

Simple Statistics – not always as simple as they seem!

Summary:

- There are many different statistical methods, and different methods can produce different results.
- Australia's 1996 gun laws provide a useful illustration of this principle.
- The way data is grouped to look at rates of decline in firearm deaths pre- and post-laws is important.
- If 1979-1996 is compared with 1997-2003, it emerges that there is no change in the rate of decline in firearm homicides or suicides following the introduction of the 1996 laws.
- However, if 1996 is included in both the pre- and post-law groups (1979-1996 vs 1996-2003), the high firearm homicide rate in 1996 alters the results and overall interpretation.
- Including 1996 in the post-law group gives the impression that firearm homicides declined more rapidly after the laws were introduced.
- This interpretation is simply a product of including the 1996 rate of firearm homicides (a 'statistical outlier') in the post-law data group.

Background

Research is a vital foundation for public policy and legislation, and enables effective allocation of attention and resources. Research, in turn, involves statistics.

The mere mention of statistics can be enough to provoke slumber, but statistics are used every day to make points, support arguments, or disprove theories.

The problem is that statistics can be misused, misunderstood, and misinterpreted.

Firearms legislation is an excellent, and invariably controversial, example of the use and misuse of statistics. Indeed, much debate over gun laws comes down to different analyses and interpretations of the same information!

There are hundreds of different ways in which different statistics can be applied to one set of numbers, and different methods give different results. Sometimes the difference is inconsequential, but other times the difference is enough to completely change interpretations of what has gone on in the ‘real world’.

Australian data provides an excellent illustration. In 1996, Australia introduced some of the most stringent firearms legislation in the developed world, but researchers still dispute the effects of that legislation on gun deaths (as well as deaths overall, a topic not covered in these notes).

A method commonly used to address the question “did the 1996 legislation reduce gun deaths” is simple linear regression. This is sometimes referred to as ‘parsimonious’ regression.

Regressions try to use one variable (time, for example) to predict another (such as the rate of gun deaths). Regression is a good way to examine changes over time. Using regression, we can ask “did gun deaths decline more quickly after 1996 than they did before 1996?”.

A helpful way to visualise linear regression is by plotting data points on a graph, and then applying a “line of best fit”. This gives a measure of how the data is changing over time.

For example, the graph below shows the line of best fit for firearm suicides in Australia from 1979 to 2003.

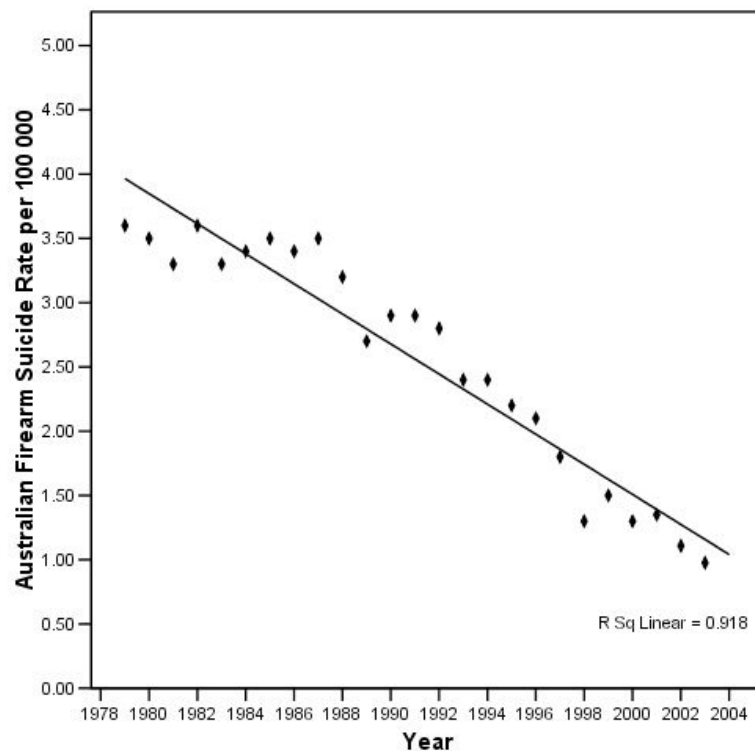


Fig. 1: Firearm suicide rates from 1979-2003.

From this, we see that there has been an ongoing decline in firearm suicides over time – but this doesn’t answer “before and after” questions.

Because there is a downwards trend throughout the data, we cannot ask “were there less deaths, on average, after 1996 than before?”. When a downward trend over a period of years is present, figures at the ‘later’ end will by definition be lower than those at the ‘earlier’ end. What we have to ask is “did the *rate* at which firearm deaths declined *change* after 1996?” (in other words, did the downwards trend become “quicker” after the tougher laws were implemented).

How can ‘rate of change’ be assessed?

First, split the data into two groups: a “pre-laws” group (1979-1996) and a “post-laws” group (1997-2003). Once this is done, the two groups can be compared.

These examples show firearm suicides (Fig.2) and firearm homicides (Fig. 3) , looking at the rates of change over time within the pre- and post-laws groupings:

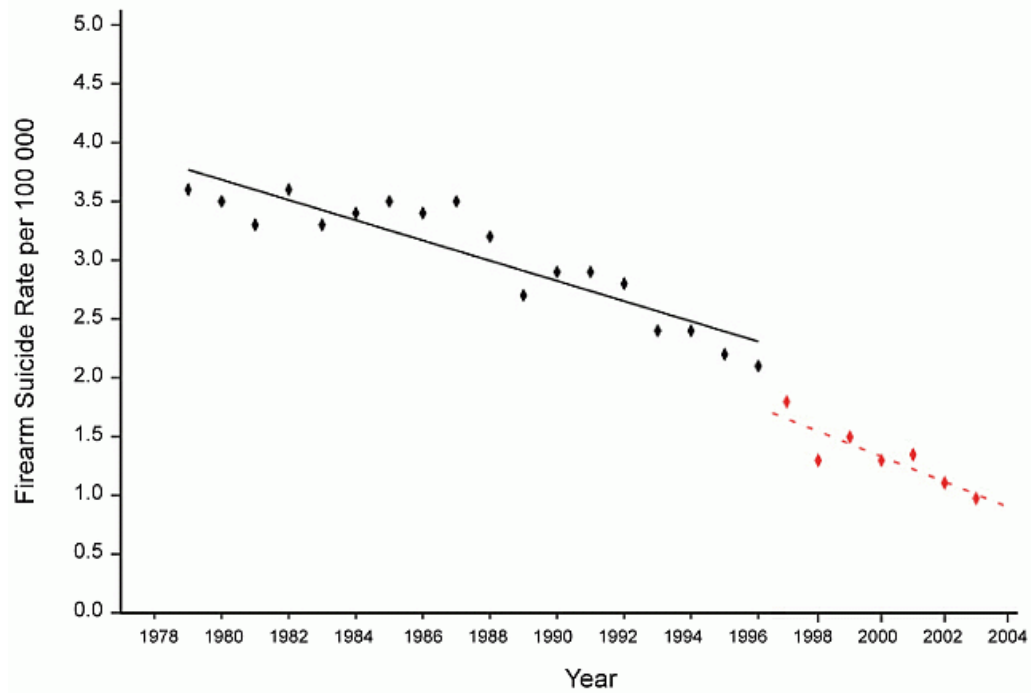


Fig. 2: Firearm suicide rates per 100 000 population, 1979-1996 vs 1997-2003

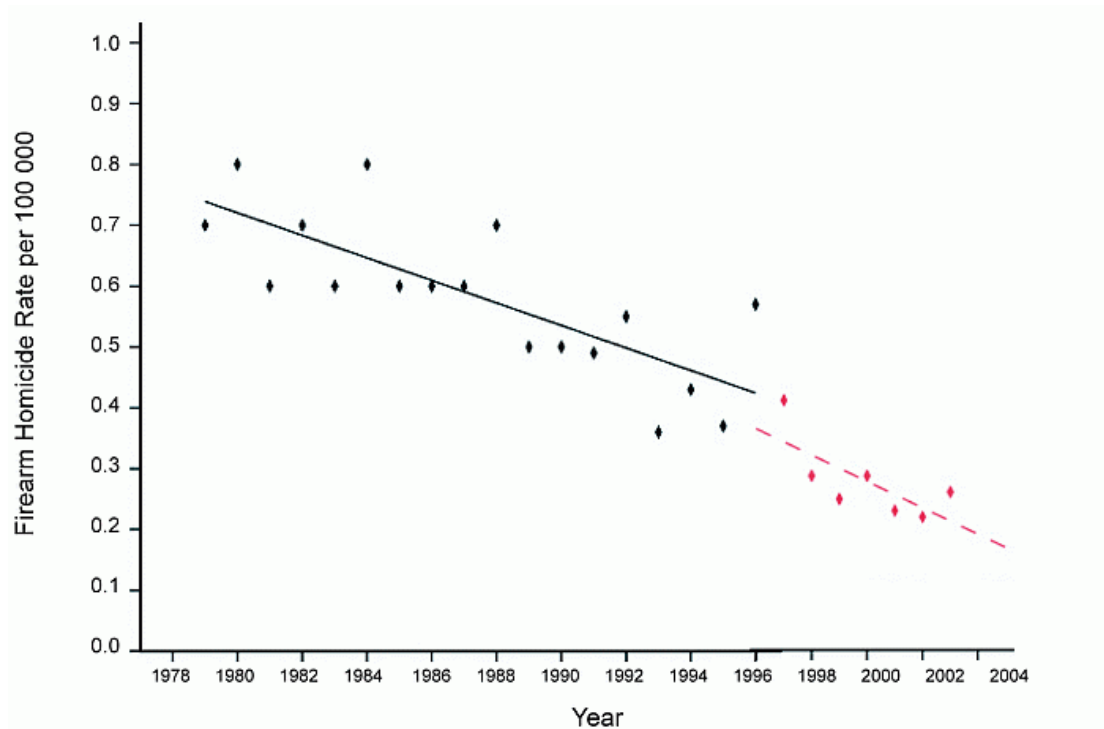


Fig. 3: Firearm homicide rates per 100 000 population, 1979-1996 vs 1997-2003

Using these data groupings, we find that the rate at which firearm suicides and homicides declined was the same pre- and post-laws. Firearm deaths did not decline more rapidly after 1996.

However, just look at the difference if we change our grouping method slightly, this time looking at 1979-1996, versus 1996-2003.

In this case, 1996 has been included twice (as the endpoint in the “pre-laws” group, and the startpoint of the “post-laws” group). The inclusion of 1996 twice is important, and will be discussed later.

Figure 4 shows firearm suicide rates 1979-1996 vs 1996-2003. Figure 5 shows homicide rates 1979-1996 vs 1996-2003.

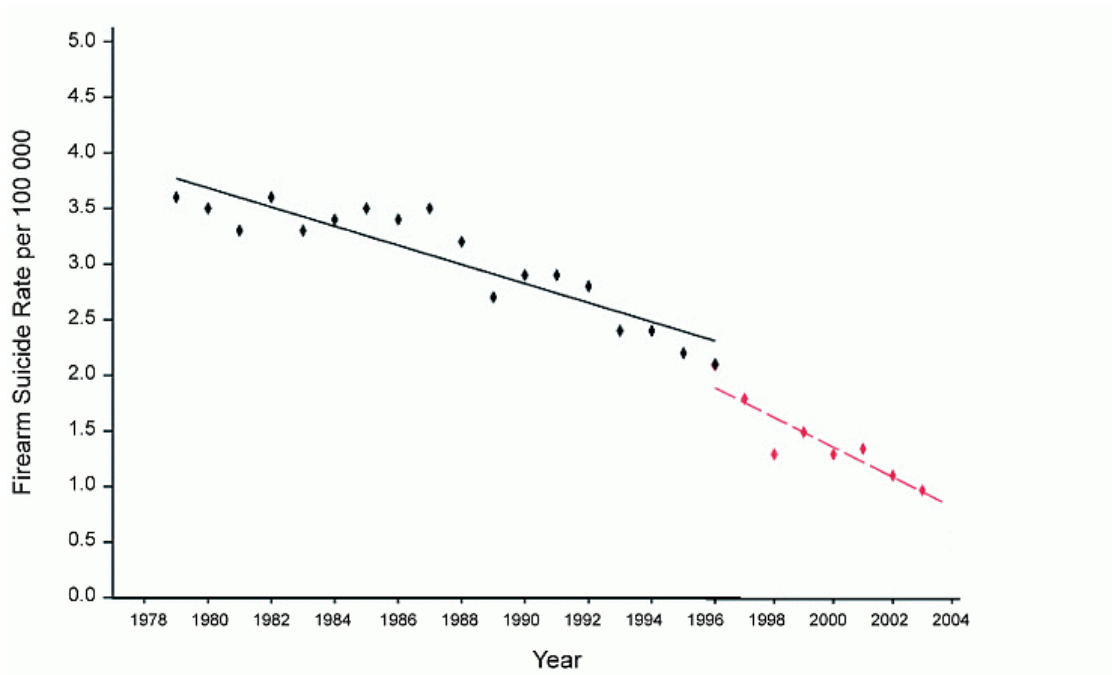


Fig. 4: Firearm suicide rates per 100 000 population, 1979-1996 vs 1996-2003

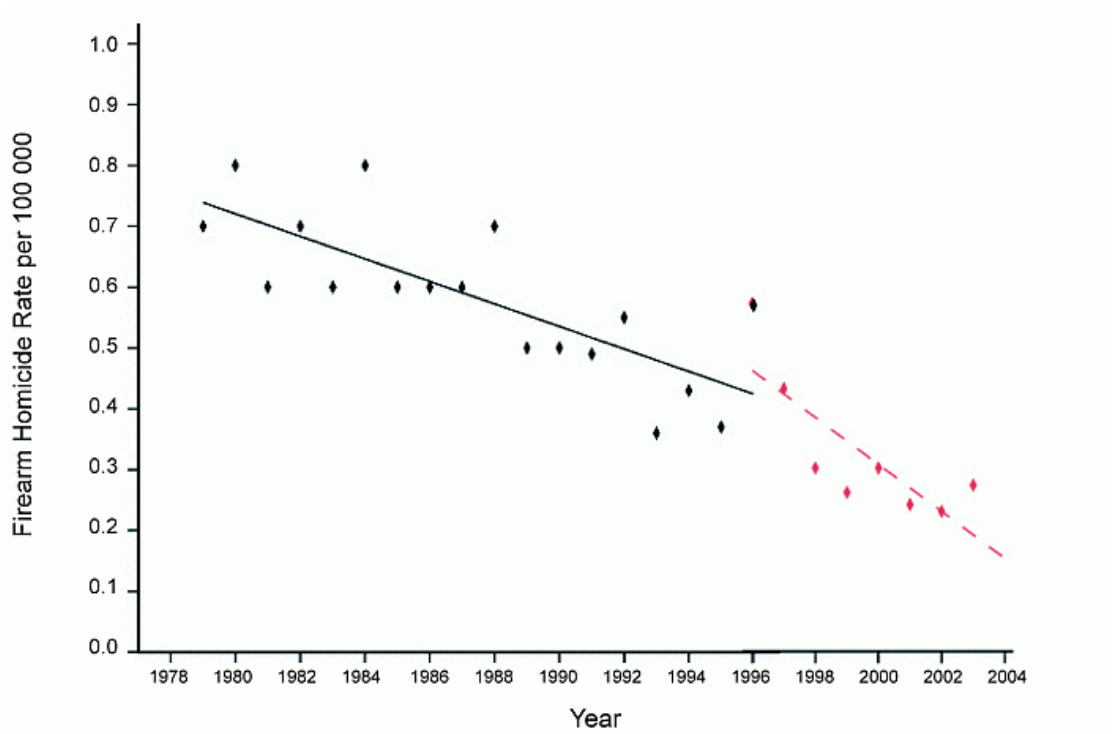


Fig. 5: Firearm homicide rates per 100 000 population, 1979-1996 vs 1996-2003

For firearm suicide rates, using 1996 twice doesn't make a big difference. However, if 1996 is included in the post-laws group there emerges a striking difference in the rate of decline in firearm homicide rates, compared with the post-laws group based on 1997-2003 data.

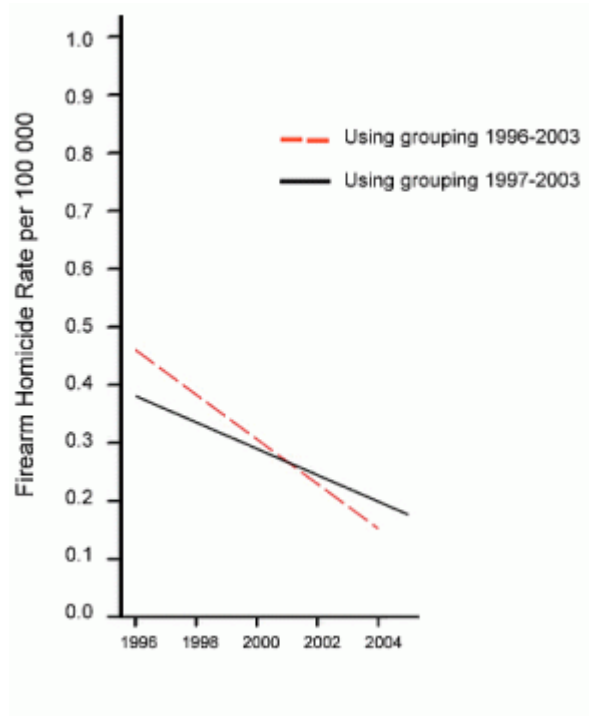


Fig. 6: Comparison of trends for 1997-2003 vs 1996-2003

One very small difference in the way “groups” are defined dramatically changes every other result. In this case, the change in groupings alters whether or not the corresponding statistics tell us that a significant change in the rate of decline has taken place.

Using 1979-1996 vs 1997-2003, there is no change in the decline in homicide rates pre and post-laws. We would conclude that firearm homicide rates did not decrease more rapidly after the 1996 laws.

However, if we look at 1979-1996 vs 1996-2003, it appears as though there occurred a sudden decrease in firearm homicides post-laws, relative to pre-law rates. This would lead us to believe that the laws were followed by a significant change in the rate of decline in firearm homicides.

Why did this happen?

The answer is simple: in 1996, the Australian firearm homicide rate was high due to the Port Arthur mass killing.

This does not make a great difference in the “1979-1996” group, because the higher than usual firearm homicide rate for 1996 is still much lower than the firearm homicide rates for the first years in the group (this is what happens with downwards trends).

So, the firearm homicide rate for 1996 didn’t make a difference to the overall trend over the 17 year time period 1979-1996, even though it did slightly elevate the ‘end’ of the trend for that period.

However, the high firearm homicide rate in 1996 had a big effect on the “1996-2003” group – because in that group, 1996 represents a “statistical outlier”.

Including statistical outliers in a small sample (just 8 years for 1996-2003, compared with 17 in the pre-laws group) can have a remarkably strong effect on the results.

That is why including 1996 in the “post-laws” group makes a dramatic change to subsequent statistics and, ultimately, the way we interpret the results.