



Trends in Suicide Mortality in Canada by Sex and Age Group, 1981 to 2017: A Population-Based Time Series Analysis

Tendances de la mortalité par suicide au Canada selon le sexe et le groupe d'âge, 1981 – 2017 : Une analyse de séries chronologiques dans la population

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Abstract

Objectives: Suicide is a complex global public health issue. The objective of this study was to assess time trends in suicide mortality in Canada by sex and age group.

Methods: We extracted data from the Canadian Vital Statistics Death Database for all suicide deaths among individuals aged 10 years and older based on *International Statistical Classification of Diseases and Related Health Problems, Ninth Revision* (E950-959; 1981 to 1999) and *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* (X60-X84, Y87-0; 2000 to 2017) for a 37-year period, from 1981 to 2017. We calculated annual age-standardized, sex-specific, and age group-specific suicide mortality rates, and used Joinpoint Regression for time trend analysis.

Results: The age-standardized suicide mortality rate in Canada decreased by 24.0% from 1981 to 2017. From 1981 to 2007, there was a significant annual average decrease in the suicide rate by 1.1% (95% confidence interval, –1.3 to –0.9), followed by no significant change between 2007 and 2017. From 1981 to 2017 and from 1990 to 2017, females aged 10 to 24 and 45 to 64 years old, respectively, had a significant increase in suicide mortality rates. However, males had the highest suicide mortality rates in all years in the study; the average male-to-female ratio was 3.4:1.

Conclusion: The 3-decade decline in suicide mortality rates in Canada paralleled the global trend in rate reductions. However, since 2008, the suicide rate in Canada was relatively unchanged. Although rates were consistently higher among males, we found significant rate increases among females in specific age groups. Suicide prevention efforts tailored for adult males and young and middle-aged females could help reduce the suicide mortality rate in Canada.

Abrégé

Objectif : Le suicide est une question de santé publique complexe et mondiale. L'objectif de la présente étude était d'évaluer les tendances temporelles de la mortalité par suicide au Canada selon le sexe et le groupe d'âge.

Méthodes : Nous avons extrait des données de la Base de données canadienne sur les décès (CVSD) pour tous les décès par suicide chez les personnes de 10 ans et plus, d'après la CIM-9 (E950-959; 1981-1999) et la CIM-10 (X60-X84, Y87-0; 2000-

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2017) pour une période de 37 ans, de 1981 à 2017. Nous avons calculé des taux de mortalité par suicide annuels normalisés pour l'âge, spécifiques au sexe et au groupe d'âge, et nous avons utilisé une régression du modèle Joinpoint pour l'analyse des tendances temporelles.

Résultats : Les taux de mortalité par suicide normalisés pour l'âge au Canada ont diminué de 24,0 % de 1981 à 2017. De 1981 à 2007, il y a eu une diminution moyenne annuelle significative du taux de suicide de 1,1 % (IC à 95 % -1,3 à -0,9), suivie d'un changement non significatif entre 2007 et 2017. De 1981 à 2017 et de 1990 à 2017, les femmes âgées de 10 à 24 ans et de 45 à 64 ans, respectivement, ont représenté une augmentation significative des taux de mortalité par suicide. Cependant, les hommes avaient les taux de mortalité par suicide les plus élevés dans toutes les années de l'étude, le rapport moyen homme à femme était de 3,4:1.

Conclusion : La baisse des taux de mortalité par suicide durant trois décennies au Canada était parallèle aux tendances mondiales de réduction des taux. Toutefois, depuis 2008, le taux de suicide au Canada est relativement inchangé. Bien que les taux aient été régulièrement plus élevés chez les hommes, nous avons observé des hausses de taux significatives chez les femmes de groupes d'âge spécifiques. Des initiatives de prévention du suicide adaptées pour les hommes adultes et les femmes jeunes et d'âge moyen pourraient aider à réduire le taux de mortalité par suicide au Canada.

Keywords

suicide, self-harm, mortality, surveillance, public health, Canada

Introduction

Suicide prevention is a key public health priority for communities, governments, and international organizations.¹ In 2014, the World Health Organization (WHO) called on all member states to develop national suicide prevention strategies.¹ This was an effort to encourage investment in coordinated and evidence-based approaches to prevention and to achieve the goal of reducing the incidence of suicide by 10% by 2020.¹ Furthermore, the United Nations includes preventing suicide in its health-related Sustainable Development Goals (SDGs) through a goal to reduce premature mortality by one-third, as measured by suicide mortality rates (SDG indicator 3.4.2).² According to their projections, if current trends continue, Canada will not meet the SDG of reducing suicide mortality by 33.0% by 2030.³

A recent analysis from the Global Burden of Disease Study reported that the global age-standardized mortality rate (ASMR) from suicide decreased by 32.7% between 1990 and 2016.³ This decline was driven by decreases in 63 countries, including China and India, which accounted for 44.2% of all suicide deaths globally.³ By contrast, some low- and middle-income countries in central Latin America and Western sub-Saharan Africa, such as Zimbabwe (96.2%), Jamaica (70.9%), Paraguay (70.4%), Zambia (61.6%), and Belize (52.2%), experienced significant increases in age-standardized suicide rates from 1990 to 2016.³

Recently, high-income countries including the United States and the United Kingdom have experienced increases in national suicide rates.^{4,5} From 1999 to 2017, the ASMR in the United States increased by 33.0% from 10.5 to 14.0 per 100,000 population.⁵ In the United Kingdom, the ASMR declined steadily from a peak of 14.7 per 100,000 in 1981 to 10.0 in 2007; the ASMR decreased slightly between 2013 and 2017, then increased by 11.8% from 10.1 to 11.2 suicide deaths per 100,000 between 2017 and 2018.⁴ By contrast, a

previous study of Canada found that the ASMR decreased by 27.8% between 1979 and 2012, from 14.4 to 10.4 per 100,000.⁶

In addition to wide variations in suicide mortality rates across regions and countries, there are marked differences in sex- and age group-specific rates.^{3,5-8} Globally, suicide rates in 2016 were higher among males than females (15.6 vs. 7.0 deaths per 100,000) and between 1990 and 2017, the decline in suicide rates was larger among females (-49.0%) compared to males (-23.8%).³ Although suicide is the second leading cause of death among those aged 15 to 29 years old,⁷ youth under 30 years old account for less than 30.0% of all suicide deaths globally.³

The heterogeneity of trends in suicide mortality underscores the need to monitor patterns of suicide across sex and age groups and identify opportunities for population-based and targeted interventions. To support these aims, the WHO recommended that all member states strengthen the capacity and role of national suicide surveillance systems and track progress toward global suicide rate reduction targets.¹ In Canada, the Federal Framework for Suicide Prevention Act directed federal government agencies to make "publically available existing statistics about suicide and related risk factors."⁹ The aim of this study was to examine trends in suicide mortality in Canada by sex and age group from 1981 to 2017.

Methods

Study Design and Participants

This study used data from the Canadian Vital Statistics Death Database, a national administrative database derived from death certificates for all deaths registered in each province and territory. From 1981 to 1999, suicide deaths were classified using the *International Statistical Classification of Diseases and Related Health Problems, Ninth Revision*

(ICD-9), with the codes E950-959. Mortality data for this period were obtained through a data sharing agreement between the Public Health Agency of Canada and Statistics Canada. Suicide mortality data were available for the population aged 10 and older. From 2000 to 2017, the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10)* was used with codes X60-X84 and Y87.0. Data for this period were obtained from Statistics Canada Table 13-10-0392-01. Suicide mortality data were available for the population aged 10 years and older. This surveillance study was based on aggregated, deidentified secondary data shared with the Public Health Agency of Canada under the purview of the federal Statistics Act¹⁰ as well as data that are publicly available online from Statistics Canada. Therefore, research ethics board approval was not required. We used the *Reporting of studies conducted using observational routinely-collected health data* to report the results from this study.¹¹

Procedure

Crude, age-specific, and sex-specific suicide mortality rates were calculated for each year from 1981 to 2017. Age-standardized suicide mortality rates (ASMRs) from 1981 to 1999 were calculated by the direct method of standardization using the 2011 Canadian census population as the standard population. These data were obtained from Statistics Canada Table 13-10-0800-01.¹² Data for 2000 to 2017 were already age-standardized using the 2011 standard population by Statistics Canada. All rates are presented per 100,000 population. To examine sex differences, we calculated male-to-female ratios of ASMR for each year.

Statistical Analysis

To analyze trends in suicide mortality, we used Joinpoint Regression Program Version 4.6.0.0 (National Cancer Institute, USA). The Joinpoint method is based on the Poisson regression model. This method connects several different line segments on a log scale at “joinpoints” and can identify whether there is a statistically significant change in the slope of the trend.¹³ Model selection was based on permutation tests ($n = 4,499$) to identify the number of joinpoints.¹³ The Joinpoint program calculates the annual percent change (APC) along with 95% confidence intervals (95% CI) to interpret the change in rate from one joinpoint to the next.¹³ Trends were examined at the national level (all ages, both sexes) and stratified by sex (males and females) and age group (10 to 14, 15 to 24, 25 to 44, 45 to 64, 65 to 74, and 75+). A Bonferroni correction was used to adjust for type 1 error when multiple models were run (e.g., by sex and age group). For the age-standardized trend analyses, P values were considered statistically significant if they were less than 0.017 ($0.05/3 \rightarrow 3$ sex groups). Trends for age-specific rates were considered statistically significant if they

were less than 0.003 ($0.05/3 \times 6 \rightarrow 3$ sex groups, 6 age groups).

Results

From 1981 to 2017, there were a total of 138,548 deaths by suicide across Canada for individuals aged 10 years old and over (Table 1). More than three-quarters of all suicide deaths ($n = 106,764$) were among males; 23.0% were among females ($n = 31,784$). The ASMR in Canada decreased by 24.0% between 1981 and 2017, from 15.0 deaths per 100,000 to 11.4 deaths per 100,000. The overall decrease in the ASMR for males and females was similar, at 23.9% (22.6 deaths per 100,000 to 17.2 deaths per 100,000) and 24.7% (7.7 deaths per 100,000 to 5.8 deaths per 100,000), respectively. From the early 2000s, the 45 to 64 age group had the highest rate of suicide in (Figure 1) overall and by sex (Figure 1). During the 37-year period, the ASMR for males was on average 3.4 times greater than the rate for females (Table 1).

The total ASMR decreased by 1.2% (95% CI, -1.4 to -0.9) per year until 2007, with no significant change between 2007 and 2017 (Figure 2A). The ASMR for males decreased by 0.9% (95% CI, -1.1 to -0.8) per year from 1981 to 2017. In contrast, the ASMR for females decreased by 3.3% (95% CI, -4.5 to -2.0) per year from 1981 to 1991 and then stabilized from 1991 to 2017. Figures 2B and C shows the results of joinpoint regression analyses by age groups for females and males; results by age groups for both sexes combined are given in Supplemental eFigure 1. We present a graph of ASMR by sex from 1981 to 2017 and a table with rates by year, sex, and age group in the Supplemental eFigure 2 and eTable 1.

Suicide rates among males aged 10 to 14 years old were stable from 1981 to 1996 and decreased significantly from 1996 to 2017 (APC = -3.8 ; 95% CI, -5.4 to -2.1). For females in the same age group, there was a significant increase of 4.5% (APC = 4.5; 95% CI, 3.3 to 5.7) per year. For males aged 15 to 24 years old, suicide mortality rates were stable from 1981 to 1996, decreased by 4.5% (APC = -4.5 ; 95% CI, -5.8 to -3.1) per year from 1996 to 2006, and remained stable from 2006 to 2017. For females aged 15 to 24 years old, there was a significant gradual increase in rates from 1981 to 2017, with an APC of 1.1% (95% CI, 0.8 to 1.4).

For males aged 25 to 44 years old, there was no change in the rate of suicide mortality from 1981 to 1995, but a significant decrease of 1.8% (APC = -1.8 ; 95% CI, -2.2 to -1.4) per year from 1995 to 2017. For females in the same age group, there was a significant, gradual decrease from 1981 to 2017, with an APC of -0.8% (95% CI, -1.0 to -0.5). Among males aged 45 to 64 years old, there was a significant, gradual decline in suicide mortality rates from 1981 to 2017, with an APC of -0.4% per year (95% CI, -0.6 to -0.2). In contrast, females in the same age group showed a significant decline in suicide mortality of 5.2% per year

Table 1. Total Number of Suicide Deaths, ASMR per 100,000, and Male: Female Ratio from 1981 to 2017 in Canada.

Year	Total		Females		Males		Male to female ratio of ASMR
	N	ASMR	n	ASMR	n	ASMR	
1981	3,391	15.0	828	7.6	2,563	22.7	3.0
1982	3,507	15.2	793	7.0	2,714	23.7	3.4
1983	3,749	16.1	866	7.7	2,883	24.9	3.2
1984	3,431	14.5	774	6.7	2,657	22.6	3.4
1985	3,254	13.5	693	5.9	2,561	20.0	3.4
1986	3,663	14.9	819	6.8	2,844	23.4	3.4
1987	3,581	14.4	797	6.5	2,784	22.7	3.5
1988	3,508	13.8	776	6.1	2,732	21.7	3.6
1989	3,488	13.5	796	6.2	2,692	21.0	3.4
1990	3,377	12.6	705	5.2	2,672	20.3	3.9
1991	3,591	13.3	717	5.3	2,874	21.6	4.1
1992	3,705	13.6	785	5.8	2,920	20.2	3.5
1993	3,802	13.8	789	5.8	3,013	22.2	3.8
1994	3,746	13.4	779	5.6	2,967	19.9	3.6
1995	3,960	14.0	809	5.7	3,151	22.5	4.0
1996	3,938	13.8	845	5.9	3,093	21.9	3.7
1997	3,679	12.8	767	5.3	2,912	20.6	3.9
1998	3,697	12.6	773	5.3	2,924	20.3	3.8
1999	4,074	13.8	850	5.7	3,224	22.0	3.9
2000	3,606	11.9	808	5.3	2,798	18.8	3.6
2001	3,692	12.1	822	5.4	2,870	19.1	3.5
2002	3,650	11.9	799	5.1	2,851	19.0	3.7
2003	3,765	12.1	862	5.5	2,903	19.0	3.5
2004	3,613	11.4	879	5.5	2,734	17.6	3.2
2005	3,743	11.6	886	5.4	2,857	18.1	3.4
2006	3,512	10.8	817	5.0	2,695	17.0	3.4
2007	3,611	11.0	884	5.3	2,727	16.9	3.2
2008	3,705	11.1	928	5.5	2,777	17.0	3.1
2009	3,890	11.5	901	5.3	2,989	18.1	3.4
2010	3,951	11.6	970	5.7	2,981	17.8	3.1
2011	3,896	11.3	986	5.7	2,910	17.1	3.0
2012	3,926	11.3	954	5.5	2,972	17.4	3.2
2013	4,054	11.5	1,013	5.7	3,041	17.6	3.1
2014	4,254	12.0	1,095	6.1	3,159	18.1	3.0
2015	4,405	12.3	1,136	6.3	3,269	18.5	2.9
2016	3,978	11.0	1,039	5.7	2,939	16.5	2.9
2017	4,157	11.4	1,045	5.8	3,112	17.2	3.0
Annual average							3.4

Note. ASMR = age-standardized mortality rate.

Data source: Statistics Canada and Vital Statistics—Death Database.

(95% CI, -6.9 to -3.4) from 1981 to 1990, and a significant, slight increase from 1990 to 2017 (APC = 0.5; 95% CI, 0.1 to 0.8).

Suicide rates among males aged 65 to 74 years old significantly decreased by 2.5% per year (95% CI, -3.0 to -2.0) from 1981 to 2004, then stabilized from 2004 to 2017. Similarly, suicide rates among females in this age group showed a significant decrease of 4.3% per year (95% CI, -5.7 to -2.8) from 1981 to 1997 and stabilized from 1997 to 2017. Over the 37-year period, males and females aged 75 and older experienced a gradual, significant decline in suicide mortality, where males had an APC of -1.3% per year (95% CI, -1.6 to -1.0) compared to -1.2% per year for females (95% CI, -1.9 to -0.6).

Discussion

Overall, we found that the suicide rate in Canada decreased by 24.0% over nearly 4 decades, from 1981 to 2017. The rate decline occurred primarily during the period of 1981 to 2007; the suicide rate was relatively stable between 2008 and 2017. Similar trends have been observed in other high-income European countries, including Germany,¹⁴ Spain,¹⁴ Italy,¹⁴ and Denmark.¹⁵

The suicide rate decline was similar for males and females, at 24.0% and 25.0%, respectively. However, most of the decline among females occurred between 1981 and 1991, while males experienced decreases over the entire study period (1981 to 2017). Within specific sex and age

groups, patterns diverged. Suicide mortality rates among females in the 10- to 14-year-old and 15- to 24-year-old age groups increased during the study period, whereas rates among males in those same age groups decreased or remained stable.

While our study did not investigate the causes of the decline in the ASMR, the observed changes, particularly

from 1981 to 2006, may be related to several macrolevel factors. Some authors have suggested that declines in suicide may reflect gains in overall population health, as the global decline in the ASMR from suicide parallels the global decline in the total ASMR.³ The role of universal, targeted, and indicated suicide prevention interventions should be further explored.^{8,16,17} Since 2007, suicide mortality rates have remained stable in Canada. Existing literature supports a link between unemployment and suicide¹⁸ and recent evidence from Europe and the United States has shown a rise of suicide mortality after the 2008 economic crisis.¹⁹ As such, the flattening of the suicide rate may be due, in part, to the 2008 to 2009 economic crisis.^{3,14} Future studies should explore the impact of social, environmental, and economic factors, such as the coronavirus disease (COVID-19) pandemic and age-period-cohort effects on suicide mortality in Canada. A recent modeling study projected an increase of between 418 and 2114 suicide deaths in Canada in 2020 to 2021 related to possible increases in the unemployment rate secondary to the COVID-19 pandemic.²⁰

Over the past 37 years, young females in Canada experienced a gradual increase in suicide mortality, which is concerning. This is consistent with results of studies from the United States,²¹ Australia,²² and another Canadian study.²³ While middle-aged females between the ages of 45 to

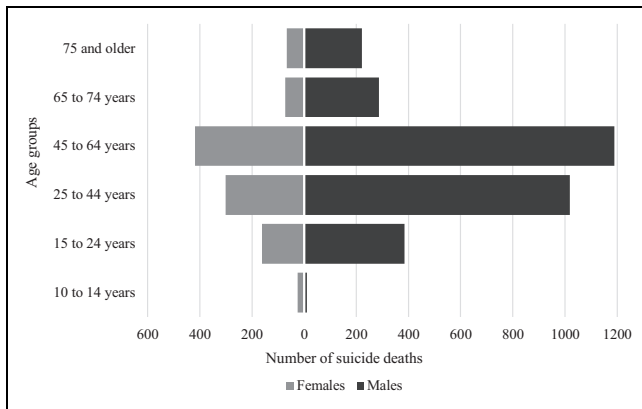


Figure 1. Number of suicide deaths ($n = 4,157$) in Canada, by age group and sex, 2017. *Data source:* Statistics Canada and Vital Statistics—Death Database.

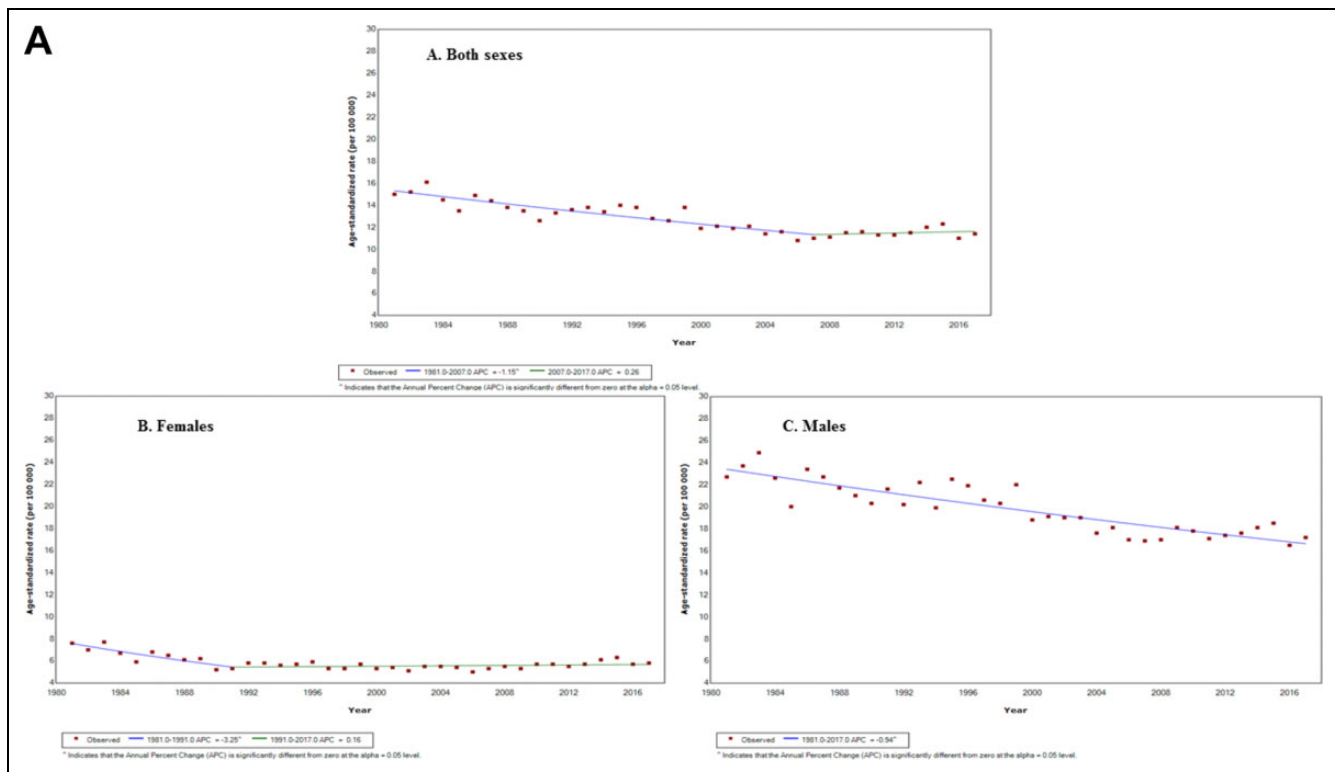


Figure 2. A, Joinpoint analysis of age-standardized suicide mortality rates from 1981 to 2017, by sex. *Bonferroni correction $P < 0.017$. *Data source:* Statistics Canada and Vital Statistics—Death Database. B, Trend analysis of age group-specific suicide mortality rates from 1981 to 2017 for females. *Bonferroni correction $P < 0.003$. *Data source:* Statistics Canada and Vital Statistics—Death Database. C, Trend analysis of age group-specific suicide mortality rates from 1981 to 2017 for males. *Bonferroni correction $P < 0.003$. *Data source:* Statistics Canada and Vital Statistics—Death Database.

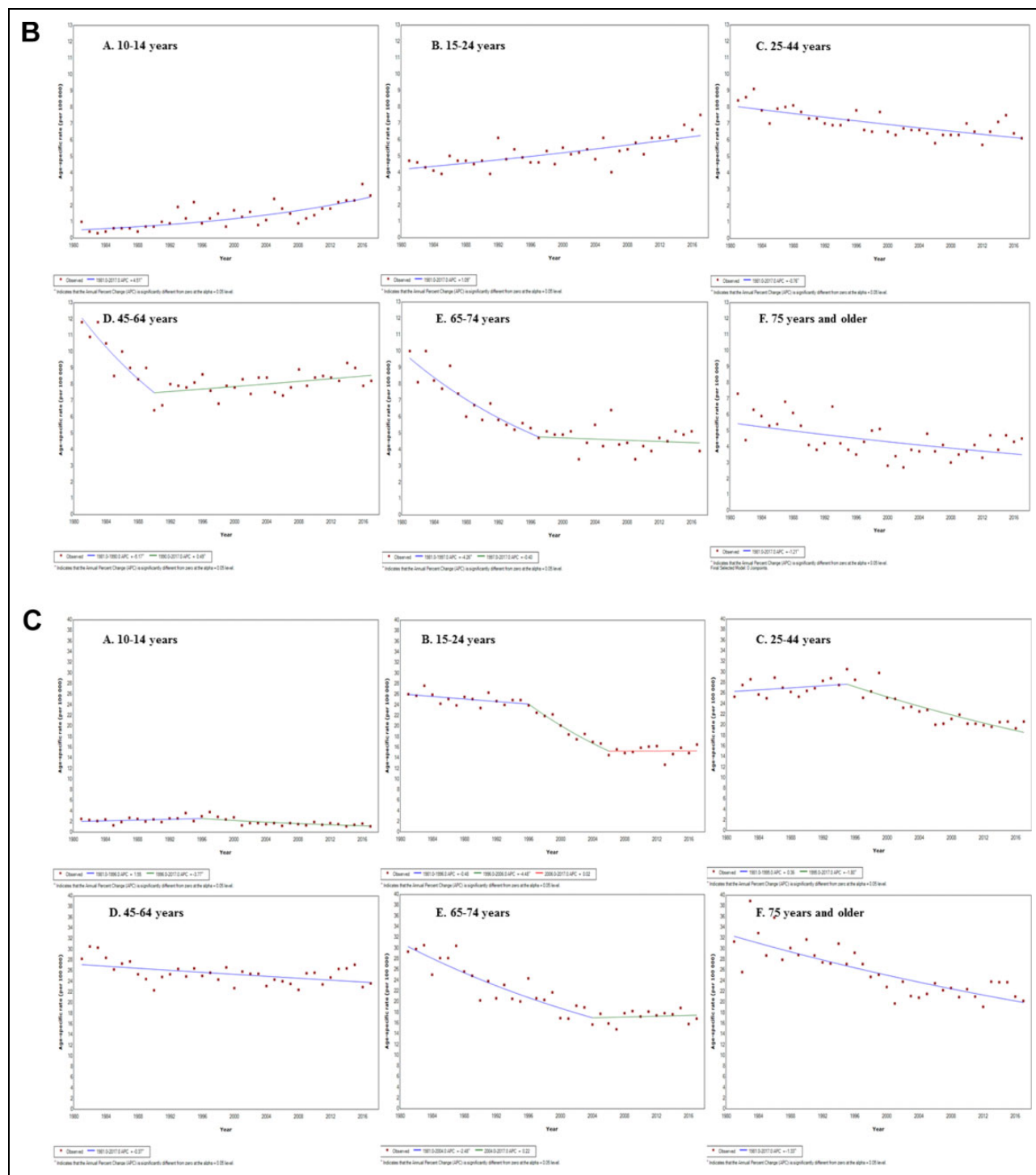


Figure 2. (Continued.)

64 years old demonstrated large and significant decreases in suicide mortality from 1980 to 1990, they also experienced significant, albeit small, annual increased suicide rates from 1990 to 2017. In part, the increased suicide rates among females could be due to changes in patterns of suicide methods.^{21,23,24} While females have higher suicide attempt rates than males, they typically use means that have a lower risk of serious injury and death, such as poisoning and cutting.²⁵ By

contrast, males appear to attempt suicide less frequently, but use highly lethal means such as hanging or firearms.^{1,25} A Canadian study of trends in suicide mortality among youth found that between 1980 and 2008, there was an increase in suicide mortality by hanging and that it was the most commonly used method.²³ Similarly, an American study found increases in suicide deaths by suffocation and hanging among female youth.²¹ A Norwegian study of long-term

suicide trends by method showed that increasingly women were using more lethal methods.²⁴ Between 1969 and 2012, suicide rates by hanging gradually increased for women, whereas rates for suicide by poisoning and drowning increased during the first few years and decreased thereafter.²⁴ If females in Canada are turning toward more lethal means such as hanging, this could contribute to increased suicide mortality, even if suicide attempt rates have not changed. These patterns are important to monitor as suicide is currently the second leading cause of death among females aged 15 to 24 years in Canada²⁶ and aged 15 to 29 years worldwide.⁷ As Vital Statistics data include information about suicide methods, future research exploring these trends over time is warranted to better guide and inform public health means restriction strategies.

We found that suicide mortality rates were highest among males across all age groups compared to females.³ However, the overall percentage decrease in the ASMR for males and females from 1981 to 2017 was similar. In the last 2 decades in Canada, the burden of suicide has remained highest among middle-aged adults aged 45 to 64 years, among both males and females. This is consistent with the United Kingdom⁴ and Australia,¹⁴ where suicide rates were highest for middle-aged adults. This differs, however, from the global pattern and from other countries such as Denmark and Brazil where the burden of suicide mortality is highest among older adults (65 years and over).^{3,15,27}

Lastly, our analysis revealed the heterogeneity of trends in suicide rates for people of different ages. Specifically, we found a gradual increase in rates among females between the ages of 10 and 24 years compared to a gradual decrease among females aged 25 to 44 and 75+ years. Moreover, women aged 45 to 64 years had a gradual decrease of mortality rates followed by a slight increase, whereas women between the ages of 65 and 74 years had a gradual decrease followed by no change in trend. Trend patterns also differed by age group for males, but the trends were either of decreasing or stable rates. Figure 2B and C visually depicts this heterogeneity. Subsequent studies should examine sociodemographic characteristics, risk and protective factors among specific age groups in the Canadian context to provide further insight into the different age-related patterns in suicide mortality that we found in this study. Correspondingly, adopting a life course approach to suicide prevention based in part on age-specific risk factors could help design interventions that target specific periods of vulnerability.

Strengths and Limitations

Globally, the quality of official mortality data is varied.^{28, 29} Canada is one of only 60 WHO member states considered to have a good quality vital statistics system.¹ Existing studies have measured the performance of the Civil Registration and Vital Statistics systems for countries included in the Global Burden of Disease database with a single composite score called the Vital Statistics Performance Index (VSPI).^{28,29}

This index is based on 6 criteria including the completeness and quality of death reporting, the level of cause-specific detail, internal consistency, quality of age and sex reporting, and the timeliness/availability of data.²⁹ This VSPI scores on a scale ranging from 0 to 1, with a score closer to 1 indicating stronger performance.²⁹ A 2015 study found that Canada had a high VSPI score (0.85 and above), which was similar to other high-income countries in Europe, along with the United States and Australia.²⁸ Despite the overall strength of vital statistics in Canada, previous studies have raised concerns about misclassification and underreporting of suicide deaths in administrative data.^{2,30} Conversely, a recent validation study from Ontario found that there was a high degree of concordance between deaths registered as suicide in the vital statistics system and those identified as suicide deaths by the coroner.³¹ The rate of agreement improved slightly over a 10-year period (from 95.69% to 98.79%) and between the ICD-9 and ICD-10 codes.³¹ Although our study covers the period when the change from ICD-9 to ICD-10 was implemented, which could have affected trends over time, previous studies have reported that switching from ICD-9 to ICD-10 did not impact trends in suicide mortality.^{32,33} Moreover, the *International Statistical Classification of Diseases and Related Health Problems* codes that were used in the analysis do not include undetermined deaths or injuries, which could exclude potential suicide deaths and underestimate the burden of suicide in Canada.^{34,35} Previous Canadian research found that undetermined and unintentional poisonings increased from 2000 to 2011, which suggests that misclassification may be a factor.³⁴ Future research comparing trends in suicide methods to trends in undetermined poisonings and injuries by sex and age group might provide additional insight on this issue.

Lastly, this analysis was descriptive and as such, we did not identify factors that contributed to the trends or examine risk and protective factors that are associated with suicide. Vital statistics data in Canada has universal coverage, but the variables included in the data set are limited to cause of death and demographics. Future studies with potential correlates at the individual level could be examined using data linkage.

While these limitations should be considered, the long period that was covered in this analysis and the generalizability of these findings to the population in Canada are strengths. We looked at suicide mortality in Canada by sex and age groups over almost 4 decades, which yielded a robust trend analysis. This study addressed the WHO's recommendation of strengthening national suicide surveillance and complements existing studies on the importance of monitoring patterns across sex and age. Furthermore, this was the first study to describe temporal trends in suicide mortality rates by sex and by age group across the life span in Canada.

Conclusion

Suicide prevention is a global public health priority. Although a small number of high-income countries have experienced

recent increases in suicide rates, globally suicide rates have fallen by almost a third since 1990. In Canada, the ASMR declined by 24.0% from 1981 to 2017, with the largest reductions occurring prior to 2007. When suicide rates are disaggregated by sex and age group, demographic variations were evident. Suicide mortality increased for females between the ages of 10 and 14, 15 and 24, and 45 and 64, whereas rates for males decreased or remained stable. The increasing rates among females is concerning and could indicate that young and middle-aged women might be turning toward more lethal means. Future studies examining suicide methods over time by sex and age group are warranted to further understand these trends. Despite significant increases in suicide among certain age groups for females, the burden of suicide mortality was highest for males. This result underscores the need for sex-specific interventions. National suicide prevention strategies should include a focus on middle-aged and older males, as well as young and middle-aged females.

Authors' Note

All authors advised on the conception and design of the secondary data analysis. MV conducted the data analysis. NJP drafted the introduction; MV drafted the rest of the manuscript. All authors critically revised and read every draft of the article and approved the final submission. The majority of MV's contribution (conception, design, data analysis and drafting of manuscript) to this project occurred when she was affiliated with the Public Health Agency of Canada. The Canadian Vital Statistics Death Database (CVSD) is a census of all deaths in Canada. Statistics Canada receives this information from provinces and territories. Requests for the 1981 to 2017 data should be made to Statistics Canada. There was no funding provided for this study. The corresponding author had full access to the data and had final responsibility for the decision to submit for publication.

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Declaration of Conflicting Interests


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Supplemental Material

Supplemental material for this article is available online.

References

1. World Health Organization. Preventing suicide: A global imperative. Geneva (Switzerland): World Health Organization; 2014.
2. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development; 2015.
3. Naghavi M; Global Burden of Disease Self-Harm Collaborators. Global, regional, and national burden of suicide mortality 1990 to 2016: systematic analysis for the Global burden of disease Study 2016. *BMJ*. 2019;364:l94.
4. Manders B, Kaur J. Suicides in the UK: 2018 Registrations. Office for National Statistics; 2019. <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/suicidesintheunitedkingdom/2018registrations#:~:text=In%202018%2C%20there%20were%206%2C507,the%20first%20increase%20since%202013.>
5. Hedegaard H, Curtin S, Warner M. Suicide mortality in the United States, 1999-2017. *NCHS Data Brief*. Centers for Disease Control; 2018:1. <https://stacks.cdc.gov/view/cdc/60894>
6. Skinner R, McFaull S, Draca J, et al. Suicide and self-inflicted injury hospitalizations in Canada (1979 to 2014/15). *Health Promot Chronic Dis Prev Can*. 2016;36(11):243-251.
7. World Health Organization. Suicide in the World: Global Health Estimates; 2019.
8. Turecki G, Brent DA. Suicide and suicidal behaviour. *Lancet*. 2016;387(10024):1227-1239.
9. Government of Canada. Federal Framework for Suicide Prevention (S.C. 2012, c. 30). Ottawa (ON): Public Works and Government Services Canada; 2012.
10. Government of Canada. Statistics Act (R.S.C., 1985, c. S-19). Ottawa (ON): Public Works and Government Services Canada; 1985.
11. Benchimol EI, Smeeth L, Guttman A, et al. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement. *PLOS Med*. 2015;12(10):e1001885.
12. Statistics Canada. Table 13-10-0800-01: Deaths and Mortality Rate (Age Standardization using 2011 Population), by Selected Grouped Causes. Ottawa (ON): Statistics Canada; 2019.
13. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. *Statist Med*. 2000;19(3):335-351.
14. Alicandro G, Malvezzi M, Gallus S, La Vecchia C, Negri E, Bertuccio P. Worldwide trends in suicide mortality from 1990 to 2015 with a focus on the global recession time frame. *Int J Public Health*. 2019;64(5):785-795.
15. Dyvesether SM, Nordentoft M, Forman JL, Erlangsen A. Joinpoint regression analysis of suicides in Denmark during 1980-2015. *Dan Med J*. 2018;65(4):A5477.
16. Mann JJ, Apter A, Bertolote J, et al. Suicide prevention strategies: a systematic review. *JAMA*. 2005;294(16):2064-2074.

17. Zalsman G, Hawton K, Wasserman D, et al. Suicide prevention strategies revisited: 10-year systematic review. *Lancet Psychiatry*. 2016;3(7):646-659.
18. Blakely TA, Collings SC, Atkinson J. Unemployment and suicide. Evidence for a causal association? *J Epidemiol Community Health*. 2003;57(8):594-600.
19. Chang SS, Stuckler D, Yip P, Gunnell D. Impact of 2008 global economic crisis on suicide: time trend study in 54 countries. *BMJ*. 2013;347:f5239.
20. McIntyre RS, Lee Y. Projected increase in suicide in Canada as a consequence of COVID-19. *Psychiatry Res*. 2020;290:113104.
21. Ruch DA, Sheftall AH, Schlagbaum P, Rausch J, Campo JV, Bridge JA. Trends in suicide among youth aged 10 to 19 years in the United States, 1975 to 2016. *JAMA Network Open*. 2019;2(5):e193886-e193887.
22. Stefanac N, Hetrick S, Hulbert C, Spittal MJ, Witt K, Robinson J. Are young female suicides increasing? a comparison of sex-specific rates and characteristics of youth suicides in Australia over 2004–2014. *BMC Public Health*. 2019;19(1):1389.
23. Skinner R, McFaul S. Suicide among children and adolescents in Canada: trends and sex differences, 1980–2008. *CMAJ*. 2012;184(9):1029-1034.
24. Puzo Q, Qin P, Mehlum L. Long-term trends of suicide by choice of method in Norway: a join point regression analysis of data from 1969 to 2012. *BMC Public Health*. 2016;16(1):255.
25. Schrijvers DL, Bollen J, Sabbe BG. The gender paradox in suicidal behavior and its impact on the suicidal process. *J Affect Disord*. 2012; 138(1):19-26.
26. Statistics Canada. Table 13-10-0392-01: Deaths and Age-Specific Mortality Rates, by selected Grouped Causes. Ottawa (ON): Statistics Canada; 2019.
27. Martini M, da Fonseca RC, de Sousa MH, et al. Age and sex trends for suicide in Brazil between 2000 and 2016. *Soc Psychiatry Psychiatr Epidemiol*. 2019;54(7):857-860.
28. Mikkelsen L, Phillips DE, Abou Zahr C, et al. A global assessment of civil registration and vital statistics systems: monitoring data quality and progress. *Lancet*. 2015;386(10001):1395-1406.
29. Phillips DE, Lozano R, Naghavi M, et al. A composite metric for assessing data on mortality and causes of death: the vital statistics performance index. *Popul Health Metr*. 2014;12:14.
30. Edwards N, Alaghebbandan R, MacDonald D, Sikdar K, Collins K, Avis S. Suicide in Newfoundland and Labrador: a linkage study using medical examiner and vital statistics data. *Can J Psych*. 2008;53(4):252.
31. Gatov E, Kurdyak P, Sinyor M, Holder L, Schaffer A. Comparison of vital statistics definitions of suicide against a coroner reference standard: a population-based linkage study. *Can J Psychiatry*. 2018;63(3):152-160.
32. Gjertsen F, Bruzzone S, Vollrath ME, Pace M, Ekeberg Ø. Comparing ICD-9 and ICD-10: the impact on intentional and unintentional injury mortality statistics in Italy and Norway. *Injury*. 2013;44(1):132-138.
33. Statistics Canada. Comparability of ICD-10 and ICD-9 for Mortality Statistics in Canada. Ottawa (ON): Statistics Canada; 2005.
34. Skinner R, McFaul S, Rhodes AE, Bowes M, Rockett IRH. Suicide in Canada: is poisoning misclassification an issue? *Can J Psychiatry*. 2016;61(7):405-412.
35. Auger N, Burrows S, Gamache P, Hamel D. Suicide in Canada: impact of injuries with undetermined intent on regional rankings. *Inj Prev*. 2016;22(1):76-78.