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Reduction of speed limit from 110 km/h to 100 km/h on certain roads in South Australia: a follow up evaluation

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Abstract

In July 2003, the speed limit on approximately 1,100 km of rural arterial roads in South Australia was reduced from 110 km/h to 100 km/h. An earlier study, conducted in 2006, found that this speed limit change was associated with a 19.7 per cent reduction in casualty crashes. However, this finding was not statistically significant, potentially due to the limited quantity of crash data available at the time. This paper details a follow up investigation using more crash data (10 years before and 10 years after the speed limit change). The number of casualty crashes on the subject roads since the speed limit was lowered was found to be 27.4 per cent lower than would have been expected if the subject roads had simply matched the reductions on the control roads (that remained at 110 km/h). This reduction was found to be statistically significant with 95% confidence limits of ±12.4%. While the methodological design of the study was not ideal, the size of the effect, the consistency of the various elements, and agreement with other research provides rather convincing evidence that the lowered speed limits were effective in reducing casualty crashes by a large amount.

Introduction

In July 2003, the speed limit on approximately 1,100 km of rural arterial roads (made up of 73 road sections) in South Australia was reduced from 110 km/h to 100 km/h. Long et al. (2006) investigated the change in casualty crashes on these road segments, as well as on 8,671 km of control road segments where the speed limit remained at 110 km/h, using data from two years before and two years after the speed limit reduction. This earlier investigation found that the speed limit change was associated with a 19.7 per cent reduction in casualty crashes but this result was not statistically significant, potentially due to the limited quantity of crash data available.

Other research from Australia on the effects of reducing the speed limit from 110 km/h to 100 km/h has shown similar results. In 1987 the speed limit on the Victorian freeway network was increased from 100 km/h to 110 km/h. Then in 1989 the 110 km/h speed limit was removed and a 100 km/h limit was reintroduced. Sliogeris (1992) investigated the effect that these speed limit changes had on the rate of casualty crashes. It was found that casualty crashes increased by 25 per cent following the speed limit increase and decreased by 19 per cent following the subsequent speed limit decrease.

An investigation into the effects of a speed limit reduction from 110 km/h to 100 km/h on the Great Western Highway in rural NSW was conducted by Bhatnagar et al. (2010). A reduction in mean travelling speeds, from above 102 km/h to less than 98 km/h, was accompanied by a reduction in casualty crashes of 27 per cent. The analysis did not make use of control sites.

International research has also produced evidence that a reduction in the speed limit on high speed roads will result in a corresponding reduction in crash frequency.

An investigation by De Pauw et al. (2014) into the effect of reducing speed limits from 90 km/h to 70 km/h on Flemish highways found a statistically significant decrease of 33 per cent in the number of crashes involving serious injuries or fatalities.

Similarly, Jaarsma et al. (2011), who looked at the effect of the reduction of the speed limit from 80 km/h to 60 km/h on minor rural roads in the Netherlands, found a statistically significant decrease of 24 per cent in casualty crashes. Although it should be noted that the speed limit change was also complemented by infrastructure upgrades such as edge marking, speed humps, and raised platforms at intersections.

In the United States there have been several instances of speed limits being increased on high speed rural roads. A major trigger of such action was the repeal of the national maximum speed limit in 1995, which allowed each state to set their own speed limits for rural Interstate routes. As a result of the repeal many states increased the rural Interstate speed limit from 65 mph (105 km/h) to 70 mph (113 km/h) or 75 mph (121 km/h).

Farmer et al. (1999) investigated how the frequency of fatalities was affected in 24 states where the speed limit on rural Interstates was increased. Fatalities on rural Interstates in seven states that did not change the speed limit were used as a control. An increase in fatalities of 15 per cent was found, rising to 17 per cent if changes in mileage were taken into account.

A similar situation in the state of Iowa, which increased the speed limit on most rural Interstates from 65 mph to 70 mph in 2005, was investigated by Souleyrette and Cook (2010). A statistically significant increase of 25 per cent in total crashes was found. Increases of 52 per cent in night time fatal crashes and 25 per cent in serious cross median crashes were also identified but were not statistically significant.

The analysis presented below details a follow up investigation of the effect of the speed limit reductions on the road segments identified previously in Long et al. (2006). Casualty crash data on the subject road segments from ten years before and ten years after the speed limit reduction were analysed. New control road segments, where the speed limit has remained at 110 km/h during the longer analysis period, were identified. Mackenzie et al. (2015) provides further details on the analysis presented below.

Method

The investigation presented here consists of a before and after analysis of casualty crashes on the road segments where the speed limit was reduced from 110 km/h to 100 km/h. The before period spans 10 years, from July 1993 to June 2003. The after period also spans 10 years, from July 2003 (during which the speed limit was reduced) to July 2013.

Because of the considerable length of the analysis period, control road segments (where the speed limit remained at 110 km/h) were used to account for background changes in casualty crash numbers.

Defining subject and control road segments

As in the previous analysis (Long et al., 2006), the South Australian Department of Planning, Transport and Infrastructure (DPTI) provided a list of 48 roads (consisting of 73 unique segments) where the speed limit was reduced from 110 km/h to 100 km/h in July 2003. Another list containing all 151 roads (made up of 328 road segments) where the speed limit remained at 110 km/h through the analysis period of July 1993 to June 2013 was also provided by DPTI. These two lists defined the subject road segments and control road segments analysed in this study.

All major South Australian roads have an associated road code. Each coded road also has an associated start and end point such that a specific location along the road can be identified via a 'run distance', which is the travel distance from a designated start point to the point of interest. Each of the subject and control road segments is defined by a start and end run distance along a particular road that is specified by the corresponding road code.

Characteristics of subject and control road segments

It should be noted that the application of speed limit reductions to the subject road segments was not random and the control road segments were not matched characteristically (e.g. by traffic volume or level of infrastructure) in any way to the subject road segments.

The geographic location of the subject road and control road segments can be seen in Figure 1. The majority of the subject road segments are located on the Yorke Peninsula or within a few hundred kilometres of Adelaide. Conversely, the control road segments are located relatively far away from Adelaide and comprise several major arterial rural highways. Given that the majority of South Australia's population is located in and around Adelaide, the subject road segments are likely to experience greater traffic flows compared to the control road segments. Similarly, because of their remote location, there are likely to be differences in the safety infrastructure of the control road segments compared to the subject road segments.

The potential effect that these study deficiencies may have upon the results are covered in the Discussion section below. While these potential effects cannot be ignored, it is unlikely that the differences in the characteristics of the subject and control road segments would be sufficient to explain the crash reductions reported in the Results section.

Locating crashes in South Australia

Details of all police reported crashes that occur in South Australia are reviewed by DPTI and entered into the Traffic Accident Reporting System (TARS) database. Within the TARS database, crashes are located using road codes and run distances in three ways. The first is used to locate crashes that occur at major intersections by noting the codes of the two intersecting roads. Crashes that occur between intersections (or intersections with minor roads that do not have an associated road code) can be located by providing a single road code and run distance. A crash can also be located at an unknown point between two intersections by providing three road codes; the first code indicates the road on which the crash occurred and the remaining two codes indicate the bounding intersections between which the crash is located.

Crashes are often also located with GPS coordinates. However, the facilities to match GPS coordinates to the specified road segments were not available.

Identifying crashes on subject and control road segments

Data on all casualty crashes that occurred between July 1993 and June 2013 were extracted from the TARS database. Each crash was then categorised as occurring on a subject road segment, a control road segment, both a subject road segment and a control road segment, or neither type of road segment (in which case they were removed from the analysis).

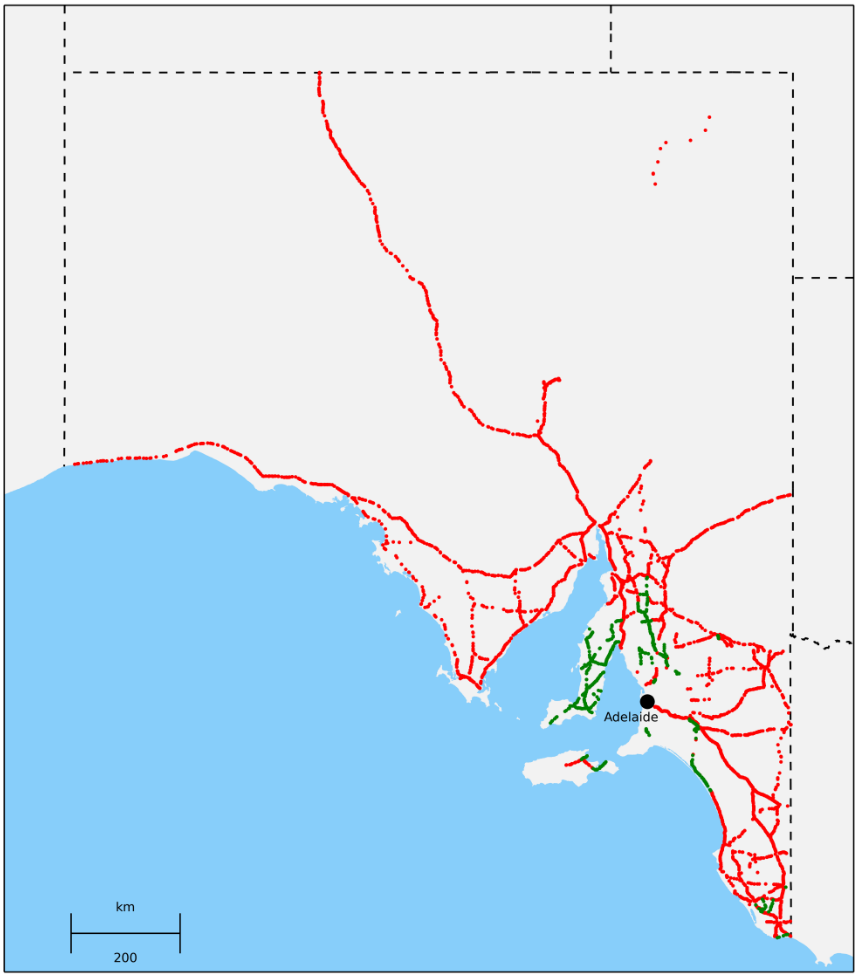
Crashes that were located with a single road and run distance were categorised relatively simply; checking for a match to a road on either the subject road or control road lists, and then investigating whether the run distance was situated between the start and end point of the corresponding segment.

For crashes located with two or three road codes, the categorisation process was more complex. First, those crashes that occurred on a subject or control road were identified. This was achieved by checking for a match to either of the intersecting roads for crashes located with two road codes, or to the main road for crashes located with three road codes. Next, a manual check was conducted to establish whether the intersecting road or both bounding roads were situated between the start and end point of the subject or control road segment.

Using these methods, there were 935 crashes identified on subject road segments and 4,884 crashes identified on control road segments. There were 105 crashes categorised as occurring on both a subject road segment and a control road segment. Since these crashes were unable to be definitively categorised they were removed from the analysis.

Figure 1 shows the location of all the identified crashes on both the subject and control road segments. These data points were mapped using the GPS coordinates associated with each crash.

Figure 1. Location of crashes on subject road segments (green dots) and on control road segments (red dots) between July 1993 and July 2013



Results

Because the speed limit on the subject road segments was reduced in July 2003, the data analysis is conducted using financial years (i.e. beginning July of one year and ending June of the following year).

The casualty crashes identified in each financial year on the subject road segments and the control road segments is shown in Table 1. The table presents the number of crashes split into the before and after periods and disaggregated by crash severity. The total number of casualty crashes (of all severities) on the subject road and control road segments per financial year is also shown in Figure 2.

The average number of crashes on both the subject road segments and the control road segments declined from the before period to the after period. This reduction in the average number of crashes was apparent for all severity categories apart from crashes that resulted in injuries that required hospital treatment on control road segments, which showed a slight increase from the before to the after period.

Table 1. Number of casualty crashes on the subject and control road segments per financial year (1993/94 - 2012/13) by crash severity

Period	Financial year	Subject road segments (by crash severity)					Control road segments (by crash severity)				
		Doctor	Treat	Admit	Fatal	Total	Doctor	Treat	Admit	Fatal	Total
Before (110 km/h on subject roads)	1993/94	5	23	23	4	55	18	96	112	27	253
	1994/95	6	23	23	3	55	21	123	88	14	246
	1995/96	4	27	36	4	71	18	105	123	36	282
	1996/97	8	19	19	3	49	18	104	115	20	257
	1997/98	3	23	18	3	47	14	99	102	19	234
	1998/99	7	26	19	4	56	12	111	107	23	253
	1999/00	4	32	17	3	56	14	113	119	15	261
	2000/01	4	23	13	7	47	14	105	107	13	239
	2001/02	4	29	23	6	62	18	116	86	19	239
	2002/03	4	26	27	8	65	14	121	131	29	295
	Total	49	251	218	45	563	161	1093	1090	215	2559
	Average	4.9	25.1	21.8	4.5	56.3	16.1	109.3	109.0	21.5	255.9
After (100 km/h on subject roads)	2003/04	3	24	16	8	51	18	111	110	17	256
	2004/05	1	20	14	1	36	12	119	96	24	251
	2005/06	4	17	16	4	41	8	90	98	23	219
	2006/07	1	26	16	1	44	7	124	93	4	228
	2007/08	5	16	12	3	36	9	118	86	13	226
	2008/09	5	30	13	0	48	13	94	110	16	233
	2009/10	2	25	8	2	37	14	124	89	25	252
	2010/11	3	15	8	1	27	10	124	86	18	238
	2011/12	2	9	12	2	25	5	112	75	13	205
	2012/13	0	11	13	3	27	16	124	60	17	217
	Total	26	193	128	25	372	112	1140	903	170	2325
	Average	2.6	19.3	12.8	2.5	37.2	11.2	114.0	90.3	17.0	232.5

Doctor – Treated by local doctor, Treat – Treated at hospital, Admit – Admitted to hospital

In Table 2, the ratio of casualty crashes on subject road segments to casualty crashes on control road segments in each financial year is shown. The results are again presented disaggregated by before/after period and by crash severity. The ratio of the total number of casualty crashes per financial year is shown in Figure 3.

This method of using the ratio was utilised because it is a simple and straightforward way of using the control road data and has the advantage of not needing to specify a model (e.g. constant rate of decline) for the dependence on financial year.

The ratio results reveal that the decline in the number of casualty crashes from the before period to the after period was greater on the subject road segments compared to the control road segments. This is evidenced by the reduction in the average ratio from 0.2197 in the before period to 0.1595 in the after period. That is, the number of crashes on the subject road segments in the after period was lower than would have been expected if the subject road segments had simply matched the control road segment reductions. This greater reduction on subject road segments was found for all crash severity categories. When looking at Figure 3, the step drop in the ratio of crash frequency from the before period to the after period can be seen clearly.

Figure 2. Number of casualty crashes on subject road and control road segments per financial year (1993/94 – 2012/13)

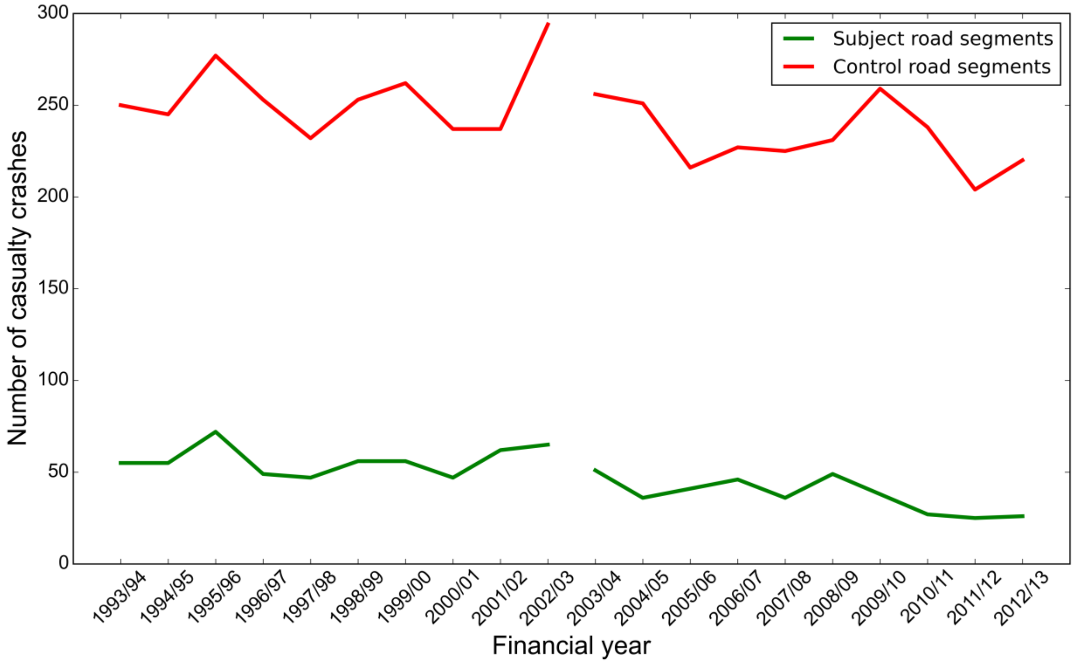
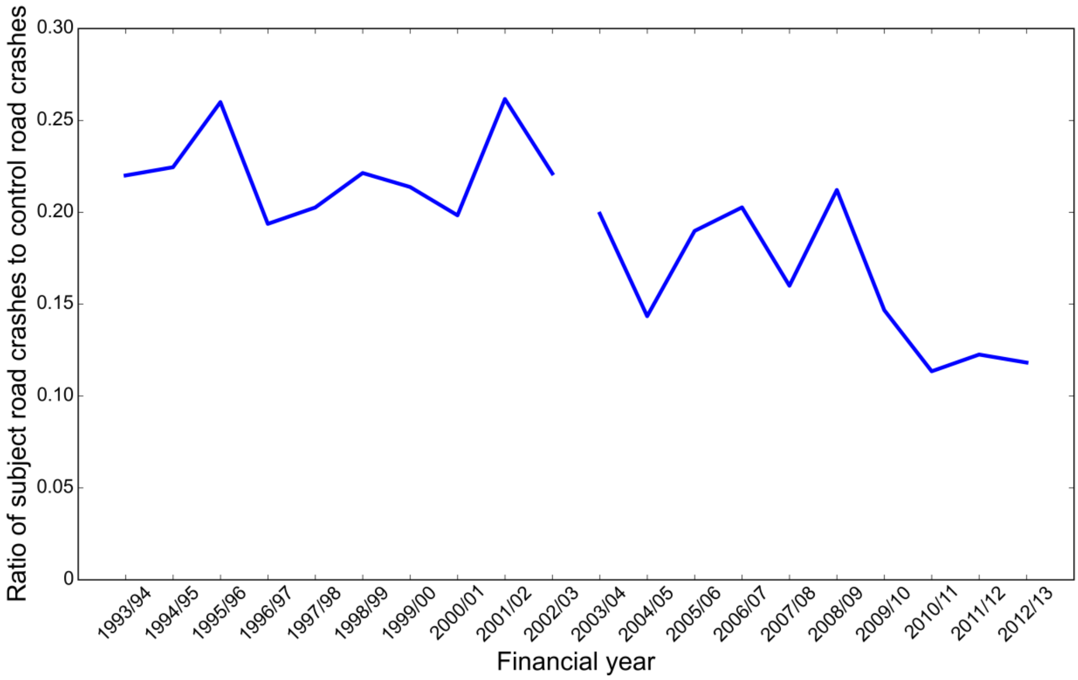


Table 2. Ratio of casualty crashes on subject road segments to casualty crashes on control road segments per financial year (1993/94 – 2012/13) by crash severity

Period	Financial year	Crash severity				Total
		Doctor	Treated	Admitted	Fatal	
Before (110 km/h on subject roads)	1993/94	0.2778	0.2396	0.2054	0.1481	0.2174
	1994/95	0.2857	0.1870	0.2614	0.2143	0.2236
	1995/96	0.2222	0.2571	0.2927	0.1111	0.2518
	1996/97	0.4444	0.1827	0.1652	0.1500	0.1907
	1997/98	0.2143	0.2323	0.1765	0.1579	0.2009
	1998/99	0.5833	0.2342	0.1776	0.1739	0.2213
	1999/00	0.2857	0.2832	0.1429	0.2000	0.2146
	2000/01	0.2857	0.2190	0.1215	0.5385	0.1967
	2001/02	0.2222	0.2500	0.2674	0.3158	0.2594
	2002/03	0.2857	0.2149	0.2061	0.2759	0.2203
	Average	0.3107	0.2300	0.2017	0.2285	0.2197
After (100 km/h on subject roads)	2003/04	0.1667	0.2162	0.1455	0.4706	0.1992
	2004/05	0.0833	0.1681	0.1458	0.0417	0.1434
	2005/06	0.5000	0.1889	0.1633	0.1739	0.1872
	2006/07	0.1429	0.2097	0.1720	0.2500	0.1930
	2007/08	0.5556	0.1356	0.1395	0.2308	0.1593
	2008/09	0.3846	0.3191	0.1182	0.0000	0.2060
	2009/10	0.1429	0.2016	0.0899	0.0800	0.1468
	2010/11	0.3000	0.1210	0.0930	0.0556	0.1134
	2011/12	0.4000	0.0804	0.1600	0.1538	0.1220
	2012/13	0.0000	0.0887	0.2167	0.1765	0.1244
	Average	0.2676	0.1729	0.1444	0.1633	0.1595

Figure 3. Ratio of casualty crashes on subject road segments to casualty crashes on control road segments per financial year (1993/94 – 2012/13)



The amount by which crashes were reduced on the subject road segments compared to the control road segments was investigated further. Table 3 shows the average before and after ratio for each severity category, along with the percentage ratio change which represents the additional crash reduction on the subject road segments beyond those found on the control road segments. An independent sample t-test was applied to the crash ratios in each financial year to determine the upper and lower 95% confidence limits of the change in crash ratio between the before and after periods.

The results from Table 3 reveal a 27.4 per cent reduction in all casualty crashes on subject road segments beyond that of the control road segments. The associated bounds of ± 12.4 per cent indicate that this reduction in crashes is highly statistically significant ($p < 0.0001$). The reductions in crashes that resulted in an admission to hospital or treatment at hospital were also statistically significant. However, the confidence intervals were too wide to determine whether there were greater reductions for crashes of a higher severity category.

Table 3. Change in the ratio of crashes between the before and after period by crash severity

Crash severity	Average ratio (before)	Average ratio (after)	% ratio change	Upper confidence limit	Lower confidence limit
Fatal	0.2285	0.1633	-28.56	25.24	-82.35
Admitted to hospital	0.2017	0.1444	-28.40*	-6.01	-50.78
Treated at hospital	0.2300	0.1729	-24.82*	-2.45	-47.19
Treated by doctor	0.3107	0.2676	-13.88	33.23	-60.99
Any severity	0.2197	0.1595	-27.40*	-39.82	-14.97

* Statistically significant

Looking again at Figure 3 it appears that there may be a general downward trend in the after period or a greater reduction in the ratio during the final three financial years. It is considered most likely that this effect is the result of random fluctuation but two other potential explanations are suggested.

The first is that there is a true downward trend in the ratio after the speed limit change in 2003. This could be due to drivers on the subject road segments taking some time to adapt to the new speed limit. If true, it would mean the 27 per cent reduction in crashes identified here is an underestimate of a long term effect and an overestimate of the short term effect.

An alternate explanation is that the reduction in the last three years is brought about by a continuation of a general downward trend in the ratio across both the before and after periods (with the possibility that the downward trend was increased in the after period). This could be the result of gradual changes in the distribution of traffic, infrastructure improvements, and/or enforcement on the subject and control road segments. If this was the case, then the identified 27 per cent reduction in crashes would be an overestimate of the mean effect.

Discussion

The number of crashes on the roads with speed limits lowered from 110 km/h to 100 km/h was found to be 27.4 per cent lower than would have been expected if these roads had simply matched the reductions identified on the control roads. The result was highly statistically significant, with the 95 per cent confidence interval being plus or minus 12.4 per cent.

The large size of this effect and relatively narrow confidence interval provides convincing evidence that the lower speed limits were highly effective in reducing casualty crashes. However, this study was not based on a randomised case control design where potential sites are randomly allocated into treatment or control groups to avoid selection and other biases. Therefore, there are other possible explanations for the results seen in this study. These need to be carefully considered when interpreting the results.

Regression to the mean on subject roads

The subject roads may have been selected, in part, because of their high crash rates. Part of this high crash rate could have been random variation in the high direction shortly before treatment that would not recur subsequently. This phenomenon is often referred to as regression to the mean and would lead to an apparent reduction that is not related to the treatment effect.

Such an effect is unlikely to be large given the relatively consistent crash numbers on the subject roads over the 10 years before the speed limit was lowered (see Table 1 and Figure 2). It appears that the treatment roads were chosen more on their characteristics than on their recent crash rate.

Comparability of control roads

In order to account for changes in other safety measures over the course of the study (such as safer vehicles and general road improvements) a control group of roads was used. This consisted of road segments that remained at 110 km/h over the study period. However, this group of roads is not directly comparable to the subject roads. The control roads included major highways and multilane roads throughout the State, whereas the subject roads were generally arterial two lane roads closer to Adelaide (see Figure 1). If there were significant differential effects on the two road types that coincided with the 2003 speed limit change on the subject roads, then an apparent effect could be produced that is not representative of the actual effect of the speed limit change. Such effects cannot be ruled out but the ones that could conceivably have lowered crashes on the subject roads or increased crashes on control roads (which would lead to the observed change) are considered below:

- A decrease in traffic on subject roads or an increase on control roads

- An upgrade of infrastructure on subject roads
- A change in the type of traffic on the subject or control roads - for example, a reduction in the number of motorcycles and bicycles on subject roads which would lead to fewer casualty crashes
- An increase in the level of enforcement on the subject roads compared to the control roads from the before period to the after period (or vice versa)
- A change in crash reporting (or processing) by the police responsible for the rural areas that encompass the subject or control road segments.

Each of these effects may produce gradual changes over time but it was considered unlikely that any could have occurred with sufficient rapidity or intensity so as to result in the sudden and significant reduction in injury crashes between the before and after period observed here. Thus, while the possibility remains that the results of this study are an artefact of the roads analysed rather that the reduction in speed limit, it seems unlikely.

Conclusion

While the present study is not definitive, the results together form a consistent picture:

- A distinct drop in casualty crashes is apparent on the subject road segments after the speed limit was lowered
- There is a long-term trend of a reduction in crashes on the control road segments that remained at 110 km/h
- Making allowance for this reduction by calculating the ratio of crashes on the subject road segments to crashes on control road segments, an extra reduction on the subject road segments is detected
- The subject road segments differed from the control road segments, but no likely confounding effects could be identified
- These results are consistent with other research on speed, speed limits and casualty crashes.

While the study has some methodological limitations, the size of the effect and the consistency of the various elements provide rather convincing evidence that the lowered speed limits were effective in reducing casualty crashes by a large amount.

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