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Evaluation of the Adelaide Hills speed limit change from 100 km/h to 80 km/h

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ABSTRACT

In January 2002 the speed limit was changed from 100 km/h to 80 km/h on 18 sections of roads in the Adelaide Hills area. An analysis has been conducted of the effect that these changes had on the number of casualty crashes and casualties occurring on these roads. A before and after comparison was made for the five years before and five years after the changes: an eight per cent reduction in casualty crashes was found. Comparisons were also made with trends in crash data and with relevant control groups, with the aim of accurately representing the effect of the speed limit change while taking into account any unrelated system wide effects. Different comparison methods lead to different estimated reductions in casualty crashes. For example, not using a control group, and assuming a trend of 1.3 per cent per annum increase (based on population growth) implies an estimated reduction of 15 per cent. Whichever method is used, the estimate of the change is not statistically significantly different from zero. The merits and failings of the different methods are discussed.

KEYWORDS

Speed limit, Crash reduction, Adelaide Hills, Before-and-after

Summary

In January 2002 the speed limit was changed from 100 km/h to 80 km/h on 18 sections of roads in the Adelaide Hills area. The treated roads are state owned and are managed by the Department for Transport, Energy and Infrastructure (DTEI).

An analysis has been conducted of the effect that these changes had on the number of casualty crashes and casualties occurring on these roads. A before and after comparison was made for the five years before and five years after the changes: an eight per cent reduction in casualty crashes was found. Comparisons were made with trends in crash data and relevant control groups, with the aim of accurately representing the effect of the speed limit change while taking into account any unrelated system wide effects.

There are a number of ways to evaluate the effects of the change: they differ regarding how to predict what would have happened had no speed limit change been made. For example, it might be assumed that there would have been no change in casualty crashes had the speed limit remained at 100 km/h, or it might be assumed that there would have been an increase of six per cent per year, based on the trends in the annual crash numbers before and after the change.

The different comparison methods and the related estimated reductions in casualty crashes for the treated roads are as follows:

- No control group, assume no change in crash numbers would have occurred, i.e. trend of 0% p.a.: estimated reduction 8%
- No control group, trend of average 6% p.a. increase estimated from data: estimated reduction 36%
- No control group, assumed trend of average 1.3% p.a. increase based on population growth: estimated reduction 15%
- Control group A (same geographical area, roads where speed limit was not changed) no change observed: estimated reduction 8%
- Control group B (a different, but nearby, geographical area) 4% reduction observed: estimated reduction 3%

Whichever method is used, the estimate of the change is not statistically significantly different from zero.

The merits and failings of the methods are discussed. Given the different methods it appears reasonable to conclude that the crash reduction attributable to the speed limit change is the 15 per cent derived by adding seven per cent (itself the population growth) to the eight per cent casualty crash reduction.

Contents

1 Introduction

At the beginning of 2002 the speed limit on a number of roads in the Adelaide Hills was reduced from 100 km/h to 80 km/h. The change in speed limit came about as a result of a review of speed limits conducted by the Department for Transport, Energy and Infrastructure (DTEI), covering all DTEI roads in the Adelaide Hills (the areas of the Adelaide Hills Council and the District Council of Mount Barker).

We have conducted a before and after evaluation of casualty crash numbers associated with the reduction of speed limit on sections of some DTEI roads in the Adelaide Hills. Comparisons were made with casualty crash numbers on the remaining roads in the Adelaide Hills area, with roads in the surrounding council areas, and with trends in casualty crashes. Corresponding calculations for the number and severity of casualties, and the associated cost to the community have also been made. We have also asked whether there has been any statistically significant change in casualty crash numbers.

Woolley and Dyson (2003) analysed traffic speed and volume data from thirteen sites in the Adelaide Hills approximately six months before and after the introduction of the 80 km/h limit. The measurements were taken over a period of just over a week, with seven consecutive days of data used for their analyses. Analysing data for weekdays only, they found mean travelling speeds dropped by 2.5 km/h, 85th percentile speeds by 4.3 km/h and 95th percentile speeds by 4.8 km/h. The speed analysis indicated there was a drop in travelling speeds, but there were not enough measurements to confirm this was an effect of the treatment.

Section 2 of this report gives background information about the change in speed limit and its implementation. Sections 3, 4, 5, and 6 follow the conventional pattern of methods, results, discussion, and conclusion.

2 Background: the speed limit changes made in the Adelaide Hills

The Adelaide Hills or the Hills, as referred to in this report, means the areas of the Adelaide Hills Council and the District Council of Mount Barker, a total area of approximately 1390 square kilometres to the east of the Adelaide metropolitan area.

The changes to speed limits, from 100 km/h to 80 km/h, occurred in the Adelaide Hills on 18 road sections of DTEI maintained roads. The lengths of the road sections range from less than a kilometre to almost thirty kilometres, half of them being less than ten kilometres in length. Some of the longer sections pass through small towns which have existing 60 km/h or 50 km/h speed limits in place. The resulting total length of changed road sections is less than 128 kilometres.

The change in speed limit involved the installation of 100 new signs, most displaying the new speed limits and some to remind drivers of the change. These signs were installed through January 2002 and installation was completed by the end of the month. The new speed limit was effective and was enforced by the South Australia Police (SAPOL) as soon as the new signs were installed on each road.

All sealed DTEI roads with a speed limit of 100 km/h, lying in the Adelaide Hills Council and the District Council of Mount Barker were assessed. According to Woolley and Dyson (2003), the speed limits were set based on traffic engineers' assessments of suitable speed limits, according to the characteristics of the roads and the speed zoning principles of the Australian Standards. The roads under consideration all had their speed limit notionally set at 80 km/h, with the original 100 km/h limit re-assigned only in cases where a set of predetermined criteria were met (Simons 2002). Through this process, the 'treated' roads, where the speed limit was changed from 100 km/h to 80 km/h, were predominantly winding Hills roads where a 100 km/h limit could not be justified; affecting 40 per cent of the state owned 100 km/h road network in the Adelaide Hills.

Between the end of May and the end of June 2002 further 100 km/h to 80 km/h speed limit reductions occurred in the Hills on a number of council managed roads. These changes were completed with the installation of the new speed limit signs by DTEI and affected 124 local roads. This was reported in The Advertiser, the daily newspaper of Adelaide, on 29 May 2002. Evaluation of these further changes was not in the scope of this report and the crash occurrence on these roads has not been investigated. However, the local government managed roads where further changes occurred were identified, in order to be excluded from control groups used in this report.

3 Method of estimating the effect of the speed limit reduction

Sections 3.1, 3.2, and 3.3 describe the dataset, the processing with respect to crashes on the roads where the speed limit was changed, and the processing with respect to crashes on the control roads. Section 3.4 discusses how a before-after comparison might be made without a control group, Section 3.5 discusses the use of a control group, and Section 3.6 outlines why we prefer one of the methods of comparison over the others. Section 3.7 indicates how results for numbers of casualties and associated costs were obtained, and Section 3.8 comments on the relevance of statistical tests.

3.1 The crash dataset (TARS)

The DTEI Traffic Accident Reporting System (TARS) database was the source of all crash and casualty data used in this analysis. The TARS database contains records of all casualty crashes that are reported to the police in South Australia and is maintained by DTEI. Data are available from 1981 and are updated regularly such that complete data for a year is usually available during the following year. The information in TARS includes the location of a crash, the severity of injuries sustained by occupants, the speed limit for the crash location as reported by people involved or the police at the scene, and the date and time of day.

The changes in speed limit were made during January 2002. At the time of analysis, casualty crash data were available in TARS from 1981 to 2006. The time period of January 1997 until the end of December 2006 was chosen, allowing comparisons to be made between crash occurrences in the five years before the change and the five years that followed. The After period begins on the first of January 2002.

A routine crash dataset often has errors in it. Specifically, the location and speed limit of the crash site may have been reported by the driver or other person involved. If they remember seeing an 80 km/h sign, they may report the location as inside the treated section, even if they had later left it and crashed where the default speed limit was 100 km/h. This may explain why the recorded speed limit in TARS has been found to be somewhat unreliable. In cases where a change in speed limit has occurred the speed limit is often recorded as the prior value.

Our analyses are of crashes that involved at least one casualty. The severity of a casualty crash is determined by the severity of the most severely injured person. Hence in the case of a crash where a person was treated at hospital and another admitted, the crash severity would be recorded as admitted to hospital. The four categories of casualty and thus casualty crash severity in TARS are doctor treated, hospital treated, admitted to hospital and fatal. These severity categories are abbreviated in results tables later as doctor, treated, admitted and fatal. Crashes are commonly reported under three categories: fatal, serious injury and minor injury. In this report the category admitted to hospital means serious injury, and hospital treated and doctor treated combined represent minor injury.

3.2 Data processing for treated roads

In order to evaluate the crash occurrence on the treated roads, a list of the roads where the speed limit was altered was supplied by DTEI, with the sections of road identified by running distances and some brief descriptions.

To identify all of the crashes that occurred within the altered road sections, the road sections were located on maps. Then, using TARS, three lists were compiled, identifying each possible crash location within the treated road sections by using the three ways used in TARS to describe crash locations; at the intersection of two roads, at a section on a road between two other roads or by a particular running distance on a road.

In this study we wish to select crash and casualty data for roads where the speed limit was changed from 100 km/h to 80 km/h. Later for comparison we also require crash and casualty data for a relevant control group of roads. As mentioned above, we have found recorded speed limits in TARS to be somewhat unreliable, so we selected speed limits of 80, 100 and 110 km/h for both before and after the change. By mapping selections of crashes according to their recorded speed limit separately for the periods before and after the change, we could check the accuracy of this method. An advantage of using speed limit as a condition for selecting crashes is that where there were small town centres within the changed sections which had speed limits set at 60 or 50 km/h they would also be correctly excluded from the treated cases.

Data for the treated roads were selected using the three lists of descriptions of treated roads, the time periods of 1997 to 2001 before the change and 2002 to 2006 after, and recorded speed limits of 80, 100 and 110 km/h.

3.3 Data processing for control roads

Crashes on the control sets of roads were selected using local government area (LGA), the same recorded speed limits as were used for the treated roads, and by excluding the treated roads. Two control groups have been selected to compare the observed changes on the treated roads with the unchanged roads and to gain an idea of whether there were any system wide effects that would have also happened on the treated roads.

The first control group, control group A, consists of similar roads, but ones which did not change, in the same area as the treated roads, the areas of the Adelaide Hills Council and the District Council of Mount Barker. Crashes were selected if they had a recorded speed limit of 80, 100 or 110 km/h, excluding the treated roads. We are aware that a number of further changes of speed limit, again from 100 km/h to 80 km/h, occurred in the Hills region, this time for council managed roads. These changes were implemented approximately six months after the changes under evaluation and the road sections where this second set of changes occurred have been excluded from this control group.

The second control group, control group B, covers a larger area, and was selected in order to increase the amount of data available for comparison. To remain in close proximity to the Hills region with the intention that the conditions would correspond to those in the Hills, the crash data for the second control group were extracted for the surrounding local government areas of the Barossa Council, the Mid Murray Council, the Rural City of Murray Bridge, the Alexandrina Council and the City of Onkaparinga. There have been some infrastructure improvements and a limited number of speed limit reductions in these areas, in particular in the Barossa region, but these changed roads have not been excluded. If these have an effect on the crash numbers for this control group then they should only produce a more conservative estimate of the effect on the treated roads. Both control groups have the same selection criteria for recorded speed limit as the treated roads.

3.4 Choices concerning how a simple before and after comparison might be made

Choices need to be made about the details of a before and after comparison. The simplest method is not to have a control group: compare the five annual numbers before the change with the five annual numbers after. In Section 4.1 below, we will report an eight per cent reduction (not statistically significant).

However, notice that this assumes there is no general change in the number of crashes. If we thought that crashes were increasing one per cent annually, we would expect the After period to have five per cent more crashes than the Before period. Consequently, having found an eight per cent reduction in the number, we would estimate that the effect of the speed limit change was to reduce crashes by 13 per cent. This shows that we need to make a decision about how to handle the possible trend.

We can estimate the trend from the data: that is, fit a line whose slope is the same both before and after the speed limit reduction, but whose location changes at that time. This is an objective method, as both the trend and the reduction are estimated from the data, without extraneous assumptions. However, it will be reported in Section 4.1 that the estimated annual increase is about six per cent. Our view is that this is implausibly large: the population of the area is growing at only about 1.3 per cent annually (Australian Bureau of Statistics, 2007a).

The rate of population growth provides us with another method. If the underlying trend in crashes is an increase of 1.3 per cent per year, the number should have increased by 7 per cent in five years, and thus we can attribute a 15 per cent reduction (8 + 7) to the speed limit reduction. (Taking a broader perspective, the state-wide trend in casualty crashes on 80-110 km/h roads has been an increase of two per cent per year, again appreciably less than five per cent.)

A further point about the trend is relevant to generalising these results to other areas. We are not sure on what grounds this geographical area (Adelaide Hills and Mount Barker) was chosen for a speed limit change. Suppose that an increasing number of road crashes (about ten per cent per year in the period 1997-2001) was one of the reasons. Very possibly, at least part of that trend is simply random variation. If so, the estimated trend is greater than the true value. Thus it may be that the same mechanism — a trend that, by chance, is more steeply increasing than the true trend — that leads to an area being chosen for the introduction of a road safety measure also leads to an over-estimation of the effect.

We do not have details from DTEI of the extent to which infrastructure work (such as shoulder sealing, guard rail installation, or road widening) might have been carried out on either the treated or the control roads. Thus we cannot entirely exclude it as a factor which may have affected crash numbers and our results.

3.5 The use of a control group

In principle, having a control group would overcome the necessity of making an assumption about the trend. If lengths of road had been randomly assigned to treatment and control groups, comparison would be straightforward, and if the control group were large, the estimate of the change would be an accurate one. In practice, there was no random assignment, and it seems unlikely that an appropriate control group will be large. Consequently, it will be difficult to choose a control group, and there will be appreciable random error resulting from its limited size.

Calculation of the ratio of crashes on the treated roads to crashes on the control roads will make allowance for system-wide changes. In order to conduct a statistical test, we need to estimate the year-to-year variability. Therefore the ratio is calculated for each year separately. Then a standard method (such as the t-test) can be used to test whether the five Before ratios have the same mean as the five After ratios.

A disadvantage of principle in using a control group is that conceivably an effect of the speed limit reduction may not be confined to the sections of road that were treated: a lower speed limit on one section of road may lead to lower speeds, and fewer crashes, on adjoining untreated sections of road also.

3.6 Which method is best?

All methods are defensible. The range of results obtained give an idea of how much uncertainty stems from choice of method.

The preferred method is based on assuming that crashes would have increased at the same rate as population. This is a simple assumption based on the reasoning that traffic volumes will rise proportionately with population, and that the number of crashes will rise proportionately with traffic volumes. There has been considerable development and population growth in Mount Barker in recent years so this assumption seems more plausible than assuming there would be no change in crash numbers.

- The case against estimating the trend from the data is that this turns out to be six per cent per year, which we think is implausibly large. (That result could not have been foreseen. What could have been foreseen is that the estimation of this extra quantity could mean that the estimation of the effect of speed limit change is very imprecise.)

- The case against assuming no trend at all is that there has been considerable population growth in the Mount Barker area.

- The case against using control group A is that it is small, and random error is consequently introduced. Further, it is fairly plausible that reduced speeds on treated roads might have spread on to control roads.

- The case against using control group B is that there is the potential for introducing some systematic error in the data processing. We know there was local government reorganisation, and allowed for that in selection of crashes from the database. But if there were changes in the accuracy of reporting crash location, we could not make allowance for that.

We consider none of the above to be "knock out" reasons against one or other of the methods, but to be sufficiently cogent that we prefer to assume crashes would have increased at the same rate as population.

Instead of asking which method is best, we could simply ask what happened to the number of crashes. This question directs attention to the simple comparison of number of crashes before with number of crashes after, and it is intended that its answer be descriptive, without any intention to attribute any difference to the change of speed limit.

3.7 Numbers of casualties, and costs

The main results are comparisons of the numbers of casualty crashes, but also consider numbers of casualties, and the corresponding costs. The economic cost of a casualty is calculated using the Bureau of Transport Economics (2000) human capital method updated to 2007 dollars (Australian Bureau of Statistics (ABS) 2000; ABS 2007b). If some measure of outcome other than casualty crashes is chosen — total crashes (including property damage-only), crashes involving serious injury only, total casualties, total equivalent monetary cost — the results will be somewhat different from those for casualty crashes.

3.8 A comment on statistical significance

In this report we attempt to not only estimate the size of any change, but also to establish whether it was statistically significant. If a reduction is found to be statistically significant then we would be fairly confident that the reduction did not occur due to chance alone. If a change is found not to be statistically significant then we cannot discard the possibility that the change was a random event; the random year-to-year variation in crash numbers is sufficiently great that we cannot confidently say that they are really different in the After period compared with what they were in the Before period. However, to say that the data are consistent with a zero difference is not the same as saying that the data have shown that the difference is zero. The fact that the results are not significant does not mean that the difference is not real and should not be given value.

4 Estimates of the effect of the speed limit reduction

This Section provides the results of the analysis of the reduction in speed limit. In Section 4.1 we give the base data of the numbers of casualty crashes and casualties before and after the change, followed by comparisons with the trends in the crash occurrence before the change and their implications. Sections 4.2 and 4.3 provide comparisons with two different control groups. Section 4.4 provides an estimate of the cost saving attributable to the treatment.

4.1 Results in terms of crashes and casualties: no control group

Casualty crashes were identified for the years of 1997 to 2006, for the severity range described in Section 3.1. The before period covers the years 1997 to 2001 and the after period covers the years 2002 to 2006. Table 4.1 shows the number of casualty crashes for each severity of casualty that occurred in each five year time period, before and after the change in speed limit, for the roads where the speed limit was altered. Table 4.2 shows the number of casualties that occurred in each time period. In these and later tables, the severity category abbreviations of Doctor, Treated, Admitted and Fatal represent the categories as used in TARS; doctor treated, treated at hospital, admitted to hospital and fatal. The categories of doctor treated and hospital treated represent minor injury cases while admitted to hospital represents serious injury.

Table 4.1
Casualty crash numbers for roads where the speed limit was altered from 100 km/h to 80 km/h (altered road network)

Severity	Before	After	Difference	% Change	Difference/year
Doctor	70	38	-32	-45.71	-6.4
Treated	149	170	21	14.09	4.2
Admitted	84	72	-12	-14.29	-2.4
Fatal	7	6	-1	-14.29	-0.2
Total	310	286	-24	-7.74	-4.8

Table 4.2
Casualty numbers for the altered road network

Severity	Before	After	Difference	% Change	Difference/year
Doctor	79	55	-24	-30.38	-4.8
Treated	213	233	20	9.39	4.0
Admitted	104	88	-16	-15.38	-3.2
Fatal	7	6	-1	-14.29	-0.2
Total	403	382	-21	-5.21	-4.2

In Table 4.1 and Table 4.2 we can see that the reduction in casualty crashes and casualties amounted to about 8 per cent fewer crashes and 5 per cent fewer casualties. These are the figures for the observed crash occurrence on the roads where the speed limit reduction occurred. In these and all tables in this report a negative value in the '% Change' column indicates a reduction in crashes or casualties.

Expanding the data to show the casualty crash and casualty numbers for each of the 10 years, we can see, in Table 4.3 and Table 4.4, that there was much variation year to year. Because of this, we do not expect any result that we find to be statistically significant, and find that it is not, as the standard error of the estimate of an 8 per cent reduction in casualty crashes is about 10 per cent.

Table 4.3
Casualty crash numbers for the altered road network for 1997 to 2006

Severity	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Doctor	10	14	18	18	10	8	6	11	4	9
Treated	24	20	35	35	35	31	39	38	23	39
Admitted	15	14	10	24	21	12	18	12	18	12
Fatal	1	1	0	1	4	0	2	2	0	2
Total	50	49	63	78	70	51	65	63	45	62

Table 4.4
Casualty numbers for the altered road network for 1997 to 2006

Severity	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Doctor	10	16	19	21	13	12	11	18	4	10
Treated	38	29	43	51	52	43	61	47	34	48
Admitted	20	14	11	33	26	12	19	17	21	19
Fatal	1	1	0	1	4	0	2	2	0	2
Total	69	60	73	106	95	67	93	84	59	79

There were fewer crashes in the After period compared with the Before period, by 8 per cent. As discussed in Section 3.4, considering that there may be general trends over time in the number of crashes, there are a number alternative assumptions that might be made about this. We suggest three as having appeal:

- Assume no general trend over time. The estimated effect of the speed limit change is then eight per cent.
- Assume the trend over time is the same as the trend of population. That is an average increase of 1.3% per year for the time period and region we are considering (Australian Bureau of Statistics, 2007a). This accumulates to a total increase in population of seven per cent. The reduction in crashes in this case is estimated to be 15 per cent.
- Estimate the trend from the annual numbers of crashes (Table 4.3) That is, fit a straight line that has a change in level from 2001 to 2002, but has the same slope in 1997-2001 as in 2002-2006. It turns out that the trend is an increase of about six per cent per year, and the estimated reduction in crashes is 36 per cent. (The estimated standard error is 21 per cent, and the reduction is not statistically significant.)

The third method has the attraction of relying solely on the crash data, not on some separate assumption. However, we consider the estimated annual increase of 6 per cent to be implausibly large. (And, also, it is not statistically significantly different from zero.)

The year-to-year variation in crash numbers is actually rather larger than would be the case were crashes random events with numbers following what is termed the Poisson distribution. This is reasonably well-known in road accident studies (Hutchinson and Mayne, 1977) (but the reasons for it are not well understood). For example, the numbers of crashes on the treated roads averaged 62.0 and 57.2 in 1997-2001 and 2002-2006, and the standard deviations would thus be expected to be 7.9 and 7.6, but in fact were greater (12.6 and 8.7). Consequently, it is more difficult to establish statistical significance than it would otherwise be.

4.2 Results in terms of crashes and casualties: control group A

As described in Section 3.3, control group A refers to a control group of crashes extracted from the same area as where the changes occurred, within the Adelaide Hills Council and District Council of Mount Barker local government areas, excluding crashes that occurred on the changed roads. Table 4.5 shows the shows the number of casualty crashes for each severity of casualty that occurred in each five year time period, before and after the change in speed limit. By chance, for control group A, there were exactly the same number of total crashes in the After period as in the Before period.

The percentage changes from Tables 4.1 and 4.5 are compared in Table 4.6. The difference between the altered network and the control group percentage changes indicates the overall benefit of the speed limit reduction. There was a 7.7 per cent reduction in total casualty crashes on the roads where the speed limit was altered from 100 km/h to 80 km/h, and no change on the control roads. Hence the reduction attributable to the speed limit reduction is estimated to be 7.7 per cent.

Table 4.5
Casualty crash numbers for 80, 100, 110 km/h roads
in the Adelaide Hills region excluding the treated roads (control group)

Severity	Before	After	% Change
Doctor	131	137	4.58
Treated	303	319	5.28
Admitted	187	167	-10.70
Fatal	35	33	-5.71
Total	656	656	0.00

Table 4.6
Results of the comparison between crash numbers
five years before and five years after the change,
for the altered road network and the control group (percentage change)

Severity	Control roads	Altered roads	Difference
Doctor	4.58	-45.71	-50.29
Treated	5.28	14.09	8.81
Admitted	-10.70	-14.29	-3.59
Fatal	-5.71	-14.29	-8.58
Total	0.00	-7.74	-7.74

Casualty numbers were also extracted from the TARS database for the same time period and casualty severity categories, for control group A (Table 4.7), and an estimate of the reduction in casualties is given in Table 4.8: a four per cent reduction in the total number of casualties is attributed to the change in speed limit.

Table 4.7
Casualty numbers for each casualty severity for the control group

Severity	Before	After	% Change
Doctor	176	170	-3.41
Treated	458	491	7.21
Admitted	247	205	-17.00
Fatal	38	39	2.63
Total	919	905	-1.52

Table 4.8
Results of the comparison between casualty numbers five years before and five years after the change, for the altered road network and the control group (percentage change)

Severity	Control roads	Altered roads	Difference
Doctor	-3.41	-30.38	-26.97
Treated	7.21	9.39	2.18
Admitted	-17.00	-15.38	1.62
Fatal	2.63	-14.29	-16.92
Total	-1.52	-5.21	-3.69

4.3 Results in terms of crashes and casualties: control group B

Control group B consists of crashes and casualties on 100 km/h and 80 km/h roads in five council areas surrounding the Adelaide Hills: the Barossa Council, the Mid Murray Council, the Rural City of Murray Bridge, the Alexandrina Council and the City of Onkaparinga. (See also Section 3.3 above.) This control group was selected due to the close geographical proximity of the areas in this group relative to the Adelaide Hills, and in order to increase the amount of data available for comparison. The results of this analysis are presented in this section in the same way as they were for control group A.

The results for casualty crashes are shown in Table 4.9. The percentage changes from Table 4.1 and Table 4.9 are compared in Table 4.10 The difference between the altered network and the control group percentage changes indicates the overall benefit of the speed limit reduction, when compared with this particular control group. Table 4.10 shows that there was a 7.7 per cent reduction in total casualty crashes on the roads where the speed limit was altered from 100 km/h to 80 km/h and a 4.4 per cent reduction in casualty crash numbers on roads that were not altered, the control roads. By comparing these values, the reduction attributed to the change in speed limit is three per cent.

Table 4.9
Casualty crash numbers for control group B

Severity	Before	After	% Change
Doctor	304	231	-24.01
Treated	870	877	0.80
Admitted	464	447	-3.66
Fatal	88	95	7.95
Total	1726	1650	-4.40

Table 4.10
Results of the comparison between crash numbers five years before and five years after the change, for the altered road network and the control group (percentage change)

Severity	Control roads	Altered roads	Difference
Doctor	-24.01	-45.71	-21.70
Treated	0.80	14.09	13.29
Admitted	-3.66	-14.29	-10.62
Fatal	7.95	-14.29	-22.24
Total	-4.40	-7.74	-3.34

The casualty numbers and calculations of the percentage change between the Before and After period for the control group of roads are shown in Tables 4.11 and 4.12. Again the percentage changes from Table 4.2 and Table 4.11 are compared in Table 4.12 to make comparison between the treated roads and the control roads and to find an overall estimate of the effect of the change on casualties. This method of calculation gives a three per cent increase in the total number of casualties attributed to the change in speed limit, after considering that there was an eight per cent decrease in the total number of casualties on the control roads.

Table 4.11
Casualty numbers for each casualty severity for the control group

Severity	Before	After	% Change
Doctor	384	302	-21.35
Treated	1426	1364	-4.35
Admitted	661	596	-9.83
Fatal	101	107	5.94
Total	2572	2369	-7.89

Table 4.12
Results of the comparison between casualty numbers five years before and five years after the change, for the altered road network and the control group (percentage change)

Severity	Control roads	Altered roads	Difference
Doctor	-21.35	-30.38	-9.03
Treated	-4.35	9.39	13.74
Admitted	-9.83	-15.38	-5.55
Fatal	5.94	-14.29	-20.23
Total	-7.89	-5.21	2.68

4.4 Results in terms of dollars

The percentage reductions in the specified levels of casualties attributed to the reduced speed limit in Table 4.2 can be presented in terms of economic value, using conventional dollar figures for casualties. Table 4.13 shows a difference of 1.8 million dollars per year (all monetary figures are in Australian dollars). In this table the column marked "2007$/casualty" shows the costs for each level of casualty severity based upon the Bureau of Transport Economics (2000) human capital method, updated to 2007 dollars by accounting for inflation (ABS 2000; ABS 2007b). The pre-change average casualty numbers are for the altered roads using the 1997 to 2001 casualty data, averaged over the five years to give the average number of casualties for each category for one year.

The change in casualty numbers column shows the observed change in casualty numbers calculated in Section 4.1, with no comparisons with trends or control groups.

Table 4.13
Cost reduction attributable to the reduced speed limit on the altered roads for one year

Severity	2007$/casualty	Pre-change average casualty numbers (1 year)	% difference	Change in casualty numbers	Resulting difference in cost for 1 year
Doctor	$15,269	15.8	-30.38	-4.8	-$73,291
Treated	$15,269	42.6	9.39	4.0	$61,076
Admitted	$427,401	20.8	-15.38	-3.2	-$1,367,683
Fatal	$1,972,620	1.4	-14.29	-0.2	-$394,504
Total					-$1,774,402

Amounts for 2007$/casualty calculated from table 7.1 of the Bureau of Transport Economics report *Road Crash Costs in Australia* (BTE 2000), and using all groups index numbers from consumer price index reports from the Australian Bureau of Statistics (ABS 2007b; ABS 2000).

The above results use different percentage changes for different severities of injury. They also assume no general change in crash numbers over time. Alternatively, the figures in Table 4.2 may be used to calculate that the average annual cost of road crashes on the altered road network was 12.5 million dollars. This amount may be multiplied by the percentage crash reductions estimated by the different methods (see Sections 4.1 - 4.3). The results are shown in Table 4.14.

Table 4.14
Cost reduction attributable to the reduced speed limit on the altered roads for one year, according to different methods of comparison

	0% p.a. trend	6% p.a. trend	1.3% p.a. trend	Control A	Control B
Total saving (million dollars)	-1.0	-4.5	-1.9	-1.0	-0.4

As with the estimate of the effect of the change on casualty crash numbers, the estimate of a cost saving due to the change is highly variable depending on the method of comparison used and the assumptions made. Above in Table 4.14 we can see that this variation ranges from a saving of four hundred thousand dollars up to a saving of more than four million dollars. The uncertainties in the estimates relating to each method follow through to these cost estimates.

5 Discussion

The speed limit change from 100 km/h to 80 km/h in the Adelaide Hills was made on a set of roads where it was thought appropriate based on their configuration, where the road conditions would not justify a 100 km/h speed limit. This was also in an area with a higher level of crashes and casualties than some other areas in the state.

There are two strategies for comparing the number of crashes (or casualties) before and after the speed limit change. Either a control group of roads (i.e., ones on which no speed limit change was made) or no control group of roads are used.

The number of casualty crashes decreased by eight per cent when comparing the before and after period. This is based on the assumption that there would have been no change had the new 80 km/h speed limits not been introduced.

There are a number of assumptions that can be made between the before and after periods:

(1) As the After period is only 5 years after the Before period, assume no change in the number of crashes: 0% change.

(2) Assume the number of crashes changed in line with the population change, which was an average 1.3% p. a. increase in population: +7% over five years.

(3) Assume that the change in crashes would have been the same in the after period as it was in the before period. This was an average increase in crashes of 6% p. a.: +29% over the five years.

(4) Assume there would be no annual change as there was found for control group A: 0% change.

(5) Assume the annual change would be the same as was found for control group B where there was a 4% decrease in crashes over the 5 years of the before period: -3% change.

Using method (3), we estimate the effect of the speed limit change to have been as large as a 36% reduction by combining this assumption with the reduction in crashes found for the treated roads. Using method (5), we estimate it to have been as small as 3%. These and the other estimates are in Table 5.1. As mentioned earlier, quite apart from uncertainty arising from choice of method, random year-to-year variation in crash numbers means that the various estimates of the effect are not significantly different from zero.

Table 5.1
Summary of the reductions in crashes estimated by different methods

Method	Estimated reduction
No control group, assumed trend of 0% p.a.	8%
No control group, trend of 6% p.a. estimated from data	36%
No control group, assumed trend of 1.3% p.a. based on population growth	15%
Control group A	8%
Control group B	3%

As discussed in Section 3.6, our opinion is that the most likely figure for the crash reduction attributable to the speed limit change is the 15 per cent derived by adding 7 per cent (itself the population growth) to the 8 per cent casualty crash reduction.

In principle, comparison of before with after is simple. Yet we have considered five methods in this report, which could all be argued as being appropriate. It might be asked whether the research could have been approached in some way that would have provided a clearer answer. Two important points are worth making regarding this proposition.

The first is that a large part of the reason for uncertainty is random variation, that we cannot escape from because of the limited size of the area where the speed limit was changed. To reduce the random variation, it would have been necessary to include the Hills area in a wider scheme of reducing speed limits on similar roads in other places (perhaps interstate and internationally) — and the elaborate organisation needed would be quite foreign to road safety research, more closely resembling medical research.

The second point is that a true experiment could have been performed which would have involved making a list of road sections that were candidates for speed limit reduction, and then randomising them to either treatment or control groups. Randomisation ensures fairness. However, we consider that the above overstates the advantages of true experiments. There are practical problems that are widely acknowledged. There are also disadvantages of principle. (For example, suppose there were an advantage for the treatment group, but on closer examination this were seen to stem from no change in crashes in the treatment group along with an inexplicable increase in the control group. Would the advantage for the treatment group still be plausible?) Both the advantages accompanying bigger sample sizes and true experiments, and difficulties in research that are not overcome by these strategies, are discussed by Hutchinson (2007).

6 Conclusion

On the road sections where the speed limit was reduced from 100 km/h to 80 km/h, casualty crashes were found to drop by eight per cent. We have considered several methods for estimating the effect of the speed limit reduction — that is, the difference between what the number of casualty crashes was and what it would have been in the absence of a speed limit reduction. The estimates were of values of between three per cent and 36 per cent. There is also year-to-year variability in crash numbers which is difficult to allow for in evaluating crashes over time.

Our opinion is that the most likely figure for the crash reduction attributable to the speed limit change is the 15 per cent derived by adding seven per cent (itself the population growth) to the eight per cent casualty crash reduction.

On this basis, we may say there is some evidence to suggest that the reduction in speed limits from 100 km/h to 80 km/h had an effect on reducing casualty crashes on the affected roads.

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