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Research

The effect of legislation on firearm-related deaths in Canada: a systematic review

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Abstract

Background: Firearm misuse is common in cases of homicide, suicide and unintentional injury; this is a major public health issue, with societal and economic costs extending beyond the immediate injury or loss of life. We sought to review the evidence on the effectiveness of Canadian legislation in reducing deaths caused by firearms.

Methods: Five databases (PubMed, Embase, CINAHL, Web of Science and Scopus) were searched from inception to May 2021 for studies evaluating the effect of Canadian gun control laws Bill C-51 (1977), Bill C-17 (1991) and Bill C-68 (1995) on rates of firearm-related death. Two reviewers performed article screening independently and in duplicate. We synthesized data using descriptive statistics. The primary outcome of interest was firearm-related mortality rates. Because of study heterogeneity, a meta-analysis was not performed.

Results: Overall, 1479 articles were screened, and 18 studies were included. Ten studies examined the effect on homicides, of which 5 reported a reduction during the postlegislation period; 1 study reported evidence of substitution from firearms to other methods of homicide among people aged 15–24 years. Eleven studies evaluated the effect on suicides, with 9 finding a reduction in suicide rates. Eight of these studies reported evidence of substitution from firearms to other suicide methods. Two studies investigated accidental deaths; neither reported any benefit after legislation.

Interpretation: Evidence supporting the effectiveness of Canadian firearms legislation in the reduction of homicide and accidental death rates is inconclusive; a decrease in firearm-related suicide rates was observed by most studies, but evidence of method substitution was also identified. Re-evaluation of existing laws may be beneficial to build an improved and effective evidence-based national framework for prevention of gun violence. **PROSPERO registration:** CRD42020192486

Various legislative approaches have been implemented to regulate firearm access and use.[1] In Canada, rates of suicide by firearm remain relatively unchanged since 2007,[2] yet firearm-related homicide rates increased in recent years, peaking in 2020.[3] Misuse of firearms is often observed in cases of homicide and suicide, and to a lesser degree in cases of unintentional injury, with suicides (75%) and homicides (20%) accounting for most firearm deaths.[4] The federal government introduced the basis for firearm control in 1968 and passed 3 major pieces of legislation in 1977 (Bill C-51), 1991 (Bill C-17) and 1995 (Bill C-68).[5] Bill C-51 introduced mandatory record-keeping by arms dealers and made these records available to police for inspection, enacted a ban on fully automatic firearms, and required Firearm Acquisition Certificates (FACs) for rifles and shotguns. Bill C-17 strengthened the process for obtaining an FAC, and Bill C-68 created the *Firearms Act*, which removed administrative and regulatory aspects of the licensing and registration system from the *Criminal Code*, replacing the FAC system with 2 new licensing systems requiring expanded applicant screening.

No major reform of firearms control has occurred in Canada since 1995; however, some notable policy changes include abolishment of the long-gun registry in 2012 and the ban of 1500 assault-style weapons in the wake of the 2020 Portapique shootings in Nova Scotia.[6,7] The effectiveness of Canadian firearms legislation has been the subject of extensive debate in the media and literature. Previous reviews report limited evidence and suggest that knowledge gaps prevent definitive conclusions from being drawn.[1,8–11]

Gun violence causes irreparable harm to communities,[12] and physicians are uniquely positioned to witness the suffering experienced by those injured and their families. Thus, clinicians can

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play a critical role in advocating for effective preventive measures, including improved governmental regulations. Our primary objective was to review the evidence regarding the effect of Canadian firearms legislation on rates of firearm-related death. As a secondary objective, we sought to determine the effect of firearm legislation on rates of nonfatal firearm injuries.

Methods

This systematic review was conducted using the *Cochrane Handbook for Systematic Reviews of Interventions* and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[13,14] The study protocol was prospectively registered with PROSPERO (PROSPERO 2020: CRD42020192486). Since registration, the Newcastle–Ottawa Scale was added to the quality assessment.[15]

Three major pieces of legislation forming the framework of the Canadian firearms control schema are Bill C-51 (1977), Bill C-17 (1991) and Bill C-68 (1995) (Table 1). Together, these bills were intended to strengthen governmental regulation over all firearm and ammunition control categories: usage, sale, ownership, transport, storage and penalties. Importantly, not all provisions of each bill were implemented immediately; in some cases, rules came into effect years after legislation was passed.

Data sources and search strategy

A systematic search of PubMed (1946 onward), Embase (1966 onward), CINAHL (1963 onward), Web of Science (1900 onward) and Scopus (1788 onward) was conducted in May 2020 and updated in May 2021. PubMed was the primary bibliographic database used. We used Medical Subject Headings including "Firearms," "Policy," "Wounds and Injuries," "Mortality" and "Canada," along with variations of keywords including "gun," "firearm," "legislation," "law," "injury" and "death," and terms for provinces/territories and major cities in Canada. The search strategy was developed in collaboration with an experienced health sciences librarian and translated from PubMed to other databases (Appendix 1, available at www.cmajopen.ca/content/10/2/E500/suppl/DC1). Proximity and truncation search techniques were applied. No limitations were placed on date or publication language.

Eligibility criteria

Criteria for inclusion were as follows: design — peer-reviewed studies with any design; population — all inhabitants of Canada; exposure — enactment of 1 or more pieces of Canadian firearms legislation (Bill C-51, Bill C-17 and/or Bill C-68); and outcome — rates of firearm-related death or injury. We excluded studies that were not peer-reviewed or if it was not possible to extract data specifically on firearm-related deaths.

Table 1: Major pieces of firearms legislation in Canada[5]

Bill	Description	Relevant dates
C-51	• Mandatory FACs required criminal record checks of all firearm purchasers and record-keeping systems • New definitions for prohibited and restricted firearms • Mandatory minimum sentences (1–14 yr consecutive sentence for use of firearm to commit indictable offence) and increased penalties for firearm homicides • Granted search and seizure powers	Aug. 5, 1977: Bill received royal assent Jan. 1, 1978: All provisions came into effect except requirements for FACs Jan. 1, 1979: Requirements for FACs came into effect

C-17	• Changes to the FAC system:
	  • Expanded application form and screening check
	  • Required psychological questionnaire, photo identification, 2 references, spousal endorsement, 28-day waiting period, safety training
	• New definitions for prohibited and restricted weapons
	• New prohibitions and restrictions on many military and high-firepower guns and ammunition
	• New *Criminal Code* offences and increased penalties for firearm-related crimes
	• Clearly defined regulations for safe storage, handling and transportation of firearms
		Dec. 5, 1991: Bill received royal assent
		1992–1994: All provisions came into effect
		Jan. 1, 1994: Requirements for FAC applicant safety training and psychological questionnaire completion came into effect

C-68	• Creation of the *Firearms Act*, to take administrative and regulatory aspects of the licensing and registration system out of the *Criminal Code* • FAC system replaced with 2 new licensing systems (POLs and PALs), which required expanded screening of applicants • Registration of all firearms, including shotguns and rifles • Increased penalties for certain serious crimes using firearms • Authorization requirement for transportation of restricted or prohibited firearms	Dec. 5, 1995: Bill received royal assent January 1996: Provisions requiring increased penalties for serious firearms crimes came into effect Dec. 1, 1998: The *Firearms Act* came into effect March 1998: Government passed the *Firearms Act* regulations Jan. 1, 2001: Requirements for POLs/PALs came into effect Jan. 1, 2003: Requirements for registration of all firearms including nonrestricted rifles and shotguns came into effect

Note: FAC = Firearm Acquisition Certificate, PAL = Possession and Acquisition Licence, POL = Possession Only Licence.

Article screening and data extraction

Article deduplication, screening and selection was performed using Covidence software (Veritas Health Innovation). Two reviewers (N.B. and M.K.) independently screened articles in duplicate by title and abstract. The full text of potentially relevant articles was screened by the same 2 reviewers. Any disagreements were resolved by consensus; if consensus was unattainable, a third reviewer (M.E.) was consulted. Articles published in a language other than English were translated using Google Translate. References of articles meeting inclusion criteria were searched for relevant studies. Interrater agreement for article screening was calculated using nonweighted Cohen's κ;[16] agreement interpretation was based on established categories.

Data were abstracted by a single reviewer (N.B.) using a standardized data extraction form. We collected data regarding the effect of legislation on firearm-related injuries or deaths, and any evidence of method substitution (i.e., increased death rate from nonfirearm methods after legislation). Data from multiple reports of the same study were collated in accordance with recommendations from Cochrane.[14]

Quality assessment

Two reviewers (N.B. and M.K.) independently assessed risk of bias for each study. Using the Newcastle–Ottawa Scale for risk of bias, overall scores of 0–3 were considered low quality, scores of 4–6 were considered moderate quality and scores of 7–9 were considered high quality.[15]

Study quality was summarized using 4 metrics adapted from the *Guide to Community Preventive Services*[17]: Were appropriate data source(s) and outcome measure(s) used for the study question?; Was the time frame studied adequate (i.e., sufficient surveillance before/after enactment)?; Were appropriate statistical tests used?; and Was the study design suitable? A score of 3 (good quality) was assigned to studies that achieved all 4 metrics. Studies that achieved 2 to 3 metrics, including appropriate statistical testing, were assigned a score of 2 (fair quality). For studies that achieved 1 metric, or 2 to 3 metrics without appropriate statistical testing, a score of 1 (poor quality) was assigned.

Data analysis

We used simple descriptive statistics to report the results. Studies were grouped by primary outcome: firearm mortality rates from homicide, suicide and accidental death. Studies were also grouped by secondary outcome (rate of nonfatal firearm injuries), sex and age (females, males, younger males [15–34 yr], older males [≥ 60 yr]). We did not perform a meta-analysis because of considerable heterogeneity in effect measures and because several studies included the same data, to varying degrees. A narrative synthesis was conducted.[14]

We categorized studies investigating the effect of legislation on firearm-related homicide, suicide or accidental death as the legislation being "beneficial" (statistically significant reduction in death rate), "harmful" (statistically significant increase in death rate), "ineffectual" (no statistically significant effect on death rate), "inconclusive" (not possible to determine effect from available data) or "not assessed" for the entire population and relevant subgroups. Two reviewers (N.B. and M.K.) independently assigned levels for the overall effect of legislation reported by each study. A third reviewer (M.E.) was consulted to resolve any disagreements.

Ethics approval

No human participants were involved; thus, ethics approval was not required.

Results

Overall, 2361 studies were identified in the search, from which 882 duplicates were removed (Figure 1). Screening by 2 independent reviewers identified 90 articles for full-text review, of which 21 were included (κ = 0.56, moderate agreement). An additional 2 articles were identified from references of primary studies and literature reviews. Six articles meeting inclusion criteria were determined to be multiple reports of the same study as they were performed by the same authors and evaluated the same legislation (Bill C-51), population and time period.[18–23] Outcomes evaluated in these 6 reports included homicide[19–22] and suicide.[18,20,21,23] For the purpose of this review, data from these reports were collated as a single study (referred to as reference 23) in accordance with recommendations from Cochrane.[14] Thus, a total of 18 studies were included in the analysis.

Study characteristics

Although all studies were set in Canada,[23–40] 2 also included data from the United States (Table 2).[25,26] Ten studies investigated the effect of Bill C-51,[23–30,36,37] 8 examined Bill C-17[31–37,40] and 5 examined Bill C-68;[36–40] 3 studies evaluated more than 1 piece of legislation.[36,37,40] Most studies examined the effect of legislation on suicide (n = 11)[23,25,26,28,29,31–35,40] and/or homicide (n = 10);[23–25,27,31,36–40] 2 studies investigated accidental deaths.[25,30] Regarding our secondary outcome looking at the effect of legislation on nonfatal firearm injuries, 0 studies were identified in the search.

All studies used a retrospective time-series design and most were conducted using population data from Statistics Canada (n = 14).[23–25,27–31,33,36–40] Four studies were limited to Quebec,[32,34,35,37] 2 used data from Ontario[26,28] and 1 included all provinces except Newfoundland and Labrador;[27] the remaining studies included data from all provinces and territories. Two studies analyzed the effect of legislation by province on rates of suicide[29] and homicide;[36] neither reported substantial variation in the effect of legislation across provinces. Most studies included all ages and both sexes (n = 15);[23–25,27–32,34,36–40] 2 studies focused on males,[26,35] and another was limited to youths aged 15–19 years.[33] Five studies used models adjusted for demographic factors (e.g., income, divorce);[23,27,36,37,40] no study adjusted for history of mental health issues. All included studies addressed the same legislation either over different time frames or across different (or overlapping) geographical regions;[23–40] thus, large parts of the same data were analyzed using different methods, and these results should not be considered independent.

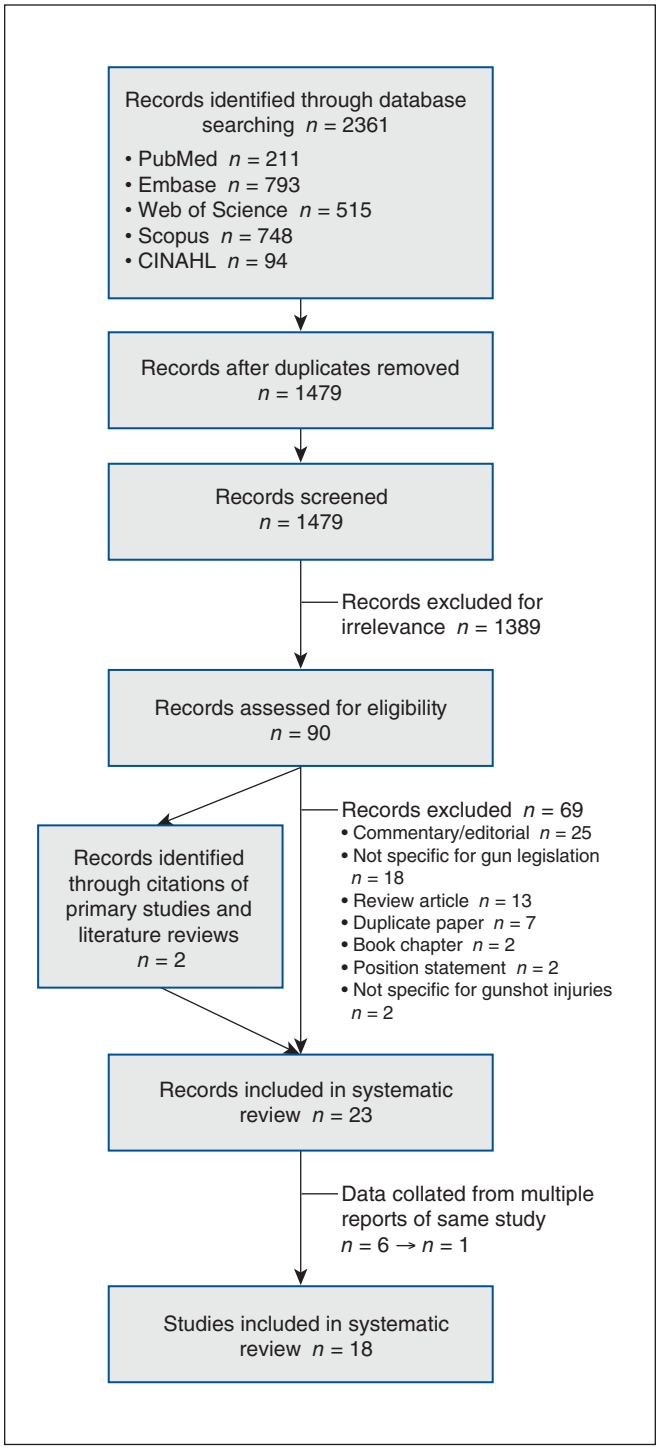

Figure 1: Flow diagram of studies selected for inclusion in the review.

Effect on homicide

Among 10 studies evaluating homicides, 5 observed a beneficial effect on homicide rates during postlegislation periods (Table 3; Appendix 2, available at www.cmajopen.ca/content/10/2/E500/suppl/DC1).[23,24,31,36,38]

Regarding Bill C-51, 6 studies investigated its effect on homicide, of which 3 observed a beneficial effect;[23,24,36] 1 of these reported increased use of nonfirearm methods for homicide among people aged 15–24 years.[23] Of 4 studies assessing the effect of Bill C-17,[31,36,37,40] 1 reported a beneficial effect;[31] this study also found the raw homicide rate by all other methods decreased after legislation. Five studies examined the effect of Bill C-68;[36–40] 2 of these reported a beneficial effect after legislation (neither study reported evidence of method substitution).[36,38] Reduction in firearm homicide was most noticeable in homicides committed with long guns (shotguns, hunting rifles).[36] The authors attributed the effectiveness of the law to reduced access and availability of firearms rather than the severity of sentences provided in the legislation.[36] Differences in study design precluded us from quantifying changes in mortality rates after legislation implementation.

Effect on suicide

Eleven studies evaluated the effect of legislation on firearm suicides, of which 9 reported a beneficial effect (Table 4; Appendix 3, available at www.cmajopen.ca/content/10/2/E500/suppl/DC1).[23,25,28,29,31–33,35,40] Regarding Bill C-51, 5 studies investigated its effect, of which 4 observed a benefit after legislation.[23,26,28,29] Two of these studies reported evidence of method substitution. Rich and colleagues observed an increase in the proportion of male suicides by leaping,[26] and Leenaars and colleagues found increasing trends in suicide by nonfirearm methods (albeit a nonsignificant increase in multivariate analysis).[23] The effect of Bill C-17 was examined in 6 studies;[31–33,35,40] 5 of these studies reported a benefit after legislation. These 5 studies all reported evidence of method substitution from firearms to other methods; 3 studies specifically found increased rates of suicide by hanging.[33,35,40] Caron and colleagues observed a decrease in rates of firearm suicide; however, the trend was not significant when compared with the trend before Bill C-17.[34] Finally, Langmann evaluated the effect of Bill C-68 on suicide and found no benefit.[40] This study observed an increase in firearm suicides compared with suicide by hanging among men.[40] Sensitivity analysis supported a substitution effect from suicide by firearm to hanging and not a switch to hanging from other suicide methods.[40]

Effect on accidental death

Leenaars and Lester reported that passage of Bill C-51 had a beneficial effect on the accidental death rate from firearms for males (decreased from 9.89/million/yr to 4.82/million/yr, $p < 0.001$) and females (decreased from 0.98/million/yr to 0.52/million/yr, $p < 0.01$) of all ages;[30] however, they noted that the mortality rate for males began to decline 2 years before implementation. After adjusting for divorce rate and unemployment rate, the impact of Bill C-51 on the accidental death rate from firearms was negative but did not reach statistical significance.[30] In addition, Mundt reported that Bill C-51 had no effect on the accidental death rate for all ages and both sexes.[25]

Quality assessment

Using the Newcastle–Ottawa Scale for risk of bias, 6 studies received a score of 5 (moderate quality),[25,26,28,32,33,35] 4 studies received a score of 6 (moderate quality),[24,31,34,39] 5 studies received

Table 2: Characteristics of included studies

Study (year)	Location	Population	Period	Law(s)	Outcomes	Statistical methods
Sproule and Kennett (1988)[24]	Canada	All	1972–1982	Bill C-51	Homicide	Analysis of variance
Mundt (1990)[25]	Canada; United States	All	1971–1988	Bill C-51	Homicide, suicide, accidental death	Visual inspection
Rich et al. (1990)[26]	Toronto; San Diego	Males	1973–1983	Bill C-51	Suicide	*t* tests, time series analysis
Mauser and Holmes (1992)[27]	Canada (excluding Newfoundland and Labrador, and 3 territories)	All	1968–1988	Bill C-51	Homicide	Pooled cross-section time series model
Leenaars et al.* (1993,1994, 1996,1997, 2001, 2003)[18–23]	Canada	All	1969–1985	Bill C-51	Homicide, suicide	*t* tests, simple linear regression, multiple regression, interrupted time series
Carrington and Moyer (1994a)[28]	Ontario	All	1965–1989	Bill C-51	Suicide	*t* tests, time series analysis
Carrington and Moyer (1994b)[29]	Canada	All	1965–1989	Bill C-51	Suicide	Interrupted time series
Leenaars and Lester (1997)[30]	Canada	All	1969–1985	Bill C-51	Accidental death	*t* tests, simple linear regression, multiple regression
Bridges (2004)[31]	Canada	All	1984–1998	Bill C-17	Homicide, suicide	*t* tests, simple linear regression
Caron (2004)[32]	Abitibi-Témiscamingue, Que.	All	1986–1996	Bill C-17	Suicide	χ^2 and likelihood ratio tests
Cheung and Dewa (2005)[33]	Canada	Age 15–19 years	1979–1999	Bill C-17	Suicide	Time series models
Caron et al. (2008)[34]	Quebec	All	1987–2001	Bill C-17	Suicide	Linear regression, interrupted time series analysis, Pearson correlation coefficient analyses, multivariate analysis
Gagne et al. (2010)[35]	Quebec	Males	1981–2006	Bill C-17	Suicide	Joinpoint analysis, Poisson regression analysis
Blais et al. (2011)[36]	Canada	All	1974–2004	Bill C-51, Bill C-17, Bill C-68	Homicide	Multiple time series analysis
Langmann (2012)[37]	Canada	All	1974–2008	Bill C-51, Bill C-17, Bill C-68	Homicide	Interrupted time series Poisson regression, ARIMA, Joinpoint analysis
Linteau and Blais (2013)[39]	Quebec	All	1974–2006	Bill C-68	Homicide	Extreme bounds analysis
McPhedran and Mauser (2013)[38]	Canada	All	1974–2009	Bill C-68	Homicide, domestic homicide	ARIMA, Zivot–Andrews structural breakpoint test
Langmann (2020)[40]	Canada	All	1981–2016	Bill C-17, Bill C-68	Homicide, suicide	Difference in differences analysis, negative binomial regression

Note: ARIMA = autoregressive integrated moving average.
*Data from multiple reports investigating the same legislation, population and outcome were collated.

Table 3: Evidence for the effect of legislation on firearm homicide by subgroups

Bill	Study	Entire population	Males			Females
			All	Younger*	Older†	
Bill C-51	Sproule and Kennett (1988)[24]	Beneficial	Not assessed	Not assessed	Not assessed	Not assessed
	Mundt (1990)[25]	Ineffectual	Not assessed	Not assessed	Not assessed	Not assessed
	Mauser and Holmes (1992)[27]	Ineffectual	Not assessed	Not assessed	Not assessed	Not assessed
	Leenaars and Lester (1994, 1996,1997, 2001)[19–22]	Beneficial	Beneficial	Beneficial	Beneficial‡	Beneficial
	Blais et al. (2011)[36]	Beneficial	Not assessed	Not assessed	Not assessed	Not assessed
	Langmann (2012)[37]	Ineffectual	Not assessed	Not assessed	Not assessed	Not assessed
Bill C-17	Bridges (2004)[31]	Beneficial	Not assessed	Not assessed	Not assessed	Not assessed
	Blais et al. (2011)[36]	Ineffectual	Not assessed	Not assessed	Not assessed	Not assessed
	Langmann (2012)[37]	Ineffectual	Not assessed	Not assessed	Not assessed	Not assessed
	Langmann (2020)[40]	Not assessed	Ineffectual	Ineffectual§	Ineffectual	Ineffectual
Bill C-68	Blais et al. (2011)[36]	Beneficial	Not assessed	Not assessed	Not assessed	Not assessed
	Langmann (2012)[37]	Ineffectual	Not assessed	Not assessed	Not assessed	Not assessed
	Linteau and Blais (2013)[39]	Beneficial	Not assessed	Not assessed	Not assessed	Not assessed
	McPhedran and Mauser (2013)[38]	Not assessed	Ineffectual	Not assessed	Not assessed	Ineffectual
	Langmann (2020)[40]	Not assessed	Ineffectual	Ineffectual§	Ineffectual	Ineffectual

*Age 15–34 years.
†Age ≥ 60 years.
‡Assessed older men aged ≥ 65 years.
§Assessed younger men aged 15–29 years.

a score of 7 (high quality)[23,27,29,30,38] and 3 studies received a score of 8 (high quality) (Appendix 4, available at www.cmajopen.ca/content/10/2/E500/suppl/DC1).[36,37,40] Using criteria from the *Guide to Community Preventive Services*, a score of 3 (good quality) was assigned to 9 studies,[23,27,34–40] and a score of 1 (poor quality) was assigned to 9 studies (Appendix 5, available at www.cmajopen.ca/content/10/2/E500/suppl/DC1).[24–26,28–33]

One study did not use accurate dates of firearms legislation implementation for the postlegislation analysis period.[24] Although all studies had appropriate data sources and outcome measures, time frames and design suitability, there was variation in statistical analyses. Most studies published before 2008 had analyses with weak statistical power, failed to measure immediate or gradual effects of the law, or failed to control for societal and economic variables.[24–26,28–33]

Interpretation

Although our review found some evidence of a decrease in homicide and accidental death rates after introduction of firearms legislation, a lack of high-quality literature makes it difficult to determine the effectiveness of these laws. Regarding suicides, most studies reported a decrease in firearm-related suicide rates, but there was evidence of method substitution identified (predominantly in males), indicating that individuals may have turned to other methods, such as hanging. Few studies controlled for important confounders (e.g., social determinants of health, mental health) known to be associated with gun violence.[41,42] Owing to heterogeneity in methodologies, pooling was judged to be inappropriate, and a narrative synthesis was conducted.

Our results are consistent with those of similar reviews published in the last 15 years. Santaella-Tenorio and colleagues found that the effect of Canadian firearms legislation on homicide rates varied and that, although rates of firearm suicide were reduced, method substitution likely occurred, as overall suicide rates did not change.[1] Cohen and Burk reported that legislation likely reduced some portion of the violent crime rate, given that it restricts easy access to firearms, and that rather than having an effect on reducing suicides overall, the introduction of stricter Canadian firearms legislation forced people to find alternative means to die by suicide.[8] Ferguson and Koziarski found mixed results in the literature, with some studies reporting significant changes in homicide and suicide rates after legislation, some observing no change in rates, and others contending that firearms legislation produced inverse effects.[9] These reviews concluded that substantial knowledge gaps and study design flaws warrant further investigation on this topic.

Our literature search did not identify any studies that reported on our secondary outcome of the effect of Canadian firearms legislation on nonfatal firearm injuries. Data on nonfatal firearm injuries are available via sources such as the Canadian Institute for Health Information and provincial trauma registries,

Table 4: Evidence for the effect of legislation on firearm suicide by subgroups

Bill	Study	Entire population	Males			Females
			All	Younger*	Older†	
Bill C-51	Mundt (1990)[25]	Ineffectual	Not assessed	Not assessed	Not assessed	Not assessed
	Rich et al. (1990)[26]	Not assessed	Beneficial	Not assessed	Not assessed	Not assessed
	Carrington and Moyer (1994a)[28]	Beneficial	Not assessed	Not assessed	Not assessed	Not assessed
	Carrington and Moyer (1994b)[29]	Beneficial	Not assessed	Beneficial‡	Ineffectual	Not assessed
	Leenaars et al. (1993, 1996,1997, 2003)[18,20,21,23]	Beneficial	Beneficial	Beneficial	Beneficial§	Beneficial
Bill C-17	Bridges (2004)[31]	Beneficial	Not assessed	Not assessed	Not assessed	Not assessed
	Caron (2004)[32]	Beneficial	Beneficial	Not assessed	Not assessed	Beneficial
	Cheung and Dewa (2005)[33]	Not assessed	Not assessed	Beneficial¶	Not assessed	Beneficial¶
	Caron and colleagues (2008)[34]	Ineffectual	Ineffectual	Not assessed	Not assessed	Ineffectual
	Gagné and colleagues (2010)[35]	Not assessed	Beneficial	Beneficial	Ineffectual§	Not assessed
	Langmann (2020)[40]	Not assessed	Ineffectual	Ineffectual‡	Beneficial	Beneficial
Bill C-68	Langmann (2020)[40]	Not assessed	Ineffectual	Harmful‡	Ineffectual	Ineffectual

*Age 15–34 years.
†Age ≥ 60 years.
‡Assessed younger men aged 15–29 years.
§Assessed older men aged ≥ 65 years.
¶Assessed males and females aged 15–19 years.

and should be analyzed for the effect of firearms legislation. There is also a lack of published research on illegal firearms in Canada. The seriousness of the illicit firearms trade in Canada is demonstrated by the fact that all firearms used in the 2020 Nova Scotia mass shooting were obtained illegally.[43]

Limitations

We urge caution in interpreting the results of this review owing to methodological limitations and considerable variation among included studies. Most studies did not account for potential confounding variables in their analyses. Since most studies used national data, the extent of provincial variation in application of the firearms laws is unclear; although the federal government designed the firearms control scheme, it is the provincial and territorial governments that are responsible for applying and administering the provisions of the *Criminal Code*.

For articles in French, we used Google Translate rather than a formal translator. Data extraction was performed by a single reviewer. Although our search involved snowballing, we did not hand-search select journals cover to cover; thus, it is possible that our search did not capture relevant articles that were missed during indexing. Finally, owing to Canada's size and population distribution, and the federal origins of firearms legislation, the results of studies that used national data disproportionately reflect the situation in the country's most populous provinces.

Conclusion

Evidence supporting the effectiveness of Canadian firearms legislation in reducing homicide and accidental death rates is inconclusive. Although a decrease in rates of firearm-related suicide was observed, evidence of method substitution was also identified. Re-evaluation of existing laws may be beneficial to build an improved and effective evidence-based national framework for prevention of gun violence.

References

1. Santaella-Tenorio J, Cerda M, Villaveces A, et al. What do we know about the association between firearm legislation and firearm-related injuries? *Epidemiol Rev* 2016;38:140-57.
2. Liu L, Capaldi CA, Orpana HM, et al. Changes over time in means of suicide in Canada: an analysis of mortality data from 1981 to 2018. *CMAJ* 2021;193:E331-8.
3. *Number, rate and percentage changes in rates of homicide victims* [Table 35-10-0068-01]. Ottawa: Statistics Canada; 2021. Available: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3510006801 (accessed 2022 May 11).
4. *Deaths, by cause, Chapter XX: External causes of morbidity and mortality (V01 to Y89)* [Table 13-10-0156-01]. Ottawa: Statistics Canada; 2020. Available: https://doi.org/10.25318/1310015601-eng (accessed 2020 July 14).
5. History of firearms in Canada. Ottawa: Royal Canadian Mounted Police; 2020. Available: https://www.rcmp-grc.gc.ca/en/history-firearms-canada (accessed 2021 Oct 4).
6. Firearms legislation for safer communities. Ottawa: Public Safety Canada; modified 2021 Dec. 7. Available: https://www.publicsafety.gc.ca/cnt/cntrng-crm/frrms/index-en.aspx (accessed 2021 Oct. 4).
7. Abolishing the long-gun registry: proposed reforms to the *Firearms Act* and *Criminal Code*. Ottawa: Public Safety Canada; modified 2015 Nov. 20. Available: https://www.publicsafety.gc.ca/cnt/nws/nws-rlss/2011/20111025-2-en.aspx (accessed 2021 Oct. 4).

8. Cohen IM, Burk K. A literature review on illegal firearms. Abbotsford (BC): University of the Fraser Valley; 2016. Available: https://cjr.ufv.ca/wp-content/uploads/2018/03/A-Literature-Review-on-Illegal-Firearms.pdf (accessed 2021 Aug. 16).
9. Ferguson L, Koziarski J. What do we know about firearms in Canada? A systematic scoping review. *Sociology Publications* 2019;50:1-39.
10. Lee LK, Fleegler EW, Farrell C, et al. Firearm laws and firearm homicides: a systematic review. *JAMA Intern Med* 2017;177:106-19.
11. Hahn RA, Bilukha O, Crosby A, et al.; Task Force on Community Preventive Services. Firearms laws and the reduction of violence: a systematic review. *Am J Prev Med* 2005;28(Suppl 1):40-71.
12. Austin K, Lane M. The prevention of firearm injuries in Canadian youth. *Paediatr Child Health* 2018;23:35-42.
13. Moher D, Liberati A, Tetzlaff J, et al. PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA Statement. *Open Med* 2009;3:e123-30.
14. Li T, Higgins JPT, Deeks JJ, editors. Chapter 5: Collecting data. In: Higgins JPT, Thomas J, Chandler J, et al., editors. *Cochrane handbook for systematic reviews of interventions version 6.2*. Cochrane; 2021. Available: www.training.cochrane.org/handbook (accessed 2021 June 9).
15. Wells GA, Shea B, O'Connell D, et al. The Newcastle–Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analysis. Ottawa: The Ottawa Hospital; 2014. Available: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp (accessed 2021 July 28).
16. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159-74.
17. Briss PA, Zaza S, Pappaioanou M, et al. Developing an evidence-based guide to community preventive services — methods. The task force on community Preventive Services. *Am J Prev Med* 2000;18(Suppl):35-43.
18. Lester D, Leenaars A. Suicide rates in Canada before and after tightening firearm control laws. *Psychol Rep* 1993;72:787-90.
19. Leenaars AA, Lester D. Effects of gun control on homicide in Canada. *Psychol Rep* 1994;75:81-2.
20. Leenaars A, Lester D. Gender and the impact of gun control on suicide and homicide. *Arch Suicide Res* 1996;2:223-34.
21. Leenaars A, Lester D. The impact of gun control on suicide and homicide across the life span. *Can J Behav Sci* 1997;29:1-6.
22. Leenaars A, Lester D. The impact of gun control (Bill C-51) on homicide in Canada. *J Crim Justice* 2001;29:287-94.
23. Leenaars AA, Moksony F, Lester D, et al. The impact of gun control (Bill C-51) on suicide in Canada. *Death Stud* 2003;27:103-24.
24. Sproule CF, Kennett DJ. The use of firearms in Canadian homicides 1972–1982: the need for gun control. *Can J Criminol* 1988;30:31-8.
25. Mundt RJ. Gun control and rates of firearms violence in Canada and the United States. *Can J Criminol* 1990;32:137-54.
26. Rich CL, Young JG, Fowler RC, et al. Guns and suicide: possible effects of some specific legislation. *Am J Psychiatry* 1990;147:342-6.
27. Mauser GA, Holmes RA. An evaluation of the 1977 Canadian firearms legislation. *Eval Rev* 1992;16:603-17.
28. Carrington PJ, Moyer S. Gun control and suicide in Ontario. *Am J Psychiatry* 1994;151:606-8.
29. Carrington P, Moyer S. Gun availability and suicide in Canada: testing the displacement hypothesis. *Stud Crime Crime Prev* 1994;3:168-78.
30. Leenaars AA, Lester D. The effects of gun control on the accidental death rate from firearms in Canada. *J Safety Res* 1997;28:119-22.
31. Bridges FS. Gun control law (Bill C-17), suicide, and homicide in Canada. *Psychol Rep* 2004;94:819-26.
32. Caron J. Gun control and suicide: possible impact of Canadian legislation to ensure safe storage of firearms. *Arch Suicide Res* 2004;8:361-74.
33. Cheung AH, Dewa CS. Current trends in youth suicide and firearms regulations. *Can J Public Health* 2005;96:131-5.
34. Caron J, Julien M, Huang JH. Changes in suicide methods in Quebec between 1987 and 2000: the possible impact of Bill C-17 requiring safe storage of firearms. *Suicide Life Threat Behav* 2008;38:195-208.
35. Gagné M, Robitaille Y, Hamel D, et al. Firearms regulation and declining rates of male suicide in Quebec. *Inj Prev* 2010;16:247-53.
36. Blais É, Gagné MP, Linteau I. The effect of gun control laws on homicides in Canada, 1974–2004 [article in French]. *Can J Criminol Crim Justice* 2011;53:27-61.
37. Langmann C. Canadian firearms legislation and effects on homicide 1974 to 2008. *J Interpers Violence* 2012;27:2303-21.
38. McPhedran S, Mauser G. Lethal firearm-related violence against Canadian women: Did tightening gun laws have an impact on women's health and safety? *Violence Vict* 2013;28:875-83.
39. Linteau I, Blais É. The effect of Bill C-68 on homicides in Quebec: an analysis of the extreme bounds [article in French]. *Criminologie* 2013;45:219-48.
40. Langmann C. Effect of firearms legislation on suicide and homicide in Canada from 1981 to 2016. *PLoS One* 2020;15:e0234457.
41. Kim D. Social determinants of health in relation to firearm-related homicides in the United States: a nationwide multilevel cross-sectional study. *PLoS Med* 2019;16:e1002978.
42. Rozel JS, Mulvey EP. The link between mental illness and firearm violence: implications for social policy and clinical practice. *Annu Rev Clin Psychol* 2017;13:445-69.
43. Tutton M. Detailed portrait emerges of gun acquisitions, cash stockpiles of N.S. mass killer. *CTV News [Atlantic]* 2020 Dec. 16. Available: https://atlantic.ctvnews.ca/detailed-portrait-emerges-of-gun-acquisitions-cash-stockpiles-of-n-s-mass-killer-1.5234777 (accessed 2021 Jan. 15).

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