Current Trends in Youth Suicide and Firearms Regulations

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ABSTRACT

Background: Despite numerous prevention initiatives, suicide remains the second leading cause of death in youth aged 10-19. One of the major prevention strategies is the introduction of restrictive firearms regulations. For example, Bill C-17 was enacted in 1991 to promote safer handling and storage of firearms through mandatory safety courses for all new gun owners. Examining the suicide rates subsequent to Bill C-17 may shed light on the possible benefit of these regulations as a solution to this major public health issue. Therefore, this paper examines the trends in youth suicide from 1979-1999 and the association with changes in the firearms act in 1991.

Methods: Age-specific suicide rates for youth between 15-19 years and rates by methods of suicide were calculated based on data from Statistics Canada for the years 1979-1999. Time series analyses were conducted.

Results: Although the overall rates did not change from 1979-1999 in youth aged 15-19, there was a substantial change in the methods used. In particular, the rates of suicide by firearms dropped from 60% to 22% while suicide due to hanging/suffocation increased from 20% to 60% in this age group over this period of time.

Conclusion: These results suggest a possible association between changes in the firearms act in 1991 and the methods used by youth to complete suicide. However, the overall rates of suicides did not change over this same period. These trends underscore the need for broader prevention interventions that do not solely focus on methods of suicide but rather, their underlying causes.

MeSH terms: Adolescent; suicide; firearms; Canada

La traduction du résumé se trouve à la fin de l'article.

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Suicide claims more than 250 young lives annually.¹ In 1998 alone, 13 of every 100,000 Canadian youths aged 15-19 committed suicide.¹ It accounted for 24% of deaths in youths aged 15-24 in 1998.¹ Despite numerous efforts to prevent youth suicide, it has become the leading cause of death, second only to motor vehicle accidents.²

Many prevention programs have focussed on methods of suicide because method restriction is considered one of the most effective prevention strategies. Jurisdictions have targeted a variety of suicide methods. In the United Kingdom, several examples of suicide prevention initiatives using method restriction include: 1) the "British experience" when natural gas replaced coal gas, and 2) the recent limiting of the packaging size of acetaminophen and salicylates sold over the counter.^{3,4} Both these interventions were associated with reductions in the number of suicides by these particular methods but not in the total suicide rate. This phenomenon, commonly known as switching or substitution, occurs when one method of suicide is substituted for another when access to the first method is restricted.^{3,4}

In North America and other parts of the world, major prevention strategies also focus on method restriction.² One of the most widely advocated strategies has been more restrictive firearms regulations.⁵⁻⁸ There are several reasons for this. First, initial studies in the 1980s found lower rates of suicide by firearms in geographical areas with more restrictive firearms regulations.⁹ Further studies examining the impact of more restrictive firearms regulations found decreased rates of firearm-related suicides.^{10,11} For example, Snowden et al. found a decrease in firearms suicides after more restrictive firearms legislations were implemented in Australia.¹² However, controversy remains regarding the impact of these regulations on the total suicide rate and the occurrence of substitution/switching.^{10,11} Findings from studies in the US and Canada support the substitution theory.^{13,14} However, the previous research suggests that more restrictive firearms regulations may have a greater impact in preventing suicides in the younger age group compared to other age groups.^{8,15} Furthermore, youth suicides by firearms are most common in North America and previous research has found positive corre-

lations between accessibility to firearms and suicides.^{3,16}

Given the examples of method restriction, and the fact that gun deaths is one of the leading causes of death in youth, professional organizations such as the American Academy of Pediatrics and the Canadian Pediatric Society have focussed on the prevention of deaths by firearms, both intentional and accidental, in children and adolescents through the promotion of more restrictive firearms regulations.^{5,6} The majority of recommendations from these and other professional organizations focus on the safe storage of firearms and education of gun owners regarding the dangers of firearms in the home – issues which were addressed in the changes to the firearms legislations in 1991.^{5,6} Strategies limiting the availability of firearms in households with youth is thought to decrease the number of completed suicides in this age group.

Although further changes to the firearms regulations (Bill C-68) such as the development of the Canada Firearms Centre and a national gun registry were proclaimed in 1995, regulations focussing on safe storage and education of gun owners, which have been assumed to have the greatest impact on suicide in youth, were enacted more than 10 years ago in 1991.^{5,6,17} This legislation was Bill C-17 which strengthened and clarified the definition of safe storage of firearms and enforced mandatory safety courses for all firearms owners. Bill C-17, implemented between 1992 and 1994, clearly outlined the regulations around safe storage, handling and transportation of firearms. It also forced gun applicants to be certified as competent in handling firearms safely. Previous legislation such as Bill C-51 – requiring acquisition certificates, restricting the availability of some types of firearms to certain individuals, setting up procedures for handling and storing of firearms, requiring selling permits and increasing sentences for firearms offences – was associated with decreased rates of suicides by firearms but no change in overall rates.¹⁰

There has been a paucity of research examining the impact of Bill C-17 legislation on rates and method of completed suicides in youth. Examining rates subsequent to the implementation of these

changes may shed some light on the possible benefit of more restrictive firearms regulations as a solution to this major public health issue. This paper examines trends in youth suicide from 1979-1999 in Canada and explores the association of changes in the firearms act in 1991 (Bill C-17) and the change in the overall suicide rates and rates by specific methods in Canadian youth aged 15-19.

METHODS

Suicide rates

Data on the number of age-specific suicides from 1979-1999 were obtained from Statistics Canada for adolescents aged 15-19. The data were obtained through death certificate records from each of the provincial governments.¹⁸ Death certificate records are considered the most accurate information on causes of death since autopsies are completed on the majority of suicide victims (Data Manager, Chief Coroner's Office, Toronto, Ontario, March 2004).¹⁹ They are the most accurate national data available on suicide deaths (Data Manager, Chief Coroner's Office, Toronto, Ontario, March 2004).¹⁹

The annual population for this age group was based on the Annual Demographic Statistics report from Statistics Canada.²⁰ The following age-specific formula was used to calculate annual age-specific suicide rates/100,000 from 1979-1999 for completed suicides by youth aged 15-19:

$$\text{Annual age-specific rate/100,000} = \frac{\text{Annual number of completed suicides} * 100,000}{\text{Annual population for youth aged 15-19}}$$

Method of suicide

Data on the number of age-specific suicides by method from 1979-1999 were calculated using data obtained from Statistics Canada for adolescents aged 15-19.¹⁸ The methods of suicide were grouped based on the eight categories used by Statistics Canada: firearms/explosives (firearms), hanging, poisoning by gas, overdose, jumping from a high place, submersion, cutting/piercing and other methods (e.g., crashing automobile).⁹ Firearms, hanging, poisoning by gas and overdose accounted for more than 90% of total suicide deaths.

Time series models were used to examine whether there were significant changes in rates of suicide by firearms and hanging before and after 1990 (Bill C-17 became law in 1991). These models adjusted for the presence of serial correlation by adjusting for autocorrelation with a one period lag.

Two models were estimated to examine if suicide rates were similar in the pre-1990 and post-1990 time periods. In Model 1,

$$Y_{tj} = \beta_{0j} + \alpha Y_{t-1,j} + \beta_{1j} \text{Year} + \varepsilon_{tj}$$

where Y_{tj} = the rate of suicide in Year t (t = 1980-1990) by method j (j = firearms or hanging)

$Y_{t-1,j}$ = the rate of suicide in Year $t - 1$ ($t-1$ = 1979-1989) by method j (j = firearms or hanging)

Year = Year of observation

The predicted values of Y for Model 1 were based on pre-Bill C-17 data. Forecasts using this model assume the pattern in these years continues throughout the post-Bill C-17 years.

In Model 2,

$$Y_{tj} = \gamma_{0j} + \delta_j Y_{t-1,j} + \gamma_{1j} \text{Year} + \gamma_{2j} \text{BillC17} + \gamma_{3j} \text{BillC17} * \text{Year} + \zeta_{tj}$$

such that Y_{tj} = the rate of suicide in Year t (t = 1980-1999) by method j (j = firearms or hanging),

$Y_{t-1,j}$ = the rate of suicide in Year $t - 1$ ($t-1$ = 1979-1989) by method j (j = firearms or hanging)

BillC17 = dichotomous variable indicating when Bill C-17 went into effect

BillC17 * Year = interaction term between BillC17 and Year.

TABLE I
Number of Suicides for Canadian Adolescents Aged 15-19 by Method and Annual Census Data, 1979 and 1999

Method of Suicide (ICD-x code)	1979 Number of Completed Suicide (annual census)	1999 Number of Completed Suicide (annual census)
Total (X60-84)	308 (2,428,070)	252 (2,062,760)
Firearms (X72-75)	162 (2,428,070)	56 (2,062,760)
Hanging (X70)	66 (2,428,070)	160 (2,062,760)
Poisoning by Gas (X66-67)	25 (2,428,070)	10 (2,062,760)
Overdoses (X60-65, X68-69)	29 (2,428,070)	4 (2,062,760)

Source of data: Statistics Canada

Figure 1. Annual suicide rates by method, Canadian adolescents ages 15-19 years, 1979-1999
 Source of data: Statistics Canada

Figure 2. Annual suicide rates due to firearms, 1979-1999
 Source of data: Statistics Canada

With the introduction of the Bill C-17 indicator variable and the BillC17*Year interaction term, the pattern in the years subsequent to Bill C-17's implementation was allowed to be different from the pre-Bill C-17 years. If γ_{2j} and γ_{3j} were significantly different from 0, this would indicate the level and trend (i.e., the pattern) in suicide changed in the post-1990 years subsequent to Bill C-17's introduction. Since

firearms and hanging accounted for more than 80% of total suicide deaths, these two methods were the foci of the models.

RESULTS

The average annual suicide rate in Canadians aged 15-19 from 1979-1999 was 12.18/100,000 ranging from 10.9 in 1985 to 13.20 in 1995 (Figure 1). The

most commonly used methods to complete suicide for youth between 15-19 years of age from 1979-1999 (making up over 90% of total suicide deaths) are, in order from highest to lowest incidence, firearms, hanging, poisoning by gas, and overdoses.

The annual rate of death by firearms decreased since 1979 (Figure 1). The average rate from 1979-1999 was 4.89. The annual rate dropped from a high of 7/100,000 in 1983 to 3/100,000 in 1999. The annual rates changed most dramatically from the early 1990s and on. The percentage of total deaths by firearms decreased from 55% in 1979 to 25% in 1999.

A similar but less drastic decline can be seen in overdose-attributed deaths (Figure 1). The annual rate of suicides completed by overdose dropped from a high of 1.2/100,000 (10% of total suicides) in 1979 to 0.2/100,000 (2% of total suicides) in 1999. In contrast to death rates by firearms and overdose, annual death rates by hanging increased over the last 20 years. The percentage of total deaths by hanging grew from 21% (2.6/100,000) in 1979 to 64% (7.8/100,000) in 1999 of the total annual number of suicides. Changes in the annual death rates by hanging was also most dramatic in the early 1990s. Annual death rates by poisoning by gas have remained consistent over the last 20 years, making up about 8% (1/100,000) of the total annual number of suicide deaths in this age group. Table I shows the number of suicides for Canadian adolescents aged 15-19 by method and annual census data for 1979 and 1999.

In years subsequent to Bill C-17's introduction, annual rates of suicide by firearms decreased; however, there was an increase in the annual rate of suicide by hanging (Table I). This is illustrated in Figure 2 which contains the predicted rates based on Models 1 and 2 (Table II) as well as the observed rates of suicide by firearms. The pre-1991 rates estimated by Models 1 and 2 are identical through 1990. In addition, they closely follow the observed patterns in these years. In 1991, the trends endorsed by Models 1 and 2 diverge. Based on the pre-C-17 rates of suicide by firearms, Model 1 forecasts lower rates in the years immediately following the Bill than were actually observed. However, from 1994 onward, the trend changes; there were

actually lower rates of firearm-related suicides than would have been expected based on the pre-Bill C-17 experience.

In Figure 3, the opposite was true for suicide by hanging. In 1991, there seems to be a divergence between the actual rates and those that would have been forecast based on pre-Bill C-17 experience. At this point, the rates increase faster than pre-Bill C-17 trends would suggest.

DISCUSSION

The study findings suggest a substantial decrease in firearm-related suicides among youth but no significant decrease in this age group's overall suicide rate. The decrease in firearm-related suicides may be linked to changes in legislations in 1991. Bill C-17 strengthened and clarified firearm safe storage procedures and enacted mandatory safety courses for all gun owners. These results support previous findings that more restrictive firearms regulations may be effective in decreasing the number of firearm-related suicides in this younger age group.

At the same time, experts have argued that method restriction, such as changes to the firearms act, is not a viable option for reducing overall suicides since there are always other available methods (i.e., jumping, hanging).³ This opinion is further supported by previous research suggesting switching may occur and method restriction may not actually reduce the total number of suicide deaths.³ The trends observed in this study support this argument.^{13,14} Although the findings suggest method restriction on firearms reduced the number of firearm-related suicide deaths, it did not change overall suicide death rates.^{13,14} Although there have been previous case studies in this area, this is the first Canadian population-based study examining this relationship in youth and it supports findings in the adult literature.¹⁶ These trends also are similar to mortality patterns observed in cardiovascular research. In particular, in cholesterol reduction trials, cardiovascular mortality was reduced with the lowering of cholesterol levels but all-cause mortality did not change.²¹ That is, reducing cholesterol levels did not prevent total deaths. Instead, people died from other causes. Similarly, in the case of suicide, adolescents appeared

TABLE II

Regression Results: Models 1 and 2

	Model 1		Model 2	
	Coefficient	95% CI	Coefficient	95% CI
Firearms				
Year	-0.116	(-0.199, -0.324)	-0.113	(-0.192, -0.0339)
Year t - 1	-0.502	(-1.350, 0.347)	-0.358	(-0.878, 0.162)
Bill C-17			589.010	(299.612, 878.587)
Bill C-17 * Year			-0.296	(-0.441, -0.150)
Constant	4.936	(4.189, 5.683)	4.963	(4.289, 5.636)
χ^2	7.74	(df = 2, p<0.0209)	277.08	(df = 4, p<0.0001)
Hanging				
Year	0.165	(0.0889, 0.241)	0.164	(0.102, 0.225)
Year t - 1	-0.224	(-0.903, 0.455)	-0.330	(-0.872, 0.212)
Bill C-17			-383.130	(-693.682, -72.579)
Bill C-17 * Year			0.193	(0.368, 0.348)
Constant	4.717	(4.285, 5.148)	4.709	(4.357, 5.062)
χ^2	29.99	(df = 2, p<0.001)	405.28	(df = 4, p<0.0001)

Figure 3. Annual suicide rates due to hanging, 1979-1999

Source of data: Statistics Canada

to have substituted methods. However, although total suicide rates did not change, there may be other benefits from the legislation including reductions in accidental firearms death that should be investigated.

Finally, time series analyses were used because it has been suggested that traditional methods of examining trends in suicide rates are inadequate and multivariate analyses should be considered.¹⁰ Therefore, although the findings suggest an association between changes in the firearms regulations and method of youth suicide, this is a preliminary study. One major limitation of this study is that other factors that may be correlated with changes in the method of suicide were not examined such as changes in employment rates, rates by gender and income levels.² Given that the analyses were based on the pre-1991 trends and only assumed that these trends would continue, factors besides the introduction of C-17 may have contributed to the changes in methods. However, by using time series analyses, some of these influ-

ences are controlled for. Given the known gender, age and regional differences in choice of suicide method, this general analysis of national data may not have detected the impact of the legislation on specific gender, age groups and regions. Therefore, further research should examine the influence of these factors on the rates of suicide by method.

CONCLUSIONS

Amendments to the firearms act in the early 1990s may be associated with changes in the type of method used by youth to complete suicide, but the lack of change in the overall rates of suicides, likely due to switching, leads one to question the possible benefit of more restrictive firearms regulations as the solution to this major public health issue. However, there are other possible outcomes, such as decreases in accidental injuries, which are also important considerations when evaluating the benefits of such legislations.

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RÉSUMÉ

Contexte : Malgré de nombreuses initiatives de prévention, le suicide demeure la deuxième cause de mortalité chez les jeunes de 10 à 19 ans. L'une des principales stratégies de prévention est la mise en place d'une réglementation restreignant l'usage des armes à feu. Par exemple, le projet de loi C 17 adopté en 1991 favorise le maniement et l'entreposage sécuritaires des armes à feu en obligeant tous les nouveaux propriétaires d'armes à feu à suivre un cours de formation à la sécurité. Un examen des taux de suicide après l'adoption du projet de loi C 17 pouvait nous éclairer sur les avantages possibles de tels règlements pour résoudre ce grave problème de santé publique. C'est pourquoi nous avons examiné les tendances du suicide chez les jeunes entre 1979 et 1999 et leurs liens avec les modifications apportées à la Loi sur les armes à feu en 1991.

Méthode : Nous avons calculé les taux de suicide selon l'âge chez les jeunes de 15 à 19 ans et les taux selon la méthode de suicide à partir des données de Statistique Canada pour la période 1979 à 1999. Nous avons ensuite procédé à une analyse de série chronologique.

Résultats : Bien que les taux globaux n'aient pas changé entre 1979 et 1999 chez les jeunes de 15 à 19 ans, les méthodes de suicide utilisées ont beaucoup évolué. Plus précisément, les taux de suicide par arme à feu ont chuté, passant de 60 % à 22 %, tandis que les suicides par pendaison ou par suffocation ont augmenté dans une proportion de 20 à 60 % dans ce groupe d'âge durant la période de référence.

Conclusion : Ces résultats donnent à penser qu'il pourrait exister un lien entre les modifications apportées à la Loi sur les armes à feu en 1991 et les méthodes utilisées par les jeunes pour se suicider. Cependant, les taux globaux de suicide n'ont pas changé durant la période. Ces tendances soulignent le besoin d'étoffer les mesures de prévention pour qu'elles mettent l'accent sur les causes sous-jacentes du suicide plutôt que sur les méthodes utilisées.

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