AN INTERIM EVALUATION OF THE DEFAULT 50 KM/H SPEED LIMIT IN VICTORIA

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ABSTRACT
A statewide default 50 km/h speed limit in built-up areas (except where otherwise signed), was introduced in Victoria on January 22, 2001. This legislation was brought in with the aim to reduce the incidence and severity of casualty crashes, in particular, crashes involving the more vulnerable users of this road class (ie, pedestrians). An interim evaluation has been conducted to estimate the effect of the 50 km/h speed limit on crash frequency, which compared a five year pre-implementation period with a five month post-implementation period. Poisson regression has been used to model crash frequency for the period January 1996 to June 2001. Crashes of all severity types were analysed, as were those involving specific road user groups such as pedestrians, and young and older drivers. The analysis has shown a statistically reliable reduction in all casualty crashes on roads with the new default limit and for all road user groups except older drivers, at this stage in the evaluation. The interim results presented are part of an ongoing project and estimate the effect of the 50km/h limit in only the first five months after its introduction. Results are also subject to a number of assumptions and qualifications.

INTRODUCTION
On 22 January 2001, a statewide 50km/h default urban speed limit was introduced in Victoria. This limit has been applied principally on residential streets, and on a proportion of collector roads. The balance of the collector roads and the remainder of the road network have remained zoned 60 km/h or higher, with additional signage erected where warranted. The primary objective of this initiative was to reduce the incidence and severity of casualty crashes, in particular, in casualty crashes involving the more vulnerable users of this road class (ie, pedestrians).

Analysis by VicRoads has shown that over 2400 people are injured or killed on local streets each year and state that many of these crashes are caused by excessive or inappropriate speeds (VicRoads 2000). Further more, research has also shown clear links between both crash risk and crash severity and travel speed. Studies also indicate strong links between risk of pedestrian death and vehicle travel speed in a collision between a vehicle and pedestrian. If hit by a vehicle at 50 km/h, a pedestrian has less than a 40 per cent chance of being killed. At 60 km/h a pedestrian has a 70 per cent chance of being killed (VicRoads 2000). These figures, along with demonstrated crash reductions associated with the introduction of 50km/h speed limits in other Australian states (eg. RTA 2000) led to the introduction of the default 50km/h urban speed limit in Victoria.

The primary aim of this evaluation is to estimate the net effect of the introduction of the 50km/h speed limit on crash frequency in metropolitan Melbourne in the five months following the implementation. Difficulties in identifying current speed limits on roads in regional areas meant that it was not possible to retrospectively identify to which roads the change had been applied. Hence, the results of this evaluation are applicable to the metropolitan region only. Also explored is the effect of this speed limit on speeding behaviour via a review of the results of a preliminary study that investigated the effect of the 50 km/h speed limit on vehicular speeds.

The crash evaluation, which will be updated at regular intervals, has utilised five full years of comprehensive crash data pre-implementation, and five full months of crash data post-implementation. Further analyses are planned adding more crash data as it becomes available. In the following sections, the size of the effect (proportional reduction) on crashes and crash severity on built-up streets is examined. Target groups for which there have been significant reductions are also identified.

METHOD
Study Design
The generic null hypothesis tested in this study was that the introduction of the 50 km/h speed limit in Victoria had no effect on total injury crash counts in the target road user population being examined. This was assessed against the alternative hypothesis that the introduction of the 50 km/h speed limit produced some change without assumption of the direction of change, ie, a two-tailed hypothesis. Testing the null hypothesis entailed using a quasi-experimental design. Crash history on those roads that became 50km/h was compared from before the change to after the change. This was then compared to changes in crash history at a set of suitably comparable 'control' sites over the same before and after time periods. The net difference in the before to after 50km/h implementation crash frequency change between the treatment and control sites was the estimated effect of the 50km/h change. It was necessary to use control groups in this study, rather than simply compare

crash history before and after the change on the 50km/h roads, to represent the influence of other factors, besides the 50km/h introduction, on crash frequency.

The two control groups used in this study, were (i), those roads that remained at 60 km/h after the change, and (ii) all roads 60 km/h and above. The most appropriate control group was considered to be those roads that remained at 60 km/h as these were considered to be more comparable to 50 km/h roads in terms of traffic and physical characteristics. The second control group was assessed in the hope it would provide equivalent control information but with increased sample size and thereby enhanced statistical power of the test.

Using the TAC SafeCar project (Healy 2002) speed zone coverage for metropolitan Melbourne, it was possible to identify crashes occurring on all other roads that did not change to 50km/h along with the speed zoning of these other roads. Further, the analysis method employed allowed the assessment of the homogeneity between the roads remaining 60km/h, compared with higher speed zones, in terms of providing control information in the analysis. Because of this, both options for control site selection were considered in the analysis and the homogeneity between the analysis results was assessed, the results of which are discussed later.

The primary purpose of this study was to identify the crash effects of the 50km/h speed limit introduction. However, it was also of interest to see if any crash changes estimated due to the 50km/h introduction are supported by changes in speeding behaviour. Ratio Consultants have undertaken collection and analysis of speed data associated with the introduction of the 50 km/h limit. A report on the analysis of data collected has been released and this has been examined in relation to the crash analysis results as far as possible.

Crash data

Crash data for the period January 1996 to June 2001 was supplied by VicRoads, for use in this evaluation. The data encompassed all Police reported casualty crashes occurring in both regional and metropolitan Victoria although, as noted above, only crash data from metropolitan Melbourne was utilised. Data after June 2001 was not complete for use in the study.

Crash severity, as coded by VicRoads from Police collision reports (V.P. form 510), was utilised in this study to examine the effect of the 50km/h implementation on crash severity levels. This variable is determined on the basis of the most severely injured person involved in the crash and is categorised into three groups: fatal, serious and other injury. A crash is coded as ‘fatal’ when at least one person involved in a crash has been killed or has died within 30 days of the crash. A ‘serious’ crash is broadly one where at least one person involved in the crash has been admitted to hospital, while a crash categorised as ‘other’ represents a crash where at least one person involved sustained non-serious injuries that may or may not have been medically treated. It should be noted that there is anecdotal evidence to suggest that a number of crashes coded as ‘serious’ do not actually involve a person being admitted to hospital.

Each crash in metropolitan Melbourne was labelled according to the speed zone that existed at the crash site at the time of labelling (December 2001), regardless of the date the crash occurred. This allowed identification of crashes that occurred in sites currently zoned 50km/h, which were previously 60 km/h, along with crashes occurring in areas that have remained zoned at other speeds (the ‘control’ crashes). This speed zone labelling process required the linking of the electronic speed zone map from the TAC SafeCar project with the map of all crash locations using the geographical information system (GIS) package ARCINFO. VicRoads Land Information and Survey Department carried out the linking.

Crashes were labelled as occurring before or after the implementation of the 50km/h speed limit using the recorded date of the crash. The before treatment period was defined as January 1996 to January 2001, a period of 61 months. A before treatment of this duration was chosen in order to give an accurate estimate of pre-treatment crash trends over a period where road trauma in Victoria was relatively stable. The after treatment period was chosen as February 2001 to June 2001, the maximum period of after change data available for the study.

Poisson regression

Poisson regression models were used to assess statistically the crash effects of the 50km/h implementation on local roads. This technique assumes that crash data follow a Poisson distribution[1] (Nicholson, A.J.,1985; Nicholson A.J., 1986). The

[1] A Poisson distribution describes how count data, such as the number of crashes, is distributed. This distribution is assumed whenever number of events is being counted.

theoretical basis for this assumption is that crashes are rare events that occur randomly and independently of other crashes, characteristics common to all Poisson distributed data. Data that follow this distribution cannot be analysed using traditional regression for three reasons. They are: (1) the rare occurrence of a crash over a given time interval skews the distribution of crashes to the right, making it asymmetrical, (2) the Poisson distribution has a mean that varies with its variance and (3) data is limited to non-negative values (ie, negative crash numbers are not possible). In addition, it is much more logical to assume that the explanatory variables interact with the outcome variable multiplicatively rather than linearly. Traditional linear regression methods, however, assume that the data is symmetric, has a constant variance and can produce predicted values that are negative. To overcome these difficulties, Poisson regression applies a natural log-transformation to the response variable (crash count) allowing regression analysis to be conducted. Performing a traditional regression would not make the necessary adjustments to the crash data, nor would it preclude implausible results, such as predicted negative crash frequencies.

A Poisson regression model of the following general form was fitted to the monthly series of crash frequency data from the treatment (50km/h) and control (60km/h; or 60km/h and above) areas. [2],

$$\ln(y) = \beta_0 + \beta_1 (Treatment\ /\ Control) + \beta_2 (Before\ /\ After) + \beta_3 (Treatment\ /\ Control \times Month) + \beta_4 (Treatment\ /\ Control \times Before\ /\ After)$$

where

y	is the monthly crash count in either treatment or control group
Treatment/Control	is an indicator for treatment or control crash series
Before/After	is an indicator of before or after 50km/h implementation
Month	is the sequential month of the crash data count
AxB	indicates an interaction between factors A and B.

Separate models were fitted to crashes at each severity level as well as to all casualty crashes. The severity levels investigated were fatal crashes, serious injury crashes, fatal and serious injury crashes pooled, and 'other' injury crashes.

Homogeneity assessment
As noted in the Study Design, two different control areas were considered in this study, namely those roads remaining at 60km/h and all roads 60km/h and above. Using the Poisson regression model analysis structure, it is possible to assess the equivalence of the 60km/h zones and each of the higher speed zones individually (70, 80, 90km/h, etc) in providing control information in the analysis.

Homogeneity was assessed by fitting firstly a regression model to the data with the speed zones from 60km/h and above treated in an aggregate way and then fitting a second model with each zone from 60km/h and above treated separately. The difference in the scaled deviances[3] between the two models, which has a Chi-squared (χ^2) distribution, is the homogeneity measure and can be tested for significance by a table of χ^2 probabilities. The assumption of homogeneity is rejected when χ^2 is large, suggesting that significant variation is present in the control information presented between the speed zones.

Specific road user groups
Specific road user groups were also investigated in this study. Pedestrians, who are known to have high exposure and vulnerability on 50 km/h and 60 km/h roads compared to other roads, are expected to gain significantly from this implementation. Young and older driver crash statistics were also investigated, prompted by the finding of significant estimated reductions due to the 50km/h introduction in NSW (RTA 2000) in the order of 18.7% and 49.5%, respectively.

Speed surveys
The effect of 50 km/h speed limit on speeding behaviour was explored via a review of the results of a preliminary study that investigated the effect of this speed limit on vehicular speeds. A separate study commissioned by VicRoads, evaluated mass speed survey data collected by both metropolitan and regional Local Government Authorities (LGAs). Survey sites were limited to local and collector roads with data collected at some sites for a period of up to 12 months prior to the implementation. Although not stated explicitly, it is estimated that the post implementation data collection ended around

[2] The β coefficients of each variable are regression coefficients allowing comparison of the relative contribution of each independent variable in the prediction of the crashes.

[3] Scaled deviance is a measure of how well the fitted model describes the observed data.

June 2001. In the period to June 2001, the study concluded that there had been an overall 2-3 km/h reduction in both mean and 85th percentile speeds since the 50km/h speed limit implementation. Two test sites showed an increase in both mean and 85th percentile speeds. The control sites also showed an overall reduction in vehicular speed but only in the order of 1-2 km/h. Due to the small number of test sites analysed in the study, it was not possible to establish statistical significance, prompting a recommendation for further work involving the acquisition of sufficient, high quality data. The results of these findings are discussed in conjunction with the outcomes of the crash analysis.

RESULTS

The results in Table 1 are given as estimates of the net percentage change in crash rates in 50 km/h zones relative to each comparison area, obtained using Poisson regression analysis. Estimates are given for each crash severity level and all casualty crashes for all crashes, and for each roaduser subgroup. Statistical significance values are also given for each result Those under 0.05 represent a statistically reliable result and are indicated by the shaded areas in the table below.

All casualty crashes

Analysis of all casualty crashes (encompassing all roaduser groups) produced statistically significant estimated net reductions for all casualty crashes of 13% and 12% relative to 60 km/h zones and all other zones greater than 50 km/h, respectively. The introduction of the 50 km/h speed limit also achieved statistically significant crash reductions for 'other' injury crashes, namely 13% and 12% with respect to each of the comparison groups.

		50km/h Zones vs 60km/h Zones		50km/h Zones vs All Other Speed Zones	
	Crash Severity	Crash Reduction Estimate	Statistical Significance	Crash Reduction Estimate	Statistical Significance
All Casualty Crrashes	Fatal Crashes	52.89%	0.1276	58.70%	0.0569
	S I Crashes	12.64%	0.1036	11.46%	0.1154
	O I Crashes	13.27%	0.0093	11.84%	0.0113
	All C Crashes	13.27%	0.0014	12.32%	0.0016
Pedestrian Crashes	Fatal Crashes	44.82%	0.4225	40.93%	0.4513
	S I Crashes	46.22%	0.0005	40.11%	0.0028
	F + S I Crashes	46.14%	0.0003	40.24%	0.0019
	O I Crashes	-4.31%	0.7719	-2.61%	0.8528
	All C Crashes	22.17%	0.0229	19.39%	0.0414
Older driver Crashes	Fatal Crashes	-	-	-	-
	S I Crashes	10.76%	0.5772	9.16%	0.6196
	F + S I Crashes	13.54%	0.4693	12.67%	0.4767
	O I Crashes	-2.84%	0.8186	-6.01%	0.6108
	All C Crashes	2.59%	0.8016	0.16%	0.9873
Young driver crashes	Fatal Crashes	16.89%	0.1428	6.12%	0.9398
	S I Crashes	-29.11%	0.0932	-22.79%	0.1428
	F + S I Crashes	-29.19%	0.0877	21.96%	0.1501
	O I Crashes	34.10%	<0.0001	31.32%	<0.0001
	All C Crashes	19.90%	<0.0072	18.64%	0.0076
F = fatal, S I =serious injury, O I =other injury, All C Crashes = all casualty crashes					

Table 1 Estimated crash reduction in 50km/h zones relative to 60 km/h zones and to all other speed zones

Casualty crashes involving older drivers

Poisson regression results for older drivers (55 years and over) were inconclusive at this stage of the evaluation. Due to insufficient numbers of fatal crashes in this target group, crash reduction estimates could not be made for this category and, statistically significant estimates were also not achieved for any of the crash severity categories examined. However, estimates suggest the 50km/h limit may have been successful in reducing fatal and serious injury crashed combined by around 13 percent for this crash sub group.

Casualty crashes involving young drivers

In this study, drivers 18 to 25 years of age were defined as young drivers, with a young driver crash having at least one vehicle controller involved in the crash being in the defined young age group. A statistically significant crash reduction estimate of 18% was achieved in all casualty crashes involving young drivers, and highly significant reduction estimates of 34.1% and 31.3% in non-serious injury crashes relative to 60 km/h and all other speed zones, respectively. Statistically reliable estimates were not achieved for serious injury and fatal crashes.

Casualty crashes involving pedestrians

Statistically significant results were obtained for all casualty crashes and serious injury crashes for the two comparison sets of roads. A graphic illustration of the net reduction for all casualty crashes relative to all roads 60 km/h and above is presented in Figure 1. The large step change in 50 km/h zones relative to all other speed zones is reflected in the significant estimate reduction of 19.4% for all casualty crashes, and is shown graphically in Figure 1. Significant reductions were also achieved when fatal and serious injury crashes were pooled. The negative crash reductions in Table 1 indicate estimated crash increases.

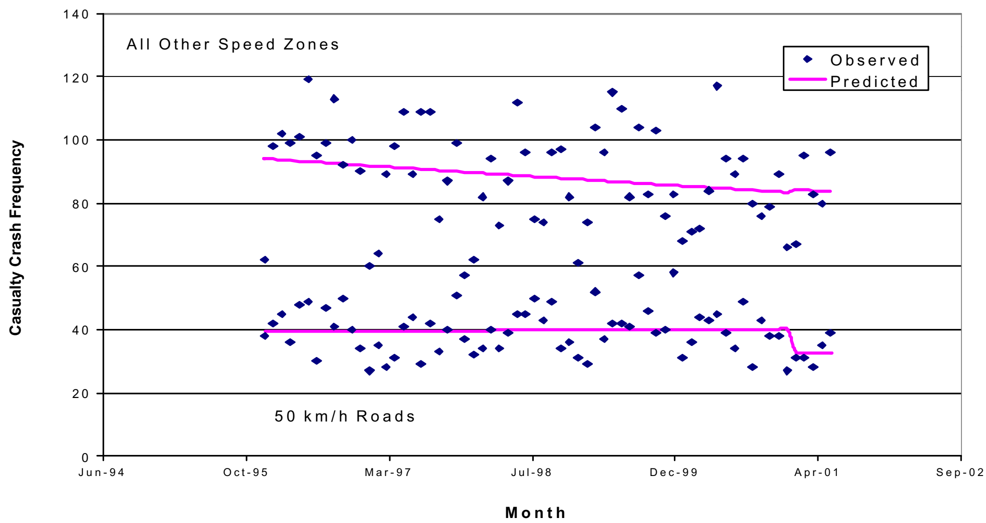

Figure 1 **Observed and predicted monthly casualty crashes involving pedestrians: 50 km/h vs all other speed zones – all crash types**

Homogeneity analysis

The results of the homogeneity analysis showed no statistically significant variation in program effectiveness estimates obtained using only 60km/h areas as controls and those obtained using all speed zones 60km/h and above as controls. This was the case for all crash types considered at all severity levels. Given that 50km/h crash effect estimates based on all speed zones 60km/h and above are based on greater data quantities, these estimates are likely to be more accurate than those based on comparison with the 60km/h zones only.

DISCUSSION

Specific road user groups

Analysis in this report relating to specific road user categories shows that the greatest casualty crash reductions were achieved for crashes involving pedestrians. Based on analyses conducted on the effects of the NSW 50 km/h speed limit, it was expected from the outset that this group would benefit due to their high exposure to 50 km/h and 60 km/h roads along with their known vulnerability to impact speed in road crashes. Young drivers also benefited from the speed limit reduction although the results suggest benefits were largely seen in non-serious crashes. The lack of statistically significant reduction estimates for serious and fatal crashes in this group could be attributable to insufficient data at this stage. Results suggest that higher severity crashes involving older drivers have reduced after the introduction of the 50km/h speed limit. None of the estimated reductions for this crash group are statistically reliable, however, which is most likely attributable to the limited data available for this group at this stage of the study.

Speed Survey Data

The results from the VicRoads report prepared by Ratio Consultants found an overall reduction of 2 to 3km/h in the 85th percentile and mean speeds on the 50km/h streets tested. This small decrease in vehicular speed is consistent with the findings of the crash-based evaluation, with other research on the relationships between crash risk and speed suggesting even small speed reductions can be directly linked to measurable reductions in casualty crashes. Unfortunately, data analysed in the report was not detailed enough to make full assessment of changes in speed distributions, particularly at higher speeds where severe crash risk is likely to be greatest. It is estimated that the speed survey results also utilised five months of post-implementation data.

CONCLUSIONS

Crash frequency analysis showed a number of significant reductions associated with the new speed limit on casualty crashes as a whole and within target groups. Statistically significant estimated crash reductions in 50km/h zones, relative to changes observed in similar crash groups in all other speed zones, were found in the following:

- 12% for all casualty crashes
- 40% in death and serious injury for pedestrian-involved crashes
- 19% in all casualty crashes involving young drivers.

Statistically significant reductions were not found for casualty crashes involving older drivers at this stage in the evaluation.

Results of the crash analysis undertaken here were generally consistent with speed survey data published by VicRoads that showed reductions in mean and 85th percentile speeds after the 50km/h introduction of between 2 and 3km/h.

It should be noted that the results presented in this report consider the effects of the default 50km/h speed limit introduction in only the first five months after introduction and may not be indicative of the long-term effectiveness. The results are also subject to a number of assumptions and qualifications which are given below. Ongoing work is being undertaken considering a longer period of data after implementation of the lower default limit as well as other specific crash types.

Analysis presented here has been able to show some statistically reliable estimated net crash reductions due to the implementation of the 50km/h default urban speed limit in Victoria. Validity of the results relies on a number of assumptions. It is assumed that labelling of the current speed zoning of crash locations by Vicroads is accurate. It also assumes that the form of the statistical models used for analysis are correct and that the comparison groups in the analysis adequately represent the effect of other factors affecting crash history in the 50km/h zones other that the speed change. Further to this, it is also assumed that the use of the comparison group corrects for any variation in time in the accuracy of recording crash severity by police.

Because of limitations in the available data, analysis has only been able to measure the effects of the 50km/h speed limit on the frequency of injury crashes reported to police. It is unknown whether the injury crash frequency reductions measured were a result of reduced exposure, reduced crash risk, reduced injury risk in a crash or some combination of the three.

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