From:	Ellen Seccombe
To:	Todd Buttsworth
Cc:	Finn Seccombe
Subject:	Submission
Date:	Friday, 26 October 2018 9:42:16 AM
Attachments:	Chapman 2006.pdf Ozanne-Smith 2004.pdf Yip 2012.pdf

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Dear Todd,

Please see below (with supporting attachments) our submission to the Select Committee on Firearms Legislation and Policy.

We are happy for the submission to be published via the Committee webpage, however, ask that you redact personal contact details (street address, phone numbers and email addresses) before publication.

Best Regards,

Ellen & Finn Seccombe

The Secretary
House of Assembly Select Committee on Firearms Legislation and Policy
Legislative Council
Parliament House
HOBART 7000

26 October 2018

To the Secretary of the House of Assembly Select Committee on Firearms Legislation and Policy,

We write to submit a case against the proposed changes to firearm laws in Tasmania. There is substantial peer-reviewed research evidence to suggest that weakening the laws set out in the National Firearms Agreement established in 1996 will lead to increased human injury and death from willful shootings, firearm accidents and suicide by shooting.

Researchers are bound to a far higher level of objectivity in their views than the rhetoric offered by lobbyists and politicians. The scientific method, as administered under peer-reviewed conditions, offers the most reliable and trustworthy evidence upon which to base sound policy and legislative decisions, and we urge you to heed the evidence gathered by researchers in your decision-making, rather than falling prey to ill-informed and potentially corrupt rhetoric.

Ten years after the gun law reforms of 1996 were made (prompted by the tragic shootings in Port Arthur in 1996 in which a lone gunman took the lives of 35 people using a semi-automatic rifle) a peer-reviewed article was published by Chapman et al (2006) in *Injury Prevention,* surveying the changes to gun violence in Australia in the decade following the shooting. The articles is titled ‘Australia’s 1996 gun law reforms: faster falls in firearm deaths, firearm suicides and a decade without mass shootings’.

The article concludes, verbatim:

“Australia’s 1996 gun law reforms were followed by more than a decade free of fatal mass shootings, and accelerated declines in firearm deaths, particularly suicides. Total homicide rates followed the same pattern. Removing large numbers of rapid-firing firearms from civilians may be an effective way of reducing mass shootings, firearm homicides and firearm suicides.”

It is important to note that the Port Arthur massacre in 1996 was not an isolated anomaly. In the decade prior to 1996 there were 11 mass shootings in Australia. The importance of strong regulatory reform as an effective means for preventing mass shootings and gun deaths is highlighted, over and again, by experts and researchers.

Consistent with Chapman et al (2006), the research of Ozanne-Smith et al (2004) found that that the gun law reforms of 1996 ensured: “dramatic reductions in overall firearm related deaths and particularly suicides by firearms were achieved in the context of the implementation of strong regulatory reform.”
Suicide using firearms represents the largest component of firearm death. The following statistics should be considered carefully by the Tasmanian Legislative Council before making decisions to change the National Firearms Agreement.

Further, as Chapman et al (2006) states:

“Firearm suicides represent the largest component cause of total firearm deaths in Australia (more than three in four of all firearm deaths). In the 18 years (1979–96), there were 8850 firearm suicides (annual average 491.7). In the 7 years for which reliable data are available after the announcement of the new gun laws, there were 1726 firearm suicides, an annual average of 246.6.”

More recently, an article published in the highly regarded 'Lancet' journal, authored by Yip et al (2012), supported this and went further to conclude that restrictions to lethal weapons do, in and of themselves, reduce suicides:

“Limitation of access to lethal methods used for suicide—so-called means restriction—is an important population strategy for suicide prevention. Many empirical studies have shown that such means restriction is effective. Although some individuals might seek other methods, many do not; when they do, the means chosen are less lethal and are associated with fewer deaths than when more dangerous ones are available.”

Suicide and violence remain an overwhelming concern for our community. Tasmania has the highest rate of youth suicide in Australia (according to ABS 2016 data), and of the total suicide rate in Tasmania, the rate of male suicide was found to be three times the rate of female suicide (according to 2017 DHHS statistics). The accessibility of guns, in rural areas of Tasmania in particular, is a major concern for the male suicide rate. It is vital that Tasmanians stand together on this grave issue, ensuring that we uphold strong legislation to prevent injury, death and suicide by shootings.

We are deeply shocked and concerned that the Tasmanian government is considering the weakening of gun laws. We believe that the proposed changes are completely unnecessary and post a serious risk to the safety of all Tasmanians. Further, we believe that the proposed changes breach the National Firearms Agreement that was established after the Port Arthur massacre in 1996.

We urge the Legislative Committee to actively prevent the proposed legislative changes

from being passed. A gun in the wrong hands is fatal. You, as the key decision-makers in this process, hold lives in your hands and must choose to be part of the solution rather than the ever-widening problem of violence and suicide in Tasmania.

Yours Sincerely,

Ellen & Finn Seccombe

[redacted]

References (also provided as attachments to this submission)

Chapman, S., Alpers, P., Agho, K. and Jones, M., 2006. Australia's 1996 gun law reforms: faster falls in firearm deaths, firearm suicides, and a decade without mass shootings. Injury Prevention, 12(6), pp.365-372.

Ozanne-Smith, J., Ashby, K., Newstead, S., Stathakis, V.Z. and Clapperton, A., 2004. Firearm related deaths: the impact of regulatory reform. Injury Prevention, 10(5), pp.280-286.

Yip, P.S., Caine, E., Yousuf, S., Chang, S.S., Wu, K.C.C. and Chen, Y.Y., 2012. Means restriction for suicide prevention. The Lancet, 379(9834), pp.2393-2399.

Ellen Seccombe [redacted]

ORIGINAL ARTICLE

Australia's 1996 gun law reforms: faster falls in firearm deaths, firearm suicides, and a decade without mass shootings

S Chapman, P Alpers, K Agho, M Jones

Injury Prevention 2006;**12**:365–372. doi: 10.1136/ip.2006.013714

See end of article for authors' affiliations

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Background: After a 1996 firearm massacre in Tasmania in which 35 people died, Australian governments united to remove semi-automatic and pump-action shotguns and rifles from civilian possession, as a key component of gun law reforms.
Objective: To determine whether Australia's 1996 major gun law reforms were associated with changes in rates of mass firearm homicides, total firearm deaths, firearm homicides and firearm suicides, and whether there were any apparent method substitution effects for total homicides and suicides.
Design: Observational study using official statistics. Negative binomial regression analysis of changes in firearm death rates and comparison of trends in pre–post gun law reform firearm-related mass killings.
Setting: Australia, 1979–2003.
Main outcome measures: Changes in trends of total firearm death rates, mass fatal shooting incidents, rates of firearm homicide, suicide and unintentional firearm deaths, and of total homicides and suicides per 100 000 population.
Results: In the 18 years before the gun law reforms, there were 13 mass shootings in Australia, and none in the 10.5 years afterwards. Declines in firearm-related deaths before the law reforms accelerated after the reforms for total firearm deaths ($p=0.04$), firearm suicides ($p=0.007$) and firearm homicides ($p=0.15$), but not for the smallest category of unintentional firearm deaths, which increased. No evidence of substitution effect for suicides or homicides was observed. The rates per 100 000 of total firearm deaths, firearm homicides and firearm suicides all at least doubled their existing rates of decline after the revised gun laws.
Conclusions: Australia's 1996 gun law reforms were followed by more than a decade free of fatal mass shootings, and accelerated declines in firearm deaths, particularly suicides. Total homicide rates followed the same pattern. Removing large numbers of rapid-firing firearms from civilians may be an effective way of reducing mass shootings, firearm homicides and firearm suicides.

On 10 May 1996, 12 days after 35 people were shot dead and 18 seriously wounded by a gunman at Port Arthur, Tasmania, Australia's state and federal governments agreed to enact uniform gun control laws. Between June 1996 and August 1998, the new restrictions were progressively implemented in all six states and two territories. As the Port Arthur gunman and several other mass killers had used semi automatic weapons, the new gun laws banned rapid fire long guns, specifically to reduce their availability for mass shootings. Under the 1996 7 Australian Firearms Buyback, 643 726 newly prohibited semi automatic and pump action rifles and shotguns were purchased by the federal government from their civilian owners at market value, funded by a levy on income tax.[1] Tens of thousands of gun owners also voluntarily surrendered additional, non prohibited firearms without compensation.[2] In total, more than 700 000 guns were removed and destroyed from an adult population of about 12 million. Australia's revised gun laws also require that all firearms be individually registered to their licensed owners, that private firearm sales be prohibited and that each gun transfer through a licensed arms dealer be approved only after the police are satisfied of a genuine reason for ownership. In this context, possession of firearms for self defence in Australia is specifically prohibited and few civilians are licensed to possess handguns. A detailed summary of the reforms can be found in Ozanne Smith *et al*.[3]

In Australian federal law, firearm means "a device designed or adapted to discharge shot, bullets, or other projectiles by means of an explosive charge or a compressed gas".[4] Legislation in all Australian states and territories echoes this definition, and all include airguns and com pressed gas guns in their definition of a firearm.[5]

Using publicly available data, we examined Australian firearm death rates before and after the Port Arthur massacre and the gun law reforms it precipitated to explore the hypothesis that the introduction of the gun laws was associated with an accelerating decline in deaths caused by firearms. We also examine all cause homicides and all method suicides in order to assess the possibility that substitution effects may have occurred: that reduced access to firearms may have caused those with homicidal or suicidal intent to use substitute methods.

METHODS

Data on unintentional (accidental), and intentional (suicide and homicide) deaths caused by firearms were obtained from the National Injury Surveillance Unit,[6][i] sourced from the Australian Bureau of Statistics (ABS) mortality data collec tion 1979 2003, coded as International Classification of Diseases, 9th revision and 10th revision. This represents a census of all firearm deaths in Australia for those 25 years. In all Australian jurisdictions (state and territory Firearms Acts

[i]These figures were updated in a private correspondence from NISU on 16 October 2006 (table 2).

Abbreviation: ABS, Australian Bureau of Statistics

and Regulations), at federal level (the Customs Act and Regulations) and in the ABS mortality collection, ''firearm'' includes guns whose projectiles are propelled by compressed air or gas. Although we know of no such fatalities, any deaths from airguns or ball bearing guns would be included in this dataset.

Population data were obtained from the ABS for the same period. Firearm death rates per 100 000 were then calculated. The trend in these rates for the 18 years up to and including the year in which the new firearm laws were announced (1996) were compared with the corresponding trend for the next 7 years (1997 2003), to examine the hypothesis that the announcement and implementation of the gun laws were associated with an acceleration in the existing decline in firearm homicides, firearm suicides and total firearm deaths. Fatal ''legal intervention'' shootings by police, which averaged 4.5 per annum, were excluded as they were not targeted by the gun laws in question. For the post Port Arthur period, rates of total all cause (and non gun) homicides and suicides were also examined, to consider whether perpetrators may have substituted other means of killing if the gun laws reduced their access to firearms.

Numbers of deaths by category (total and components) have been viewed as arising from an overdispersed Poisson process and analyzed using negative binomial regression, with annual Australian population estimates used as an offset. In practical terms, the model views deaths as a number of events per head of population, although for convenience we report rates per 100 000 heads of population. The model has been used to estimate the change in trend of the relative rate of firearm deaths associated with the introduction of uniform gun laws. Given that the rate of firearm deaths had been decreasing before the harmonization of gun laws, the statistical question addressed is not just whether death rates were lower after the laws were changed, as the pre existing trend would predict this even in the absence of changed laws, but whether the rate of decrease in firearm deaths seems to be greater after the gun laws were announced. Given the observational nature of the data available, we can directly comment on the association of gun law harmonization and firearm related death rates, but conclusions regarding causality of the association must remain interpretive rather than definitive. However, as it would be politically almost inconceivable that any government would conduct a randomized controlled trial of gun law effects, the evidence presented must be among the best that could ever be available to deal with the question of the effects of such law reform. As counts are of deaths, it is reasonable to assume that observations are independent across years. Three models have been fitted for each type of firearm death.

$$\ln\{\text{deaths/population}\} = \beta_{00}+\beta_{10}\times\text{year}, \text{year} = 1979,\ldots,1996 \quad (a)$$

$$\ln\{\text{deaths/population}\} = \beta_{01}+\beta_{11}\times\text{year}, \text{year} = 1997,\ldots,2003 \quad (b)$$

$$\ln\{\text{deaths/population}\} = \beta_{02}+\beta_{12}\times\text{year}+\beta_{22}\text{Law}_j+\beta_{32}\times\text{year}\times\text{Law}_j,\ \text{year} = 1979,\ldots,2003,\ j = 0,1 \quad (c)$$

Models (a) and (b) are used to estimate the trend (measured as average annual change in rate/100 000 population) in gun deaths before and after the introduction of gun laws, through the terms $e^{\beta_{10}}$ and $e^{\beta_{11}}$ respectively. Model (c) is used to estimate the effect on trends in firearm related deaths associated with the introduction of gun laws through the interaction term ''year×law''. As the model is parameterized, $\beta_{32} = \beta_{11} \beta_{10}$ and therefore $e^{\beta_{32}}$ estimates the ratio of trend after introduction to that before the introduction of the gun laws. Trends and relative trends have been reported as relative rates (before and after 1996) and relative trends (comparing periods) with 95% confidence intervals. The statistical significance of the relative trends has also been reported. Analysis has been undertaken separately in firearm related and non firearm related deaths as well as total deaths for homicide and suicide to investigate possible substitution effects. If substitution occurred, we would expect an increasing downward trend in firearm deaths after the introduction of gun control laws but a compensatory lesser downward or even upward trend in non firearm related deaths over the same period. The extent of influence of mass shootings has been investigated by repeating firearm related homicides excluding mass (⩾5 victims died) shootings.

An alternate view of these data might have been as a time series of mortality rates, as was done by gun lobby affiliated researchers Baker and McPhedran.[7] However, we saw two disadvantages to this approach. One is that calculating mortality rates and then treating them as a number in a time series ignores the natural variability inherent in the counts that make up the numerator of the rate. Another is that the Box Jenkins class of models, including the auto regressive integrated moving average model used by Baker and McPhedran,[7] is unable to explicitly address the effect of an intervention such as the introduction of gun laws. Interpretation of these models is reduced to comparing the mortality rates expected under a model assuming no effect of the intervention with that observed, both in the post intervention period. This is however an insensitive approach, and its interpretation is not based on formal statistical inference but rather on visual inspection and qualitative interpretation of graphs, which may be prone to selectivity.

The second author has archived reports of all mass shooting incidents in Australia (defined here as when ⩾5 victims died; table 1). These were used to compare the incidence of such shootings before and after the introduction of the new gun laws.

RESULTS

In the 18 years up to and including 1996, the year of the massacre at Port Arthur, Australia experienced 13 mass shootings. In these events alone, 112 people were shot dead and at least another 52 wounded (table 1).[8] In the 10.5 years since Port Arthur and the revised gun laws, no mass shootings have occurred in Australia. Figure 1 comprises seven graphs plotting both pre law and post law data and trends for (a) firearm homicide death rate, (b) non firearm homicide death rate, (c) firearm homicide minus mass shootings death rate, (d) unintentional firearm death rate, (e) firearm suicide death rate, (f) non firearm suicide death rate and (g) total firearm death rate.

Each graph presents the observed annual death rate (triangles) and the expected death rate under the hypothesis of an effect of gun laws (dots) estimated from a negative binomial model. The vertical line on the horizontal axis indicates the revision of gun laws commencing in 1996.

An interpretive note that applies to all the graphs in fig 1 is that the shape of fitted lines (trend pre law and trend post law) involves two components. The first is that the post law trend line is shifted upward or downward according to the underlying rates of mortality in the pre gun law and post gun law periods. Where there is a pre existing downward trend in mortality, such a shift would occur regardless of the effect of gun laws. The more interesting component is how much the slopes of the pre gun law and post gun law trends differ. Although it can be difficult to judge the magnitude from the graph itself, this is quantified in the final column of table 3, which provides estimates of the relative slopes of the post to pre law trends.

Total firearm deaths

Table 2 shows that gun related deaths (both in numbers and as a rate per 100 000) had been steadily falling throughout

Table 1 Mass shootings* in Australia, January 1979–October 2006

Date	Location and state	Victims killed by gunshot	Perpetrators killed	Total killed by gunshot	Victims wounded	Perpetrators
28 April 1996	Port Arthur, TAS	35	0	35	19	Martin Bryant
25 January 1996	Hillcrest, QLD	6	1	7	0	Peter May
31 March 1993	Cangai, NSW	5	1	6	0	Leabeater and Steele
27 October 1992	Terrigal , NSW	6	0	6	1	Malcolm Baker
17 August 1991	Strathfield, NSW	6	1	7	7	Wade Frankum
30 August 1990	Surry Hills, NSW	5	0	5	0	Paul Evers
25 September 1988	Oenpelli, NT	6	0	6	0	Dennis Rostron
8 December 1987	Queen St, VIC	8	1	9	5	Frank Vitkovic
10 October 1987	Canley Vale, NSW	5	1	6	1	John Tran
9 August 1987	Hoddle St, VIC	7	0	7	19	Julian Knight
19 June 1987	Top End, NT/WA	5	1	6	0	Josef Schwab
1 June 1984	Wahroonga, NSW	5	1	6	0	John Brandon
24 September 1981	Campsie, NSW	5	1	6	0	Fouad Daoud
Total		104	8	112	52	

*Definitions of "mass shooting" and "mass homicide" have ranged from 3 to 5 victims killed.[28 29] To exclude most of the more common firearm related spousal and family violence killings, "mass shooting" is defined here as one in which ⩾5 firearm related homicides are committed by one or two perpetrators in proximate events in a civilian setting, not counting any perpetrators killed by their own hand or otherwise.
Details of each case were collected from police and coroners' files, by personal communication with police and counsel involved, or as a last resort from corroborating newspaper reports.

the years before the new gun laws were announced. In the 18 years (1979 96), there were 11 299 firearm deaths (annual average 627.7). In the 7 years for which reliable data are available after the announcement of the new gun laws, there were 2328 firearm deaths, (annual average 332.6). Figure 1G and table 3 indicate that although the rate per 100 000 of total firearm deaths was reducing by an average of 3% per year, this rate doubled to 6% after the introduction of gun laws. The ratio of trend estimates differed statistically from 1 (no effect; $p = 0.03$). The decline in total firearm deaths thus accelerated after the introduction of the gun laws.

Firearm suicides

Firearm suicides represent the largest component cause of total firearm deaths in Australia (more than three in four of all firearm deaths). In the 18 years (1979 96), there were 8850 firearm suicides (annual average 491.7). In the 7 years for which reliable data are available after the announcement of the new gun laws, there were 1726 firearm suicides, an annual average of 246.6. Figure 1E and table 3 indicate that while the rate of firearm suicide was reducing by an average of 3% per year, this more than doubled to 7.4% per year after the introduction of gun laws. The ratio of trend estimates differed statistically from 1 (no effect; $p = 0.007$). Again, we conclude that the decline in total firearm suicides accelerated after the introduction of the gun laws.

Firearm homicides

In the 18 years (1979 96), there were 1672 firearm homicides (annual average 92.9). In the 7 years for which reliable data are available after the announcement of the new gun laws, there were 389 firearm homicides, an annual average of 55.6. Figure 1A and table 3 show that while the rate of firearm homicide was reducing by an average of 3% per year, this increased to 7.5% per year after the introduction of gun laws. However, the ratio of trend estimates failed to reach statistical significance ($p = 0.15$) because of the low power inherent in the small numbers involved.

When all firearm mass homicides (⩾5 victims shot dead per incident) were removed from the data (fig 1C and table 3), the conclusions were only slightly altered. The reason for this slight change is that all mass shootings in Australia in the years studied occurred before the introduction of gun laws (table 1). This increases the apparent downward trend in the pre gun law period (0.971 when all homicides are considered, *v* 0.961 when mass shootings are removed, table 3). The trend in the post gun law period is unaffected.

Unintentional firearm deaths

Unintentional (accidental) firearm deaths have always been the smallest component of the total firearm deaths in Australia, representing around 6% of all firearm deaths. Figure 1D and table 2 indicate that although the rate of total gun deaths reduced by an average of 7.6% per year, the rate of unintentional gun deaths actually increased by 8.5% per year after the introduction of the gun laws. We discuss this finding below.

Total homicides

Figure 1B and table 3 indicate that the rate of total non firearm homicides increased by an average of 1.1% per year before the introduction of the gun law and reduced by an average of 2.4% per year after the introduction of the gun laws (see row 3, columns 2 and 3, respectively, in table 3). The ratio of the pre law to post law trends differ to a significant extent ($p = 0.05$).

Table 2 also shows the total homicides (by all methods) for the period 1979 2003. In the pre gun law period, total non firearm homicides were essentially stable and did not differ from steady state to a statistically significant extent (table 3). After the introduction of gun laws, a significant downward trend was evident in total homicides, and the ratio of pre law to post law trends differed statistically from "no effect" ($p = 0.01$, table 3). We conclude that the data do not support any homicide method substitution hypothesis.

Totalsuicides

Figure 1F and table 3 indicate that the rate of total non firearm suicides increased by an average of 2.3% per year before the introduction of the gun law and reduced by an average of 4.1% per year after the introduction of the gun laws (see row 6, columns 2 and 3, respectively in table 3). The ratio of the pre law to post law trends differs statistically ($p<0.001$).

Table 2 also shows total suicides for the period under review. Total suicides follow a similar pattern as total non firearm homicides. In the pre gun law period, total suicides were essentially stable (table 3). After the introduc tion of gun laws a significant downward trend was evident in total suicides and the ratio of pre law to post law trends differs statistically from "no effect" ($p<0.001$; table 3). We

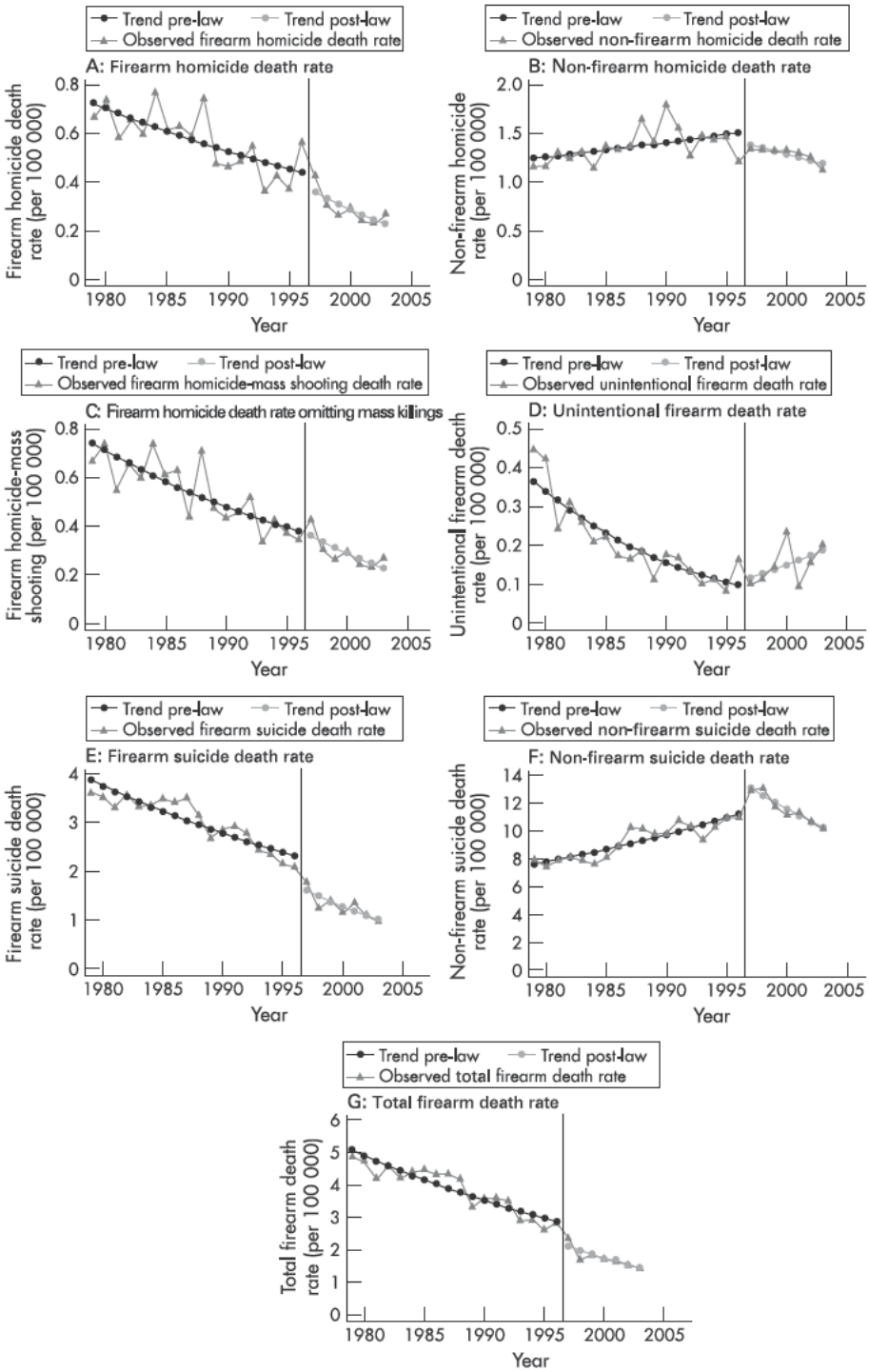

Figure 1 (A–G) Total firearm deaths (excluding "legal intervention" (police shootings)), firearm homicides and suicides, unintentional firearm deaths, total homicides and suicides; rates per 100 000, Australia 1979–2003. Note that the total firearm deaths include deaths of undetermined intent as shown in table 2.

conclude that the data do not support any suicide method substitution hypothesis.

In all, total suicide (all methods including firearms) increased by an average of 1% per year before the introduc tion of the gun laws and decreased by an average of 4.4% per year after the introduction of the gun laws, whereas, total homicide (all methods including firearm) was essentially steady (decreasing by an average of 0.1% per year) before the introduction of the gun law and decreased further by 3.3% per year after the introduction of the gun law. The ratio of the pre law to post law trends reaches statistical significance for both total suicide ($p<0.001$) and total homicide ($p = 0.01$; table 3).

DISCUSSION

After 11 mass shootings in a decade and 13 in the 18 years before the introduction of the new gun control laws, Australia collected and destroyed categories of firearms designed to kill many people quickly. In his immediate reaction to the Port Arthur massacre, Australian Prime Minister John Howard said of semi automatic long guns: "There is no legitimate interest served in my view by the free availability in this country of weapons of this kind… Every effort should be made to ensure such an incident does not occur again. That is why we have proposed a comprehensive package of reforms designed to implement tougher, more effective and uniform gun laws."[9 10]

Table 2 Gun-related deaths, Australia, 1979–2003

Year	Population	Firearm suicide	Firearm homicide	Homicide minus mass shootings	Unintentional	Undetermined	Total	Total non-firearm suicide	Total non-firearm homicide	Suicide by all methods including firearm	Homicide by all methods including firearm
1979	14 515 729	523 (3 60)	97 (0 67)	97 (0 67)	65 (0 45)	20 (0 14)	705 (4 86)	1154 (7 95)	168 (1 16)	1677 (11 55)	265 (1 83)
1980	14 695 356	516 (3 51)	109 (0 74)	109 (0 74)	62 (0 42)	11 (0 07)	698 (4 75)	1091 (7 42)	171 (1 16)	1607 (10 94)	280 (1 91)
1981	14 923 260	495 (3 32)	87 (0 58)	82 (0 55)	36 (0 24)	11 (0 07)	629 (4 21)	1177 (7 89)	195 (1 31)	1672 (11 20)	282 (1 89)
1982	15 184 247	541 (3 56)	100 (0 66)	100 (0 66)	48 (0 32)	8 (0 05)	697 (4 59)	1236 (8 14)	189 (1 24)	1777 (11 70)	289 (1 90)
1983	15 393 472	512 (3 33)	92 (0 60)	92 (0 60)	40 (0 26)	6 (0 04)	650 (4 22)	1214 (7 89)	202 (1 31)	1726 (11 21)	294 (1 91)
1984	15 579 391	523 (3 36)	120 (0 77)	115 (0 74)	32 (0 21)	7 (0 04)	682 (4 38)	1189 (7 63)	179 (1 15)	1712 (10 99)	299 (1 92)
1985	15 788 312	550 (3 48)	97 (0 61)	97 (0 61)	35 (0 22)	24 (0 15)	706 (4 47)	1277 (8 09)	217 (1 37)	1827 (11 57)	314 (1 99)
1986	16 018 350	548 (3 42)	101 (0 63)	101 (0 63)	28 (0 17)	15 (0 09)	692 (4 32)	1434 (8 95)	214 (1 34)	1982 (12 37)	315 (1 97)
1987	16 263 874	571 (3 51)	96 (0 59)	71 (0 44)	27 (0 17)	10 (0 06)	704 (4 33)	1669 (10 26)	223 (1 37)	2240 (13 77)	319 (1 96)
1988	16 532 164	521 (3 15)	123 (0 74)	117 (0 71)	30 (0 18)	17 (0 10)	691 (4 18)	1676 (10 14)	272 (1 65)	2197 (13 29)	395 (2 39)
1989	16 814 416	450 (2 68)	80 (0 48)	80 (0 48)	19 (0 11)	13 (0 08)	562 (3 34)	1646 (9 79)	239 (1 42)	2096 (12 47)	319 (1 90)
1990	17 065 128	486 (2 85)	79 (0 46)	74 (0 43)	30 (0 18)	15 (0 09)	610 (3 57)	1675 (9 82)	306 (1 79)	2161 (12 66)	385 (2 26)
1991	17 284 036	505 (2 92)	84 (0 49)	78 (0 45)	29 (0 17)	5 (0 03)	623 (3 60)	1855 (10 73)	270 (1 56)	2360 (13 65)	354 (2 05)
1992	17 494 664	488 (2 79)	96 (0 55)	90 (0 51)	24 (0 14)	7 (0 04)	615 (3 52)	1806 (10 32)	223 (1 27)	2294 (13 11)	319 (1 82)
1993	17 667 093	431 (2 44)	64 (0 36)	59 (0 33)	18 (0 10)	6 (0 03)	519 (2 94)	1650 (9 34)	262 (1 48)	2081 (11 78)	326 (1 85)
1994	17 854 738	420 (2 35)	76 (0 43)	76 (0 43)	20 (0 11)	6 (0 03)	522 (2 92)	1838 (10 29)	256 (1 43)	2258 (12 65)	332 (1 86)
1995	18 071 758	388 (2 15)	67 (0 37)	67 (0 37)	15 (0 08)	3 (0 02)	473 (2 62)	1980 (10 96)	266 (1 47)	2368 (13 10)	333 (1 84)
1996	18 310 714	382 (2 09)	104 (0 57)	63 (0 34)	30 (0 16)	5 (0 03)	521 (2 85)	2011 (10 98)	222 (1 21)	2393 (13 07)	326 (1 78)
1997	18 517 564	329 (1 78)	79 (0 43)	79 (0 43)	19 (0 10)	3 (0 02)	430 (2 32)	2391 (12 91)	250 (1 35)	2720 (14 69)	329 (1 78)
1998	18 711 271	235 (1 26)	57 (0 30)	57 (0 30)	22 (0 12)	8 (0 04)	322 (1 72)	2448 (13 09)	250 (1 34)	2683 (14 34)	307 (1 64)
1999	18 925 855	269 (1 42)	50 (0 26)	50 (0 26)	28 (0 15)	NA	349 (1 84)	2223 (11 75)	250 (1 32)	2492 (13 17)	300 (1 59)
2000	19 153 380	222 (1 16)	57 (0 30)	57 (0 30)	45 (0 23)	NA	326 (1 70)	2141 (11 18)	256 (1 34)	2363 (12 34)	313 (1 63)
2001	19 413 240	261 (1 34)	47 (0 24)	47 (0 24)	18 (0 09)	NA	329 (1 69)	2193 (11 30)	253 (1 30)	2454 (12 64)	300 (1 55)
2002	19 640 979	217 (1 10)	45 (0 23)	45 (0 23)	31 (0 16)	0 (0 0)	293 (1 49)	2103 (10 71)	246 (1 25)	2320 (11 81)	291 (1 48)
2003	19 872 646	193 (0 97)	54 (0 27)	54 (0 27)	40 (0 20)	NA	289 (1 45)	2020 (10 16)	224 (1 13)	2213 (11 14)	278 (1 40)
Total		10 576	2061	1957	791	209	13 637	43 097	5803	53 673	7864

NA, not available Values are n (rate/100 000) Where the nimber of undetermined cases is ⩽3, these were suppressed by the National Injury Surveillance Unit to protect privacy The column total is the accurate total

Table 3 Estimated effect of gun laws on trends in firearm-related death rates using negative binomial models

Mortality	Trend before 1997 RR (95% CI)	Trend in 1997 and later RR (95% CI)	Ratio of slopes RR (95% CI), p value
Firearm homicide	0.971 (0.958 to 0.984)	0.925 (0.881 to 0.973)	0.955 (0.897 to 1.016), p=0.15
Firearm homicide (omitting mass shootings)	0.961 (0.948 to 0.973)	0.925 (0.880 to 0.973)	0.965 (0.908 to 1.024), p=0.2
Total non firearm homicide	1.011 (1.001 to 1.021)	0.976 (0.954 to 0.999)	0.965 (0.932 to 0.999), p=0.05
Total homicide (all methods including firearm)	0.999 (0.992 to 1.006)	0.967 (0.946 to 0.988)	0.968 (0.943 to 0.993), p=0.01
Firearm suicide	0.970 (0.964 to 0.977)	0.926 (0.892 to 0.961)	0.954 (0.922 to 0.987), p=0.007
Total non firearm suicide	1.023 (1.018 to 1.029)	0.959 (0.951 to 0.968)	0.938 (0.920 to 0.956), p<0.001
Total suicide (all methods including firearm)	1.010 (1.005 to 1.015)	0.956 (0.948 to 0.964)	0.946 (0.930 to 0.963), p<0.001
Unintentional firearm deaths	0.924 (0.907 to 0.942)	1.085 (0.975 to 1.207)	1.171 (1.070 to 1.282), p=0.001
Total firearm deaths	0.967 (0.961 to 0.973)	0.936 (0.912 to 0.961)	0.968 (0.940 to 0.997), p=0.03

In the 10.5 years which followed the gun buy back announcement (May 1996 October 2006), no mass shootings have occurred in Australia. As one study on the Australian firearm buy back notes: "Given that mass murders cause so much community fear, it is appropriate to choose this as an evaluation outcome separate from homicide rates gener ally."[11] Yet, in a recent paper examining the same dataset,[7] two authors with declared affiliations with firearm advocacy groups failed entirely to report on this fundamental outcome, and issued press releases headlined *Gun Laws Failed to Improve Safety* and *New Research Vindicates Gun Owners.*[12 13] Given that the banning of semi automatic rifles and pump action shotguns was premised on the explicit objective of reducing the likelihood of mass shootings, such a flagrant omission from their analysis is extraordinary.

We suggest an analogy here. If a government addressed a recurrent incidence of level crossing car/train collisions by mandating alarmed barrier gates, it would be appropriate to ask two questions when later evaluating the effect of such a measure. One could ask "Have there been fewer level crossing car/train collisions and fatalities?" and "Have there been fewer road toll deaths from any cause?". The outlawing of rapid fire rifles and shotguns in the revised Australian gun laws was the equivalent of level crossing barrier gate legislation: its primary intention was to reduce mass shootings, a national concern after the Port Arthur massacre. Accelerating the reduction in overall firearm deaths as occurred is a bonus, particularly as the data show that there is no evidence of method substitution for either suicide or homicide.

Three categories dominate firearm death data in Australia: suicide, homicide and unintentional (accidental) shootings. Suicide is the leading category, with an average of 79% of all firearm deaths each year. Firearms have a high lethality index (or "completion rate") in both homicide and suicide.[14] Had the gun law reforms not occurred, more Australians contemplating suicide in particular, impulsive young peo ple might have more easily found a method of instant completion. Reliable national data on suicide attempts are not available in Australia to examine whether suicide completion rates changed after Port Arthur. However, the data show that the declining rate of suicide by firearms accelerated significantly after the 1996 gun laws, with there being no apparent substitution by other methods.

As only a single shot is involved in most firearm suicides, it might be argued that reduced access to rapid firing semi automatic weapons would be irrelevant in policies designed to reduce suicide: a person intending suicide with a firearm need use only a single shot gun. However, a person attempting suicide might just as easily use any available gun, including one capable of firing rapidly. The removal of more than 700 000 guns from an adult population of around 12 million therefore may have reduced access to guns among potential suicide attempters.

However, many gun owners own >1 firearm and may well have handed in the newly prohibited weapons after the new laws required this, but retained their non prohibited weap ons. This means that although 700 000 firearms were removed from the community, the number of persons (and households) with access to (still legal) firearms is unlikely to have reduced significantly. What can be said with certainty though is that 700 000 fewer guns were available to be stolen or otherwise leaked from lawful owners to criminals.

The finding that there was a significant increase in unintentional (accidental) firearm deaths after the new gun laws is perplexing, although it should be emphasized that the numbers involved in this increase are small. The average annual increase in unintentional firearm deaths in the 7 years since 1996 was just 1.4 deaths. We can conceive of no plausible hypothesis as to why the removal of more than 700 000 guns from the population, the introduction of firearm registration and the tightening of shooter licensing procedures would be associated with an increase in uninten tional fatal shootings, however small in number.

There are considerable problems in accurately estimating the number of gun owners and guns in a community. Given the political volatility of gun control, and the widespread and virulent opposition of many firearm owners to gun laws, which is often manifested in statements of open defiance on gun lobby websites and publications, under reporting of gun ownership is common in both survey research and in police registers of licensed gun owners. In 1992, Kellerman *et al* reported that owners of registered handguns were much more likely to be prepared to answer questions about gun ownership than about their income.[15] However, licensed firearm owners are those who self select to obey shooter licensing requirements. Before the 1996 gun law reforms, there was no national system of firearm registration in Australia, so there is no way of accurately comparing the estimated number of guns in the Australian community before the 1996 gun laws with the known number of registered guns after the introduction of the laws. Notwithstanding these uncertainties, in a trend that preceded the Australian Firearms Buyback but seems to have been greatly accelerated by it, the reported private gun ownership fell by 45% between 1989 and 2000, leaving a three times less likelihood of an Australian household reporting owning a firearm compared with a US household.[16] By destroying an estimated one fifth of their country's estimated stock of firearms the equivalent figure in the US would be 40 million guns[17] Australians have chosen to significantly shrink their private arsenal. All remaining guns must now be individually registered to their licensed owners, private (owner to owner) firearm sales are no longer permitted, and each gun purchase through a licensed arms dealer is scrutinized by the police to establish a "genuine reason" for ownership. Possession of firearms for self defence is speci fically prohibited, and very few civilians are permitted to own

handguns. Australia's state governments, police forces and police unions all supported the tightened gun laws. In 2002 3, Australia's rate of 0.27 firearm related homicides per 100 000 population was one fifteenth that of the US.[18 19]

It would also be negligent to omit what seemed plain to Australians, but could be less easy to measure in empirical terms. After the death and serious injury of 54 people at Port Arthur, facilitated by firearms then openly marketed by licensed gun dealers as "assault weapons", a national upwelling of grief and revulsion saw pollsters reporting 90 95% public approval for stringent new gun laws.[20 21] Resistance to gun control was roundly condemned in virtually all news media,[22] and governments' 12 days of resolve deprived the firearm lobby of crucial delay time. Announcing the law changes, Prime Minister John Howard invoked the majority will of Australians when he said "This represents an enormous shift in the culture of this country towards the possession, the use and the ownership of guns. It is an historic agreement. It means that this country, through its governments, has decided not to go down the American path ... Ours is not a gun culture, ours is a culture of peaceful cooperation."[23 24] Later opinion polling ranked Howard's new gun laws as by far the most popular decision in the first year of his conservative government.[25] In the opinion of the authors, the 1996 sea change in Australian attitudes and perhaps also a significant component of the public health benefits of lower rates of firearm related mass shootings, suicide and homicide reported here is best described as a national change of attitude to gun owners and their firearms.

Limitations

Table 2 shows that across the 25 years, there were 200 firearm deaths classified as being of undetermined intent. Of these, 157 (80.1%) occurred before 1991, and only 15 23 after 1996. (To preserve victims' privacy, publicly released data for years in which there are ⩾3 firearm deaths of undetermined intent are recorded as NA. This was the case for 4 of 7 years between 1997 and 2003, meaning that there could have been a maximum of 12 and a minimum of 4 undetermined cases in this time.) Across the study period, firearm deaths of unknown intent comprised 1.3% of all firearm deaths, falling to 0.8% after 1990 and 0.4% after 1996. The decrease in "unknowns" is attributed to improved reporting practices. These "missing data" from the component analyses of firearm suicide, homicides and unintentional deaths may account for small variations in the results shown, were their status able to be known.

Although ABS mortality data were also available for 2004, the National Injury Surveillance Unit warned of significant questions of accuracy due to the number of coroners' cases not closed at the time, and potential miscoding of suicide, homicide and unintentional firearm related death in that year.[26] Accordingly, this study ends with 2003, the most recent year of reliable data.

Implications for prevention

The data swings shown are so obvious that if one were given the data in table 2 and were asked to guess the date of a major firearm intervention, it would be clear that it happened between 1996 and 1998. The Australian Firearms Buyback remains the world's most sweeping gun collection and destruction program.[27] A combination of laws making semi automatic and pump action shotguns and rifles illegal, paying market price for surrendered weapons, and registering the remainder were the central ingredients. The Australian example provides evidence that removing large numbers of firearms from a community can be associated with a sudden and ongoing decline in mass shootings and accelerating declines in total firearm related deaths, firearm homicides and firearm suicides.

Key points

- A radical gun law reform occurred in Australia after a gun massacre (35 dead and 18 seriously injured) in April 1996. Semi automatic and pump action shotguns and rifles were banned; a tax funded firearm buyback and amnesties saw over 700 000 guns surrendered from an adult population of about 12 million.
- The total firearm deaths, firearm homicides and firearm suicides had been falling in the 18 years preceding the new gun laws. In all, 13 mass shootings were noticed in the 18 years preceding the new gun laws.
- In the 10.5 years after the gun law reforms, there have been no mass shootings, but accelerated declines in annual total gun deaths and firearm suicides and a non significant accelerated decline in firearm homi cides. No substitution effects occurred for suicides or homicides.

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ORIGINAL ARTICLE

Firearm related deaths: the impact of regulatory reform

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Objectives: To examine trends in rates of firearm related deaths in Victoria, Australia, over 22 years in the context of legislative reform and describe and investigate impact measures to explain trends.
Design: Mortality data were extracted from vital statistics for 1979–2000. Data on firearm related deaths that were unintentional deaths, assaults, suicides, and of undetermined intent were analyzed. Rates were calculated with population data derived from estimates by the Australian Bureau of Statistics. A quasi-experimental design that used a Poisson regression model was adopted to compare relative rates of firearm related deaths for Victoria and the rest of Australia over three critical periods of legislative reform. The Wilcoxon signed ranks test was used to assess changes in the types of firearm related deaths before and after 1998.
Results: In Victoria, two periods of legislative reform related to firearms followed mass shooting events in 1988 and 1996. A national firearm amnesty and buyback scheme followed the latter. Victorian and Australian rates of firearm related deaths before reforms (1979–86) were steady. After initial Victorian reforms, a significant downward trend was seen for numbers of all firearm related deaths between 1988 and 1995 (17.3% in Victoria compared with the rest of Australia , $p<0.0001$). A further significant decline between 1997 and 2000 followed the later reforms. After the later all state legislation, similar strong declines occurred in the rest of Australia from 1997 (14.0% reduction compared with Victoria , $p=0.0372$). Victorian reductions were observed in frequencies of firearm related suicides, assaults, and unintentional deaths before and after the 1988 reforms, but statistical significance was reached only for suicide.
Conclusion: Dramatic reductions in overall firearm related deaths and particularly suicides by firearms were achieved in the context of the implementation of strong regulatory reform.

Deaths and non fatal injuries from firearms remain a major public health problem in many countries, including the United States, Mexico, South Africa, Columbia, Estonia, and Brazil.[1] In the United States in 2000, 28 663 firearm related deaths occurred (10.4 per 100 000 population).[2] In addition, in 1997, an estimated 64 207 firearm related injuries were treated in American hospital emergency departments (24.0 per 100 000 population; 95% confidence interval 13.8 to 34.1), with about 40% of patients needing inpatient hospital care.[3] American inpatient care costs for people with firearm related injuries in 1993 were reported as $4 billion.[4] Strong correlations have been reported between firearm ownership and firearm related suicide, homicide, assault, and unintentional deaths.[5 13]

The American annual rate of firearm related deaths decreased by 2% from 10.6 per 100 000 population in 1999 to 10.4 per 100 000 in 2000.[2] Other Western industrialised nations also have shown reductions. Canadian rates of firearm related deaths are available for 1970 99 and show a decrease from a peak of 7.2 per 100 000 population in 1977 and 1978 to a low of 3.3 per 100 000 in 1998 and 1999.[14] Rates of firearm related deaths in New Zealand over the 12 years from 1988 to 1999 decreased from 4.5 per 100 000 in 1988 to 1.3 per 100 000 in 1999.[15] In Australia in 2000, the rate of firearm related deaths had declined to 1.8 per 100 000 about 20% of the corresponding rate in the United States. Comparison of the trends and relatively low rate of firearm related deaths in Australia with those of other countries provide contrasts that may be of public health benefit internationally. Furthermore, comparisons of firearm own ership in 2000 showed that about 33% of American house holds had firearms compared with 11% of Australian households.[2 16]

The relation between strengthening firearm control reg ulations and rates of firearm related deaths warrants further investigation. In Australia, regulation of firearms is under state jurisdiction, and variance over time between the strength of state laws provides a natural experiment.

FIREARMS LEGISLATION IN AUSTRALIA

In Victoria, two episodes of tightening of firearm laws followed mass shooting events. The first, in 1988, followed the 1987 Hoddle and Queen Street massacres and the combined deaths of 15 people. After these events, the federal government established a National Committee on Violence, whose recommended reforms included uniform national firearm laws. At a state premiers' conference in 1987, two states refused to adopt this national approach. Victoria tightened restrictions on semiautomatic longarms in 1988 but fell short of the recommended national uniform laws (fig 1).[16]

Uniform firearm laws finally were achieved nine years later in the aftermath of the 1996 Port Arthur massacre in Tasmania (35 deaths). In May 1996, the Australian Police Ministers' Council agreed to a 10 point nationwide agreement on firearms, to be implemented by each Australian state and territory. The Victorian response, the Firearms Act 1996, was implemented on 30 April 1997 (fig 1) and changed existing regulations. Table 1 outlines the details of the 10 point nationwide agreement and the Victorian response.

A national firearm buyback scheme was progressively implemented from September 1996 and ran for 12 months. This was supported by a national firearm amnesty in which people in possession of illegal firearms could hand them in without penalty (fig 1).

This study aimed to describe trends in rates of firearm related deaths in the state of Victoria compared with the rest of Australia for the 22 years between 1979 and 2000 in the context of strong legislative reform to prevent firearm

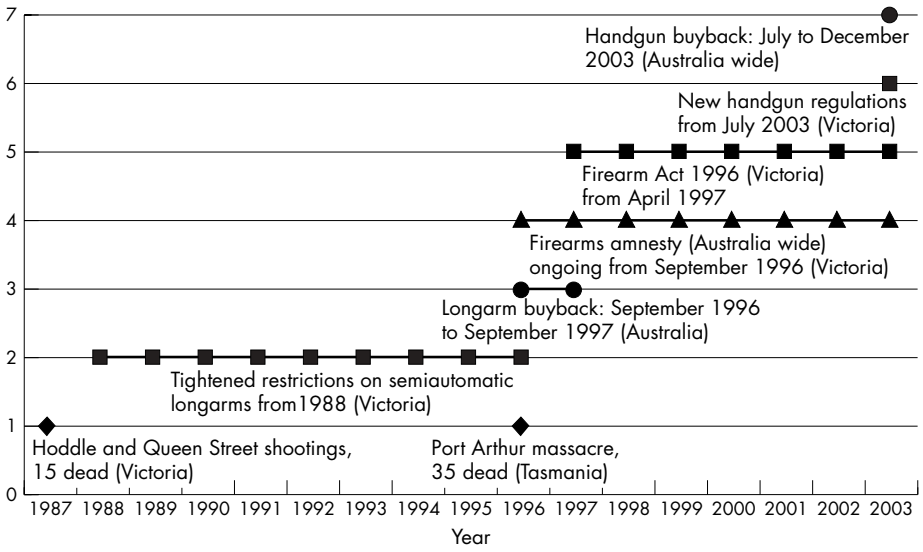

Figure 1 Interventions timeline.

fatalities. It also investigates comparative trends and impact measures to explain the trends.

METHODS

We used data analysis, literature reviews, and key informant interviews to identify details of death rates, trends, and interventions for control of firearms over the period 1979 2000 in Victoria and Australia. Victoria, which has a population of 4.2 million, is the second most inhabited Australian state, and Australia has a population of 19.8 million. Victoria's largest city is Melbourne, and 75% of Victorians reside in metropolitan areas.

We reviewed changes to firearm regulations with govern ment documents, and we obtained population data from the Australian Bureau of Statistics.

We extracted death data, by intent, from the death unit record file of the Australian Bureau of Statistics. Monash University Accident Research Centre holds this data file from 1990 2000; we obtained earlier data from the National Injury Surveillance Unit. We analyzed data on unintentional firearm related deaths (International Classification of Diseases, ninth revision (ICD 9) codes E922.0 E922.9), assaults (E965.0 E965.4), suicides (E955.0 E955.4), and deaths of undeter mined intent (E985.0 E985.4). The last two years studied use the 10th revision of the ICD (ICD 10), so we mapped data to ICD 9 for comparison.

We calculated rates with population figures derived from estimates by the Australian Bureau of Statistics. We adopted a quasiexperimental design with a Poisson regression model to compare relative rates of firearm related deaths between Victoria and the rest of Australia over three critical periods of legislative reform. These three periods represented pre legislative and post legislative reforms in Victoria and the rest of Australia: period 1 no legislation (1979 86); period 2: legislation introduced in Victoria (1988 95); and period 3: legislation introduced to the rest of Australia (1997 2000). Data from the rest of Australia acted as the ''control'' for periods 1 and 2, with the Victorian gun control legislation introduced in period 2. In period 3, the roles of the ''treatment'' and ''control'' in the analysis were reversed, with Victoria acting as the control because the gun laws for the rest of Australia came into line with Victoria in period 3. Under this analysis design, we assessed the decrease in the rate of firearm related deaths in Victoria in period 2 relative to Australian trends, as well as the decrease in rates of firearm related deaths in Australia in period 3 relative to Victorian trends. We compared relative shifts in the rates for Victoria and the rest of Australia with a Poisson regression model that incorporated a fixed offset. We used the death counts as the dependent random variable in the model, while we included an offset (the population counts by region and year) to focus the analysis on rates rather than absolute death counts. Equation 1 shows the form of the model fitted to the annual death counts in Victoria and Australia, where y is the annual death count; i is an indicator for Victoria or the rest of Australia; j is the indicator for year; v is the indicator for period 2 or 3 in Victoria; a is the indicator for period 3 in the rest of Australia; *population* is the population count for the region and year indexed; and α, β, δ, γ, and ϕ are parameters of the model.

$$\ln(y_{ijva}) = \ln(population_{ij}) + \alpha + \beta_i + \delta_j + \phi_v + \lambda_a \quad (1)$$

The indicators in the model take the values $j = 1979, 1980, \ldots, 2002$; $i = 0$ for Victoria or 1 for the rest of Australia; $v = 1$ if period is 2 or 3 and region is Victoria and 0 otherwise; and $a = 1$ if period is 3 and region is Australia and 0 otherwise.

We included the model offset in population levels as a fixed factor, with no associated parameter estimated. Equation 2 gives the net effect of the gun control laws on death rates in Victoria during period 2, relative to Australia, measured as a net percentage reduction in death rate. It measures the change in Victorian death rates from period 1 to period 2, adjusted for corresponding changes in death rates in Australia over the same time period.

$$\Delta VictoriaPeriod2 = (1 - \exp((\phi_1 - \phi_0))) \times 100\% \quad (2)$$

In practice, parameterisation of the factors in the model given by equation 1 leaves parameters ''aliased.'' Aliased parameters are those that cannot be estimated because they are a linear product of other parameters in the regression design matrix. Aliased parameters are set to zero in the regression equation. With careful parameterisation and fitting of the model in equation 1, the parameters ϕ_0 can be aliased. This leads to a reduction in equation 2 to give equation 3.

Table 1 Details of firearm reform in Australia after the 1996 nationwide agreement and the response in Victoria

Law requirement for each state and territory according to 10 point nationwide agreement	Victorian response to law requirement through Firearms Act 1996 and Firearms (Amendment) Act 1998
• Ban on importation, ownership, sale, resale, transfer, possession, manufacture, or use of all self loading centre rifles, all self loading and pump action shotguns, and all self loading rimfire rifles (some exemptions allowable to primary producers and clay target shooters)	• Continuation of existing ban in Victoria of semiautomatic long guns and pump action shotguns
• Compensatory buyback scheme through which firearm owners would be paid the market value for prohibited firearms handed in during a 12 month amnesty	• Longarms buyback scheme in Victoria in conjunction with the national buyback scheme from 29 September 1996 to 30 September 1997
• Registration of all firearms as part of integrated shooter licensing scheme	• Firearm registration had been required from 1984, so Victoria Police now to keep comprehensive list of all firearms in Victoria
• Shooter licensing based on requirement to prove "genuine reason" for owning a firearm, including occupational use, demonstrated membership of an authorized target shooting club, or hunting (with proof of permission from a rural landowner)	• Several categories of licensing based on new way of categorising firearms (see below for details). Genuine reasons for applying for licence vary with category for firearm: – **Category A or B longarms**: sport or target shooting; hunting; primary production; employed as security or prison guard; or accepted official, commercial, or other prescribed purpose – **Category C longarms**: primary production; professional hunting; clay target shooting; or official, commercial, or other prescribed purpose. Proof that category A or B firearms would not do required job – **Category D longarms**: professional hunting; accepted official, commercial, or other prescribed purpose. Proof that category A, B, or C firearm would not do required job – **Category E**: accepted official, commercial, or other prescribed purpose – **Handguns**: sport or target shooting; employed as security or prison guard; or official, commercial, or other prescribed purpose
• Licensing scheme based on five categories of firearms, minimum age of 18 years, and criteria for a "fit and proper person"	• Adherence to new nationally agreed way of categorizing firearms: – **Category A**: airguns, rimfire rifles, shotguns, or any combination of these other than pump action and semiautomatic types – **Category B**: muzzle loading firearms, centre fire rifles other than semiautomatic or fully automatic, or any combination of these – **Category C**: semiautomatic rimfire rifles with a magazine capacity of no more than 10 rounds, semiautomatic shotguns with a magazine capacity of no more than five rounds, pump action shotguns with a magazine capacity of no more than five rounds, or tranquillizer guns – **Category D**: semiautomatic rimfire rifles with a magazine capacity of more than 10 rounds, semiautomatic shotguns with a magazine capacity of more than five rounds, pump action shotguns with a magazine capacity of more than five rounds, or semiautomatic centre fire rifles – **Category E**: machine guns, tear gas guns or projectors, shotguns or rifles with a length of less than 75 centimetres parallel to the barrel, cannons, mortars, bazookas, rocket propelled grenades, or similar large calibre military firearms) – Handguns
	• A clear ban on prohibited persons owning or using firearms including a person serving a term of imprisonment for an indictable offence, assault or drug related offence; a 15 year ban, from completion of the prison term, for a person who has served a term of imprisonment of more than 5 years for any of the above offences; a 5 year ban, from completion of the prison term, for a person who has served a term of imprisonment of less than 5 years for any of the above offences; a 5 year ban on persons subject to a domestic violence intervention order in any Australian State or Territory; a 12 month ban against holding a licence for anyone guilty of an offence against the Firearms Act 1996; and a 12 month ban against holding a licence for anyone guilty of an indictable offence
• New licence applicant required to undertake accredited training course in firearm safety	• To own or use longarms or handguns in Victoria, applicants must be able to show they successfully completed a firearms safety training course approved by Victoria Police
• As well as licence to own a firearm, separate permit required for each purchase of a firearm subject to a 28 day waiting period	• When applying for renewal of a firearms licence, owners required to list all firearms owned • When new firearm "acquired" (bought, inherited, received as gift, or ownership in any other way), "permit to acquire" application must be obtained from Firearms Registry. A 28 day waiting period applies on permits
• Uniform and strict firearm storage requirements	• General security requirement: firearms must be carried and used in a manner that is secure and not dangerous, reasonable precautions must be taken against loss or theft, and firearm must not be allowed to be used or carried by person unauthorized to do so

Table 1 Continued

Law requirement for each state and territory according to 10 point nationwide agreement	Victorian response to law requirement through Firearms Act 1996 and Firearms (Amendment) Act 1998
	• Specific storage requirements for firearm categories: – **Category A or B**: firearm must be stored in receptacle constructed of hard wood or steel that, if weighs <150 kg when empty, must be fixed to the frame of the floor or wall of premises and must be locked when a firearm stored within – **Category C, D, or handgun**: firearm must be stored in steel safe that is of a thickness not easily penetrable and that, if weighs <150 kg when empty, must be bolted to the structure of the premises and must be locked when a firearm is stored in it – **All categories**: ammunition must be stored in a separate locked container
• Firearms sales to be conducted only through licensed firearm dealers and all records of sale to be provided to the police	• All acquisitions and disposal of firearms must be directly with a licensed firearms dealer • Licensed dealers must keep register of all firearm transactions and forward return to Victoria Police of a transaction occurring
• Sale of ammunition only for firearms for which purchaser is licensed and limitations on quantities purchased within time period	

$$\Delta VictoriaPeriod2 = (1 - \exp(\phi_1)) \times 100\% \quad (3)$$

The form of equation 3 is much more convenient in practice, as statistical testing of the difference in f1 from zero directly tests the significance of the change in death rate in Victoria in period 2 relative to that in Australia. Similarly, the variance of ϕ_1 can be used to compute confidence limits on the estimated change in rate of firearm related deaths.

Similarly, the change in death rate in Australia in period 3, relative to Victoria, is measured by equation 4.

$$\Delta AustraliaPeriod3 = (1 - \exp(\lambda_1)) \times 100\% \quad (4)$$

We fitted the Poisson regression model with the Genmod procedure in SAS software (version 8.02). We considered trends to be statistically significant if the p value of the parameter estimate of the model was less than 0.05.

As deaths from injuries are not distributed normally, we used the non parametric equivalent of the paired samples *t* test, the Wilcoxon signed ranks test, to assess changes in types of injury and deaths caused by firearms (assault, suicide, and unintentional death) for Victoria before and after 1988. All p values quoted for the Wilcoxon signed ranks test are two tailed, and statistical significance was taken as $p<0.05$.

Self reported data on firearm ownership for 1992 and 1998 were extracted from surveys by the Australian Bureau of Statistics on hazards and safety features in the home conducted on a representative sample of about 5000 house holds in Melbourne, Victoria (population 3 122 971 accord ing to statistics from the 1996 census). Victoria Police provided data on registered firearms and licence holding registered shooters for 1979 2000.

RESULTS

Firearm related deaths

Figure 2 shows the trend in rates of firearm related deaths for Victoria and the rest of Australia from 1979 to 2000, with the 1988 and 1996 Victorian legislative changes indicated. The Victorian death rate for firearm related deaths decreased significantly from 4.2 per 100 000 in 1979 to 1.5 per 100 000 in 2000, which represented an estimated annual percentage change of 4.9% (95% confidence interval 5.9 to 3.9) and 64.3% overall. The death rate for firearm related deaths for the rest of Australian decreased significantly from 5.1 per 100 000 in 1979 to 1.8 per 100 000 in 2000, which represented an estimated annual percentage change of 3.9% (4.8 to 3.1) and an overall reduction of 64.7%.

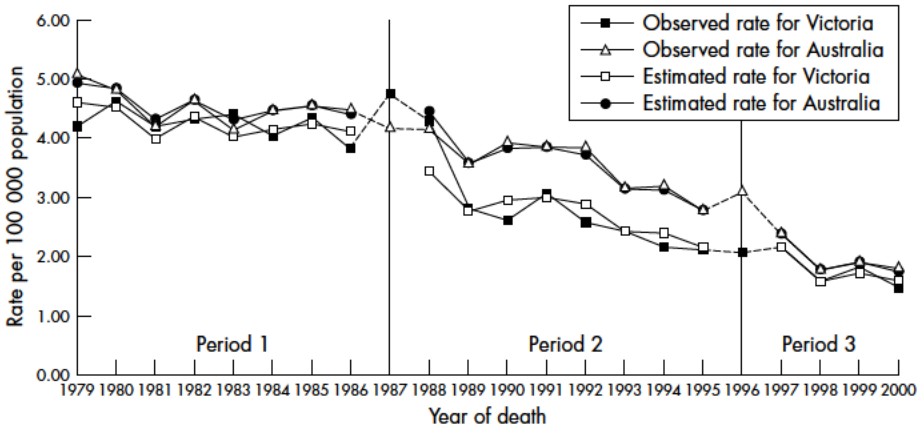

Figure 2 Observed and modelled rates of firearm related deaths in Victoria and the rest of Australia before and after legislative reforms.[17] Lines show that data from 1987 and 1996 were excluded from these analyses.

Table 2 Regression model parameter estimates for rates of firearm related deaths for Victoria and rest of Australia for periods 2 and 3

Effect	Parameter estimate	Estimated reduction		Significance test		
		Calculation	%	χ^2	Degrees of freedom	p Value
Victoria: period 2 (1988 95)	0.1903 (SE 0.0478)	1 exp(0.1903)	17.3	15.88	1	<0.0001
Australia: period 3 (1997 2000)	0.1511 (SE 0.0725)	1 exp(0.1511)	14.0	4.34	1	0.0372

The particularly high Victorian rate of 4.9 per 100 000 in 1987 corresponds with the Hoddle and Queen Street massacres. The high rate in the rest of Australia in 1996 corresponds with the 35 deaths at Port Arthur in Tasmania. We excluded the 1987 and 1996 massacre years from analysis, as these would make the declines seem more pronounced. Table 2 reports the estimated percentage reduction in death rates associated with the Victorian gun legislation in period 2 and the nationally agreed legislation in period 3, along with statistical significance levels derived from the model.

The Victorian legislation in period 2 was associated with a statistically significant 17.3% decrease in death rate relative to Australia ($p<0.0001$). The Australian (all states and territory) legislation in period 3 was associated with a statistically significant 14.0% drop in death rate in the rest of Australia relative to Victoria ($p = 0.0372$). Figure 2 shows the fit of the estimated model to the observed data.

A further important analysis outcome was the assessment of the efficacy of the quasiexperimental design. In particular, assessment was needed to determine whether the latent trends in death rates by year were similar in Victoria and the rest of Australia after controlling for the effects of the legis lation changes on the series. Similarity in trends indicates each series is a good control for the other. We assessed this by determining the fit of the fitted model by examining the estimated deviance of the model. The model deviance is a χ^2 statistic, with low values indicating adequate model fit.

Analysis of the deviance of the model showed the model was an adequate fit to the data ($\chi^2 = 24.15$, degrees of freedom = 17, $p = 0.1154$). Consequently, we concluded that the analysis design was valid.

After the 1988 legislative revisions, statistically significant reductions in Victorian frequencies of all firearm related deaths ($p = 0.011$) and firearm related suicides ($p = 0.008$) were seen when we compared the periods 1979 87 and 1988 96. Although decreases were also evident in assaults ($p = 0.108$) and unintentional firearm related deaths ($p = 0.05$) over this same time period, they did not reach statistical significance (table 3). Further declines in overall firearm related deaths and firearm related suicides and assaults followed the additional legislative reforms in 1996. Unintentional firearm related deaths increased slightly during 1997 2000 in Victoria. The annual average frequency is low, however, and therefore prone to fluctuation. The reduction in annual frequency for suicide accounted for 78% of the total reduction in annual average frequency of firearm related deaths over this period.

Firearm ownership

Representative household surveys in Melbourne, Victoria, undertaken by the Australian Bureau of Statistics in 1992 and 1998, show that the number of households that reported firearm and ammunition possession decreased in Melbourne over this period. The 1992 survey found that 7.4% of all households and 8.3% of households with children aged <5 years kept a firearm on the property and that 5.2% of all households and 5.6% of households with children aged <5 years kept ammunition. The repeat survey found reductions in all categories. In the 1998 survey, 4.4% of all households and 3.5% of households with children aged <5 years kept a firearm on the property and 3.1% of all households and 2.5% of households with children aged <5 years kept ammunition.

Data from the Victoria Police firearm registry show that the numbers of registered firearms and current licence holding registered shooters in Victoria declined during the four years between 1997 98 and 2000 01 (fig 3). These figures equate to a 25% reduction in registered firearms and 15% reduction in licences over the four years.

The National Firearms Buyback Scheme and associated publicity operated for 12 months from September 1996 (fig 1). Over this period, 660 959 firearms were collected and destroyed nationwide, with a total compensation cost of

Table 3 Firearm related deaths in Victoria by intent before and after legislative reform in periods 1 (1979–87), 2 (1988–96), and 3 (1997–2000)

Period	Intent			
	Suicide	Assault	Unintentional	Total*
Average annual frequency of deaths (period total frequency)				
1	132.5 (1193)	29.0 (261)	7.7 (69)	174.1 (1567)
2	90.5 (815)	20.4 (184)	4.1 (37)	118.1 (1063)
3	60.3 (241)	14.5 (58)	6.0 (24)	82.0 (328)
Change in average annual frequency between different periods				
1 and 2	42	8.6	3.6	56
2 and 3	30.2	5.9	+1.9	36.1
1 and 3	72.2	14.5	1.7	92.1
Change between different periods (%)				
1 and 2	31.7	29.7	46.8	32.2
2 and 3	33.4	28.9	+46.3	30.6
1 and 3	54.5	50.0	22.1	52.9

*Includes cases of undetermined intent.

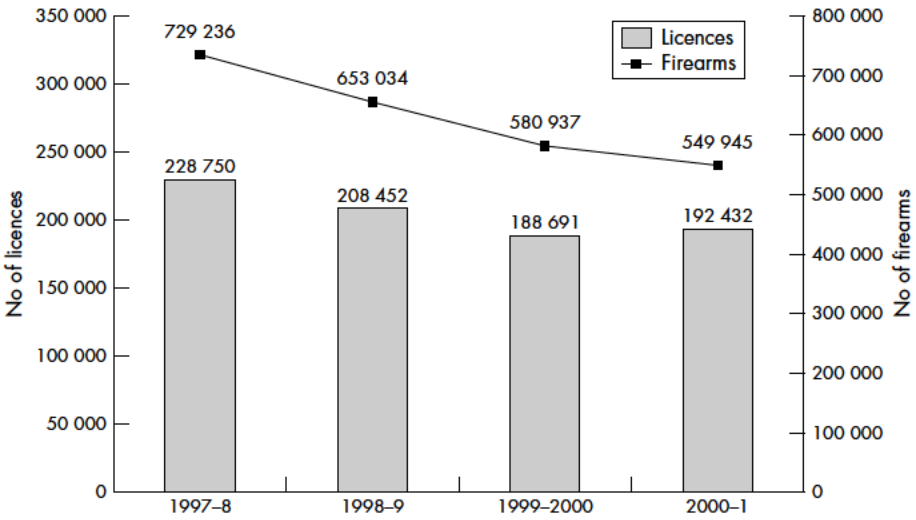

Figure 3 Gun owner licences and registered firearms in Victoria.[18]

almost $A394 million ($176m). Some 207 409 of the collected firearms were from Victoria.[19]

DISCUSSION

This study shows dramatic declines in rates of firearm related deaths in the state of Victoria, and for the rest of Australia, for the 22 years between 1979 and 2000 in the context of strong legislative reform. Earlier legislative reform in Victoria, compared with the rest of Australia, was associated with more rapid initial declines. Evidence for this relation is strengthened by the differential rates associated with the tightening of regulations earlier in Victoria (in 1988) compared with the remainder of Australia and the ultimate ''catch up'' by the rest of Australia after regulation was introduced in the other states. Declines in household ownership of firearms, firearm licences, and licenced shooters in Victoria and the national firearms buyback scheme (from 1996) were associated with these trends. These changes were associated with substantial publicity, unprecedented community awareness, and advocacy for gun control reform from antigun groups and the broader community.[16]

In particular, our data analysis shows significant reductions in firearm related suicides and assaults after both periods of reform in Victoria. Studies that focused only on suicide in the states of Queensland and South Australia support our findings.[20 21] Similarly, two international studies by Rich *et al* and Loftin *et al*, which examined the effects of strengthened firearm laws in Ontario and Washington, DC in the United States, respectively, reported decreases in firearm related suicides.[22 23]

Supportive evidence for the relation between firearm ownership and prevalence of fatalities also comes from a number of American studies. Miller *et al*, in a pooled cross sectional time series analysis over 10 years (1988 97), found that a disproportionately high number of children aged 5 14 years died from suicide, homicide, and unintentional firearm related deaths in American states and regions in which firearms were more prevalent.[6] Kellermann *et al* conducted case control studies to examine the links between firearm ownership as a risk factor for suicide and homicide in the home.[10 12] After controlling for several factors, they found that the presence of one or more firearms in the home was associated with an increased risk of suicide (adjusted odds ratio 4.8, 95% confidence interval 2.7 to 8.5).[10] Similarly, keeping a firearm in the home was strongly and independently associated with an increased risk of homicide (adjusted odds ratio 2.7, 1.6 to 4.4).[12]

The methods used in this study were capable of showing a strong association between firearm regulations and the significant decline in firearm related fatalities. This relation was further supported by impact measures. Further evidence would be needed to show that the relation is causal. For reasons associated with coding systems, this study was unable to consider type of firearm.

For the same period, despite the declines related to firearms, overall suicide and homicide rates in Victoria did not show a similar decline. An analysis of substitution or displacement to other methods of suicide or homicide was beyond the scope of this study. Investigation of the rates of non fatal firearm related injury was also out of the scope of this study.

The very low rate of fatalities from firearms achieved in Australia by the year 2000 (<2 per 100 000 population) raises the question of whether vision zero (elimination of firearm related fatalities) is achievable. In the course of this research, our own institution Monash University was the site of a shooting that resulted in the death of two members of our community. In the aftermath of the events at Monash, the Australian, state, and territory governments made a National Handgun Control Agreement. This agreement aims to reduce the number of handguns held in the community, particularly concealable handguns, and to strengthen control over access to handguns.[24] The *Firearms (Trafficking and Handgun Control) Act 2003* started in Victoria on 1 July 2003 with a supporting amnesty and buyback scheme to run until 31 December 2003. The impact of this further reform will be monitored.

Key points

- Significant and dramatic declines in rates of firearm related deaths occurred in Victoria and Australia after periods of strong legislative reform.
- Statistically significant reductions in firearm related suicides were observed after legislative reforms.
- In 2000, rates of firearm related deaths were less than two per 100 000 population for Victoria and Australia compared with 10.4 per 100 000 population for the United States.
- In Victoria, reductions in the numbers of registered firearms of 25% and of licensed shooters of 15% were seen over the four years between 1997 98 and 2000 01.

CONCLUSION

Dramatic reductions in overall firearm related deaths and particularly suicides by firearms are achievable in the context of the implementation of strong regulatory reform.

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Suicide 3

Means restriction for suicide prevention

Paul S F Yip, Eric Caine, Saman Yousuf, Shu-Sen Chang, Kevin Chien-Chang Wu, Ying-Yeh Chen

Limitation of access to lethal methods used for suicide—so-called means restriction—is an important population strategy for suicide prevention. Many empirical studies have shown that such means restriction is effective. Although some individuals might seek other methods, many do not; when they do, the means chosen are less lethal and are associated with fewer deaths than when more dangerous ones are available. We examine how the spread of information about suicide methods through formal and informal media potentially affects the choices that people make when attempting to kill themselves. We also discuss the challenges associated with implementation of means restriction and whether numbers of deaths by suicide are reduced.

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This is the third in a Series of three papers about suicide

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See Online for appendix

Introduction

For more than a century, writers and researchers have considered suicide from two opposite perspectives, invoking broad cultural and societal factors as causes or focusing on uniquely individual characteristics and experiences to explain why people kill themselves. Public health approaches to suicide prevention, however, have to integrate these viewpoints and to develop strategies that will benefit most lives in an effective and measurable way.

Suicide is a well recognised public health challenge. WHO estimates that the global suicide rate is about 16 per 100 000 individuals per year, which is a 45% increase in the past 45 years.[1] Depending on the nation cited by WHO, suicide is one of the top three leading causes of death in people aged 10–24 years or 15–44 years, and often is an especially large burden late in life, when suicide rates are highest in many countries.[2] Therefore, suicide causes the loss of many potential years of life and has substantial economic and emotional costs, disrupting families, communities, and society, broadly ramifying sadness and loss.[3]

Many countries have initiated suicide prevention programmes,[4,5] which use public health strategies that focus on individuals in known high-risk groups and promote population-oriented strategies to broadly reduce risk, in keeping with Rose's theorem (many people at low risk might give rise to more cases than would a small number at high risk).[6] Suicide is not a disease caused by well defined pathological mechanisms, and the occurrence of suicidal behaviour is usually an outcome of complex interactions of socio-environmental, behavioural, and psychiatric factors.[6] Identified risk factors, such as severe depression or other mental illnesses, do not have sufficient specificity (ie, high rates of false positives) to guide effective preventive actions.[7]

One important population strategy to reduce suicides has been modification of the environment to decrease general access to suicide means. This approach (so-called means restriction) is reported to be one of the intervention measures with strongest empirical support.[8,9] Several factors apparently underpin the effectiveness of this approach. Many suicidal people cannot be accessed with interventions or restrictions at the time of their greatest risk; indeed, they often seek to avoid detection. The probability of individuals attempting suicide decreases when they are precluded from implementing a preferred method[10]—ie, suicide attempts are often method-specific. Moreover, if a highly lethal method is not available and some individuals do not defer their attempt, they frequently use less lethal, more common ones (eg, drug overdose). From the perspectives of public health and injury prevention, the choice of a method that is less lethal than are others can be advantageous if the attempt proves to be non-fatal.

The case fatality of suicide methods varies greatly (appendix).[11–14] The potentially fatal moments of suicidal crises are often brief. Strongly felt ambivalence is common, with competing wishes to die and to live.[9] The sudden, unplanned (or briefly planned) nature of many suicides implies that individuals tend to use the method most readily accessible to them. When a lethal method is unavailable at the moment of potential action, suicide attempts might be delayed so that (in some cases at least) suicidal impulses will pass without fatal effects.[15] Even when individuals have planned, poor access to the most lethal means can be a substantial impediment.

Search strategy and selection criteria

We searched PubMed, PsycINFO, ISI Web of Knowledge, and The Cochrane Library, with the terms "suicide" in combination with each method (ie, "jumping", "hanging", "charcoal burning", "carbon monoxide poisoning", "drowning", "pesticide*", "firearm*" and "medicine*" or "drug overdose") and "restriction", "availability", "access", or "means". We included reports of epidemiological studies showing change in suicides or suicide rates after method restriction published between January, 2001, and January, 2012. Review articles, case reports, or studies based on clinical populations or those that had non-fatal outcomes (eg, suicidal behaviour or ideation) were excluded. The reference lists of identified reports were also examined for relevant references.

Although means restriction is considered a generic preventive intervention, few investigators have assessed the relative strength of supporting evidence for different methods. Moreover, the potential effect of decreased access to various methods on overall suicide rates in different countries or regions has not been established. We review the empirical evidence for means restriction from the past decade (figure) and assess its effectiveness and its relation to the dissemination of information about different methods of suicide through various media outlets. We put special emphasis on the difficulties encountered when attempts to measure potential substitution effects are made. Additionally, we draw attention to the potential of socially enacted means restriction (ie, not absolute restriction) as a public health intervention for commonly available products.

Theory of means restriction

Suicide is a rare event and high-risk factors are common (eg, depression, other mental disorders). A recurring challenge in suicide prevention is how to accurately identify vulnerable individuals in populations at risk. A prevention strategy that targets the population as a whole, such as means restriction, has many advantages, especially when implemented through so-called distal measures—eg, removal of carbon monoxide from domestic gas or withdrawal of highly lethal pesticides from the market.

Means restriction entails a community or societal action that (ideally) does not depend on an individual's intention or volition. Applied to the population as a whole, it typically affects people whose suicide risk is otherwise undetected and who do not seek therapeutic assistance to prevent their crisis or for life-saving interventions when necessary. Removal or restriction of access to a lethal method changes the context of a potential suicide by precluding potentially fatal actions or forcing the use of a less lethal method. Because means restriction is broadly applied, detection of its individual-level effect is often impossible; it is best measured by aggregate findings of method-specific community rates of suicide and related self-harm injuries.

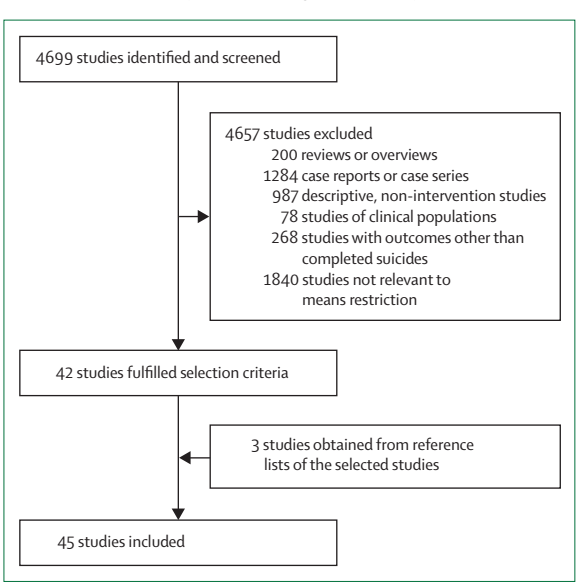

Figure: **Selection process of studies cited**

As a public health measure, means restriction has a long history; removal of the pump handle in Broad Street, London, UK, by John Snow was an early example and a historic landmark in public health practice.[16] Similar approaches have been widely applied in criminology, with the label of opportunity-reduction theory (or so-called situational crime prevention).[17] Instead of a focus on individual criminals, an opportunity-reduction approach introduces discreet managerial and environmental changes to reduce the opportunities for crime. Suicide can be affected or forestalled by alteration of environments or access.[17] To be successful, this type of strategy depends on committed societal leadership and sustained political will. This approach fits with the notion of context changes to make individuals' default decisions healthy. The principle of this type of intervention is that individuals would have to expend substantial effort not to benefit.[18]

Although means restriction can be broadly applied, related approaches exist for individuals. Clinicians can work with high-risk patients and their kin to remove potentially lethal methods from the immediate environment. By contrast with universal approaches, this strategy necessitates care providers' vigilance and cooperative participation by people close to the suicidal individual. Such safety planning is not means specific, but is tailored to individuals and situations.

Suicide rate, method availability, and lethality

International variations in common suicide methods suggest that these patterns are linked closely to differences in the availability and lethality of specific approaches.[19] Suicides by pesticide poisoning (case fatality up to 75%) have been common in many Asian and Latin American countries where there are large agrarian populations,[20] whereas many individuals killing themselves in cities and city states jump from high places (70% lethality).[21,22] Indeed, jumping has accounted for more than 50% of suicides in Hong Kong and 80% of those in Singapore in the past 20 years.[21]

Thomas and colleagues[23] described the large increase in suicides in the UK, first in men and later in women, after carbon monoxide gas from coalmines became widely available in the first half of the 20th century. Gas rose to become the primary national method of suicide. The replacement of coal gas with natural gas from North Sea wells between the late 1950s and early 1970s led to a gradual reduction in the carbon monoxide content of domestic gas, which in turn was followed by a steady and prominent decrease in fatal gassing and the overall suicide rate in the UK.[23,24] This decline in the overall rate was directly caused by the reduction in suicide with domestic gas. Thomas and colleagues[23] showed that the

number of fatal gas poisonings in the UK rose in the early 1980s, but it later fell after the introduction of catalytic converters into car exhaust systems.[25–29]

The increased use of pesticides during the second half of the 20th century was associated with an increase in suicides in many agrarian societies.[30] Prevention strategies have sought to substitute less lethal, newer generation compounds,[31–33] and to install double-lock boxes[34] to remove access to potentially lethal but commonly available chemicals. Enforcement of gun-control policies lowers numbers of firearm suicides.[35–52]

An individual's choice of method is not only dependent on ready access to a specific means of suicide, but also on its socio-cultural acceptability.[53] Local norms and traditions, moral attitudes towards suicide, knowledge about past suicides, and personal experience and accessibility all potentially shape a person's suicidal actions. In turn, means restriction should shape contextual factors, promoting healthy decisions.

Means substitution after restriction

A common concern about means restriction has been that individuals will simply switch to other methods of suicide—ie, so-called means substitution. Such concern could be a result of distressed individuals being considered by clinicians as equally at risk of suicide by any method when they are assessed as being very suicidal. However, studies[5] have shown that restriction of one method of suicide does not inevitably lead to a compensating rise in the use of others (as shown in the UK in the 1970s), just as the emergence of a new method (eg, domestic gas in the UK in the first half of the 20th century, or the burning of charcoal in confined spaces to generate toxic amounts of carbon monoxide in Hong Kong in the late 1990s) does not result in a substantial decline in the use of long-available means.

The occurrence of substitution varies between regions and is associated with individual characteristics such as age and sex (appendix).[25,46] The effectiveness of means restriction differs between the sexes; women seem to be more responsive than are men, and method substitution is more common in men than in women (appendix).[46] Where means restriction has been implemented in Asia—typically of pesticide and charcoal—substitution has been reported rarely.[31,33,54,55] The cause of this apparent difference is unknown; characteristics of the populations affected or the restricted methods might play a part.

At the population level, means restriction proves most effective when the method is common and highly lethal, accounting for a substantial percentage of deaths.[15,18] Common methods that have been restricted, such as domestic gas and pesticides, are available in the home. The likelihood that a specific method will lead to death is related to both its lethal properties and its accessibility. When reduction of access to a highly lethal method is possible, people who do attempt suicide with less dangerous means have an increased chance of survival. If the overall population rate of suicide is to be substantially reduced by means restriction, the fatality rate of alternative methods should be lower than that of the restricted method of suicide (appendix).[15]

The role of the media

Nowadays, publicly available media—whether in print, on television, or on the internet—might affect the creation or alteration of suicide methods, and hence affect suicide rates. The deaths of celebrities have been publicised.[56] Perhaps most importantly, this type of rapid dissemination most often involves members of the public dying in extraordinary circumstances.[57] For example, the media introduced and quickly disseminated reports on the burning of charcoal in a confined space in Hong Kong and Taiwan, which then rapidly increased and spread to other Asian regions in the late 1990s.[23] An ethnographical investigation in Hong Kong[58] established that people chose charcoal burning because they were reminded of the method by newspaper reports. An interview-based study in Taiwan[59] showed that 87% of individuals who attempted suicide with charcoal burning reported that the media pointed them towards this method. Suicides by charcoal burning have been recorded in the UK.[60] Whether charcoal burning would have spread so quickly had initial graphic reports, pictures, and diagrams not been presented in Hong Kong tabloids in 1998 is unknown. Therefore, in addition to sensationalising suicide, the media can provide precise instructions about how a method can be implemented, further complicating prevention initiatives.

New online social media can be used to disseminate information within minutes or hours, rather than slow diffusion of models or methods that was the norm previously, such as when domestic gas was introduced.[61] As yet, little research has tested whether all forms of today's media can be used to positively affect vulnerable individuals or populations in a way that promotes good mental health or adaptive help seeking at times of distress.[62]

Examples of means restriction

Implementation of means restriction can be viewed as a continuum, ranging from complete elimination or removal of a potentially fatal substance or compound (eg, changes in the composition of domestic cooking gas), through impeding or interfering with access (eg, barriers to jumping and packaging changes), to promotion of educational and social interventions to enhance safety (eg, education of clinicians to encourage families to remove potentially lethal means from the home). We believe that removal of an agent would have the greatest effects on broadly measured suicide rates, whereas social-educational interventions would be least potent, especially because they necessitate concerted and sustained actions by many individuals.

Legislation to restrict the quantities of paracetamol and other analgesics (eg, aspirin) sold was enacted in the UK

in 1998. Early data suggested that mortality and morbidity associated with paracetamol overdose declined as a result,[63,64] with little evidence for substitution to other kinds of analgesics, such as ibuprofen (a compound that is safer than is paracetamol).[64] Subsequent studies[65] have cast doubt on these early findings. Implementation of such legislation does not depend on specific actions of individuals, but is done during manufacture and with widely applied sales regulations. Further research is needed to establish whether people attempting suicide hoard their paracetamol supplies until they have sufficiently lethal amounts, and whether they have the patience to open blister packs to obtain enough pills. Such findings would point to carefully planned suicides and would potentially suggest that other prevention measures are needed.

In 2010, Yip and colleagues[55] described the results of a controlled community experiment in Hong Kong, in which they moved bags of charcoal from easy self-service access on store counters to locked storage, so that customers had to ask store attendants for assistance. This measure did not prohibit purchases, but sales became a source of attention and slightly more time consuming than they had been previously. Compared with a district with a similar population size (500 000 inhabitants), area, and socioeconomic status that had no change in method of shelving, a measurable and significant decline in suicides was reported.[55]

Unlike repackaging of paracetamol, agreement of the managers of supermarket chains and day-to-day implementation by store employees was necessary to move the bags of charcoal. Such a high level of cooperation could pose substantial challenges, and many community members might resent or resist such constraints.

On the island of Cheung Chau in the Islands District of Hong Kong, deaths from poisoning by charcoal burning in holiday houses increased from three to four per year to the high of 14 in 2002.[54] Most suicides were of visitors. The community reported negative effects on the island in terms of resort business and general wellbeing after a series of suicides.[54] Island residents and businesses developed a self-help organisation to restrict access to holiday flats for distressed or suicidal individuals; owners refused to rent to people on their own. Store employees were alert to visitors who wished to purchase charcoal and beer but no food. The police cycled around the island to identify anyone deemed to be at risk of suicide and irregularities in the community. Of 40 000 residents, the number of suicides on the island declined to two in 2005, without any substantial increase on nearby islands.[54] These findings emphasise that means restriction must be embedded into other efforts to modify environments, such as the restriction of access to rental units. Cohesive community action was the central part of this initiative; means restriction—like other elements of the Cheung Chau programme—was a result of concerted and widespread commitment.

The social dilemma

Application of universal measures for means restriction might be considered intrusive by many members of the community. Moreover, the benefits for most people will be small or non-existent. Thus, use of widely applied prevention measures could be met with substantial resistance, even though data support large population effects. Many community members express common misunderstandings that, despite data showing powerful population-level effects, a seriously suicidal person will inevitably find a way to die and that all methods have roughly equal case fatalities. In many community discussions about means restriction—whether control of access to bags of charcoal safety doors on subway platforms, or bridge barriers[54,55,66–73]—many participants believe that removal of access to one method of suicide would force people to use another.

On the basis of the data for relocation of bags of charcoal in supermarket chains in Hong Kong,[55] prevention strategies should gain support from senior managers of affected companies, as well as having supporting scientific data. With appropriate media coverage and endorsement by community leaders, means restriction could gain greater acceptance and less resistance from the public than it does presently. The fundamental premise of means restriction is based on the assertion that it is both a community-level intervention and a community-supported initiative.

We suggest that policy makers and advocates consider several a priori criteria when assessing the potential benefits of means restraint. First, the method in consideration should contribute substantially to the mortality from suicide in the region because of its high lethality. Second, the method should be suitable for elimination or constraint, ideally with broadly applicable policy actions rather than day-to-day implementation by individuals, either alone or collectively. Third, they should assess whether a method is socially important or recognised (eg, suicides from iconic sites or bridges), when the preventive intervention would be noticed by many people, even though the overall contribution to regional rates might be marginal. Fourth, they should be able to monitor the implementation and effects of an intervention.

Limitations

Glasgow's 2011 report[74] emphasised that bridge barriers—however effective they might be at individual sites—do not lower regional suicide rates when people jumping from those bridges contributed little to the rates before the barriers were put in place. Although placement of such barriers might not lower regional rates—even when it prevents deaths at specific sites—the action conveys a powerful public message, expressing important community values and serving to promote help-seeking. Such committed political will to save lives could be one potential way to

counteract media-driven contagion, because it affords opportunities for widespread discussion and collective community action.

Constraint or elimination of access to commonly used suicide methods of low lethality (eg, fairly non-toxic prescription or over-the-counter drugs) would have a negligible effect on rates and also might inadvertently force individuals attempting suicide in the future to use more lethal methods.[75] When high-lethality methods have been constrained, some substitution with low-lethality means has been reported.[76] Such findings do not indicate what exactly would happen if low-lethality methods were eliminated.[75] For methods of intermediate lethality, such as charcoal burning, the potential gains from constraints that cannot entirely eliminate access should be assessed carefully (appendix).

Hanging, jumping from heights (particularly from individuals' own apartments or houses), and fatal shooting with firearms in countries with relatively non-restrictive gun laws such as the USA cannot be readily restricted. However, safety planning for firearm storage is potentially a form of means restriction when effectively applied as part of routine procedures. Similarly to the decision to place bags of charcoal behind shop counters, such changes need committed leadership, corporate co-operation, and consistent individual action to attain sustained, widespread implementation. In clinical practice, physicians and other health professionals should speak with family members about the removal of potentially lethal methods from the reach of vulnerable kin. This type of intervention necessitates an alert clinical provider, a vigilant family, and a cooperative patient, but too often one or several of these components could be absent.

Conclusion

Restriction of access to a specific suicide method can have a widespread effect when the method is highly lethal and common, and the means restriction is supported by the community. Newly emerging methods might have large effects as they spread through communities, and in the internet era, the results can be sudden and pronounced. Once a method of suicide has become common, it is especially difficult to eradicate. If faced with similar emerging methods in the future, policy makers should seek support from formal media outlets to restrain spread and lessen the effects, although informal media now makes such interventions even more challenging than previously.

It is beyond the scope of this report to define elements necessary for promotion of the type of collaborative community discussions that address the balance between the imperative of constraining potentially lethal methods of suicide and the wishes of most community members who are not at risk and might be inconvenienced. But just such discussions are necessary if further, meaningfully broad-based interventions are to be implemented. Although we have expressed concerns about the media's potential to serve as a powerful vector for spreading contagion, these venues of information dissemination can effectively pass on scientific knowledge and protective guidance. As with discussions about means restriction, broad community participation and dynamic social leadership are necessary.

No one measure, however effective, can sufficiently address the many factors that contribute to regional or national suicide rates. A frank and open discussion of a community's abiding values, legislative or policy changes, continuing community education, consultation about the challenges posed by suicide and its antecedents, and effective clinical management of individual cases are all necessary for prevention programmes.

Contributors

PSFY, EC, S-SC, KC-CW, and Y-YC conceived this report. PSFY and Y-YC wrote the first draft. EC and Y-YC revised the report. SY and S-SC undertook systematic searches of the literature. SY compiled the table in the appendix.

Conflicts of interest

We declare that we have no conflicts of interest.

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