020-2021).

We recognize that some suicides by drug overdose may be misclassified as accidental drug deaths (SIM rate). We previously showed an estimated annual effect of 1,628 more deaths in 2020 in suicide and accidental drug-related deaths.[44] In 2022, we show a decrease to 1,230 estimated excess SIM deaths with a substantial decrease in deaths from 2002 compared to the pandemic years (2020-2021).

The literature reports increased drug-related deaths in the USA,[60–62,67–107,213] Iran,[5,76] Canada,[44,76,99,103,108–110] the UK,[73,76,111] throughout the pandemic, with the most recent data being from Iran in April 2022.[5] Exceptions include decreases in New Hampshire,[79] increasing rates for Black individuals only in Massachusetts,[102] and steady rates in Baltimore, Philadelphia, and Nova Scotia.[115,214,215] Additional papers from the USA report accelerating death rates at the start of the pandemic, then slowing towards October 2020,[216,217] then a further increase during the second pandemic year (March 2021 - February 2022).[9] In England, deaths increased from 2019 to 2020, but then decreased in 2021.[112] Conversely, drug-related deaths in Scotland were increasing pre-pandemic but then leveled off.[73]

The opioid crisis and accidental drug-related deaths remain a challenge in Ontario. Our data show that accidental-drug related deaths continue to be elevated, however that the potential compounding effect of the pandemic and related-health measures may be receding. The root of this effect is not clear; however, it may be related to increased access to harm reduction services and treatment (e.g., due to lifting of physical distancing mandates and closures). It may also be related to a reduction in those who used illicit substances during the pandemic due to a now removed pandemic-related factor, (e.g., social isolation, boredom, feelings of uncertainty, physical/mental health, and financial stressors), that prompted individuals to seek a sense of euphoria/heightening well-being via drug-related use. Prescribing patterns and potential availability of opioid-related medications may also have implications both during and subsequent to the pandemic. The effect of border closures and the drug supply may also have played a role in the components and lethality of illicit substances.

Further, it is possible that the success of interventions, such as physical and mental health supports (including improved access), harm reduction service access, policing, and public health intervention strategies, aimed at reducing drug use may now be reflected in the data. Of note, drug-related deaths continue to remain elevated in Ontario and our data appear to be reflecting a trend to baseline of the continued opioid-related challenges that predated the pandemic-related increase that we previously reported. Whether the reduction will continue or increase in future years has not yet been elucidated. As such, continued monitoring and intervention also remains of utmost importance.

We previously showed that in 2020, motor vehicle collision-associated fatalities decreased slightly (estimated annual effect of 78 fewer deaths),[44] however, in 2022 rates appear to be trending back

to baseline (estimated annual effect of 51 fewer deaths). Overall, this trend is minor; however, there is a suggestion of return to baseline rates.

In most countries with available literature, motor vehicle deaths decreased during the pandemic.[2,44–55] Exceptions include Ireland, UAE (Al-Ain), Estonia, Finland, Iceland, Latvia, Luxembourg, Montenegro, and Switzerland.[50,63,64] In Poland, motor vehicle deaths decreased for females but increased for males,[132] while the USA reported heterogenous trends including increases,[65–71] increases limited to Black and Hispanic individuals,[72] decreases,[56] and steady rates.[1,57–62] Other USA studies reported a dip during lockdown followed by a rise afterwards but another stated that rates increased throughout, with the greatest increase in the second year.[9,74] Lastly, a study from Iran found that accidental deaths in general increased for men but decreased for women during the pandemic.[3]

We previously speculated that the slight decrease in motor vehicle-related fatalities during the onset of the pandemic may have been due to a reduction in drivers on the road due to the lockdown. The impact of reduction in road traffic of accidental deaths may have been countered by other factors, notably unsafe driving practices such as driving under the influence of drugs/alcohol and/or speeding/stunt driving. Our data now suggest a return to baseline (slightly above baseline): this requires continued monitoring and potential intervention to ensure the upward trend does not continue.

**Limitations**

Not all cases were closed at the time of final data extraction, potentially limiting some of our findings. However, as death investigations can take many months/years to complete, this limitation is unavoidable. As timely results are of utmost importance to the public and international community, we extracted data from open cases using preliminary data if it was provided by the Coroner. We have previously calculated using multiple data retrievals that rates of change of manners of death from open to closed cases changes only approximately 0·53% (17/3187) and is thus unlikely to have significantly impacted the results of the study.[44]

For lockdown stages, we acknowledge that there was some variation in geographical areas that were re-opened in the province towards the later stages of the lockdown, however the lockdown dates for our study were selected based on the stage that reflected the status of the majority of the province[188]. Mild variation in geographical location is unlikely to have impacted the main findings. Our study takes into account the small changes (increases) in Ontario's population over time, however, it does not specifically consider age-adjusted rates to reflect changes in Ontario's age distribution. We have conducted a preliminary investigation into those changes. Our investigation showed that there is variability in suicide rates with age ranges. However, we found that Ontario's population in different age ranges has remained relatively constant over the period under investigation. Additionally, the changes do not appear to be large enough to substantially impact the corresponding yearly death rates. Thus, we feel that changes in population age distribution are unlikely to affect our conclusions.

We acknowledge the possibility that a small percentage of cause and manner of death determinations may have been misclassified by the Coroner due to unavailable information at the time of investigation. Although we could have prefaced each manner with 'suspected', we used the official classified manner of death as recorded in the Coroner's software systems. If there was substantial uncertainty with respect to the manner of death, the case would likely have been classified as 'undetermined'. Undetermined manners of death (in closed cases) were excluded from our study as this manner represents limited practical utility to public health and policy makers in the context of our study.

In Ontario, all Coroners' investigations and conclusions are reviewed by a Regional Supervising Coroner who performs quality assurance measures on each case, ensuring multiple experts have reviewed the available information and agree on the cause and manner of death. Further, there is a quality assurance program in Ontario for forensic pathology reports for deaths in which an autopsy is performed (including routine audits, and a peer review process). We acknowledge that despite these practices, there may still be misclassifications. However, within the recognized limitations of manner of death determination based on the investigative information available, we feel misclassifications likely represent a very small percentage of cases that are unlikely to significantly impact our study. Statistically, misclassification rates are likely to have remained relatively constant each year and are therefore unlikely to have affected comparisons between years. Additionally, cases can be reopened and amended based on new information available, to ensure accurate classifications, and our study will have included cases which were corrected and closed if a case required an updated classification.

A limitation of our study is that the data do not include attempted homicides and suicides, as our data only includes the deceased population. Further, our accidental motor vehicle collision data only includes fatalities, and as such, cannot draw conclusions on motor vehicle collision rates (including non-lethal collisions).

**Conclusion**

We report a post-pandemic "trend to baseline" effect for suicides and accidental deaths, including drug-related and motor vehicle collision fatalities. Homicide rates do not appear to have been affected by the COVID-19 pandemic. All our previously reported pandemic-related effects including increased drug-related deaths and decreased suicide and motor-vehicle collision associated deaths appear to be trending back to baseline. These results may suggest an end to the pandemic-related effects on these non-natural manners of death.

Our new findings suggest interventions aimed at reducing drug use may have in part assisted to reduce drug-related deaths (however on-going monitoring and continued intervention is required). However, the study also suggests the need for potential consideration of increased mental health supports for suicide prevention, and possible interventions to reduce motor-vehicle collision associated deaths.

This study highlights the vital role of death investigation systems in providing high quality and timely data to inform public health recommendations.

**Acknowledgements**

The authors thank Andrew Stephen for extracting, anonymizing, and securing the CIS and QuinC data for this study. We thank Julia Man for assisting with coding accuracy checking between CIS and QuinC and initial input on this study. We are grateful to Dr. Andrew Williams for initial advice and insight regarding study design. We thank the librarian team at the University of Toronto for assistance with our literature search strategy. The authors thank the OCC-OFPS leadership team for support of this study. We are grateful to the Coroners, Forensic Pathologists, Technologists, Assistants, Technical and Administrative Staff, Police and all other members of the Death Investigation Team involved in these cases. We acknowledge the individuals and the loss experienced by families, friends, and communities that are represented in these data.

**Declaration of Interest**

This study adhered to scientific and medical standards of ethics and was approved by the University of Toronto Research Ethics Board (REB file #00040433). This study did not receive any funding. None of the authors declare any real or perceived conflicts of interest. All authors meet criteria for authorship per the ICMJE guidelines and all authors have approved the manuscript in its submitted form.

**Contributors**

JD conceptualized the study, gained REB approval, contributed to the study design and methodology, verified the underlying data, drafted, and reviewed the manuscript. JR contributed to the study design and methodology, verified the underlying data, performed the statistical analysis, generated figures, drafted and reviewed the manuscript. MC conducted the literature review, contributed to the study design and methodology, drafted, and reviewed the manuscript. RW contributed to the study design and methodology and reviewed the manuscript.

**Funding**

None.

**Data Sharing**

Full technical details of all of the categories and robustness tests and adjustments that we considered are available upon request.

## References


1 Reynolds L, Griffin RL. A decomposition of the effects of the COVID-19 pandemic on changes in the motor vehicle collision related mortality in Alabama. *Accid Anal Prev* 2023; **189**: 107127.
2 Shimada R, Kibayashi K. Changes in the number of traffic collisions during the various waves of COVID-19 infection in Japan. *PloS One* 2022; **17**: e0278941.
3 Pirayesh Z, Riahi SM, Bidokhti A, Kazemi T. Evaluation of the effect of the COVID-19 pandemic on the all-cause, cause-specific mortality, YLL, and life expectancy in the first 2 years in an Iranian population-an ecological study. *Front Public Health* 2023; **11**: 1259202.
4 Orellana JDY, de Souza MLP, Horta BL. Excess suicides in Brazil during the first 2 years of the COVID-19 pandemic: Gender, regional and age group inequalities. *Int J Soc Psychiatry* 2024; **70**: 99–112.
5 Behnoush AH, Bazmi E, Forouzesh M, Koehler SA, Monabati SJ, Behnoush B. Impact of COVID-19 on poisoning-related mortality in Iran: An interrupted time series study. *Int J Drug Policy* 2023; **117**: 104051.
6 Fouillet A, Martin D, Pontais I, Caserio-Schönemann C, Rey G. Reactive surveillance of suicides during the COVID-19 pandemic in France, 2020 to March 2022. *Epidemiol Psychiatr Sci* 2023; **32**: e20.
7 Al-Sabaileh S, Abusamak M, Jaber H, *et al.* Suicide Trends in Jordan in Correlation With the COVID-19 Pandemic: A Forensic Medicine Perspective. *Cureus* 2023; **15**: e42636.
8 Papsdorf R, Genuneit J, White LO, Radeloff DM. [Suicides among children, adolescents, and young adults during the COVID-19 pandemic - An analysis of police data from three German federal states]. *Psychiatr Prax* 2023. DOI:10.1055/a-2171-4889.
9 Ruhm CJ. The Evolution of Excess Deaths in the United States During the First 2 Years of the COVID-19 Pandemic. *Am J Epidemiol* 2023; **192**: 1949–59.
10 Workman A, deJong J. West Michigan Suicide Trends During the COVID-19 Pandemic. *Am J Forensic Med Pathol* 2023. DOI:10.1097/PAF.0000000000000837.
11 Sakamoto H, Ishikane M, Ghaznavi C, Ueda P. Assessment of Suicide in Japan During the COVID-19 Pandemic vs Previous Years. *JAMA Netw Open* 2021; **4**: e2037378.
12 Pell R, Fryer E, Manek S, Winter L, Roberts ISD. Coronial autopsies identify the indirect effects of COVID-19. *Lancet Public Health* 2020; **5**: e474.
13 Deisenhammer EA, Kemmler G. Decreased suicide numbers during the first 6 months of the COVID-19 pandemic. *Psychiatry Res* 2021; **295**: 113623.
14 Isumi A, Doi S, Yamaoka Y, Takahashi K, Fujiwara T. Do suicide rates in children and adolescents change during school closure in Japan? The acute effect of the first wave of COVID-19 pandemic on child and adolescent mental health. *Child Abuse Negl* 2020; **110**: 104680.
15 Byard RW. Geographic variability in homicide rates following the COVID-19 pandemic. *Forensic Sci Med Pathol* 2021; **17**: 419–21.
16 Boman JH 4th, Gallupe O. Has COVID-19 Changed Crime? Crime Rates in the United States during the Pandemic. *Am J Crim Justice AJCJ* 2020; **45**: 537–45.
17 Sakelliadis EI, Katsos KD, Zouzia EI, Spiliopoulou CA, Tsiodras S. Impact of Covid-19 lockdown on characteristics of autopsy cases in Greece. Comparison between 2019 and 2020. *Forensic Sci Int* 2020; **313**: 110365.
18 Calderon-Anyosa RJC, Kaufman JS. Impact of COVID-19 lockdown policy on homicide, suicide, and motor vehicle deaths in Peru. *Prev Med* 2021; **143**: 106331.
19 Qin P, Mehlum L. National observation of death by suicide in the first 3 months under COVID-19 pandemic. *Acta Psychiatr Scand* 2021; **143**: 92–3.
20 Vandoros S, Theodorikakou O, Katsadoros K, Zafeiropoulou D, Kawachi I. No evidence of increase in suicide in Greece during the first wave of covid-19. *medRxiv* 2020.

21 Bray MJC, Daneshvari NO, Radhakrishnan I, *et al.* Racial Differences in Statewide Suicide Mortality Trends in Maryland During the Coronavirus Disease 2019 (COVID-19) Pandemic. *JAMA Psychiatry* 2021; **78**: 444–7.
22 Leske S, Kõlves K, Crompton D, Arensman E, de Leo D. Real-time suicide mortality data from police reports in Queensland, Australia, during the COVID-19 pandemic: an interrupted time-series analysis. *Lancet Psychiatry* 2021; **8**: 58–63.
23 Mitchell TO, Li L. State-Level Data on Suicide Mortality During COVID-19 Quarantine: Early Evidence of a Disproportionate Impact on Racial Minorities. *Psychiatry Res* 2021; **295**: 113629.
24 Faust JS, Shah SB, Du C, Li S-X, Lin Z, Krumholz HM. Suicide Deaths During the COVID-19 Stay-at-Home Advisory in Massachusetts, March to May 2020. *JAMA Netw Open* 2021; **4**: e2034273.
25 Appleby L, Richards N, Ibrahim S, Turnbull P, Rodway C, Kapur N. Suicide in England in the COVID-19 pandemic: Early observational data from real time surveillance. *Lancet Reg Health Eur* 2021; **4**: 100110.
26 Pirkis J, John A, Shin S, *et al.* Suicide trends in the early months of the COVID-19 pandemic: an interrupted time-series analysis of preliminary data from 21 countries. *Lancet Psychiatry* 2021; **8**: 579–88.
27 Karakasi M-V, Kevrekidis D-P, Pavlidis P. The Role of the SARS-CoV-2 Pandemic on Suicide Rates: Preliminary Study in a Sample of the Greek Population. *Am J Forensic Med Pathol* 2021; **42**: 99–100.
28 Kim AM. The short-term impact of the COVID-19 outbreak on suicides in Korea. *Psychiatry Res* 2021; **295**: 113632.
29 Nomura S, Kawashima T, Yoneoka D, *et al.* Trends in suicide in Japan by gender during the COVID-19 pandemic, up to September 2020. *Psychiatry Res* 2021; **295**: 113622.
30 Radeloff D, Papsdorf R, Uhlig K, Vasilache A, Putnam K, von Klitzing K. Trends in suicide rates during the COVID-19 pandemic restrictions in a major German city. *Epidemiol Psychiatr Sci* 2021; **30**: e16.
31 Ruck C, Mataix-Cols D, Malki K. Will the COVID-19 pandemic lead to a tsunami of suicides? A Swedish nationwide analysis of historical and 2020 data. *Psychiatry and Clin Psychol* 2020.
32 Sutherland M, McKenney M, Elkbuli A. Vehicle related injury patterns during the COVID-19 pandemic: What has changed? *Am J Emerg Med* 2020; **38**: 1710–4.
33 Calderon-Anyosa RJC, Bilal U, Kaufman JS. Variation in Non-external and External Causes of Death in Peru in Relation to the COVID-19 Lockdown. *Yale J Biol Med* 2021; **94**: 23–40.
34 Public Health Agency of Canada. Apparent Opioid and Stimulant Toxicity Deaths. Surveillance of Opioid- and Stimulant-Related Harms in Canada; Accessed 21-Apr-2021 from https://health-infobase.canada.ca/src/doc/SRHD/UpdateDeathsMarch2021.pdf.
35 Paul LA, Li Y, Leece P, et al. Bayesian modelling of opioid mortality trends: 2003-2022. Preprint. PLoSMed 21-Apr-2021. Accessed from https://www.editorialmanager.com/pmedicine/download.aspx?id=792404&guid=086c7798-4814-44a3-9ae3-2ecea3d1632b&-scheme=1.
36 British Columbia Coroners Service. Illicit drug toxicity deaths in BC 21-Apr-2021. January 1, 2011 − March 31, 2021. Accessed from https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriageand-divorce/deaths/coroners-service/statistical/illicit-drug.pdf.
37 Government of Alberta. Alberta substance use surveillance system 21-Apr-2021. Accessed from https://healthanalytics.alberta.ca/SASVisualAnalytics/?reportUri=%2Freports%2Freports%2F1bbb695d14b1-4346-b66e-d401a40f53e6&sectionIndex=0&sso_guest=true&reportViewOnly=true&reportContextBar=false&sas-welcome=false

38 Glober N, Mohler G, Huynh P, *et al.* Impact of COVID-19 Pandemic on Drug Overdoses in Indianapolis. *J Urban Health Bull N Y Acad Med* 2020; **97**: 802–7.
39 Mason M, Welch SB, Arunkumar P, Post LA, Feinglass JM. Notes from the Field: Opioid Overdose Deaths Before, During, and After an 11-Week COVID-19 Stay-at-Home Order - Cook County, Illinois, January 1, 2018-October 6, 2020. *MMWR Morb Mortal Wkly Rep* 2021; **70**: 362–3.
40 The Ontario Drug Research Policy Research Network. Preliminary patterns in circumstances surrounding opioid-related deaths in Ontario during the COVID-19 pandemic. A collaboration between the OCC-OFPS 21-Apr-2021. Public Health Ontario and the Centre of Drug Policy Evaluation. Accessed from https://odprn.ca/wp-content/uploads/2020/11/Opioid-Death-Report_FINAL-2020NOV09.pdf.
41 Alter A, Yeager C. COVID-19 Impact on US National Overdose Crisis. Overdose Detection Mapping Application Program (ODMAP); Accessed 17-Aug-2021 from http://www.odmap.org/Content/docs/news/2020/ODMAP-Report-June-2020.pdf.
42 Tanaka T, Okamoto S. Increase in suicide following an initial decline during the COVID-19 pandemic in Japan. *Nat Hum Behav* 2021; **5**: 229–38.
43 Ueda M, Nordström R, Matsubayashi T. Suicide and mental health during the COVID-19 pandemic in Japan. *J Public Health Oxf Engl* 2022; **44**: 541–8.
44 Dmetrichuk JM, Rosenthal JS, Man J, Cullip M, Wells RA. Retrospective study of non-natural manners of death in Ontario: Effects of the COVID-19 pandemic and related public health measures. *Lancet Reg Health Am* 2022; **7**: 100130.
45 Zheng X-Y, Tang S-L, Ma S-L, *et al.* Trends of injury mortality during the COVID-19 period in Guangdong, China: a population-based retrospective analysis. *BMJ Open* 2021; **11**: e045317.
46 Laliotis I, Stavropoulou C, Ceely G, Brett G, Rushton R. Excess deaths by cause and place of death in England and Wales during the first year of COVID-19. *Health Econ* 2023; **32**: 1982–2005.
47 Silverio-Murillo A, Balmori de la Miyar JR, Martínez-Alfaro A. Non-COVID-19 deaths in times of pandemic. *J Public Health Oxf Engl* 2023; **45**: e196–203.
48 Grande E, Fedeli U, Pappagallo M, *et al.* Variation in Cause-Specific Mortality Rates in Italy during the First Wave of the COVID-19 Pandemic: A Study Based on Nationwide Data. *Int J Environ Res Public Health* 2022; **19**. DOI:10.3390/ijerph19020805.
49 Sanmarchi F, Esposito F, Adorno E, De Dominicis F, Fantini MP, Golinelli D. The impact of the SARS-CoV-2 pandemic on cause-specific mortality patterns: a systematic literature review. *Z Gesundheitswissenschaften J Public Health* 2022; **26**: 1–19.
50 Yasin YJ, Grivna M, Abu-Zidan FM. Global impact of COVID-19 pandemic on road traffic collisions. *World J Emerg Surg WJES* 2021; **16**: 51.
51 Sekadakis M, Katrakazas C, Michelaraki E, Kehagia F, Yannis G. Analysis of the impact of COVID-19 on collisions, fatalities and injuries using time series forecasting: The case of Greece. *Accid Anal Prev* 2021; **162**: 106391.
52 Vandoros S. COVID-19, lockdowns and motor vehicle collisions: empirical evidence from Greece. *Inj Prev J Int Soc Child Adolesc Inj Prev* 2022; **28**: 81–5.
53 Rapoport MJ, Chee JN, Aljenabi N, *et al.* Impact of COVID-19 on motor vehicle injuries and fatalities in older adults in Ontario, Canada. *Accid Anal Prev* 2021; **157**: 106195.
54 Jayaraj VJ, Chong DW-Q, Wan K-S, *et al.* Estimating excess mortalities due to the COVID-19 pandemic in Malaysia between January 2020 and September 2021. *Sci Rep* 2023; **13**: 86.
55 Ahmadpur M. Impact of COVID-19 spread on road safety indices of Turkey. *Int J Inj Contr Saf Promot* 2022; **29**: 382–93.
56 Malpede M, Shayegh S. Staying home saves lives, really! *Lett Spat Resour Sci* 2022; **15**: 637–51.
57 Adanu EK, Brown D, Jones S, Parrish A. How did the COVID-19 pandemic affect road

crashes and crash outcomes in Alabama? *Accid Anal Prev* 2021; **163**: 106428.
58 Kaufman EJ, Holena D, Koenig G, *et al.* Increase in Motor Vehicle Crash Severity: An Unforeseen Consequence of COVID-19. *Am Surg* 2023; **89**: 865–70.
59 Qureshi AI, Huang W, Khan S, *et al.* Mandated societal lockdown and road traffic accidents. *Accid Anal Prev* 2020; **146**: 105747.
60 Faust JS, Du C, Mayes KD, *et al.* Mortality From Drug Overdoses, Homicides, Unintentional Injuries, Motor Vehicle Crashes, and Suicides During the Pandemic, March-August 2020. *JAMA* 2021; **326**: 84–6.
61 Smith TE, Ledneva T, Cohen DE, *et al.* Ethnoracial Disparities in Rates of Non-Natural Causes of Death After the 2020 COVID-19 Outbreak in New York State. *AJPM Focus* 2023; **2**: 100151.
62 McCoy RG, Campbell RL, Mullan AF, *et al.* Changes in all-cause and cause-specific mortality during the first year of the COVID-19 pandemic in Minnesota: population-based study. *BMC Public Health* 2022; **22**: 2291.
63 Vandoros S, Papailias F. Empty Streets, Speeding and Motor Vehicle Collisions during Covid-19 Lockdowns: Evidence from Northern Ireland. *Public and Global Health* 2021. DOI:10.1101/2021.01.03.21249173.
64 Yasin YJ, Alao DO, Grivna M, Abu-Zidan FM. Impact of the COVID-19 Pandemic on road traffic collision injury patterns and severity in Al-Ain City, United Arab Emirates. *World J Emerg Surg WJES* 2021; **16**: 57.
65 Doucette ML, Tucker A, Auguste ME, *et al.* Initial impact of COVID-19's stay-at-home order on motor vehicle traffic and crash patterns in Connecticut: an interrupted time series analysis. *Inj Prev* 2021; **27**: 3–9.
66 Neuroth LM, Singichetti B, Harmon KJ, Waller AE, Naumann RB. Racial and ethnic disparities in motor vehicle crash-related outcomes in North Carolina surrounding the COVID-19 pandemic. *Inj Prev* 2024; **30**: 84–8.
67 He J, Ning P, Schwebel DC, *et al.* Injury mortality and morbidity changes due to the COVID-19 pandemic in the United States. *Front Public Health* 2022; **10**: 1001567.
68 Lee W-E, Park SW, Weinberger DM, *et al.* Direct and indirect mortality impacts of the COVID-19 pandemic in the US, March 2020-April 2021. MedRxiv Prepr. Serv. Health Sci. 2022; **15**:2022.02.10.22270721.
69 Ruhm CJ. Excess deaths in the United States during the first year of COVID-19. *Prev Med* 2022; **162**: 107174.
70 Ruhm CJ. Pandemic And Recession Effects On Mortality In The US During The First Year Of COVID-19. *Health Aff Proj Hope* 2022; **41**: 1550–8.
71 Todd M, Scheeres A. Excess Mortality From Non-COVID-19 Causes During the COVID-19 Pandemic in Philadelphia, Pennsylvania, 2020-2021. *Am J Public Health* 2022; **112**: 1800–3.
72 Chen R, Aschmann HE, Chen Y-H, *et al.* Racial and Ethnic Disparities in Estimated Excess Mortality From External Causes in the US, March to December 2020. *JAMA Intern Med* 2022; **182**: 776.
73 Angus C, Buckley C, Tilstra AM, Dowd JB. Increases in 'deaths of despair' during the COVID-19 pandemic in the United States and the United Kingdom. *Public Health* 2023; **218**: 92–6.
74 Glei DA. The US Midlife Mortality Crisis Continues: Excess Cause-Specific Mortality During 2020. *Am J Epidemiol* 2022; **191**: 1677–86.
75 Larson PS, Bergmans RS. Impact of the COVID-19 pandemic on temporal patterns of mental health and substance abuse related mortality in Michigan: An interrupted time series analysis. *Lancet Reg Health Am* 2022; **10**: 100218.
76 Rahimi-Ardabili H, Feng X, Nguyen P-Y, Astell-Burt T. Have Deaths of Despair Risen during the COVID-19 Pandemic? A Systematic Review. *Int J Environ Res Public Health* 2022; **19**. DOI:10.3390/ijerph191912835.

77 Appa A, Rodda LN, Cawley C, *et al.* Drug Overdose Deaths Before and After Shelter-in-Place Orders During the COVID-19 Pandemic in San Francisco. *JAMA Netw Open* 2021; **4**: e2110452.
78 Austin AE, Shiue KY, Combs KG, Proescholdbell S, Cox ME, Naumann RB. Racial and ethnic differences and COVID-19 pandemic-related changes in drug overdose deaths in North Carolina. *Ann Epidemiol* 2023; **85**: 88-92.e4.
79 Brown KG, Chen CY, Dong D, Lake KJ, Butelman ER. Has the United States Reached a Plateau in Overdoses Caused by Synthetic Opioids After the Onset of the COVID-19 Pandemic? Examination of Centers for Disease Control and Prevention Data to November 2021. *Front Psychiatry* 2022; **13**: 947603.
80 Cartus AR, Li Y, Macmadu A, *et al.* Forecasted and Observed Drug Overdose Deaths in the US During the COVID-19 Pandemic in 2020. *JAMA Netw Open* 2022; **5**: e223418.
81 Chu R, Sarnala S, Doan T, *et al.* COVID-19 pandemic impact on opioid overdose deaths among racial groups within the United States: an observational cross-sectional study. *Br J Anaesth* 2024; **132**: 201–4.
82 DiGennaro C, Garcia G-GP, Stringfellow EJ, Wakeman S, Jalali MS. Changes in characteristics of drug overdose death trends during the COVID-19 pandemic. *Int J Drug Policy* 2021; **98**: 103392.
83 Friedman J, Akre S. COVID-19 and the Drug Overdose Crisis: Uncovering the Deadliest Months in the United States, January–July 2020. *Am J Public Health* 2021; **111**: 1284–91.
84 Friedman J, Hansen H, Bluthenthal RN, Harawa N, Jordan A, Beletsky L. Growing racial/ethnic disparities in overdose mortality before and during the COVID-19 pandemic in California. *Prev Med* 2021; **153**: 106845.
85 Friedman J, Hansen H. Evaluation of Increases in Drug Overdose Mortality Rates in the US by Race and Ethnicity Before and During the COVID-19 Pandemic. *JAMA Psychiatry* 2022; **79**: 379–81.
86 Garcia G-GP, Stringfellow EJ, DiGennaro C, *et al.* Opioid overdose decedent characteristics during COVID-19. *Ann Med* 2022; **54**: 1081–8.
87 Ghose R, Forati AM, Mantsch JR. Impact of the COVID-19 Pandemic on Opioid Overdose Deaths: a Spatiotemporal Analysis. *J Urban Health Bull N Y Acad Med* 2022; **99**: 316–27.
88 Gomes T, Ledlie S, Tadrous M, Mamdani M, Paterson JM, Juurlink DN. Trends in Opioid Toxicity–Related Deaths in the US Before and After the Start of the COVID-19 Pandemic, 2011-2021. *JAMA Netw Open* 2023; **6**: e2322303.
89 Gondré-Lewis MC, Abijo T, Gondré-Lewis TA. The Opioid Epidemic: a Crisis Disproportionately Impacting Black Americans and Urban Communities. *J Racial Ethn Health Disparities* 2023; **10**: 2039–53.
90 Hawkins D, Phan AT. Changes in drug poisoning mortality before and after the COVID-19 pandemic by occupation in Massachusetts. *Am J Ind Med* 2022; **65**: 556–66.
91 Kelley MA, Lucas J, Stewart E, Goldman D, Doctor JN. Opioid-related deaths before and after COVID-19 stay-at-home orders in Los Angeles County. *Drug Alcohol Depend* 2021; **228**: 109028.
92 Kiang MV, Acosta RJ, Chen Y-H, *et al.* Sociodemographic and geographic disparities in excess fatal drug overdoses during the COVID-19 pandemic in California: A population-based study. *Lancet Reg Health - Am* 2022; **11**: 100237.
93 Kleinman RA, Sanches M. Methadone-involved overdose deaths in the United States before and during the COVID-19 pandemic. *Drug Alcohol Depend* 2023; **242**: 109703.
94 Knoebel RW, Kim SJ. Impact of COVID-19 Pandemic, Social Vulnerability, and Opioid Overdoses in Chicago. *AJPM Focus* 2023; **2**: 100086.
95 Lalani K, Bakos-Block C, Cardenas-Turanzas M, Cohen S, Gopal B, Champagne-Langabeer T. The Impact of COVID-19 on Opioid-Related Overdose Deaths in Texas. *Int J Environ Res Public Health* 2022; **19**. DOI:10.3390/ijerph192113796.

96 Lee H, Singh GK. Estimating the impact of the COVID-19 pandemic on rising trends in drug overdose mortality in the United States, 2018-2021. *Ann Epidemiol* 2023; **77**: 85–9.
97 Lee H, Singh GK. Monthly Trends in Drug Overdose Mortality among Youth Aged 15-34 Years in the United States, 2018-2021: Measuring the Impact of the COVID-19 Pandemic. *Int J MCH AIDS* 2022; **11**: e583.
98 Leonhardt MM, Spartz JR, Shankar A, Murphy SA. Fatal drug use in the COVID-19 pandemic response: Changing trends in drug-involved deaths before and after stay-at-home orders in Louisiana. *Front Public Health* 2023; **11**: 1117841.
99 Simha S, Ahmed Y, Brummett CM, Waljee JF, Englesbe MJ, Bicket MC. Impact of the COVID-19 pandemic on opioid overdose and other adverse events in the USA and Canada: a systematic review. *Reg Anesth Pain Med* 2023; **48**: 37–43.
100 Vieson J, Yeh AB, Lan Q, Sprague JE. During the COVID-19 Pandemic, Opioid Overdose Deaths Revert to Previous Record Levels in Ohio. *J Addict Med* 2022; **16**: e118–22.
101 Xia Z, Stewart K. A counterfactual analysis of opioid-involved deaths during the COVID-19 pandemic using a spatiotemporal random forest modeling approach. *Health Place* 2023; **80**: 102986.
102 Zang X, Walley AY, Chatterjee A, *et al.* Changes to opioid overdose deaths and community naloxone access among Black, Hispanic and White people from 2016 to 2021 with the onset of the COVID-19 pandemic: An interrupted time-series analysis in Massachusetts, USA. *Addict Abingdon Engl* 2023; **118**: 2413–23.
103 Imtiaz S, Nafeh F, Russell C, Ali F, Elton-Marshall T, Rehm J. The impact of the novel coronavirus disease (COVID-19) pandemic on drug overdose-related deaths in the United States and Canada: a systematic review of observational studies and analysis of public health surveillance data. *Subst Abuse Treat Prev Policy* 2021; **16**: 87.
104 Kaslow NJ, Lewis PC, Cheong YF, Yount KM. Longitudinal study of COVID-19 stay-at-home orders' impact on deaths of despair in the United States, January 2019 to December 2020. *J Public Health Oxf Engl* 2023; **45**: 710–3.
105 Rezaeiahari M, Fairman BJ. Impact of COVID-19 on the characteristics of opioid overdose deaths in Arkansas. *Int J Drug Policy* 2022; **109**: 103836.
106 Sprague JE, Yeh AB, Lan Q, Vieson J, McCorkle M. COVID-19 economic impact payments and opioid overdose deaths. *Int J Drug Policy* 2022; **102**: 103608.
107 Rodda LN, West KL, LeSaint KT. Opioid Overdose-Related Emergency Department Visits and Accidental Deaths during the COVID-19 Pandemic. *J Urban Health Bull N Y Acad Med* 2020; **97**: 808–13.
108 Gomes T, Kitchen SA, Murray R. Measuring the Burden of Opioid-Related Mortality in Ontario, Canada, During the COVID-19 Pandemic. *JAMA Netw Open* 2021; **4**: e2112865.
109 Lee Y, Lui LMW, Brietzke E, *et al.* Comparing mortality from covid-19 to mortality due to overdose: A micromort analysis. *J Affect Disord* 2022; **296**: 514–21.
110 Palis H, Bélair M-A, Hu K, Tu A, Buxton J, Slaunwhite A. Overdose deaths and the COVID-19 pandemic in British Columbia, Canada. *Drug Alcohol Rev* 2022; **41**: 912–7.
111 Pell R, Suvarna SK, Cooper N, *et al.* Coronial postmortem reports and indirect COVID-19 pandemic-related mortality. *J Clin Pathol* 2023; **76**: 457–62.
112 Sekeris A, Algahtani T, Aldabergenov D, *et al.* Trends in deaths following drug use in England before, during, and after the COVID-19 lockdowns. *Front Public Health* 2023; **11**: 1232593.
113 Calati R, Gentile G, Fornaro M, Tambuzzi S, Zoja R. Preliminary suicide trends during the COVID-19 pandemic in Milan, Italy. *J Psychiatr Res* 2021; **143**: 21–2.
114 Grande E, Grippo F, Crialesi R, Marchetti S, Frova L. Suicide mortality in Italy during the first year of the COVID-19 pandemic. *J Affect Disord* 2023; **339**: 776–80.
115 Schleihauf E, Bowes MJ. Suicide and drug toxicity mortality in the first year of the

COVID-19 pandemic: use of medical examiner data for public health in Nova Scotia. *Health Promot Chronic Dis Prev Can Res Policy Pract* 2022; **42**: 60–7.
116 Cabral S, Rocha T, Caetano S, Mari J, Borschmann R, Asevedo E. Decrease in suicide rates in Brazil during the COVID-19 pandemic. *Psychiatry Res* 2023; **329**: 115443.
117 Orellana JDY, de Souza MLP. Excess suicides in Brazil: Inequalities according to age groups and regions during the COVID-19 pandemic. *Int J Soc Psychiatry* 2022; **68**: 997–1009.
118 Isnar S, Oremus M. Examining the association between the COVID-19 pandemic and self-harm death counts in four Canadian provinces. *Psychiatry Res* 2022; **310**: 114433.
119 McIntyre RS, Lui LM, Rosenblat JD, *et al.* Suicide reduction in Canada during the COVID-19 pandemic: lessons informing national prevention strategies for suicide reduction. *J R Soc Med* 2021; **114**: 473–9.
120 Duarte F, Jiménez-Molina Á. Suicide and quarantine during the COVID-19 pandemic: Do we know everything? *Soc Sci Med* 2022; **309**: 115253.
121 Vuscan ME, Buciuta A, Vica ML, *et al.* Impact of the COVID-19 Pandemic on the Suicidal Behavior in Romania. *Arch Suicide Res* 2023; **27**: 554–64.
122 Holden BA, Dwyer JB. Millennials, the Most Afflicted Generation: Suicide Trends Within Dallas County From 2019 to 2021. *Am J Forensic Med Pathol* 2023. DOI:10.1097/PAF.0000000000000851.
123 Lund JJ, Tomsich E, Schleimer JP, Pear VA. Changes in self-harm and suicide in California from 2017-2021: a population-based study. *Res Sq* 2023; DOI:10.21203/rs.3.rs-2395128/v1.
124 Rossom RC, Penfold RB, Owen-Smith AA, Simon GE, Ahmedani BK. Suicide Deaths Before and During the Coronavirus Disease 2019 Pandemic: An Interrupted Time-series Study. *Med Care* 2022; **60**: 357–60.
125 Ruiz Sánchez G. COVID-19 and suicides in the United States: an early empirical assessment. *SN Bus Econ* 2022; **2**: 68.
126 Chen Y-Y, Yang C-T, Yip PSF. The increase in suicide risk in older adults in Taiwan during the COVID-19 outbreak. *J Affect Disord* 2023; **327**: 391–6.
127 Lin C-Y, Chang S-S, Shen L-J. Decrease in Suicide During the First Year of the COVID-19 Pandemic in Taiwan. *J Clin Psychiatry* 2021; **82**. DOI:10.4088/JCP.21br14137.
128 Anzai T, Fukui K, Ito T, Ito Y, Takahashi K. Excess Mortality From Suicide During the Early COVID-19 Pandemic Period in Japan: A Time-Series Modeling Before the Pandemic. *J Epidemiol* 2021; **31**: 152–6.
129 Kim AM. The impact of the COVID-19 pandemic on suicides: A population study. *Psychiatry Res* 2022; **314**: 114663.
130 Martínez-Alés G, Szmulewicz A, López-Cuadrado T, Morrison CN, Keyes KM, Susser ES. Suicide Following the COVID-19 Pandemic Outbreak: Variation Across Place, Over Time, and Across Sociodemographic Groups. A Systematic Integrative Review. *Curr Psychiatry Rep* 2023; **25**: 283–300.
131 Ehlman DC, Yard E, Stone DM, Jones CM, Mack KA. Changes in Suicide Rates - United States, 2019 and 2020. *MMWR Morb Mortal Wkly Rep* 2022;**71**: 306-12.
132 Pikala M, Krzywicka M, Burzyńska M. Excess mortality in Poland during the first and second wave of the COVID-19 pandemic in 2020. *Front Public Health* 2022; **10**: 1048659.
133 Acharya B, Subedi K, Acharya P, Ghimire S. Association between COVID-19 pandemic and the suicide rates in Nepal. *PLOS ONE* 2022; **17**: e0262958.
134 Shrestha R, Siwakoti S, Singh S, Shrestha AP. Impact of the COVID-19 pandemic on suicide and self-harm among patients presenting to the emergency department of a teaching hospital in Nepal. *PloS One* 2021; **16**: e0250706.
135 Pouradeli S, Ahmadinia H, Vazirinezhad R, Amyan A, Souresrafil A, Rezaeian M. An analysis of suicide rates in Kerman province, the largest province in Iran, before and after

COVID-19: (2017-2020). *Asian J Psychiatry* 2023; **85**: 103614.
136 Huang C, Wang L, Wei X, *et al.* Changes in Suicide Mortality Among Residents of Suzhou, China, During the COVID-19 Pandemic. *Asia Pac J Public Health* 2023; **35**: 207–9.
137 Borges G, Garcia JA, Pirkis J, *et al.* A state level analyses of suicide and the COVID-19 pandemic in Mexico. *BMC Psychiatry* 2022; **22**: 460.
138 Borges G, García JA, Monroy-Nasr Z. Suicide and Covid-19 in Mexico: an update to 2021. *Salud Publica Mex* 2023; **65**: 402–6.
139 Martínez-Alés G, López-Cuadrado T, Morrison C, Keyes K, Susser E. The impact of the COVID-19 pandemic on suicide mortality in Spain: Differences by sex and age. *J Affect Disord* 2023; **329**: 315–23.
140 Sanz-Gómez S, Alacreu-Crespo A, Fructuoso A, Perea-González MI, Guija JA, Giner L. Pandemics and Suicide Rates in Spain: From the Spanish Flu to COVID-19. *J Clin Psychiatry* 2023; **84**: 22m14601.
141 Horita N, Moriguchi S. Trends in Suicide in Japan Following the 2019 Coronavirus Pandemic. *JAMA Netw Open* 2022; **5**: e224739.
142 Eguchi A, Nomura S, Gilmour S, *et al.* Suicide by gender and 10-year age groups during the COVID-19 pandemic vs previous five years in Japan: An analysis of national vital statistics. *Psychiatry Res* 2021; **305**: 114173.
143 Lantos T, Nyári TA. The impact of the COVID-19 pandemic on suicide rates in Hungary: an interrupted time-series analysis. *BMC Psychiatry* 2022; **22**: 775.
144 Arya V, Page A, Spittal MJ, *et al.* Suicide in India during the first year of the COVID-19 pandemic. *J Affect Disord* 2022; **307**: 215–20.
145 Behera C, Gupta SK, Singh S, Balhara YPS. Trends in deaths attributable to suicide during COVID-19 pandemic and its association with alcohol use and mental disorders: Findings from autopsies conducted in two districts of India. *Asian J Psychiatry* 2021; **58**: 102597.
146 Rogalska A, Syrkiewicz-Świtała M. COVID-19 and Mortality, Depression, and Suicide in the Polish Population. *Front Public Health* 2022; **10**: 854028.
147 Semenova NB, Slobodskaya ER, Rezun EV. [An analysis of suicidal behavior in adolescents before and during the COVID-19 pandemic: gender and age aspects]. *Zh Nevrol Psikhiatr Im S S Korsakova* 2023; **123**: 113–20.
148 Osaki Y, Otsuki H, Imamoto A, *et al.* Suicide rates during social crises: Changes in the suicide rate in Japan after the Great East Japan earthquake and during the COVID-19 pandemic. *J Psychiatr Res* 2021; **140**: 39–44.
149 Ramalle-Gómara E, Palacios-Castaño M-I, Martínez-Ochoa E, Quiñones-Rubio C. Trends in suicide mortality in Spain from 1998 to 2021 and its relationship with the COVID-19 pandemic: A joinpoint regression analysis. *Psychiatry Res* 2023; **329**: 115520.
150 Borges G, Garcia JA, Sinyor M, Spittal MJ, Lopez-Arellano O, Pirkis J. Suicide after and during the COVID-19 pandemic in Mexico City. *Braz J Psychiatry* 2022;**44**: 409–15.
151 Nakanishi M, Yamasaki S, Endo K, *et al.* Suicide rates during the COVID-19 pandemic in Japan from April 2020 to December 2021. *Psychiatry Res* 2022; **316**: 114774.
152 Gerstner RM, Narváez F, Leske S, *et al.* Police-reported suicides during the first 16 months of the COVID-19 pandemic in Ecuador: A time-series analysis of trends and risk factors until June 2021. *Lancet Reg Health - Am* 2022; **14**: 100324.
153 Holik D, Dumenčić B, Epih M, *et al.* The Influence of COVID-19 Pandemic on the Frequency of Suicides in Croatia. *Psychiatr Danub* 2022; **34**: 334–41.
154 Chen Y-Y, Yang C-T, Pinkney E, Yip PSF. Suicide trends varied by age-subgroups during the COVID-19 pandemic in 2020 in Taiwan. *J Formos Med Assoc Taiwan Yi Zhi* 2022; **121**: 1174–7.
155 Su Y-J, Yu H-T, Liu T-Y, *et al.* Trends in suicide attempts and suicide deaths before and during the COVID-19 pandemic in New Taipei City, Taiwan: an interrupted time-series

analysis. *Psychol Med* 2023; **53**: 4364–72.
156 de la Torre-Luque A, Pemau A, Perez-Sola V, Ayuso-Mateos JL. Suicide mortality in Spain in 2020: The impact of the COVID-19 pandemic. *Span J Psychiatry Ment Health* 2023; **16**: 116–8.
157 Pérez V, Elices M, Vilagut G, *et al.* Suicide-related thoughts and behavior and suicide death trends during the COVID-19 in the general population of Catalonia, Spain. *Eur Neuropsychopharmacol* 2022; **56**: 4–12.
158 Clapperton A, Spittal MJ, Dwyer J, *et al.* Patterns of Suicide in the Context of COVID-19: Evidence From Three Australian States. *Front Psychiatry* 2021; **12**: 797601.
159 Dwyer J, Dwyer J, Hiscock R, *et al.* COVID-19 as a context in suicide: early insights from Victoria, Australia. *Aust N Z J Public Health* 2021; **45**: 517–22.
160 Barbic D, Scheuermeyer FX, Barbic SP, Honer WG. Suicide Deaths in British Columbia during the First Wave of the COVID-19 Pandemic. *Can J Psychiatry Rev Can Psychiatr* 2021; **66**: 830–1.
161 Knudsen AKS, Stene-Larsen K, Gustavson K, *et al.* Prevalence of mental disorders, suicidal ideation and suicides in the general population before and during the COVID-19 pandemic in Norway: A population-based repeated cross-sectional analysis. *Lancet Reg Health - Eur* 2021; **4**: 100071.
162 Stene-Larsen K, Raknes G, Engdahl B, *et al.* Suicide trends in Norway during the first year of the COVID-19 pandemic: A register-based cohort study. *Eur Psychiatry* 2022; **65**: e26.
163 Koelzer SC, Verhoff MA, Toennes SW, *et al.* Comparison of all completed suicides in Frankfurt am Main (Hessen) before and during the early COVID-19 pandemic. *Forensic Sci Med Pathol* 2023. DOI:10.1007/s12024-023-00754-8.
164 Radeloff D, Genuneit J, Bachmann CJ. Suicides in Germany During the COVID-19 Pandemic. *Dtsch Arzteblatt Int* 2022; **119**: 502–3.
165 Wollschläger D, Schmidtmann I, Blettner M, *et al.* Suicides During the COVID-19 Pandemic 2020 Compared to the Years 2011-2019 in Rhineland-Palatinate (Germany) and Emilia-Romagna (Italy). *Dtsch Arzteblatt Int* 2021; **118**: 814–5.
166 Verma SK, Verma A, Malia P, Chauhan M. Suicide hangings during pre-Covid-19 and Covid-19 - Myths debunked for the lower-middle-income group countries. *Asian J Psychiatry* 2023; **79**: 103349.
167 Yoshioka E, Hanley SJB, Sato Y, Saijo Y. Impact of the COVID-19 pandemic on suicide rates in Japan through December 2021: An interrupted time series analysis. *Lancet Reg Health West Pac* 2022; **24**: 100480.
168 Soares FC, Stahnke DN, Levandowski ML. Tendência de suicídio no Brasil de 2011 a 2020: foco especial na pandemia de covid-19. *Rev Panam Salud Pública* 2022; **46**: 1.
169 Leaune E, Samuel M, Oh H, Poulet E, Brunelin J. Suicidal behaviors and ideation during emerging viral disease outbreaks before the COVID-19 pandemic: A systematic rapid review. *Prev Med* 2020; **141**: 106264.
170 Pirkis J, Gunnell D, Shin S, *et al.* Suicide numbers during the first 9-15 months of the COVID-19 pandemic compared with pre-existing trends: An interrupted time series analysis in 33 countries. *EClinicalMedicine* 2022; **51**: 101573.
171 Lapo-Talledo GJ, Talledo-Delgado JA, Portalanza D, Rodrigues ALS, Siteneski A. Suicide rates in Ecuador: A nationwide study from 2011 until 2020. *J Affect Disord* 2023; **320**: 638–46.
172 Yan Y, Hou J, Li Q, Yu NX. Suicide before and during the COVID-19 Pandemic: A Systematic Review with Meta-Analysis. *Int J Environ Res Public Health* 2023; **20**. DOI:10.3390/ijerph20043346.
173 McCluskey CK, Black TR, Zee-Cheng J, *et al.* Suicide and Self-Harm in Adolescents During the COVID-19 Pandemic: A U.S. Virtual Pediatric Systems, LLC, Database Study of

PICU Admissions, 2016-2021. *Pediatr Crit Care Med J Soc Crit Care Med World Fed Pediatr Intensive Crit Care Soc* 2024; **25**: e73–81.
174 Reif-Leonhard C, Lemke D, Holz F, *et al.* Changes in the pattern of suicides and suicide attempt admissions in relation to the COVID-19 pandemic. *Eur Arch Psychiatry Clin Neurosci* 2023; **273**: 357–65.
175 Han C. Changes in mortality rate of the general population during the COVID-19 pandemic: an interrupted time series study in Korea. *Int J Epidemiol* 2022; **51**: 1396–407.
176 Rajapakse T, Silva T, Hettiarachchi NM, *et al.* The Impact of the COVID-19 Pandemic and Lockdowns on Self-Poisoning and Suicide in Sri Lanka: An Interrupted Time Series Analysis. *Int J Environ Res Public Health* 2023; **20**. DOI:10.3390/ijerph20031833.
177 Ryu S, Nam HJ, Jhon M, Lee J-Y, Kim J-M, Kim S-W. Trends in suicide deaths before and after the COVID-19 outbreak in Korea. *PloS One* 2022; **17**: e0273637.
178 Partonen T, Kiviruusu O, Grainger M, *et al.* Suicides from 2016 to 2020 in Finland and the effect of the COVID-19 pandemic. *Br J Psychiatry J Ment Sci* 2022; **220**: 38–40.
179 Farooq S, Tunmore J, Wajid Ali M, Ayub M. Suicide, self-harm and suicidal ideation during COVID-19: A systematic review. *Psychiatry Res* 2021; **306**: 114228.
180 John A, Eyles E, Webb RT, *et al.* The impact of the COVID-19 pandemic on self-harm and suicidal behaviour: update of living systematic review. *F1000Research* 2021; **9**: 1097.
181 Kahil K, Cheaito MA, El Hayek R, *et al.* Suicide during COVID-19 and other major international respiratory outbreaks: A systematic review. *Asian J Psychiatry* 2021; **56**: 102509.
182 Knipe D, John A, Padmanathan P, *et al.* Suicide and self-harm in low- and middle-income countries during the COVID-19 pandemic: A systematic review. *PLOS Glob Public Health* 2022; **2**: e0000282.
183 Pathirathna ML, Nandasena HMRK, Atapattu AMMP, Weerasekara I. Impact of the COVID-19 pandemic on suicidal attempts and death rates: a systematic review. *BMC Psychiatry* 2022; **22**: 506.
184 Karakasi M-V, Voultsos P, Fotou E, *et al.* Emerging trends in domestic homicide/femicide in Greece over the period 2010-2021. *Med Sci Law* 2023; **63**: 120–31.
185 Lopez E, Rosenfeld R. Crime, quarantine, and the U.S. coronavirus pandemic. *Criminol Public Policy* 2021; **20**: 401–22.
186 Hosen MZ. The impacts of COVID-19 lockdown and post-lockdown on homicide and rape in Bangladesh: A dynamic time series analysis. *Heliyon* 2023; **9**: e20061.
187 Statistics Canada. Population estimates on July 1, by age and gender. Accessed from https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000501.
188 Government of Ontario. Archived - Reopening Ontario in stages 18-Nov-2020. Accessed from https://www.ontario.ca/page/reopeningontario-stages#section-5.
189 Wasserstein RL, Lazar NA. The ASA Statement on p-Values: Context, Process, and Purpose. *Am Stat* 2016; **70**: 129–33.
190 Rockett IRH, Caine ED, Connery HS, *et al.* Unrecognised self-injury mortality (SIM) trends among racial/ethnic minorities and women in the USA. *Inj Prev* 2020; **26**: 439–47.
191 Asik GA, Nas Ozen E. It takes a curfew: The effect of Covid-19 on female homicides. *Econ Lett* 2021; **200**: 109761.
192 Cantor E, Salas R, Torres R. Femicide and Attempted Femicide before and during the COVID-19 Pandemic in Chile. *Int J Environ Res Public Health* 2022; **19**. DOI:10.3390/ijerph19138012.
193 Kegler SR, Simon TR, Zwald ML, *et al.* Vital Signs: Changes in Firearm Homicide and Suicide Rates - United States, 2019-2020. *MMWR Morb Mortal Wkly Rep* 2022; **71**: 656–63.
194 Donnelly MR, Grigorian A, Inaba K, *et al.* A Dual Pandemic: The Influence of Coronavirus Disease 2019 on Trends and Types of Firearm Violence in California, Ohio, and the United States. *J Surg Res* 2021; **263**: 24–33.

195 Schleimer JP, Buggs SA, McCort CD, *et al.* Neighborhood Racial and Economic Segregation and Disparities in Violence During the COVID-19 Pandemic. *Am J Public Health* 2022; **112**: 144–53.
196 Bridge JA, Ruch DA, Sheftall AH, *et al.* Youth Suicide During the First Year of the COVID-19 Pandemic. *Pediatrics* 2023; **151**. DOI:10.1542/peds.2022-058375.
197 Charpignon M-L, Ontiveros J, Sundaresan S, *et al.* Evaluation of Suicides Among US Adolescents During the COVID-19 Pandemic. *JAMA Pediatr* 2022; **176**: 724–6.
198 Ornell F, Benzano D, Borelli WV, *et al.* Differential impact in suicide mortality during the COVID-19 pandemic in Brazil. *Braz J Psychiatry* 2022. DOI:10.47626/1516-4446-2022-2581.
199 Goto R, Okubo Y, Skokauskas N. Reasons and trends in youth's suicide rates during the COVID-19 pandemic. *Lancet Reg Health West Pac* 2022; **27**: 100567.
200 Kikuchi K, Anzai T, Takahashi K. The Unusual Increase in Suicides Among Women in Japan During the COVID-19 Pandemic: A Time-series Analysis Until October 2021. *J Epidemiol* 2023; **33**: 45–51.
201 Okada M. Is an increase in Japan's suicides caused by COVID-19 alone? *Asian J Psychiatry* 2022; **78**: 103320.
202 Ruiz Sánchez G. Monthly suicide rates during the COVID-19 pandemic: Evidence from Japan. *Econ Lett* 2021; **207**: 110014.
203 Watanabe M, Tanaka H. Increased suicide mortality in Japan during the COVID-19 pandemic in 2020. *Psychiatry Res* 2022; **309**: 114422.
204 Kim J-H, Kim S, Park E, Kim C-Y. Inequitable distribution of excess mortality during the COVID-19 pandemic in Korea, 2020. *Epidemiol Health* 2022; **44**: e2022081.
205 Stańdo J, Czabański A, Fechner Ż, Baum E, Andriessen K, Krysińska K. Suicide and Attempted Suicide in Poland before and during the COVID-19 Pandemic between 2019 and 2021. *Int J Environ Res Public Health* 2022; **19**. DOI:10.3390/ijerph19158968.
206 Bahk J, Jung-Choi K. Cause-specific mortality in Korea during the first year of the COVID-19 pandemic. *Epidemiol Health* 2022; **44**: e2022110.
207 Balint L, Osvath P, Kapitany B, Rihmer Z, Nemeth A, Dome P. Suicide in Hungary during the first year of the COVID-19 pandemic: Subgroup investigations. *J Affect Disord* 2023; **325**: 453–8.
208 Balint L, Osvath P, Rihmer Z, Dome P. Recovering from the first shock? Changes in suicidality during the first two years of the COVID-19 pandemic in a country with traditionally high levels of completed suicides. *J Affect Disord* 2024; **347**: 230–6.
209 García-Dolores F, Tendilla-Beltrán H, Flores F, *et al.* Increased suicide rates in Mexico City during the COVID-19 pandemic outbreak: An analysis spanning from 2016 to 2021. *Heliyon* 2023; **9**: e16420.
210 Anzai T, Kikuchi K, Fukui K, Ito Y, Takahashi K. Have restrictions on human mobility impacted suicide rates during the COVID-19 pandemic in Japan? *Psychiatry Res* 2022; **317**: 114898.
211 Matsumoto R, Motomura E, Fukuyama K, Shiroyama T, Okada M. Determining What Changed Japanese Suicide Mortality in 2020 Using Governmental Database. *J Clin Med* 2021; **10**: 5199.
212 Elsner A, Mergl R, Allgaier A-K, Hegerl U. Suicide rates during and after the first COVID-19 lockdown in Germany in 2020. *PloS One* 2023; **18**: e0289136.
213 King B, Holmes LM, Rishworth A, Patel R. Geographic variations in opioid overdose patterns in Pennsylvania during the COVID-19 pandemic. *Health Place* 2023; **79**: 102938.
214 Feder KA, Sun J, Rudolph JE, *et al.* Mortality by cause of death during year 1 of the COVID-19 pandemic in a cohort of older adults from Baltimore Maryland who have injected drugs. *Int J Drug Policy* 2022; **109**: 103842.
215 Khatri UG, Pizzicato LN, Viner K, *et al.* Racial/Ethnic Disparities in Unintentional Fatal and Nonfatal Emergency Medical Services-Attended Opioid Overdoses During the COVID-19

Pandemic in Philadelphia. *JAMA Netw Open* 2021; **4**: e2034878.
216 Chen C, Shen S. Trend analysis of drug overdose deaths before and during the COVID-19 pandemic. *Am J Transl Res* 2022; **14**: 2685–8.
217 Currie JM, Schnell MK, Schwandt H, Zhang J. Trends in Drug Overdose Mortality in Ohio During the First 7 Months of the COVID-19 Pandemic. *JAMA Netw Open* 2021; **4**: e217112.