Reduction of Speed Limit from 110 km/h to 100 km/h on Certain Roads in South Australia: A Preliminary Evaluation

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ABSTRACT

The speed limit on certain rural arterial roads in South Australia was reduced from 110 km/h to 100 km/h at the beginning of July 2003. The speed limit reduction was applied to 73 separate sections of 48 roads outside of the Adelaide metropolitan area, spread across southern South Australia. Casualty crash data were used to evaluate the change in speed limit by comparing the number of casualty crashes and casualties on these roads for two years before and two years after the change in speed limit. There was a decrease in casualty crashes after the reduction in speed limit of about 32 per cent. However, there was also a decrease in casualty crashes of about 12 per cent for the remaining 110 km/h speed limit road network. Thus, it seems likely that a reduction in casualty crashes of about 20 per cent can be attributed to the changed speed limit. Similarly, a reduction in casualties of about 19 per cent can be attributed to the change in speed limit. A very limited dataset on speeds has also been examined, comparing average speeds before and after the speed limit change at six sites. This analysis showed that there was an average reduction in mean speed of 2 km/h for the measured sites. Considering the observed changes in casualty and casualty crash numbers, it must be noted that there are, however, significant uncertainties associated with the estimates. These stem from both unavoidable random variability, due to the short time period since the change and hence the small amount of data for comparison, and from the methodology, as most of the roads were selected for the speed limit reduction due to their condition or configuration and were not randomly selected, which also made the choice of appropriate control roads difficult.

INTRODUCTION

At the beginning of July 2003, the speed limit on approximately 1,100 km of South Australian rural arterial roads was reduced from 110 km/h to 100 km/h. Over the years 2000 to 2002, 58 per cent of fatal crashes and 47 per cent of serious injury crashes (59 per cent of fatalities and 50 per cent of seriously injured casualties) in South Australia occurred in rural areas (defined as all of the state outside of metropolitan Adelaide). For the same period, 16 per cent of all crashes occurred in rural areas (Transport SA, 2002; 2003a; 2003b).

The positive relationship between travelling speed and the risk of crash involvement has been widely reported, and in the rural setting, in particular, the risk of a casualty crash has been found to increase with an increase in free travelling speed (Kloeden et al, 2001). Kloeden et al. reported that a 5 km/h reduction in free travelling speed for the vehicles involved in the casualty crashes investigated in their study would have produced a 31 per cent reduction in the number of these casualty crashes. The study also showed that 24 per cent of the casualty crashes investigated would have been avoided if none of the involved vehicles had been travelling above the speed limit.

There are a number of reports which examine the effects of increases in speed limits. An Australian study of the effects of increasing the speed limit from 100 km/h to 110 km/h showed increased travelling speeds, a 20 per cent increase in the casualty accident rate per kilometre of road attributable to the raised speed limit, and increased accident severity (Asimakidis, 1996). A study in the United States found a 3 mi/h increase in average travelling speed and a 3 per cent increase in total crash rates attributable to a 10 mi/h increase in speed limits, from 55 mi/h to 65 mi/h (Kockelman, 2006). Kockelman presented a review of a number of other studies also assessing the effect of increases in speed limits after the repeal of the US National Maximum Speed Limit in 1995. The majority of the studies found an increase in fatality rates attributable to speed limit increases.

Fewer studies analyse reductions in speed limits in the rural setting. One report conducted in Norway examined the effect of lowering the speed limit from 80 km/h to 70 km/h and 90 km/h to 80 km/h on sections of the national and European network in Norway (Ragnoy, 2005). The roads where the speed limit was lowered were selected because they were considered hazardous, determined by high crash costs per kilometre. The effects of the lowered speed limit were analysed using a before and after comparison, and by comparing the actual crash experience with a long-term forecasted set of crash and casualty numbers. The before and after comparisons were made between time periods of eight years before and an average of 2.1 years after the change, raising questions of confidence in the 'after' data. Ragnoy found decreases in average travelling speed of between 2.1 km/h and 4.1 km/h for the roads that originally had an 80 km/h speed limit and between 1.6 km/h and 2.8 km/h for the roads where the limit was lowered from 90 km/h. Reductions in crashes, fatalities and in serious and slight injuries were found for the roads where the speed limit was reduced from 80 km/h. The results for the roads where the limit was originally 90 km/h were highly dependent on the comparison group used, producing either increases attributable to the speed limit change for all evaluation criteria (rates of crashes, fatalities, critical injuries, slight injuries and average travelling speeds) or increases for only three out of the five criteria.

The aim of the present paper is to assess the effect of the reduction of the speed limit by comparing the change in crashes on the treated roads, two years before with two years after, with the change in crashes on roads that were unchanged with a speed limit of 110 km/h. It is important to note that the road sections selected for the speed limit change in this study were chosen because of the condition or width of the road, high volumes of traffic or, in a few cases, due to crashes. The roads were not randomly selected, nor were they all selected based on high crash rates. This paper also presents a brief analysis of change in vehicle speeds after the changed speed limit, as a limited dataset on vehicle speeds before and after the speed limit change was available. This was analysed to determine whether the change in speed limit had an effect on mean travelling speeds.

METHOD

The change in Speed Limit

The speed limit was reduced from 110 km/h to 100 km/h on 48 rural arterial roads in South Australia, in the areas of the Barossa, Fleurieu Peninsula, Mallee, Mid North, South East, River Murray, Riverland, Yorke Peninsula and Kangaroo Island. Some of these roads run through towns and have other speed limits assigned in these sections, which splits the altered road network into 73 separate sections of road. The total length of the affected road network was 1,060 kilometres. These roads were selected for treatment based on their configuration, condition, crash rates or traffic volumes, and were not randomly selected from all 110 km/h speed limit roads. A list of the roads where the speed limit was altered was supplied by the South Australian Department for Transport, Energy and Infrastructure (DTEI) with the sections of road identified by running distances. A running distance identifies a location on a road by defining its distance along that road from a specified start point. For example, a road that runs between two intersections will have a running distance set at zero at one intersection and a running distance equal to the total length of that road at the location of the other intersection. In this way, all locations along the road can be defined by the distance from the zero point.

The Crash Database

The Traffic Accident Reporting System (TARS) database was the source of all crash and casualty data used in this analysis. The TARS database, maintained by DTEI, contains all crashes occurring in South Australia that are reported to the police. Drivers involved in a crash are required to report the crash to the police if there is a casualty or if the total value of damage exceeds $1000.

Time Period

At the time of this analysis, reliable data were available for the years 1981 to 2004 and for the first half of 2005. One of the choices made when analysing the effect of the lowered speed limit was the choice of time period for the before and after comparison. The time period of July 2001 until the end of June 2005 was chosen, allowing comparisons to be made between crash occurrences in the 2 years before the change and the 2 years that followed, and in order to use the maximum amount of data that were available after the change.

Crash Severity

The severity of a casualty crash is defined as the highest level of severity of any of the casualties in terms of the treatment required or the outcome, if fatal. Crashes are thus categorised here and in the TARS database as: treated by private doctor, treated at hospital, admitted to hospital, or fatal. For this study only casualty crashes were included in the analysis. In terms of financial and emotional costs to the community, the most significant costs are associated with fatal and serious injury crashes (DTEI, 2005).

Identification of Crashes in the relevant road sections

The location of a crash can be specified in one of three ways in the database: at the intersection of two roads, within a road section between two intersections, or at a running distance along a road. In order to identify all of the crashes that occurred within the altered road sections, three lists were compiled identifying each possible crash location within the road sections, using the three ways that the locations could have been described. The lists were of the intersections, of the road numbers and the beginning and ending running distances, and of the number of the road that the crash occurred on and the pairs of intersecting roads that the location was between. When it came to finding the relevant crashes, each crash within the appropriate time period was checked against a combined list of these three ways of defining the crash location, and counted as relevant if the location description matched one in the list.
The process of identifying the relevant road sections was complex; if there were any minor errors, their effect should at least cancel out, as the same set of location descriptors were used for the data both before and after the speed limit change.

Strategy of Comparison

Having identified the relevant roads, the numbers of crashes occurring before and after the change were compared. It is usually better to have a control group than make a simple before-after comparison, in order to remove the effects of any differences or trends unrelated to the change under evaluation. The control group selected was all roads in South Australia where the speed limit remained at 110 km/h (8,671 km), excluding the roads where the limit was reduced. There was indeed a downward trend in casualty crash numbers for the control group of roads. The percentage reduction in casualty crashes for the roads with the speed limit reduction, presumed here to be attributable to the reduced speed limit, is the difference between the percentage reduction for those roads and the percentage reduction for the control roads. The difference in casualties can similarly be obtained. Finally, the annual reduction in the number of casualties can be expressed in dollar terms.

For each component of the analysis, the method of estimation of the effect of the speed limit reduction was, in principle, straightforward. However, along with the estimate, the likely random variability should be kept in mind.

RESULTS

The following section gives the results in terms of casualty crashes, casualties, cost (dollars) and changes in vehicle speeds respectively.

Crashes

Casualty crash data were extracted for the time period of July 2001 until June 2005, for the severity range described in the previous section. Table 1 shows the number of casualty crashes for each severity of casualty that occurred in each two year time period, for the roads where the speed limit was lowered and also for the control roads. The last column of the table shows the difference between the percentage changes that occurred on the two sets of roads. The difference between the altered network and the control group percentage changes indicates the overall effect of the speed limit reduction.

There was a 31.9 per cent reduction in total casualty crashes on the roads where the speed limit was altered from 110 km/h to 100 km/h and a 12.2 per cent reduction on roads where the speed limit was not altered. By comparing these values, a reduction of 19.7 per cent is attributed to the change in speed limit.

Table 1 Casualty crash numbers and percentage change for roads where the speed limit was altered from 110 km/h to 100 km/h (altered roads), and for roads where the speed limit remained at 110 km/h (control roads).

	Altered roads			Control Roads			% Difference
Severity	Before	After	% Change	Before	After	% Change	
Doctor	8	5	-37.5	71	59	-16.9	-20.6
Treated	58	47	-19.0	449	397	-11.6	-7.4
Admitted	61	35	-42.6	374	344	-8.0	-34.6
Fatal	14	9	-35.7	79	54	-31.6	-4.1
Total	141	96	-31.9	973	854	-12.2	-19.7

Casualties

The numbers of casualties resulting from crashes were also extracted from the TARS database for the same time period and casualty severity categories (Table 2). Using the same methods as described above, an estimate of the reduction in casualties was calculated and is shown in the last column of Table 2. A 19 per cent reduction in the total number of casualties was attributed to the change in speed limit.

Table 2 Casualty numbers and percentage change in numbers for each casualty severity for the altered road network, the control road network, and the difference between the percentage changes for the two sets of roads.

	Altered roads			Control Roads			% Difference
Severity	Before	After	% Change	Before	After	% Change	
Doctor	9	5	-44.4	94	75	-20.2	-24.2
Treated	108	91	-15.7	768	658	-14.3	-1.4
Admitted	104	51	-51.0	541	473	-12.6	-38.4
Fatal	16	10	-37.5	93	69	-25.8	-11.7
Total	237	157	-33.8	1496	1275	-14.8	-19.0

Cost

The percentage reductions in the specified levels of casualties attributed to the reduced speed limit in Table 2 were examined in terms of economic benefit, using conventional monetary figures for casualties (all monetary figures are in Australian dollars). The results are presented in Table 3. In this Table the column marked "2004$/casualty" shows the costs for each level of casualty severity based on a Bureau of Transport Economics report conducted in the year 2000, plus an allowance for inflation (Australian Bureau of Statistics, 2004; Bureau of Transport Economics, 2000). The pre-change average casualty numbers are for the altered roads using the July 2001 to June 2003 casualty data, averaged over the two years to give the average number of casualties for each category for one year.

An estimated reduction in injury costs of about 9.5 million dollars per year was associated with the speed limit reduction.

Due to the low numbers of casualties on the altered roads, and random variability associated with having small amounts of data, this best estimate of 9.5 million dollars is of low precision. Over time it may be that the effect of the speed limit reduction will be found to be much greater, or even of negative value (plus or minus about 11 million dollars).

Table 3 Cost reduction attributable to the reduced speed limit on the altered roads for one year.

Severity	2004$/casualty	Pre-change average casualty numbers (1 year)	% difference attributable to speed limit reduction	Change in casualty numbers	Resulting difference in cost for 1 year
Doctor	$14,434	4.5	24.2	1.1	$15,739
Treated	$14,434	54	1.4	0.8	$11,051
Admitted	$390,922	52	38.4	20.0	$7,804,349
Fatal	$1,804,257	8	11.7	0.9	$1,687,853
Total					$9,518,993

Changes in Vehicle Speeds

No speed measurements were taken specifically for this study. However, by examining the routine speed data collection conducted by DTEI, it was found that a small number of measurement sites were situated within changed road sections. For six of these sites, speed measurements had been obtained over at least one week before, and one week after, the reduction of the speed limit. These sites are listed in Table 4.

Table 4 Sites where the speed limit was reduced and speed measurements were taken before and after the change.

Site	Date of before sample	Date of after sample
Port Clinton	29/01/2003	29/10/2003
Urania	03/04/2003	23/10/2003
Yorketown - Edithburgh	17/01/2002	17/06/2004
Corny Point - Yorketown	09/08/2002	06/08/2004
Warooka - Marion Bay	24/06/2003	03/07/2003
Murray Bridge - Jervois	04/12/2002	10/09/2003

Table 5 Change in average speed at sites where the speed limit was reduced and speed measurements were taken before and after the change.

Site	Average speed before speed limit change	Average speed after speed limit change	Change in average speed
Port Clinton	100.4	98.9	-1.5
Urania	102.6	99.5	-3.2
Yorketown - Edithburgh	99.6	96.6	-3.1
Corny Point - Yorketown	101.1	95.2	-5.9
Warooka - Marion Bay	100.7	99.7	-1.1
Murray Bridge - Jervois	96.2	95.8	-0.4
All sites combined	99.4	97.5	-1.9

Average speeds at each site are given in Table 5. However, it is acknowledged that there may be variations in speed associated with traffic conditions and weather that are not captured in such a limited dataset (note that the before and after measurements were not necessarily at the same time of year). Assuming that these data were suitable for comparison, the change in average speed was calculated. The calculations indicated that mean speeds went down by about 2 km/h after the speed limit change.

There is often specific interest in vehicles travelling at a "free" speed, rather than those which are travelling in a platoon of traffic or closely following another vehicle. On these roads it would be expected that most vehicles would have been travelling at a free speed. Indeed, the speed reduction of 2 km/h was almost unchanged when the same analysis of average speeds was conducted for free speed vehicles only. A headway of four seconds or greater was used to define free speed vehicles.

DISCUSSION

The numbers of crashes on the roads where the speed limit was reduced from 110 km/h to 100 km/h were much smaller than on the control roads. The random variability in crash numbers will therefore be (proportionately) much greater on the roads with the altered speed limit.

- On the altered roads, the numbers of crashes were (in two years) 141 before the change and 96 after. Thus, the change is approximately a 32 per cent reduction.
- The variance of crash numbers will be approximately 141 before the change and 96 after the change, assuming the number of crashes follows the Poisson distribution.
- The difference in annual crash numbers will have a variance of approximately 237. (The variance of the difference between two independent random variables is the sum of the variances.)
- The standard deviation of the difference in crash numbers is thus approximately 15. (The standard deviation is the square root of the variance.)
- This is approximately 11 per cent of 141, the number before the speed limit change.

The reduction attributable to the speed limit change was estimated to be 20 per cent. Our calculation show that the standard error associated with this is greater than 11 per cent. It is greater because the random variability of the number of crashes on the control roads has been neglected. When this is included, the standard error is found to be about 12 per cent. It is common to regard two standard errors as being the "give or take" value associated with an estimate, so the conclusion is that the percentage reduction attributable to the speed limit change is 20, plus or minus 24. Hence, it seems likely that there really was a reduction, but the quantity of data are not sufficient to be sure. In addition, it may be that random variation in crash numbers is greater than is implied by the Poisson distribution (Hutchinson and Mayne, 1977), further reducing confidence in the estimate.

Research of this type has some well-known limitations, which we should briefly mention.

- The sections of road that were treated (by reduction of the speed limit) were selected on the basis of the condition or use of the road, not on the basis of crash history. This reduces but does not necessarily eliminate the possibility that the observed reduction in crashes may have been due to regression to the mean.

- The 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.

- The selection of the control roads is an important issue and it is difficult to know whether the most appropriate decision has been made. A number of different options were considered. The current control group, roads that remained at the original speed limit, is seen to be the most relevant to this study in order to assess the effect that can be attributed to the change in speed limit. We are not aware of any factors affecting the crash rates over time on the control roads that did not apply to the treated roads.

- Routine crash data often have errors in them. Specifically, the location of the crash site may have been reported by the driver or other person involved. If they remember seeing a (relatively unusual) 100 km/h sign, they may report the location as inside the treated section, even if they had later left it and crashed where the speed limit was 110 km/h.

In short, it is easy to imagine reasons why the effect of the speed limit change may be understated or overstated. Nevertheless, being able to imagine reasons for errors in our estimate does not mean they in fact occurred. Our confidence in the reality of the reduction is increased because its mechanism is very obvious: lower speed limits lead to lower travelling speeds, reducing the likelihood of loss of control and increasing driver reaction time, and reducing the decelerations experienced if there is an impact. Thus crashes should be fewer and less severe.

CONCLUSION

On the road sections where the speed limit was reduced from 110 km/h to 100 km/h, casualty crashes were observed to drop by 32 per cent. On the 110 km/h roads that were not changed, casualty crashes were observed to drop by 12 per cent.

If there were no other factors (and we are not aware of any), a 20 per cent reduction in casualty crashes can be assumed to be the best estimate of the effect of lowering the speed limit. However, the small number of crashes on the affected roads means that this estimate is somewhat uncertain. So while the best estimate of the effect is a 20 per cent reduction, it is possible that the true effect might have been anywhere between an increase of 4 per cent and a reduction of 44 per cent.

There was a decrease in crashes and casualties on the 110 km/h roads where the speed limit did not change. This has been allowed for in the above calculations. It could mean that there is something else that affected crashes, and possibly that there was a drop in travelling speed everywhere. It might be due to an increased awareness of speed, in part because of the speed limit reduction on the roads of interest.

When comparing average speeds before and after the speed limit change, an average 2 km/h speed reduction was found, which supports the estimate that there was a reduction in casualty crashes.

ACKNOWLEDGEMENTS

This study was funded by the South Australian Department for Transport, Energy and Infrastructure (DTEI) through a Project Grant to the Centre for Automotive Safety Research. The Centre for Automotive Safety Research receives core funding from both DTEI and South Australia's Motor Accident Commission.

The views expressed in this report are those of the authors and do not necessarily represent those of the University of Adelaide or the sponsoring organisations.

A full report of this study is available from http://casr.adelaide.edu.au/reports.

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