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Controlling firearms use in Australia: has the 1996 gun law reform produced the decrease in rates of suicide with this method?

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■ **Abstract** *Background* Observed reductions in firearm suicides in Australia have been linked to the 1997 national firearms agreement (NFA) introduced following the 1996 Port Arthur massacre. The NFA placed strong access restrictions on firearms. *Aims* To assess the impact of legislative restrictions on the incidence of firearm suicide in Queensland and explore alternative or contributory factors behind observed declines. *Method* The Queensland suicide register (QSR) provided detailed information on all male suicides in Queensland (1990–2004), with additional data for Australia (1968–2004) accessed from other official sources. Trends in suicide rates pre/post NFA, and in method selection, were assessed using negative binomial regressions. Changing method selection patterns were examined using a cohort analysis of 5 years of age classes for Australian males. *Results* The observed reduction in firearms suicides was initiated prior to the 1997 introduction of the NFA in Queensland and Australia, with a clear decline observed in Australian figures from 1988. No significant difference was found in the rate pre/post the introduction of the NFA in Queensland; however, a significant difference was found for Australian data, the quality of which is noticeably less satisfactory. A marked age-difference in method choice was observed through a cohort analysis demonstrating both time and age influences. Within sequential birth cohorts, rates of firearms suicides decreased in younger males but increased in hanging suicides; this trend was far

less marked in older males. *Conclusions* The implemented restrictions may not be responsible for the observed reductions in firearms suicide. Data suggest that a change in social and cultural attitudes could have contributed to the shift in method preference.

■ **Key words** suicide – firearms – method choice – access restrictions – epidemiology

Introduction

Reports of reductions in firearm suicide are widespread, often linked with increases in suicide by hanging, particularly in the young. Gunnell et al [20], for example, in assessing method selection trends in England and Wales between 1950 and 1975, noted that while the firearm suicide rates declined in males across all ages, a 25% increase in the rate of hanging occurred in younger males. Reductions in firearm suicide rates in young males have been particularly noted [8, 28].

While restricting access to means constitutes an effective strategy in preventing suicide [16], there is increasing awareness that method choice is influenced by both availability and socio-cultural acceptability [11, 29, 35]. Durkheim [19] first recognized the importance of social influences on suicide method choice. More careful consideration of such factors has led, for example, to the articulation of “choice structuring properties” [14], these including familiarity with the chosen method, technical skills, pain, lethality, and dramatic impact in addition to accessibility.

Consequences of means restriction were rather convincing in cases such as the detoxification of domestic gas [25] and access to jumping sites [7, 9], but less defined in firearms access. Lester [26], for example, evidenced inconsistencies in the associations between reduction of suicide and gun control

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restrictions. Miller and Hemenway [30] concluded that while most researchers identify gun availability as a risk factor for youth suicide in the United States, the evidence for adults was less compelling. More recently, Hahn et al [21] concluded that available data were insufficient to determine the effectiveness of any of the firearms laws reviewed. Contrarily, an Austrian study on the implementation of licensing restrictions has demonstrated positive results [23].

The national firearms agreement (NFA), introduced in Australia in 1997 after the Port Arthur Massacre in April 1996, has been pinpointed as a further demonstration of the impact of firearms access restrictions. The legislation, placing strong restrictions on weapon access and storage [12, 32], was targeted at violent crime. This restriction was not, however, the first attempt to reduce firearm deaths. The NFA followed a series of mass shootings between 1981 and 1996, in which over 100 people died. In 1987, a meeting between State and Commonwealth leaders was convened to discuss firearm violence. This resulted in the formation, in 1988, of a National Committee on Violence charged to look at the wider occurrence of violence in the Australian community [3]. Increased limitations on firearms in individual States also occurred at this time: for example, a tightening in the restrictions on semiautomatic longarms in Victoria [32] and the introduction of the *Weapons Act, 1990* in Queensland, introducing a “cooling off” period before buying a firearm [11].

Significant decreases in firearms suicides in Australia, beginning prior to 1996, have been reported [5, 12, 17, 31, 32]. An earlier analysis of hanging and firearm suicides across Australia found opposing trends in the rates of these methods, following a decline in firearm suicide in 1987 [17]. Chapman et al. [12], in assessing pre/post NFA mortality rates, found no significant drop in deaths by assault, but identified a significant acceleration in the rate of decline in firearm suicides, along with a perplexing increase in the rate of accidental deaths. Although there has been some criticism of the analytic approaches used to assess the impact of the NFA [31], data on firearm suicides are relatively consistent in showing sustained reductions in rates post-NFA [5, 12, 32], suggesting that the reductions were the result of the regulatory reform.

There are acknowledged issues with the quality of recent suicide data [1, 2, 15]. Caution has been recommended in the interpretation of data on external causes of death in years leading up to 2004 [1]. Identified impacts of data quality issues include increases in accidents such as firearm discharge, with parallel reductions in suicide [2].

So far, assessments of the effects of the NFA rely on ABS data, which report a 29% decline in suicide rates in Australia from 1997 to 2004 [1]. However, the questionable quality of these data has the potential of confounding the real impacts of access restrictions

and the explanation behind the overall decline in firearms suicides.

This study re-examines the decline in firearm suicide pre/post the 1996 NFA using the more accurate data on the incidence of suicide in Queensland from the Queensland suicide register (QSR). This analysis challenges claims that the introduction of the NFA has, in itself, reduced firearm suicides. Possible alternative explanations are presented and discussed.

Method

The analysis was confined to males. Females have a low incidence of firearm use and suicide through this means, with suicide by firearms strongly perceived as a male suicide method [27]. Data from the QSR confirms this perception, with over 20% of males but less than 5% of females choosing firearms as a method. While high rates of suicide have been observed in Indigenous populations, the low incidence and limited use of firearms by this group precludes a separate analysis.

Data on suicides in Queensland were accessed from the QSR, a state-wide suicide register detailing suicides in Queensland from 1990 to present day. The data in this register have been derived from Police reports on all cases of suicide in Queensland 1990–2004. The characteristics and use of this database are well documented elsewhere [18]. National data were sourced to provide information on suicide incidence and a population of reference (1968–2004) for Australia and Queensland [4].

Key policy interventions impacting on the social acceptability and accessibility of firearms were used to define the time periods used in analysis. Specifically, these were: increased public concern and debate on firearms following the establishment of the National Committee on Violence in 1988 [3] and the associated introduction of firearms legislation in Victoria [32], and the 1997 implementation of firearm access restrictions under the 1996 NFA. Consequently, we chose to compare 1988–1996 to 1997–2004, with the Queensland comparison limited to 1990–1996 and 1997–2004, due to the creation of the QSR in 1990.

Tabulated data of 5-year rates for hanging/firearms [4] were used to undertake a cohort analysis detailing trends in method selection across age groups. Data from the Queensland Police Service Firearms Registry on licenses and licensed weapons 1997–2007 provided an indicator of the change in the overall distribution of arms in the community. To better visualize Australian data, the period of observation was extended retrospectively to 1968.

Statistical analysis

Regression approaches were used to assess the effect over time on the rate of firearm suicides. Poisson regression models are increasingly used in analyzing trends in suicide rates, providing a capacity to ensure non-negative values and also compare trends pre/post intervention. Negative binomial regression has recently become a popular alternative to Poisson regression due to its capacity to account for overdispersion, commonly encountered in count data [22]. The negative binomial model adds an additional parameter allowing the mean and variance to be estimated separately. Trends in suicide rates by different methods (1990–2004), pre/post NFA restrictions (1990–1996 Queensland, 1988–1996 Australia, and 1997–2004 Queensland and Australia) were analyzed using a negative binomial regression (GENMOD Proc SAS version 9.1). Slight overdispersion was noted, though the results are likely to be almost identical to an analysis using Poisson regression. The predicted values were presented against the observed rates. Parameter estimates and confidence intervals of the rate ratio for each model were reported along with the significance of the trend

(χ^2 statistic) and the ratios of pre/post trends. Two-tailed significance was set at 5%. The log of male population numbers were used as an offset in this procedure. Other descriptive analyses were undertaken using SPSS Version 14.

Results

Between 1990 and 2004, the QSR documents 6,202 cases of male suicides, with 1,274 (20.5%) of these by firearms and 2,233 (36.0%) by hanging. Trends in rates for Australia and Queensland are provided in Fig. 1, with details in Table 1. The total male suicide rate, 1968–2004, is around 20 suicides per 100,000 for Australian and a bit under 25 per 100,000 for Queensland males. While the Australian rates show a decline from 2001, this is not observed in the Queensland data [15].

The incidence of firearm suicides is presented across 3 time periods: 1968–1987, 1988–1996, and 1997–2004 (Queensland data only available for 1990–

2004). Prior to 1988, the rate of firearm suicides in Australia was around 6 per 100,000.

For Queensland significant declines in firearm suicide rates were observed both before and after the introduction in the NFA—7.2% before (rate ratio 0.9283, $P < 0.0001$) and a lesser 6.5% after (rate ratio .9350, $P = 0.0002$), resulting in a 2004 suicide rate of 2.2 per 100,000. No significant difference was observed between these trends ($P = 0.7794$). For Australia, while significant declines were observed before and after the NFA (1988–1996: 3.9% reduction, rate ratio 0.9606, $P < 0.0001$; 1997–2004: 7.1% reduction, rate ratio 0.9291, $P < .0001$), resulting in a 2004 suicide rate of 1.7 per 100,000, the difference between these trends was significant ($P = 0.0102$).

■ Availability of firearms

Accurate data on the availability of firearms has, in the past, been limited [13], with more rigorous

Fig. 1 Suicide rates for Australian and Queensland males for (A) total suicide, and (B) firearms suicide from 1968 to 2004. 1 and 2 refer to points of policy intervention: (1) establishment of National Committee on Violence; (2) NFA passed. Source: Australian rates, AIHW 2005; Queensland rates, QSR

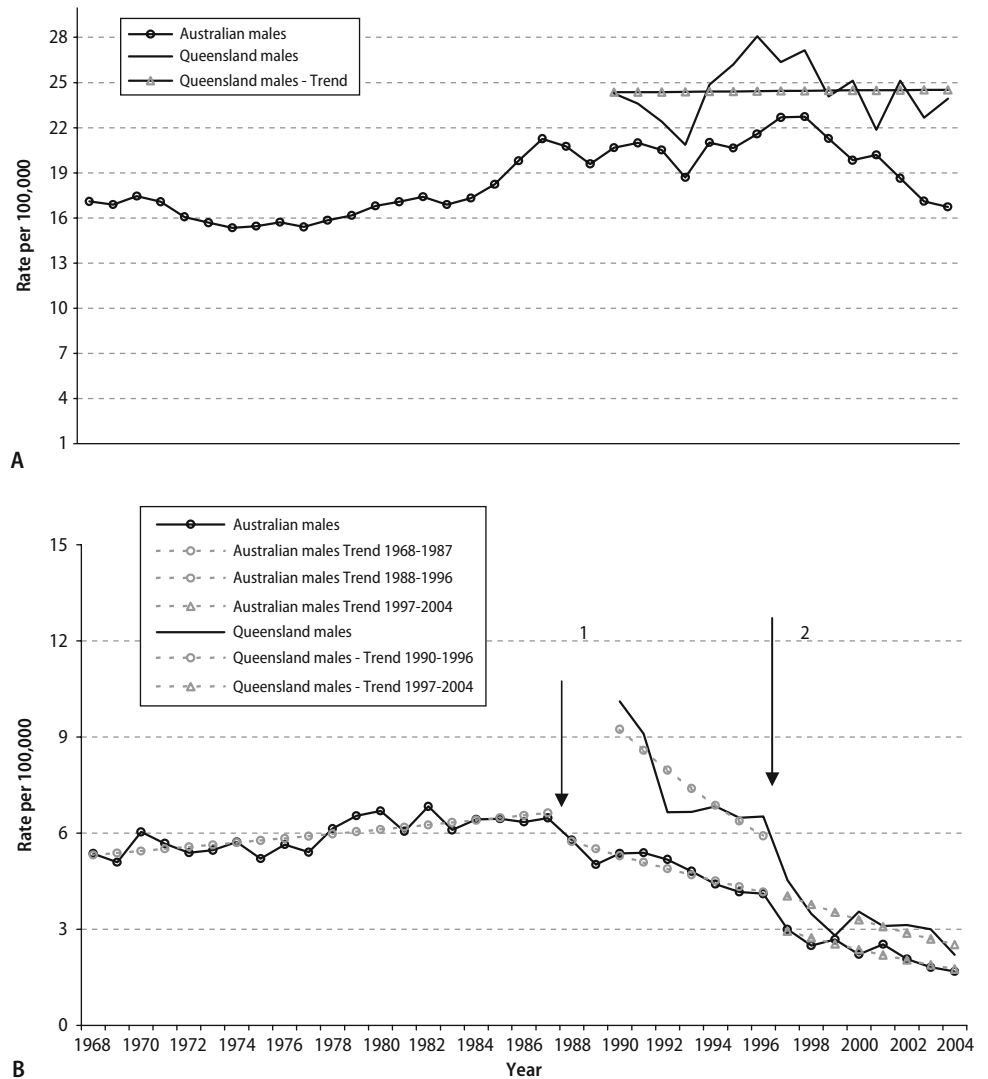


Table 1 Results of negative binomial regression analyses from Figs. 1 and 3, for total male suicide rates Queensland 1990–2004, suicide rates for males by suicide method, Queensland 1990–2004 and male firearm suicide rates, Australia 1988–2004

| Model | Trends rate ratio (95% CI) | Test for trend change | |
|---|---|-----------------------|---------|
| | | χ^2 | P |
| Total suicide rates Queensland 1990–2004 | | | |
| Queensland 1990–2004 | 1.0005 (0.9911, 1.0099) | 0.01 | =0.9100 |
| Rates by method, Queensland, 1990–2004 | | | |
| Firearms | 0.9030 (0.8891, 0.9171) | 166.84 | <0.0001 |
| Hanging | 1.0703 (1.0441, 1.0969) | 29.12 | <0.0001 |
| Poisoning | 0.9822 (0.9643, 1.0004) | 3.67 | =0.0553 |
| MVCO | 1.0054 (0.9823, 1.0291) | 0.20 | =0.6513 |
| Other | 1.0132 (0.9993, 1.0371) | 1.23 | =0.2677 |
| Pre/Post NFA comparisons: Queensland 1990–2004, Australia 1988–2004 | | | |
| Queensland 1990–1996 | 0.9283 (0.8961, 0.9618) | 16.99 | <0.0001 |
| Queensland 1997–2004 | 0.9350 (0.9022, 0.9689) | 13.65 | =0.0002 |
| Ratio of Queensland slopes (95% CI) | 1.0072, 95% CI: (0.9579, 1.0590) P = 0.7794 | | |
| Australia 1968–1987 | 1.0117 (1.0074, 1.0160) | 28.71 | <0.0001 |
| Australia 1988–1996 | 0.9606 (0.9493, 0.9719) | 44.84 | <0.0001 |
| Australia 1997–2004 | 0.9291 (0.9085, 0.9502) | 41.12 | <0.0001 |
| Ratio of Australian slopes (95% CI) | 0.9672, 95% CI: (0.9429, 0.9921) P = 0.0102 | | |

Source: Queensland, QSR, Australia, AIHW (2005)

reporting mechanisms instituted after the NFA. Past estimates identify the number of arms in Queensland in 1975 at 348,000 in a population of 201,000 firearm owners [33], and estimates in the Australian community in 1988 at 3.5 million weapons [13]. The initial NFA gun buyback scheme recovered 640,000 weapons nationally [12] while further gun amnesty and buyback schemes have been progressed to further reduce the national arsenal. The overall number of registered arms in Queensland from 1997 to 2006 remained at around 500,000, with a slight drop in rate from 150,000 to 130,000 arms per million of population.

Method selection

In Queensland, hanging and firearms suicide showed significant and opposing trends during 1990–2004 (firearms: $\chi^2_1 = 166.84$, $P < 0.001$, hanging: $\chi^2_1 = 29.12$,

$P < 0.001$) (Fig. 2, Table 1), with the decline in firearm suicides initiating prior to 1990. Non-significant trends occurred in all other methods; further analysis is restricted to comparisons of trends in hanging and firearms in males.

Trends in age and method

Patterns of method selection and age of subjects are shown in Fig. 3. While trends for Australia and Queensland show similar patterns, there are clear differences between methods. Between 1968 and 1987, the mean age of Australian male suicides by firearms and hanging declined by 1.5 and 7.2 years, respectively. Although little change was seen from 1988 to 2004 in suicides by hanging, the average age of firearm suicides showed an increase of 10.9 years. Overall, while the change in mean age of Australians

Fig. 2 Rates of male suicide in Queensland by suicide method 1990–2004, with trend from negative binomial analysis shown for hanging and firearms suicides. Source: QSR data

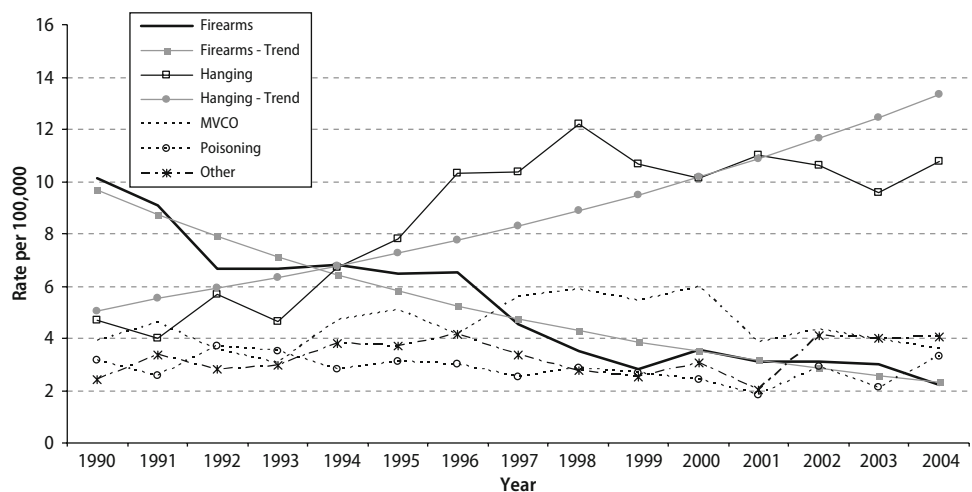
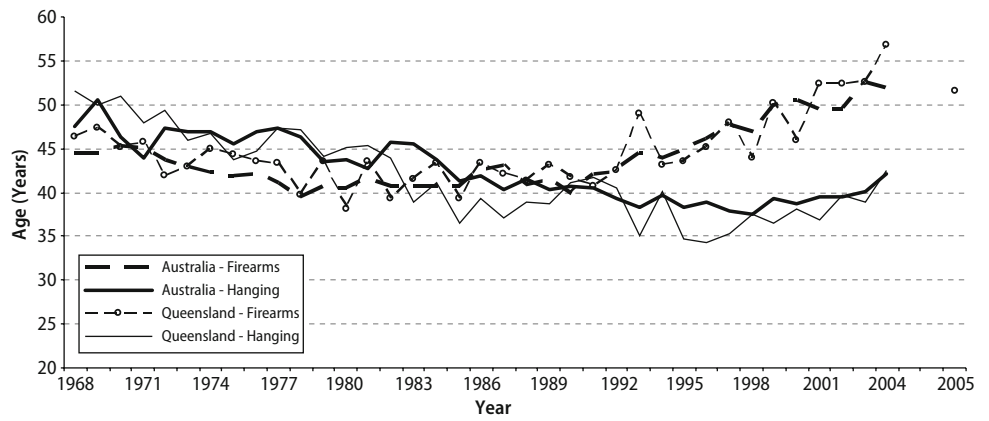


Fig. 3 The average age of males, firearms and hanging suicides, for Australia and Queensland 1968–2004 Source: AIHW, 2005



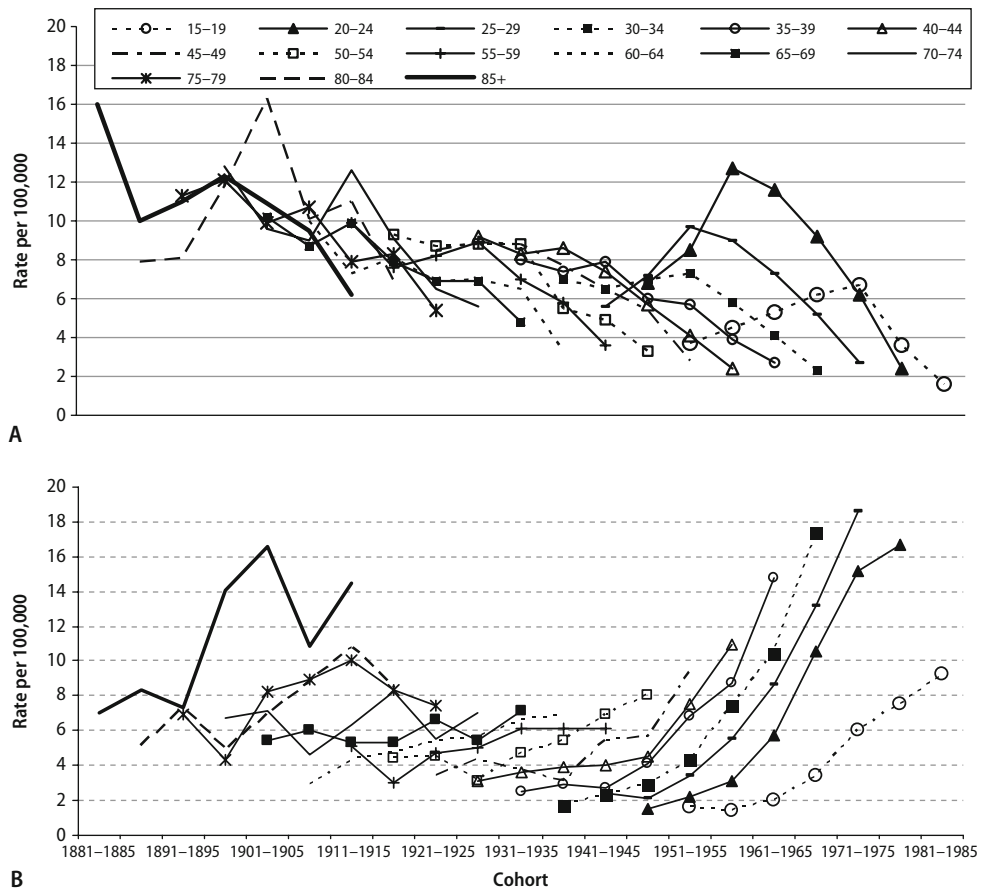
who selected hanging over this period dropped by 12.8%, the mean age of those who used firearms increased by 14.1%.

Opposing trends in age and birth cohort by method were observed through a cohort analysis for Australian hanging and firearm suicides (Fig. 4). A general downward trend occurred in suicide rates by firearms, from around 14 per 100,000 in the earliest cohort (1881–1885: 85+ males) to under 2 per 100,000 in the 1981–1985 cohort (15–19-year-old males). For those under 30 years of age, a slight peak

in rates was observed around the mid 1980's, followed by a clear decline in rates across all age classes. The decline started earlier in young males (around 1985); in older subjects the decline can be observed from 1990.

In suicides by hanging, the greatest increases were in the younger males, with the 20–24 and 25–29-year-olds showing increases from 1.5 to 16.7 and 2.4 to 18.6 per 100,000 respectively. A much flatter trend is seen in the older males, with the exception of the 85+ year olds, where the rates increase from 7.0 to 14.5 per

Fig. 4 Australian male suicides by method—(A) firearms or (B) hanging, by successive 5 year birth cohorts at different ages. Source: AIHW (2005)



100,000, peaking at 16.6 per 100,000 in the 1901–1905 cohort.

Discussion

Significant reductions in firearm suicides occurred in the considered timeframe. A marked age difference was noted in method choice with, in 2004, Australians selecting firearms being 9.7 years older than those choosing hanging. This difference was even more marked in Queensland: 14.1 years. Differences in the trends of firearm suicide were also observed with the initial rates in Queensland in the 1980's relatively high with more significant subsequent declines observed.

Our findings do not support previous research suggesting that the most significant impact on firearm suicides is related to the implementation of the NFA [5, 12, 31, 32]. Possibly, differences in data quality and time periods analyzed are at the base of this discrepancy, with the decline in firearms suicide starting prior to 1990 also requiring explanation.

Under-reporting of various external causes of death, including suicide, transport accidents and assaults has been identified in recent years [2], with the QSR demonstrating approximately 30% higher numbers than the official data in 2004 [15]. Use of official data in previous research has supported conclusions rejecting method substitution [12] or, alternatively, the success of suicide prevention strategies [5].

While under-reporting of firearm cases appears to be less probable than for other suicide methods [24], the identified data issues [2] relating to the coding of open cases suggests a suicide rate higher than reported, increasing the likelihood of a Type 1 error—a significantly higher post NFA Australian firearm suicide rate. The non-significant finding for Queensland data, based on a smaller population, could be due to a Type 2 error, however, given the reduced rate of decline in firearm suicide post NFA, this appears less likely.

The period of time selected to analyze pre-NFA trends also appears particularly influential in establishing any effectiveness of the NFA, for example, the interval 1979–1996 was used in previous research on firearm accessibility [5, 12]. In this study, the period 1988–1996 was compared to 1997–2004. Although a significant change pre/post NFA was found for Australian data, no significant difference was found for Queensland data, with a steeper slope actually recorded for the pre-NFA period. It has to be noticed that the choice of two time intervals of similar length for Queensland (7 years pre-NFA and eight years post), more balanced compared to previous studies, was simply dictated by the availability of QSR data only from 1990 on.

In trying to provide an interpretation of the observed phenomena, we are aware of a few social changes that could have particularly contributed to

the observed trends in firearm suicide. Among those already described in Australia are the increased migration of young males from rural areas to cities [6] and the social impact of major cases of mass murder involving firearms that occurred in recent years [12].

The migratory flow from rural to urban environments may have had some repercussions on rates of firearms suicide given the much greater use of firearms in country areas [34]. In addition, rural environments are traditionally characterized by the presence of stereotyped views about masculinity, which solidly link firearms use to male subjects [10].

In Australia, a change in the public acceptability of firearms seems to have particularly occurred as a consequence of the Port Arthur massacre, in 1996. In that occasion, a killing spree claimed the lives of 35 people and left wounded 37 others. Similar changes in attitudes were also noted elsewhere. For example, in 2,000, in the US the “Million Mom March” witnessed the participation of 750,000 people, who rallied to encourage a stricter gun control [36].

In parallel with a reduced public acceptance of firearms, there has also been a change in attitudes towards hanging, seemingly both in Australia and internationally. A possible contributor to this could have been the ending—in most countries—of capital punishment by hanging, this removing the stigma of hanging as associated to criminal behavior [19].

While significant differences before and after the introduction of the NFA in firearms suicide trends were not consistently found (i.e., no significant variations in Queensland data), it is obviously not possible to deny some influence of NFA in contributing to maintaining the declining trend. It is of note that rendering access to weapons more difficult would particularly impact on impulsivity of subjects, particularly those of younger age [37].

However, sustained suicide rates by firearms still characterize older males, while in younger males increases in the selection of hanging preceded the decline in firearms suicides, suggesting the presences of some age differentiated factors. On the other hand, older adults are less sensitive than youth to cultural changes and much more protective of their usual habits. In addition, it is plausible to speculate that older males may have, in general, more familiarity with firearms than young subjects. In fact, older adults were borne before World War II; they have seen firearms readily available over the counter, and are likely to have used them in a relatively informal manner. Younger generations had much less exposure to firearms. Many would never have observed over the counter sale, open availability or informal use of arms. Exposure to capital punishment through hanging would also be different, with the older males aware of numerous events, and young males mostly borne after the cessation of the death penalty. Finally, Australians in recent years saw 13 mass shootings, which involved 112 deaths. This was probably behind

the 90–95% approval ratings recorded among community members in favour of the gun laws introduced [12].

Limitations of the study

The Australian Bureau of Statistics has recognized weaknesses in recent Australian suicide statistics [1, 2], and has cautioned against interpretations being made from these data. This issue has arisen from differences in coding practices particularly where there was incomplete source information. In particular, a remarkable number of cases of suicide could have been classified as accidents, with this problem most evident for 2002–2004 [1, 2, 15]. Although this issue is likely to have affected firearms suicides less than other causes of suicide [23], the finding of a significant increase in deaths due to firearms and judged to be accidental in the years after the implementation of the gun laws [12] adds further caution in interpreting official statistics. A possible consequence, for example, could be that the significant difference between slopes pre/post NFA in Australian data may disappear.

Accessibility to firearms is particularly difficult to determine, with measures of firearms ownership used in other researches including also subscriptions to gun magazines [26]. In this investigation, data on legally registered arms represent only one proportion of the overall number of firearms present in the community; given the existence of firearms illegally detained, this number surely constitutes an underestimation of the real number. In any case, the presence of firearms does not provide proof that individuals in fact had access to this means. Current research is being undertaken to determine the association between suicide cases through firearms and firearms ownership in Queensland. This study would provide information not only on suicides through illegally detained firearms, but also on cases of subjects with a registered firearm who committed suicide with other methods.

Conclusions

The present study demonstrated that the initial reduction in the rate of firearms suicide in Queensland, initiated prior to 1990, continued at the same rate after the intervention of the 1996 NFA. Of course the influence of later restrictions cannot be ruled out. With the restrictions not implemented until 1997, the explanation for the observed decline draws on a number of factors, some of them presumably of a socio-cultural nature. Changes in method preferences by young males, increasingly evident across birth cohorts, supports the hypothesis of a greater acceptability of hanging compared to firearms. This pref-

erence is likely to be enhanced both by the strengthened legislation reducing accessibility and also reinforcing the reduced social acceptability of firearms. A more complete understanding of the mechanisms contributing to reductions in suicide incidence associated with access restrictions would improve suicide prevention efforts.

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Conflict of interest: None

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