



## RESEARCH ARTICLE

# Regional Variations in Suicide and Undetermined Death Rates among Adolescents across Canada

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## Abstract

**Objective:** Trends in rates of adolescent suicide and undetermined deaths in Canada from 1981 to 2012 were examined, focusing specifically on variations between Canadian regions. Exploratory hypotheses were formulated for regional variability in adolescent suicide rates over time in Canada. **Methods:** A descriptive time trend analysis using public domain vital statistics data was performed. All deaths from 1981 to 2012 among 15 to 19 year olds coded as suicides or undetermined intent according to the International Classification of Diseases, 9<sup>th</sup> and 10<sup>th</sup> Revisions were included. **Results:** While there was an overall stability in adolescent suicide and undetermined death rates across Canada, regional analyses showed that Quebec experienced a 7.6% annual reduction between 2001 and 2012 while the Prairies and Atlantic provinces experienced significant annual increases since 2001. Ontario and British Columbia have had non-significant fluctuations since 2001. The trends remained similar overall when excluding undetermined deaths from the analyses. **Conclusions:** Variations in adolescent suicide trends across provinces were found. Factors such as provincial suicide action and prevention legislation contributing to these variations remain to be studied, but these regional differences point towards the need for better consistency of suicide prevention strategies across the country.

**Key Words:** *suicide, adolescent, Canada, prevention, undetermined death*

## Résumé

**Objectif:** Les tendances des taux de suicide adolescent et des décès indéterminés au Canada de 1981 à 2012 ont été examinées, en mettant spécialement l'accent sur les variations entre les régions canadiennes. Des hypothèses exploratoires ont été formulées pour la variabilité régionale des taux de suicide adolescent avec le temps au Canada. **Méthodes:** Une analyse descriptive de l'évolution dans le temps utilisant les données des statistiques vitales du domaine public a été menée. Tous les décès de 1981 à 2012 chez les 15 à 19 ans codés comme suicides ou de cause indéterminée selon la Classification internationale des maladies, 9<sup>e</sup> et 10<sup>e</sup> révisions, étaient inclus. **Résultats:** Même s'il y avait une

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stabilité générale des taux de suicide adolescent et des décès indéterminés au Canada, les analyses régionales montraient que le Québec a connu une diminution annuelle de 7,6 % entre 2001 et 2012 alors que les Prairies et les provinces de l'Atlantique ont enregistré des hausses annuelles significatives depuis 2001. L'Ontario et la Colombie-Britannique ont eu des fluctuations non significatives depuis 2001. Les tendances sont demeurées semblables généralement en excluant les décès indéterminés des analyses. **Conclusions:** Des variations des tendances du suicide adolescent entre les provinces ont été constatées. Les facteurs contribuant à ces variations demeurent à étudier, comme les plans d'action et les mesures législatives provinciales de prévention du suicide. Ces différences régionales indiquent le besoin d'une meilleure cohésion des stratégies de prévention du suicide dans tout le pays.

**Mots clés:** *suicide, adolescent, Canada, prévention, décès indéterminé*

Although significant effort has been made worldwide to better understand and prevent suicide, it remains a major public health concern (Mental Health Commission of Canada, MHCC, 2014). Suicide is the second leading cause of death for people aged 15 to 29 years worldwide (World Health Organization, 2014). International reports on suicide among adolescents aged 15-19 year olds announce decreases in suicide rates worldwide in this age group since 2000, but with important variations between countries since 1990 (Matsubayashi & Ueda, 2011). Globally, suicide rates among adolescents aged 15-19 years had stabilized in the 1980s, and dropped slightly between 1990 and 2009, with larger decreases occurring in countries with historically higher suicide rates (Finland, Estonia, United States) (Bursztein, & Apter, 2009; Organization for Economic Co-Operation and Development, OECD, 2014).

Similarly to international reports, suicide is the second leading cause of death for individuals aged ten to 34 years in Canada (Public Health Agency of Canada, PHAC, 2012a), with suicide accounting for 10% of deaths in youth aged ten to 14 years, and for 23% of deaths in adolescents aged 15 to 19 years over the last 30 years (Skinner & McFaull, 2012). Reports on suicide rates of adolescents in Canada over the past years have shown suicide rates to be slightly decreasing over time (Pan et al., 2007). These decreases have been reported along with stabilizing rates of mental illness, notably depression and externalizing disorders, and decreasing trends in suicidal ideation and attempts among Canadian adolescents (McMartin, Kingsbury, Dykxhoorn, & Colman, 2014). Skinner and McFaull (2012) presented the trends in death by suicide among children and adolescents aged ten to 19 across Canada for 30 years until 2008. These trends revealed that suicide accounted for 20.4% of deaths among Canadian adolescents in 2008, in comparison to accounting for 1.5% of all deaths in Canada. Although important sex differences and variability in methods used are reported, the authors describe an overall significant national annual average decrease of 1.0% in suicide rates among adolescents from 1980 to 2008. However, they also remark that the omission of undetermined deaths in their analyses may have led to under-reporting of suicide rates.

The characteristics of individuals who died by undetermined intent are similar to those who died by suicide (Ohberg, & Lonnqvist, 1998). Deaths by suicide share many of the same classification indicators as accidental deaths, thereby rendering it difficult to determine whether the death was intentional or accidental. This can lead to misclassification of a death by suicide as an undetermined death (Bhalla et al., 2010; Gray et al., 2014; Linsley, Schapira & Kelly, 2001). Evidence has shown decreases in rates of deaths by suicide were accounted for by increases in assignment of 'undetermined' verdicts to cause of death, leading to a near 9% overestimation of reduction in suicide rates in England and France (Aouba, Péquignot, Camelin, & Jouglu, 2011; Gunnell et al., 2013). Thus, inclusion of undetermined cases when considering national suicide rates may be of particular importance for a more accurate statistical representation of deaths by suicide in Canada.

To our knowledge, an analysis of variations between Canadian regions in adolescent suicide rates has not been conducted. It is thus our objective to examine the trends in rates of death by suicide and undetermined deaths among Canadian adolescents focusing specifically on variations between Canadian regions. This analysis of a three-decade time period constitutes an opportunity to formulate exploratory hypotheses for suicide fluctuations over time in Canada.

## Method

We performed a descriptive time trend analysis using public domain vital statistics data. For Quebec, mortality data was obtained from the Quebec Statistics Institute. For all other provinces, vital statistics data was obtained from the Public Health Agency of Canada and from Statistics Canada. We included all deaths among youth aged 15 to 19 coded as suicides or of undetermined intent according to the International Classification of Diseases, 9<sup>th</sup> Revision (E950-E959 and E980-E989) for the period of 1981-1999, and according to the 10<sup>th</sup> revision (ICD-10) (X60-X84, Y87.0 and Y10-Y34, Y87.2, Y89.9) for the period of 2000-2012. To determine manner of death as suicide, in the case of an unexplained or unnatural death, the coroner or medical examiner performs an investigation as mandated through provincial/territorial

legislation. This process can take several months. Further, since the proportion of injury deaths of undetermined intent to suicides is generally less than 20% and relatively stable throughout the study period over Canadian regions, the validity of our suicide estimations can be considered adequate (Varnik et al., 2012). As such, official data in Canada is available until 2012. Death rates per 100,000 persons-year were calculated for each calendar year, using corresponding Canadian population estimates (Table 051-0001: <http://www5.statcan.gc.ca/cansim/a26>). The Prairies and Atlantic provinces were amalgamated by geographical region due to the lower population concentration in these regions.

### Statistical analysis

Statistical tests were performed with and without the inclusion of undetermined deaths. We examined temporal trends of three decades within the study period: 1981-1990, 1991-2000 and 2001-2012. To recognize important changes in suicide and undetermined death rates across Canada from 1981 to 2012, negative binomial modeling by Canadian region was used to determine whether the time trends were statistically significant. The negative binomial model is a generalization of the Poisson model. This strategy is especially suited to model a count of events in a given period in which a parameter related to overdispersion must be controlled for (Bouche, Lepage, Migeot & Ingrand, 2009). The model includes the intercept ( $\alpha$ ), the parameters associated with the time variable included in the model (ex.  $\beta_{\text{year}}$ ) and an overdispersion term. For each decade, the parameter associated with the time ( $\beta_{\text{year}}$ ) was used to estimate the annual percentage change (APC) in suicide and undetermined death rates. The APC used to describe the trend was calculated as follows:

$$APC = (e^{\beta_{\text{year}}} - 1) * 100$$

We calculated 95% confidence intervals (CI) for the APCs using the Wald method. These estimates demonstrate whether the rate trend is increasing or decreasing over a given decade. To compare the APC for two regions, we used a CI approximation for the difference between the two true APCs based on a Taylor series expansion [<https://surveillance.cancer.gov/help/joinpoint/setting-parameters/advanced-tab/average-annual-percent-change-aapc>]. To mitigate annual fluctuations and facilitate the graphic illustration of trends, five-year weighted moving averages were calculated according to the Kernel approach (Devine, 2004).

## Results

Results from the time trend analysis showed an overall stability in suicide and undetermined deaths across Canada from 1981 to 2012 among youth aged 15 to 19 years. The national annual rates of suicide and undetermined deaths are described in Table 1. From 1981 to 2000, a marginally significant nation-wide decrease of 1.3% in suicide

and undetermined death rates was observed. From 2001 to 2012, a non-significant nation-wide decrease of 0.5% was observed (Table 2). When excluding undetermined death rates from these analyses, non-significant 0.3% decreases in nation-wide suicide rates were observed from 1981 to 1990. Trends from 1991 to 2012 remained similar without undetermined deaths, with decreases ranging from 0.6% to 1.3%.

Important regional variations in suicide and undetermined deaths were found (Table 2). From 1981 to 2000, Quebec, the Atlantic Provinces, and Ontario experienced non-significant fluctuations in suicide and undetermined death rates, whereas only the Prairies and British Columbia experienced significant decreases. However, in the last decade of study, only Quebec experienced significant reductions in adolescent suicide and undetermined death rates, at an annual percent change of 7.6%. The Atlantic Provinces and Prairies showed significant annual increases in adolescent suicide and undetermined death rates, at an annual percent change of 5.7% and 3.1% respectively. British Columbia and Ontario experienced non-significant fluctuations in suicide and undetermined death rates in the last decade. When excluding undetermined deaths from the analyses as a comparison, these trends remained similar overall, with the Prairies experiencing a non-significant increasing trend in suicide rates in the last decade, at an annual percent increase of 2.3%. For a finer analysis and comparison between provinces, suicide and undetermined deaths trends per 100 000 population among youth aged 15 to 19 years were smoothed using five-year weighted moving averages, and are depicted in Figure 1.

Given these regional variations in adolescent suicide and undetermined death rates, the average annual percent change in Quebec was compared to the average annual percent change in Canada as a whole and to that in individual regions (Table 3). From 1981 to 1990, the average annual percent change in Quebec was 2.6% (NS) above that of Canada, indicating overall smaller annual reductions in suicide and undetermined death rates in Quebec compared to the rest of Canada. A significant difference emerged between Quebec and British Columbia, with Quebec demonstrating 5.4% smaller annual average percent reductions. This overall trend remained similar when excluding undetermined deaths from analyses; however some loss of significance occurred in some of the comparisons.

Similarly, from 1991 to 2000, Quebec did not experience the same reduction in suicide and undetermined death rates when compared to the rest of Canada, with 2.4% (NS) greater reductions in Canada. Quebec experienced 7.2% and 5.5% smaller reductions in suicide and undetermined death rates compared to British Columbia and the Prairies, respectively. These trends were the same when excluding undetermined deaths.

Table 1. Numbers (and rates) of suicide and undetermined deaths per 100 000 population among Canadian adolescents (aged 15–19 years) for the period 1981–2012, by regions

Year	No. of suicide and undetermined deaths (rates per 100 000 population)											
	Atlantic		Québec		Ontario		Prairies		British Columbia		Canada	
	S+U	S	S+U	S	S+U	S	S+U	S	S+U	S	S+U	S
1981	26 (11.0)	17 (7.1)	91 (14.4)	71 (11.3)	86 (10.3)	78 (9.2)	106 (25.7)	88 (21.0)	38 (15.3)	33 (13.1)	350 (14.8)	293 (12.2)
1982	25 (10.9)	23 (9.9)	94 (15.6)	83 (13.8)	76 (9.4)	73 (8.8)	85 (21.1)	74 (18.1)	33 (13.7)	30 (12.2)	319 (13.9)	282 (12.1)
1983	18 (8.1)	18 (8.0)	97 (17.1)	93 (16.4)	75 (9.6)	71 (8.9)	75 (19.5)	66 (16.8)	30 (13.1)	27 (11.6)	310 (14.1)	289 (13.0)
1984	27 (12.6)	24 (11.0)	80 (15.0)	77 (14.4)	69 (9.2)	65 (8.5)	67 (18.3)	56 (15.0)	29 (13.1)	28 (12.5)	281 (13.4)	253 (11.9)
1985	16 (7.7)	15 (7.1)	74 (14.7)	65 (12.9)	63 (8.7)	60 (8.1)	53 (15.0)	51 (14.2)	27 (12.4)	26 (11.8)	238 (11.8)	221 (10.8)
1986	24 (11.8)	21 (10.1)	80 (16.5)	73 (15.0)	69 (9.6)	64 (8.7)	66 (18.7)	60 (16.8)	21 (9.6)	20 (9.0)	264 (13.3)	241 (11.9)
1987	17 (8.5)	16 (7.8)	89 (18.9)	82 (17.4)	61 (8.5)	59 (8.1)	68 (19.6)	59 (16.8)	20 (9.2)	19 (8.6)	264 (13.5)	244 (12.3)
1988	23 (11.6)	22 (10.8)	75 (16.2)	64 (13.8)	62 (8.7)	59 (8.1)	69 (20.1)	66 (19.0)	25 (11.5)	25 (11.3)	258 (13.2)	242 (12.2)
1989	15 (7.6)	15 (7.5)	86 (18.6)	76 (16.5)	70 (9.7)	67 (9.1)	68 (20.0)	57 (16.5)	25 (11.5)	24 (10.8)	264 (13.6)	247 (12.5)
1990	23 (11.8)	23 (11.6)	69 (14.9)	66 (14.2)	53 (7.4)	51 (7.0)	67 (19.8)	59 (17.2)	23 (10.5)	23 (10.4)	238 (12.3)	225 (11.4)
1991	22 (11.5)	22 (11.2)	81 (17.4)	77 (16.5)	47 (6.6)	47 (6.5)	75 (22.2)	73 (21.3)	28 (12.9)	27 (12.2)	261 (13.5)	253 (12.9)
1992	22 (11.8)	22 (11.5)	82 (17.4)	81 (17.2)	55 (7.8)	49 (6.9)	66 (19.5)	60 (17.5)	34 (15.4)	34 (15.2)	264 (13.7)	249 (12.7)
1993	27 (14.8)	26 (14.0)	91 (19.0)	88 (18.4)	53 (7.6)	48 (6.8)	52 (15.3)	51 (14.8)	16 (7.1)	15 (6.5)	248 (12.8)	237 (12.1)
1994	14 (7.8)	14 (7.7)	105 (21.5)	103 (21.1)	60 (8.5)	53 (7.4)	67 (19.5)	65 (18.6)	18 (7.7)	17 (7.2)	264 (13.5)	252 (12.7)
1995	18 (10.2)	17 (9.4)	107 (21.6)	106 (21.4)	62 (8.7)	60 (8.3)	53 (15.2)	50 (14.1)	22 (9.1)	22 (8.9)	271 (13.7)	264 (13.1)
1996	9 (5.2)	9 (5.1)	106 (21.2)	103 (20.6)	53 (7.4)	48 (6.6)	57 (16.0)	53 (14.6)	14 (5.5)	13 (5.0)	244 (12.1)	231 (11.3)
1997	19 (11.2)	19 (11.0)	102 (20.5)	102 (20.5)	65 (8.9)	59 (7.9)	56 (15.5)	54 (14.7)	25 (9.6)	24 (9.1)	280 (13.8)	271 (13.2)
1998	13 (7.7)	13 (7.6)	103 (20.8)	101 (20.4)	64 (8.6)	54 (7.1)	63 (17.0)	62 (16.5)	15 (5.7)	15 (5.6)	269 (13.1)	256 (12.3)
1999	21 (12.6)	20 (11.9)	104 (21.3)	104 (21.3)	51 (6.7)	46 (5.9)	52 (13.7)	50 (13.0)	20 (7.4)	19 (7.0)	262 (12.6)	253 (12.0)
2000	14 (8.4)	14 (8.3)	85 (17.8)	80 (16.8)	60 (7.6)	56 (7.1)	51 (13.3)	47 (12.1)	24 (8.7)	24 (8.6)	236 (11.3)	225 (10.6)
2001	8 (4.9)	8 (4.8)	78 (16.7)	75 (16.0)	52 (6.5)	45 (5.5)	56 (14.4)	50 (12.6)	13 (4.6)	12 (4.2)	224 (10.6)	207 (9.7)
2002	13 (8.0)	12 (7.3)	74 (16.0)	71 (15.4)	57 (7.0)	54 (6.5)	60 (15.2)	54 (13.5)	22 (7.9)	20 (7.1)	231 (10.9)	215 (10.0)
2003	16 (10)	14 (8.7)	73 (16.0)	70 (15.3)	56 (6.8)	52 (6.2)	51 (12.8)	45 (11.2)	24 (8.7)	24 (8.5)	231 (10.9)	216 (10.0)
2004	10 (6.3)	10 (6.2)	58 (12.7)	55 (12.0)	61 (7.2)	54 (6.3)	76 (18.9)	66 (16.2)	18 (6.5)	17 (6.0)	231 (10.8)	210 (9.7)
2005	17 (10.8)	17 (10.7)	57 (12.3)	52 (11.2)	56 (6.5)	51 (5.9)	73 (17.9)	64 (15.5)	13 (4.7)	13 (4.7)	231 (10.6)	213 (9.7)
2006	13 (8.3)	13 (8.2)	37 (7.7)	35 (7.3)	45 (5.2)	38 (4.3)	51 (12.4)	48 (11.5)	17 (6.0)	16 (5.5)	165 (7.5)	152 (6.8)
2007	14 (9.0)	14 (8.9)	43 (8.7)	41 (8.3)	59 (6.7)	54 (6.1)	68 (16.4)	56 (13.5)	16 (5.7)	13 (4.6)	207 (9.3)	185 (8.2)
2008	15 (9.8)	14 (9.0)	44 (8.8)	42 (8.4)	51 (5.8)	49 (5.5)	84 (20.3)	79 (18.9)	16 (5.7)	16 (5.6)	218 (9.7)	208 (9.2)
2009	14 (9.3)	14 (9.1)	43 (8.5)	41 (8.1)	56 (6.3)	52 (5.8)	82 (19.8)	71 (17.1)	18 (6.4)	17 (5.9)	220 (9.8)	202 (8.9)
2010	20 (13.5)	19 (12.7)	29 (5.8)	29 (5.8)	59 (6.6)	57 (6.3)	76 (18.5)	59 (14.3)	29 (10.3)	29 (10.1)	218 (9.7)	198 (8.7)
2011	18 (12.5)	18 (12.5)	47 (9.6)	43 (8.8)	62 (6.9)	59 (6.6)	68 (16.6)	53 (12.9)	21 (7.4)	20 (7.1)	224 (10.0)	201 (9.0)
2012	16 (11.3)	15 (10.6)	41 (8.6)	41 (8.6)	71 (8.0)	67 (7.5)	89 (21.8)	77 (18.9)	19 (6.7)	19 (6.7)	246 (11.1)	229 (10.4)

S+U: Suicides and Undetermined Deaths Rates, S: Suicide rates

**Table 2. Change in suicide and underdetermined deaths rates per 100 000 population among Canadian adolescents over the last three decades by region**

Decades	Average annual percent change (95% confidence interval), p value					
	Atlantic	Québec	Ontario	Prairies	British Columbia	Canada
<b>Change in Suicide and Undetermined Deaths Rates</b>						
1981-1990	-0.5 (-5.0 to +4.3) 0.84	+1.3 (-1.0 to +3.7) 0.27	-2.0 (-4.5 to +0.6) 0.13	-1.7 (-4.2 to +0.9) 0.21	-4.1* (-7.0 to -0.0) 0.05	-1.3* (-2.5 to -0.0) 0.05
1991-2000	-3.1 (-8.1 to +2.2) 0.24	+1.1 (-1.1 to +3.4) 0.33	+0.4 (-2.4 to +3.3) 0.79	-4.4* (-7.0 to -1.7) <0.01	-6.1* (-11.1 to -0.8) 0.02	-1.3 (-2.6 to +0.0) 0.06
2001-2012	+5.7* (+1.2 to +10.4) 0.01	-7.6* (-10.1 to -5.2) <.01	+0.5 (-1.6 to +2.8) 0.47	+3.1* (+0.9 to +5.4) 0.01	+1.7 (-2.1 to +5.6) 0.38	-0.5 (-2.1 to +1.1) 0.51
<b>Change in Suicide Rates</b>						
1981-1990	+2.2 (-2.7 to +7.3) 0.38	+2.0 (-0.5 to +4.5) 0.12	-1.6 (-4.2 to +1.0) 0.23	-1.1 (-3.7 to +1.6) 0.42	-2.7 (-6.8 to +1.5) 0.20	-0.3 (-1.6 to +1.1) 0.68
1991-2000	-3.3 (-8.1 to +1.9) 0.21	+1.2 (-1.0 to +3.5) 0.3	-0.1 (-3.0 to +2.9) 0.96	-4.4* (-7.1 to -1.7) <.01	-6.0* (-11.3 to -0.4) 0.04	-1.3 (-2.6 to +0.1) 0.07
2001-2012	+5.9* (+1.3 to +10.7) 0.01	-7.6* (-9.9 to -5.2) <.01	+1.2 (-1.1 to +3.5) 0.31	+2.3 (-0.2 to +4.9) 0.07	+2.1 (-1.9 to +6.4) 0.31	-0.6 (-2.2 to +1.0) 0.45

In the last decade of study, from 2001 to 2012, the trend for Quebec reversed, and the average annual percent change in suicide and undetermined death rates was significantly different than the rest of Canada, with rates dropping 7.1% more. Quebec was also significantly different from all individual regions in Canada, with adolescent suicide and undetermined death rates in Quebec ranging between 8.1 and 13.3% greater reductions compared to individual regions in Canada. Excluding undetermined deaths from the analysis showed a similar pattern.

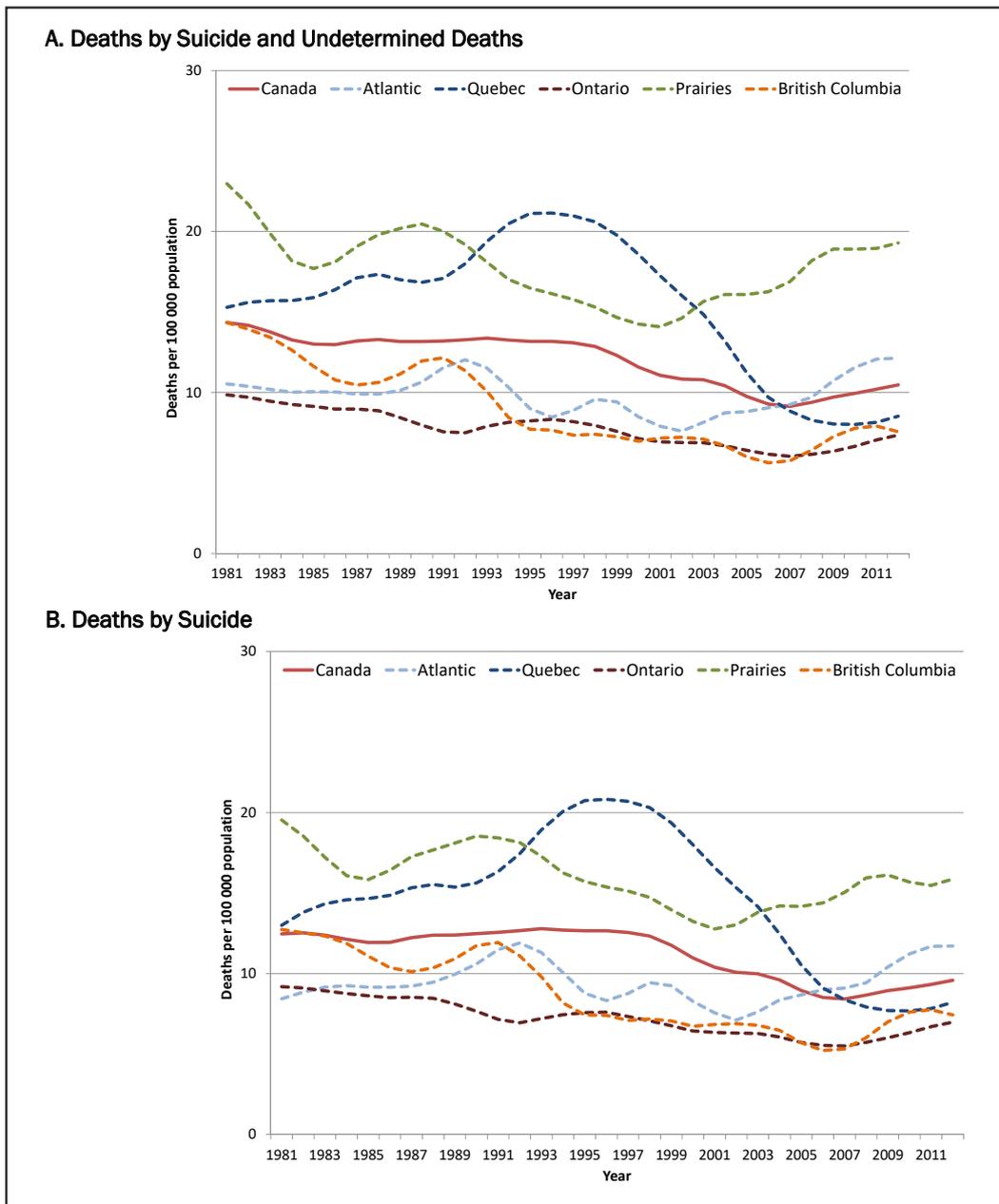
## Discussion

The purpose of this descriptive research was to explore regional variations in suicide rates among adolescents in Canada. To our knowledge, this is the first study comparing the variations between Canadian regions in time trends of adolescent suicide and undetermined death rates and to speculate on differential population-based suicide prevention strategies. The results from our analyses showed that suicides and undetermined deaths among adolescents across Canada were stable from 1980 to 2012. However,

important regional variations across Canada were also observed.

Only the Prairies and British Columbia experienced significant decreases in suicide and undetermined death rates between 1980 and 2000. Since 2001, Quebec is the only region to have experienced significant annual decreases in suicide and undetermined death rates. On the contrary, the Prairies and Atlantic provinces have experienced significant annual increases in suicide and undetermined death rates since 2001, while Ontario and British Columbia have experienced non-significant fluctuations in their rates since 2001. As such, although nationwide suicide and undetermined death rates among adolescents are reportedly stable, there remains variability across Canadian regions. In addition, comparisons between Quebec and other regions of Canada showed that in the last decade of study, Quebec has experienced greater decreases in suicide and undetermined death rates in comparison to the rest of Canada. This is notable considering that from 1981 to 2000, Quebec had showed greater increases in suicide and undetermined death rates.

**Figure 1. Suicide and undetermined deaths per 100 000 population among Canadian adolescents (aged 15–19 years) by regions. Trends were smoothed using 5-year weighted moving averages**



These results should be considered within the context of certain limitations. Although the inclusion of undetermined deaths constitutes a strength of this study to better estimate deaths by suicide (Gunnell et al., 2013), it is uncertain that undetermined deaths are in fact deaths by suicide. The comparative analyses with suicide rates excluding undetermined deaths showed similar trends to those including undetermined deaths. Next, the regionally-aggregated trends used may vary from provincial data, and do not further distinguish between groups where rates are higher than the national average (e.g. First Nation adolescents). In addition,

suicide rates among youth aged 10-14 have not been reported on in this study due to the low number of suicide cases among this category yielding precision problems for which alternative statistical strategies should be used. Finally, whereas the current study estimated the average annual percent change over three decades of suicide and undetermined death rates within and across Canadian regions, the design does not allow for the understanding of underlying factors contributing to the variability in initial suicide and undetermined death rates across regions.

**Table 3. Comparison of Quebec's average annual percent change of suicide and undetermined deaths rates per 100 000 population among adolescents with other Canadian regions over the last three decades**

Decades	Average annual percent change (95% confidence interval)				
	Atlantic	Ontario	Prairies	British Columbia	Canada
Change in suicide and undetermined deaths rates					
1981-1990	+1.8 (-3.4 to +7.0)	+3.3 (-0.2 to +6.8)	+3.0 (-0.5 to +6.5)	+5.4* (+0.8 to +10.0)	+2.6 (-0.1 to +5.3)
1991-2000	+4.2 (-1.4 to +9.8)	+0.7 (-2.9 to +4.3)	+5.5* (+2.0 to +9.0)	+7.2* (+1.6 to +12.8)	+2.4 (-0.2 to +5.0)
2001-2012	-13.3* (-18.5 to -8.1)	-8.1* (-11.3 to -4.9)	-10.7* (-14.0 to -7.4)	-9.3* (-13.8 to -4.8)	-7.1* (-10.0 to -4.2)
Change in suicide rates					
1981-1990	-0.2 (-5.8 to +5.4)	+3.6* (+0.0 to +7.2)	+3.1 (-0.5 to +6.7)	+4.7 (-0.1 to +9.5)	+2.3 (-0.5 to +5.1)
1991-2000	+4.5 (-1.0 to +10.0)	+1.3 (-2.4 to +5.0)	+5.6* (+2.1 to +9.1)	+7.2* (+1.3 to +13.1)	+2.5 (-0.1 to +5.1)
2001-2012	-13.5* (-18.8 to -8.2)	-8.8* (-12.1 to -5.5)	-9.9* (-13.4 to -6.4)	-9.7* (-14.5 to -4.9)	-7.0* (-9.9 to -4.1)
*p < .05					

Evidence has reported on the efficacy of various suicide prevention interventions, yet no single strategy seems better than others for both adults and adolescents (Zalsman et al., 2016). It has been suggested that both population-based measures and particular strategies targeted directly to high-risk groups, including adolescents, be used (Hawton, Saunders, & O'Connor, 2012). Youth-targeted mental health promotion programs such as Youth Aware of Mental Health (YAM) implemented across Europe have successfully contributed to reduced number of adolescent suicide attempts and severe suicidal ideation (Wasserman et al., 2015). A systematic review of interventions in Canada suggests that efforts to increase contact between youth and trained professionals across settings are promising for reducing adolescent suicide risk (Bennett et al., 2015). Further, methods such as means restriction (Biddle, Brock, Brookes, & Gunnell, 2008; Mann et al., 2005; Yip et al., 2012) and education of physicians have been found to reduce suicide risk (Gibbons et al., 2012; Hegerl, Althous, Schmidtke, & Niklewski, 2006; Mann et al., 2005; Rihmer, Rutz, & Pihlgren, 1995; Zalsman et al., 2016). While the efficacy of some strategies continue to be debated, such as using antidepressants among high-suicide risk depressed adolescents and school curriculum-based suicide prevention strategies (Biddle et al., 2008; Gibbons et al., 2007; Gibbons et al., 2012; Van der Feltz-Cornelis et al., 2014; Wei, Kutcher, & Leblanc, 2015), recent evidence suggests they do have some benefits (Zalsman et al., 2016). Further, while the use of psychosocial interventions, especially dialectical behaviour therapy

and cognitive-behavioural therapy, can effectively reduce self-harming behaviours, their effect seems weaker for suicidal self-harm and attempts (Ougrin et al., 2012; Ougrin, Tranah, Stahl, Moran, & Asarnow, 2015).

All Canadian provinces have adopted provincial strategies for addressing mental health issues, but not all have implemented strategies related to suicide prevention. In Germany, The Nuremberg Alliance against Depression developed a four-level community-based intervention to address depression and suicide risk among adults (Hegerl et al., 2006). These efforts consisted of: a) training physicians in diagnosing and treating depression and suicide risk; b) launching awareness campaigns to promote help seeking and better media coverage; c) providing training sessions to community case workers to assist in recognition of risk and access to care decisions; and, d) targeting at-risk individuals and their relatives to receive special support. Upon implementation of this program, while no difference was observed in completed suicide, a significant decrease of 25% in suicidal acts (ideation and attempts) among adults was observed over the first two years of implementation (Hegerl et al., 2006), with sustained effects one year after the main intervention ended (Hegerl et al., 2010). However, no empirical evidence has established the efficacy of this program for individuals under the age of 18 years.

A plan similar to the Nuremberg program was implemented in 1998 in Quebec (Mercier & Saint-Laurent, 1998), coinciding in time with the decreases in suicide rates among

adolescents in 2001 observed in this study. While no formal evaluation of this program exists, it has been documented that 50% of Quebec regions undertook physician training initiatives for better assessment of depression in adolescence (Potvin, 2004), youth center protocols have been implemented to meet specific needs of youth with risk factors for suicide (Association des Centres Jeunesse du Québec, ACJQ, 2014), and community mental health promotion and prevention programs among adolescents were implemented, reaching approximately 50 to 70% of adolescents in Quebec (Boyer & Forté, 2002). After 1999, suicide rates in general dropped by 25%, and by 35% among adolescents under 19 years (Gagné & St-Laurent, 2010).

Across some other Canadian provinces, suicide prevention and reduction strategies have also been implemented, while no formal evaluation of such strategies have been conducted. For example, British Columbia has targeted practitioner training and gatekeeping (White, 2016). Similarly, Ontario launched a youth suicide prevention plan as part of their Comprehensive Mental Health and Addictions Strategy specifically targeting suicide prevention among community youth and enhancing communication between professionals and youth (Government of Ontario, 2016). In Manitoba, the youth suicide prevention strategy targets assessment and planning of interventions with regional suicide prevention committees, mental health promotion targeting family and community functioning, and awareness and understanding of suicide risk factors via gatekeeper training and community workshops and activities (Government of Manitoba, 2008). Also, Nova Scotia's suicide prevention strategy aims to address vulnerable populations, including youth, by promoting awareness and understanding via best media practices and community outreach, inter-sectoral partnerships to strengthen suicide prevention initiatives, and establishing easily accessible intervention services and programs (Government of Nova Scotia, 2006).

Although examining legislative differences is beyond the scope of this report, we take this opportunity to formulate exploratory hypotheses that may account for the regional variations observed presently. It is possible that differences in implementation of suicide prevention strategies across the country have led to variable efficacy despite similar strategy objectives, although this remains unevaluated. It may be that misclassification of suicides between regions (Skinner et al., 2016), and differential access to means between regions, including variable firearm legislation and physician prescription practices also account for these variations in adolescent suicide and undetermined deaths. Specifically, although medication is easily accessible in Canada via universal medical insurance coverage, psychotherapy is a much more difficult service to obtain despite being an effective treatment option (Lesage, 2015). Indeed, among individuals aged 14 to 25 year old who died by suicide in Quebec, only 7.5% had received third-line psychiatric services in their last month preceding death, and only 20.9%

within their last year (Renaud et al., 2014). Data from the Canadian Community Health Survey Cycle also reports that whereas individuals 15 years and older with depression (with or without suicidality) are likely to present to mental health services, suicidal individuals without depression (comprising nearly two thirds of suicidal individuals in this sample) were much less likely to have any mental health service contact (Rhodes, Bethell, & Bondy, 2006).

It is possible to argue that these differences in risk factors across Canadian regions suggest the consideration of differential suicide prevention responses across Canadian regions rather than a national multi-level model, such as the Nuremberg model. For example, differential targeting of high-risk groups, such as First Nation populations or those with increased access to firearms or pesticides, has been recommended (Hawton, Saunders, & O'Connor, 2012). Nonetheless, there exists strong empirical support for the association between psychopathology and suicide risk for adults and adolescents, both from within Canada and from around the world (Arsenault-Lapierre, Kim, & Turecki, 2004; Cavanagh, Carson, Sharpe, & Lawrie, 2003; Renaud et al., 2014; Séguin, Renaud, Lesage, Robert, & Turecki, 2011). Further, psychopathology is consistently reported among First Nation suicides and non-native suicides in Canada (Chachamovich et al., 2015; Renaud et al., 2014). Therefore, while differential geographical and cultural risk factors are being increasingly recognized and targeted (Cho, Na, Cho, Im, & Kang, 2016; Milner, Svetlicic, & De Leo, 2013), strategies addressing more global suicide risk factors may benefit from a multi-level approach.

In the present study, important regional variations in suicide and undetermined death rates across Canada were found, with some regions experiencing decreases and others experiencing increases over time. This highlights the need for better consistency of suicide prevention strategies across the country. The introduction of national suicide prevention programs by some countries seems to have contributed to reducing adolescent suicide rates (Matsubayashi & Ueda, 2011). Establishing a national protocol in Canada could help the adoption of best mental health practices and training in suicide prevention across the country (Vogel, 2011), as well as ensure consistency of care and resources. Specific improvements to health care services in the form of better mental health promotion and training of physicians, and better coordination and continuity of care in the form of follow-ups or protocol application are essential (Renaud et al., 2014). Initial steps towards a national suicide prevention strategy have been undertaken. The Canadian Association for Suicide Prevention (CASP) has established guidelines for a national suicide prevention strategy (CASP, 2009), and the Government of Canada has established a federal framework for suicide prevention calling for evidenced-informed guidelines to identify when, where, and how to intervene in the case of suicide risk (PHAC, 2012b). Furthermore, the Mental Health Commission of Canada has

recently made mental health promotion and suicide prevention a top-priority strategic direction for better national mental health care (MHCC, 2015). Still, these are just the first steps towards the implementation of a national suicide prevention strategy.

## Conclusion

This article highlights variations in suicide rates across Canadian regions, despite stable Canadian trends overall in adolescent suicide and undetermined death rates. Specifically, in comparison to the rest of Canada, notable reductions were observed in some regions and increases in others. Future empirical research should consider multilevel models and national suicide prevention strategies as promising approaches requiring further investigation into their usefulness in youth suicide prevention. A future research agenda will be to test the speculative hypotheses formulated in this article and formally document differential strategies that might be studied among provinces and their efficacy.

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The authors have no financial relationships to disclose.

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