Outcome Evaluation of the Safe Routes to Schools Program

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Biography
Amanda Delaney joined the Monash University Accident Research Centre as a research analyst during 2002 after completing her B.Com.(Hons.) in econometrics. She is completing a law degree part-time and has a wide range of interests in road safety including enforcement effects, crashworthiness of vehicles and roadside environment safety.

Abstract
The Safe Routes to Schools (SRTS) community based road safety program has operated in primary schools throughout Victoria since 1990. The program includes education, engineering, encouragement and enforcement initiatives, aimed principally at reducing casualty crash frequency and severity for children as pedestrians, bicyclists and passengers. This paper describes the methodology and results of an evaluation of the crash effects of the Safe Routes to Schools program in Victoria.

The evaluation examines the crash effects associated with the program across a number of road user groups at all times of day and at the times at which children are likely to be travelling to and from school. The analysis was conducted using a quasi-experimental, before and after, treatment and control design. The treatment areas were defined by the postcode areas surrounding the treatment schools and control areas were defined as all other postcode areas within the same Local Government Areas (LGAs) as the treated schools.

The results of the analyses indicate that the estimated average yearly net effect of the program over the post-implementation period was beneficial in safety terms. The largest percentage reduction in casualty crashes was identified for primary school-aged pedestrians and bicyclists travelling during school travel times only (17.9%). Crashes involving primary school-aged pedestrians and bicyclists at all times, and crashes involving primary school-aged children at all times, were estimated to have fallen by 12.6 and 12.7 percent respectively. In addition, a 4.8 percent reduction in crashes involving all road users at school travel times was identified. Attempts to estimate the effect of the program in each year following the implementation of the program were statistically inconclusive, most likely because of insufficient data. In respect of the severity of crashes involving the relevant road users, no statistically reliable reductions in fatal and serious injury crash frequency could be identified at the five-percent level.

1. INTRODUCTION

The Safe Routes to Schools program (SRTS) is a community-based road safety program that was first introduced in Victoria in the early 1990s in response to concerns about the vulnerability of children as road users. The program was "designed to reduce the incidence and severity of injuries to school-aged children as pedestrians, bicyclists and passengers from Prep to Year 10" (VicRoads, 2000). In general, the program involves the investigation of the issues and needs of each school undertaking the program using tools such as local observational and travel surveys and on-site investigations of road user behaviour. After identifying the most common routes taken to and from school, a road safety action plan is then developed detailing the education, engineering, encouragement and, where appropriate, enforcement interventions required to address the road safety issues specific to the school. The school and the local municipality then implement this plan.

The purpose of this study was to examine the actual effect, if any, of the SRTS program on the involvement of primary school-aged children in reported casualty crashes en-route to school and the severity of such crashes. Further, the analysis considers the broader effects of the program in time and on road user groups beyond those targeted by the program. Change in the program over time and the relationship of these changes to the implementation and density of operation of the program are also investigated.

2. Evaluation Design

2.1 Hypothesis

Consistent with the purpose of the study, the analyses examine two distinct hypotheses. First, the effect of the SRTS program on casualty crash frequency in the defined treatment areas is examined by testing the null hypothesis that the SRTS program is not associated with any casualty crash reductions in the treatment areas against the alternative hypothesis that the SRTS program has led to changes in the casualty crash frequency in the treatment areas. Second, the effect of the SRTS program on the severity of casualty crashes occurring in the defined treatment areas is examined by testing the null hypothesis that the SRTS program is not associated with reductions in casualty crash severity in the treatment areas against the alternative hypothesis that the SRTS program was associated with reductions in casualty crash severity in the treatment areas.

Both of the general hypotheses described are tested with respect to crashes involving three road user groups: all road users, primary school-aged children only and primary school-aged pedestrians and bicyclists only. Further, each of the hypotheses is tested using crashes occurring at all times of day and during school travel times only thereby creating six road user groups/sub-groups.

2.2 Study Design

The evaluation of the effect of the SRTS program is conducted using a quasi-experimental treatment-control design. This approach compares casualty crash frequency or severity in the areas expected to be influenced by the program with casualty crash frequency or severity in the control areas before and after the implementation of the program. In doing so, real changes in the levels of road trauma associated with the introduction of the treatment at treatment sites can be identified by allowing trends related to factors other than the implementation of the SRTS program to be represented in the control areas. When appropriate treatment and control areas are defined, the difference in the change in casualty crash frequency from before to after program implementation between the two areas will represent the effect of the SRTS program.

Relevant to the selection of appropriate treatment areas is that the SRTS program aims to improve road safety for children travelling to and from school. Therefore, the effect of the program is expected to be greatest on the routes travelled by children to and from schools involved in the program. As neither the individual students nor the specific routes travelled by them could be identified, the treatment areas were defined by the postcode(s) of the treatment schools and the areas immediately surrounding them. It is expected that, given the focus of the SRTS program on pedestrians and bicyclists and the limited geographical area in which these modes of transport are likely to be used, the use of postcodes within reasonable walking or bicycling distance from the school to define treatment areas will enable the effects of the SRTS program to be identified in the areas most likely to be influenced by the program.

The control areas are defined by the postcodes falling outside the treatment areas but within the same local government area (LGA). By restricting the control areas to the same LGA as the treatment area, the controls can be matched in time to the operation of the program in a particular geographic area. This is particularly relevant given the staggered introduction of the program across the state. In addition, the restriction of control areas to the same LGA as the treatment areas is expected to ensure that factors external to the SRTS program are sufficiently similar in the treatment and control areas. However, it is assumed that the control areas will be located far enough from the treatment areas to avoid the effect of the SRTS program. If the effect of the SRTS program does in fact “spill over” into control areas the estimated effects of the SRTS program would be conservative.

It was also necessary to define the before and after periods of the study. As a number of schools in close proximity were often involved in the SRTS program and any effect of the program is likely to be evident in the area surrounding those schools, it was necessary to group such schools into geographic clusters to facilitate the determination of before and after periods. The casualty crash data were divided into before and after groups based on whether collisions took place before or after the first implementation of the SRTS program in the geographic cluster corresponding to the crash site. Collisions occurring in the period after the implementation of the program were further divided on the basis of the number of years since the implementation of the first SRTS program in the relevant cluster.

Given the staggered introduction of the program, it is not useful to examine the effect of the SRTS program in individual calendar years. Rather, it is preferable to evaluate the effect of the program in each of the years following its implementation. That is, the effect of the program one, two and three years after its introduction is to be determined regardless of the year in which the program commenced. Adopting this approach increases the power of the statistical tests by increasing the number of schools involved in any one year after implementation of the program. Determining the year of implementation is therefore critical to the adoption of this method.

3. DATA

VicRoads provided the names and locations of all Victorian schools that have implemented the SRTS program since its introduction in 1990. Given the central focus of the program on road safety for children at primary school, all secondary schools that ran the program were excluded from the evaluation. This did not significantly reduce the treatment area, as most secondary schools involved in the program were located close to primary schools running the program. Approximately 300 primary schools were documented as having commenced the full SRTS program since 1990. The crash data used in this evaluation were extracted from the VicRoads Police reported casualty crash database using the postcode of crash variable. The data covers the period from 1987 to 2000 to ensure that a minimum of three years of pre-implementation data were available for use. It is noted that within each of the six road user groups/sub-groups the number of casualty crashes available for analysis ranges from 20 to over 2000.

4. METHODOLOGY

A log-linear model form with poisson error structure, a model form commonly used for modelling crash data series (Bruhning and Ernst, 1985), was used to estimate the effect of the SRTS program on casualty crash frequency and severity. The analysis is conducted in two parts. First, the average effect of the program is estimated using aggregated post-implementation casualty crash data. That is, the average effect of the program after the introduction of the SRTS program is estimated. In contrast, stage two of the analysis estimates the effects of the program for each year following its introduction. The precise forms of the models used are detailed below.

4.1 Aggregate Analysis

The poisson log-linear model of the form shown in equation one was used to estimate the average effect of the SRTS program using aggregated post-implementation casualty crash frequency. A similar model was used in the evaluation of the Random Road Watch enforcement program in Queensland (Newstead et al, 2001). In that study, the introduction of the treatment was also staggered over time both within and across regions.

$$\ln(y_{tp}) = \alpha + \beta_t + \gamma_p + \delta_{tp} + \varepsilon_{tp} \qquad \text{Equation (1)}$$

where,

y_{tp}	casualty crash frequency
t	is an indicator for treatment or control area, 0 = treatment area, 1 = control area
p	is an indicator variable for before and after periods, 0 = before period, 1 = after period
ε_{tp}	is the cell Poisson error term
α, β_t, γ_p and δ_{tp}	are parameters of the model

To avoid redundant parameters in the model specified in Equation (1) and for ease of interpretation, it is convenient to set $\delta_{t0} = 0$ for t = 0, 1. The net effect of the SRTS program on casualty crashes after adjusting for control can therefore be determined using the following equation.

$$\Delta SRTS = \left(1 - \exp\left(\hat{\delta}_{01} - \hat{\delta}_{11}\right)\right) \times 100 \qquad \text{Equation (2)}$$

where δ_{tp} is an interaction parameter that explains the treatment effect.

Year-by-year Analysis. The casualty crash frequency for each year, as defined by the year index, is extracted from the available data and modelled for the treatment and control areas. The form of the poisson log-linear model used is given by equation three.

$$\ln(y_{ty}) = \alpha + \beta_t + \gamma_y + \delta_{ty} + \varepsilon_{ty} \qquad \text{Equation (3)}$$

where

y_{ty}	is the yearly casualty crash frequency
t	is an indicator for treatment or control area, 0 = treatment area, 1 = control area
y	is an indicator variable for the year after program implementation 0 = before period, y = 1, 2, . . , 11
ε_{ty}	is the cell Poisson error term
β_t, γ_y and δ_{ty}	are parameters of the model

Model redundancy is again avoided by setting $\delta_{t0} = 0$ for t = 0, 1. The net effect of the SRTS program on casualty crashes in each year (as defined by the year index) after adjusting for control can therefore be determined using the following equation.

$$\Delta SRTS = \left(1 - \exp\left(\delta_{0y} - \delta_{1y}\right)\right) \times 100 \qquad \text{Equation (4)}$$

where $y = 1, 2, \ldots, 11$.

where δ_{ty} is an interaction parameter that explains the treatment effect.

5. RESULTS

The models detailed above were fitted to the casualty crash data over the period 1987 to 2000. Counts of casualty crashes involving each of the six road user groups/sub-groups were extracted from the crash data for this purpose. The estimated effects generated by the aggregate and year-by-analyses measure the net effect of the SRTS program on casualty crash frequency.

5.1 Overall Program Effects

A model of the form described by Equation (1) was fitted to casualty crash data for each of the six road user groups/sub-groups to estimate the effect of the SRTS program on casualty crash frequency. These models did not consider the year in which the effect took place. The estimated changes in casualty crash frequency are summarised in Table 1and represent the average net effect of the program over the post-implementation period after adjusting for the control.

Table 1. Estimated net average effect of the SRTS program on casualty crash frequency

Road User Group/Time	**% change in casualty crash frequency**	**Pr > ChiSq**
All road users at all times	No change	0.47
All road users at school travel times only	**-4.8**	0.00
Primary school-aged road users at all times	No change	0.89
Primary school-aged road users at school travel times only	**-12.7**	0.03
Primary school-aged pedestrians and bicyclists at all times	**-12.6**	0.01
Primary school-aged pedestrians and bicyclists at school travel times only	**-17.9**	0.01

Table 1 shows that the SRTS program was associated with statistically significant reductions in casualty crash frequency across four distinct road user by time sub-groups when testing at the five-percent level of significance. Therefore, it can be stated with 95 percent confidence that the SRTS program was associated with reductions in casualty crash frequency across the following four road user by time sub-groups:

- All road users at school travel times only
- Primary school-aged children at school travel times only
- Primary school-aged pedestrians and bicyclists at all times
- Primary school-aged pedestrians and bicyclists at school travel times only

It is noted that the estimated percentage reductions in casualty crash frequency are greatest for those road user groups targeted by the SRTS program. The size of the reduction decreases as the road user groups become less precisely targeted. The SRTS program was estimated to have had no statistically significant impact on casualty crashes involving all road users at all times or primary school-aged children at all times.

5.2 Year-by-Year Analysis

A model of the form described by equation three was fitted to casualty crash data for each of the six road user groups/sub-groups to give estimates of program effectiveness by year. It was hypothesised through knowledge of the program and its effects that an individual SRTS program operating in a given school will have an impact on casualty crash frequency and severity for a period of three years commencing at the time the program is introduced. It is noted that this assumption does not influence the estimate of the overall program effect.

The majority of the results obtained from these analyses were not statistically significant and are not presented in detail here for that reason. Nevertheless, a large proportion of the estimated changes indicate that the SRTS program led to reductions rather than increases in casualty crashes. Combined with the positive results from the analysis of the aggregated post-implementation data, these results suggest that the SRTS program is associated with reductions in casualty crashes amongst the relevant road user groups but the exact magnitude of the effect in each year following the implementation of the program cannot be reliably estimated due to data insufficiency.

5.6 Crash Savings

The statistically significant results above can be translated into an estimate of the average number of actual crashes saved each year as a result of the SRTS program assuming all SRTS regions had been operating simultaneously. The base level of casualty crashes is taken from the treatment areas only in the years prior to the implementation of the program. However, given the staggered introduction of the SRTS program across Victoria the length of the pre-treatment period varies between geographic clusters. Therefore, the average frequency of casualty crashes was calculated for each cluster individually and then aggregated to determine the average casualty crash frequency in treatment areas prior to the implementation of the SRTS program. The statistically significant estimated casualty crash reductions are then applied to these pre-implementation levels. The results are presented in Table 2 below.

Table 2. Estimated average annual crash savings resulting from the SRTS program

Road User Group/Time	Estimated % change in casualty crash frequency	Average yearly pre-treatment crash frequency	Average no. of crashes saved p.a.
All road users at school travel times only	-4.8[a]	450	22
Primary school-aged road users at school travel times only	-12.7[a]	37	5
Primary school-aged pedestrians and bicyclists at all times	-12.6[a]	46	6
Primary school-aged pedestrians and bicyclists at school travel times only	-17.9[a]	21	4

[a] estimate is significant at the 5% level

The smallest estimated percentage change in casualty crashes is estimated to lead to the greatest number of actual crashes saved. However, given that this road user group includes a large proportion of all road users this result is not unexpected. Further, this saving will incorporate some of the crash savings associated with other road user groups represented within all road users at school travel times. However, the crash savings associated with primary school-aged pedestrians and bicyclist at times outside school travel times would be in addition to the savings associated with all road users at school travel times only. Therefore, the strata analysed are not mutually exclusive nor is each higher level analysis necessarily a subset of the level before.

5.7 Serious Casualty Crashes

In addition to reductions in casualty crash frequency, the SRTS program may also lead to reductions in the severity of collisions in which particular road users are involved reflected in greater reduction in serious casualty crashes. An analysis of the crash severity effect of the SRTS program was conducted using aggregated post implementation data and a model of the form described in section 4 was fitted to data for serious and fatal crashes only. The estimated effected generated by this analysis measures the average net effect of the SRTS program on the frequency of fatal and serious injury crashes only. Further, the analysis was conducted only for those road user groups in which statistically significant casualty crash reductions were found at the five percent level. The results are presented in Table 3 below.

Table 3. Estimated changes in the frequency of fatal and serious casualty crashes

Treatment group	Estimated % reduction in fatal and serious crashes	Estimated % reduction in all casualty crashes	Pr > Chi sq
All road users at school travel times only	-3.1	-4.8	0.65
Primary school-aged pedestrians and bicyclists at all times	- 13.1	-12.6	0.10
Primary school-aged road users at school travel times only	1.91	-12.7	0.92
Primary school-aged pedestrians and bicyclists at school travel times only	1.56	-17.9	0.95

The estimated reductions in the frequency of fatal and serious crashes were not statistically significant at the five percent level. However, in the case of primary school-aged pedestrians and bicyclists, the estimated reduction was significant at the less stringent 10 percent level of significance. This indicates a reduction of 13 percent in fatal and serious injury pedestrian and bicyclist crashes with 90 percent confidence.

6. DISCUSSION AND CONCLUSIONS

Overall, the evaluation of the Safe Routes to Schools program has shown that the program is associated with significant reductions in casualty crash involvement for the targeted road user groups at specific times. These results are consistent with expectations based on the nature of the program. Testing at the five-percent level of significance the operation of the SRTS program was associated with a 12.7 percent reduction in casualty crashes involving primary school-aged children at school travel times. However, this effect did not extend to primary school-aged children travelling at all times of day. Similarly, the SRTS program was shown to reduce casualty crash frequency amongst all road users at school travel times by 4.8 percent when testing at the five-percent level but did not extend, in a statistically reliable form, to all road users travelling at all times of day. In contrast, reductions in casualty crash frequency were identified for primary school-aged pedestrians and bicyclists travelling at all times of day *and* during school travel times only. Indeed, the reductions in casualty crash frequency involving this road user group were the largest in magnitude with reductions of 12.6 and 17.9 percent for primary school-aged pedestrians and bicyclists travelling at all times and at school travel times only.

These results demonstrate that the effects of the program were highly targeted but also extended to road users and travel times beyond those of primary concern. First, in the case of primary school-aged pedestrians and bicyclists there appears to have been a “spill over” effect that led to the detection of a decrease in casualty crashes involving these road users outside school travel times. However, the cause of these casualty crash reductions is unknown. It is possible that the reduction in casualty crash frequency may be due to reduced exposure to these activities. Such a change in exposure may be due to parents and carers of children involved in the program now choosing to drive their children to school to reduce the risk of injury. Whether or not changes in exposure occurred and the causes of any such changes is unknown and beyond the scope of this study. Nevertheless, these issues should be considered when interpreting the results. Second, the effect of the SRTS program extended to all road users although this effect was restricted to road users travelling during school travel times only. This extended effect may reflect the attention of the program to the involvement of parents and carers of children in the education, encouragement and enforcement components of the program. However, the restriction of the reductions in casualty crash frequency to school travel times only, indicates that this wider effect may, for example, be linked to other road users accompanying children to and from school. Further research would be required to determine whether this is actually the case.

The reductions in casualty crash frequency were found to translate into crash savings of 22, 5, 6 and 4 crashes per year for all road users at school travel times, primary school-aged road users at school travel times, primary school-aged pedestrians and bicyclists at all times and at school travel times respectively. These crash reductions confirm the existence of a ‘spill over’ effect with respect to both time and road user group. The crash savings associated with all road users at school travel times are greater than crash savings identified in sub-road user groups. Therefore, it cannot be said that a large effect in the smaller road user groups translates exactly into smaller effects in the larger road user groups. Consequently it is concluded that the effects estimated for the larger road user groups are genuine reductions for that road user group which extend beyond the reductions estimated for the smaller road user groups.

The SRTS program was also associated with reductions in the frequency of fatal and serious injury crashes involving the targeted road users groups. In particular estimated reductions were found for primary school-aged pedestrians and bicyclists travelling at all times and at school travel times only. Further, estimated reductions were identified for all primary school-aged road users at school travel times only. Nevertheless, none of the estimated reductions was statistically significant. As discussed earlier, this lack of statistical significance is most likely due to insufficient data. Therefore, these particular results should be treated with caution and at most be seen as indicative of the effect of the SRTS program.

Meaningful interpretation of the estimated crash savings in the context of the worth of this program in comparison to other road safety programs requires some knowledge of the costs associated with the SRTS program. This is likely to vary significantly from school to school and reliable estimates are currently unavailable. Analysis of the relative costs and benefits associated with the SRTS program would also benefit from an understanding of the contribution of each of the four components of the program (education, engineering, encouragement and enforcement) to the estimated crash savings. This would assist in optimising the benefits of any future program by enabling investment in the components of the program that produce the greatest benefit relative to cost. This level of detail is beyond the scope of this study; however, it may provide useful information for any future benefit-to-cost analysis or assessment of continued future investment in SRTS against investment in other road safety programs.

Finally, key limitations of the evaluation must be discussed. In particular, the results of the statistical analysis demonstrate only an association between the SRTS program and the casualty crash reductions. No conclusions can be drawn from this evaluation concerning causation of these effects. In order to prove that the SRTS program caused the casualty crash reductions, behavioural change and observational studies would be required to support the results of the analysis conducted here. Such studies may also help to identify the mechanisms through which the SRTS program operated.

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