MANAGING SPEED AT SCHOOL AND PLAYGROUND ZONES

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ABSTRACT

Since speeding is one of the major causes of frequent and severe traffic accidents around school and playground areas, many jurisdictions have reduced the speed limits in these areas to protect our children who may be at risks. In an effort to improve their effectiveness, this study investigated the speed compliance, mean speed and 85th percentile speed at selected school and playground zones in the City of Calgary in Alberta. Several one-way ANOVA tests and a linear regression model were employed to analyze the effects of different site characteristics on speed profile and the compliance. Our results showed that mean speed was lower and the rate of compliance was higher in school zone (compared to playground zone), two lane roads (relative to four lane roads), roads with fencing, presence of speed monitoring device or traffic control devices, longer zone (>200m), and on local roads (compared to collector roads). Several evidence based recommendations are provided to the effectiveness of school and playground zones.

INTRODUCTION

Road Crashes are one of the leading causes of deaths and injuries in North America and around the world. For instance, a total of 2,889 lives were lost and 199,337 injuries were sustained in traffic collisions on Canadian roads in 2006 (Transport Canada, 2006). Of the 2889 deaths in Canada, 374 (12.9%) were pedestrians and 73 (2.5%) were cyclists. These road users are especially vulnerable because of the lack of protection in a collision with a motor vehicle. Hence, both Transport Canada's *Vision 2010* and the *Alberta Traffic Safety Plan* calls for targeted effort to reduce crashes involving vulnerable road users by at least 30% by 2010.

Among the vulnerable road users, children are of special concerns to many road safety professionals and the public due to their added vulnerability and heightened emotional tolls. There may be a variety of reasons why children are hit by motor vehicles. Children are less conspicuous to drivers than adults due to their smaller physical size and they have a higher tendency to behave unexpectedly near the roads compared to a normal adult, especially when they are preoccupied with other activities (Tay, forthcoming). They also have more difficulties judging the vehicle speed and distance.

Among these influences, speeding is considered a major factor in one-tenth of all pedestrian-related traffic fatalities among children. The faster a vehicle travel and strikes a pedestrian, the more severe and potentially fatal the injuries will be. The likelihood of a pedestrian being killed if struck by a vehicle traveling 32 km/hr (20 mph) or less is about 5 percent, compared to a 40 percent likelihood of death if the vehicle is traveling at 48 km/hr (30 mph) or more (Tay, forthcoming). Hence, the likelihood of a serious collision near places where children tend to gather together is significantly increased.

Since a high proportion of school children are exposed to the road in their travel to and from school, they are particularly at risk in areas around schools. Besides schools, other locations where there are a higher proportion of children are areas around playgrounds. Hence, many jurisdictions have taken special precautions around school and playground areas to reduce the likelihood and severity of a motor vehicle collision that is likely to involve a child. One of the widely used traffic control mechanisms for these areas is the designation of a school or playground zone that has a reduced speed limit. In the Province of Alberta in Canada, for example, the speed limit in school and playground zones is 30 kph or 18.2 mph (Tay, forthcoming).

The purpose of this paper is to examine the effectiveness of school and playground zones in reducing traffic speed. In addition, this research will also examine the effects of several traffic and roadway characteristics on traffic speed and speed limit violations to provide some evidence based recommendations to improve these speed control programs. In the following sections of this paper, a brief review of the literature is presented, followed by a description of study site and data collection. The methodology and data analysis methods are then described, followed by the results of the analysis. The final section presents some discussion and concluding remarks.

LITERATURE REVIEW

The literature on the effectiveness of reduced speed limit at school and playground zones is mixed. For example, a speed study by the City of Saskatoon found that the overall compliance with the 30 km/h speed limit was low in the absence of any enforcement or traffic calming measures (Lazic, 2003). Though some drivers reduced their speed, others continued to travel at speeds above the posted speed limit. The author also cited an evaluation of the implementation of the 20 mph (32 km/h) zones in UK which found that these zones appear to be ineffective in reducing speeds or collisions.

A pilot project study in Edmonton showed that the majority of motorists adhered to 50 km/h (31mph) speed limit prior to implementation (Kelly & Saito, 2006). Following the implementation of school zones, very few motorists complied with a 30 km/h (18.6 mph) speed limit and the average speed within the trial school zones decreased by only 2-3 km/h. Even with police enforcement of the 30 km/h (18.6 mph) speed limit, the average speed still remained 15 km/h above the reduced speed limit in the school zones during the given hours that school zones were in effect. The authors also cited a speed study in Switzerland on the use of 30 km/h speed limit zones through selected neighborhood streets and residential district which found that the average vehicle speed decreased by less than 2 km/h.

In another study in the City of Calgary, Tay (forthcoming) found that the mean speed in school and playground zones were significantly lower than the residential speed limit of 50 km/h and only slightly above the posted speed limit of 30 km/h. With respect to characteristics of roadway, one study found that school and playground zones with fencing experienced speed that was lower than those that do have fencing (Tay, forthcoming). This study also found that the mean speed was lower in zones with 2 lane roads compared to zones with 4 lane roads. Finally, this study found that the average speed in school zones tend to be lower than the average speed in playground zones.

In another study of vehicle speed in school zones, "flashing light" at school zone signs were found to be effective in slowing vehicles (Lindenmann, 2005). The success of the reduced speed limit zones appear to depend on the traffic and other characteristics like speed limits, type of zone, road classification, signage, markings, warning lights, and speed monitoring displays.

DATA COLLECTION

The case study used for this paper is the City of Calgary in the Province of Alberta in Canada which implemented a reduced speed limit on roads around both school and playground zones. These zones are clearly marked by a traffic sign at the beginning and end of the zone. A school zone is in effect between 8am to 4.30 pm during school days and the playground zone is in effect starting at 8:30 a.m. and ending one hour after sunset.

A convenient sample of 31 school and playground locations was selected for this study. Since some of the zones have more than one roadway (at intersections), 46 sets of data were collected. Data on vehicle speed were collected by the research team using Ultralyte 20-20 laser speed gun. To reduce the influence of researchers on driver behavior, the speed of the vehicles were measured after they have passed the research team which is set up in an unobtrusively manner upstream. To ensure free flow speed, impeded or rushed drivers who have been influenced by others and were therefore not included in the sample. To maximize the sample of observed vehicles with adequate headway and tailway, measurements were taken mainly during daytime off peak periods. Moreover, since weather and road surface conditions affect traffic speed, measurements were only taken under dry conditions.

In addition to the traffic speed, several site characteristics were recorded to determine if they had any influence on the traffic speed. The characteristics of interests were: school or playground; children present or absent; 2 lane or 4 lane road; with or without fencing; with or without speed display; local or collector road; length of zone (<200m, 200-300m, >300m); distance from the road (abut, within 50m or >50m); and controlled or uncontrolled intersection.

METHODOLOGY AND DATA ANALYSIS

The primary objective of this paper was to investigate the speed compliance, mean speed and 85th percentile speed at school and playground zones and to determine the factors that influence the speed. The widely used mean speed and 85th percentile speed will be used to assess traffic speed. In addition, the study will also determine two indicators of non-compliance of speed limit. The first is the proportion of vehicles that are driven over speed limit of 30km/h (18.6 mph) and the second is the proportion of vehicles that are driven at 10km/h more over speed limit.

The first analysis is conducted to test whether mean speed is equal to or less than the reduced speed limit 30 km/h (18.6 mph). This hypothesis will be tested using simple t-test. Secondly, we would like to test whether mean speed is affected by any of the characteristics in our interests. This hypothesis will be tested using the simple one-way analysis of variance (ANOVA) procedure. In addition, we will construct a simple linear regression model to estimate the factors that have an influence on the outcome variable (traffic speed).

RESULTS

The overall mean speed of all locations was 31.96 km/h (19.85 mph) and the standard deviation was 6.61 km/h (4.11 mph). The mean speed was significantly (p value < 0.005) lower than the otherwise default speed limit of 50 km/h (31.06 mph) in urban areas but slightly greater than the reduced speed limit of 30 km/h (18.6 mph) in school and playground zones. The percentage of vehicle driven over 30 km/h (18.6 mph) was 54.43% which appears to be very high. However, the percentage of vehicle driven at more than 10 km/h (6.2 mph) over speed limit of 30 km/h was only 10% which appears to be lower but still constitute a significant share of the traffic. The 85th percentile speed estimated was 38.81 km/h (24.1 mph).

A series of simple ANOVA tests were performed to determine if the traffic speed was affected by the characteristics of the sites. Nine one-way analyses of variance were conducted to test the equality of the mean speed for following characteristics:

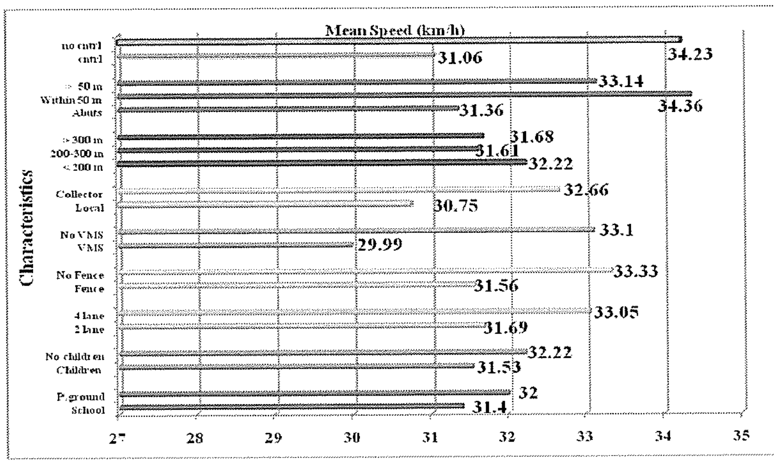
- School or playground
- With and without presence of children
- 2 lane road or 4 lane road
- With and without fencing
- With and without speed display board
- Local road or collector road
- Length of zone (<200m, 200-300m, >300m)
- Distance from road (abut, <50m, >50m)
- With and without traffic control devices

All nine statistical tests rejected the null hypothesis of the equality of means. Similar tests were also conducted for the 85th percentile speed, the non-compliance rate (over speed limit) and the rate of clear violations (over 10 km/h over the speed limit).

The mean speeds of vehicles with the different site characteristics are presented in Figure 1. Consistent with Tay (forthcoming), this study found that the mean speed in school zones (31.40 km/h; 19.5 mph) was slightly lower than the mean speed in playground zones (32 km/h; 19.9 mph) and the difference was statistically significant (p-value = 0.0003). The mean speed on roads with 2 lanes (31.69 km/h; 19.7 mph) or with fencing (31.56 km/h; 19.6 mph) was lower than on roads with 4 lanes (33.05 km/h; 20.5 mph) or without fencing (33.33 km/h; 20.7 mph). These differences were statistically significant (p-value <0.0001 for both).

Besides confirming the above site characteristics used in previous study in the same city, this also examined several additional site characteristics. We found that the mean speed at sites with speed display devices (29.99 km/h; 18.6 mph) or controlled intersections (31.06 km/h; 19.3 mph) were lower than the mean speed at sites without the speed display devices (33.10 km/h; 20.6 mph) or uncontrolled intersection (34.23 km/h; 21.3 mph). These findings were supported by findings from previous research findings (Lee et al, 2006; Kelly & Saito, 2006).

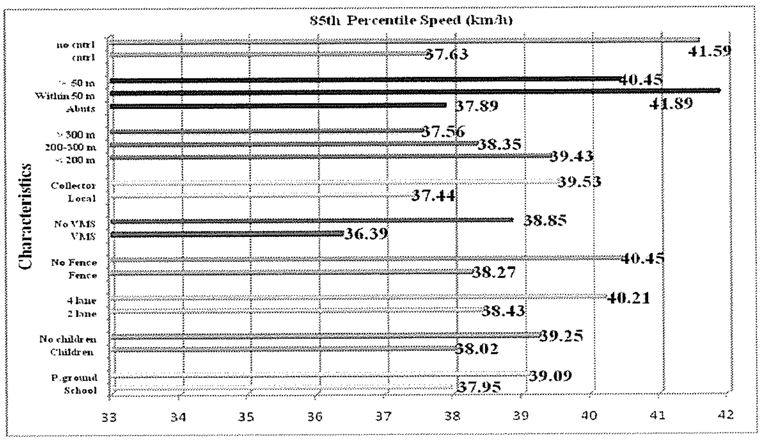
Figure 1: Summary of Mean Speed by Site Characteristics



In addition to these influences documented in the literature, this study also examined a few new features. We found that the mean speeds were lower at zones adjacent to the road (p-value <0.0001), with the presence of children (p-value = 0.003), local road (p-value < 0.0001), and longer zones of 200m or more (p-value <.0001)

Besides the mean speed, the 85th percentile speed of vehicles with different characteristics were estimated and presented in Figure 2. As expected, the 85th percentile speed was higher for playground and at sites with the absence of children, fencing, speed monitoring devices, roads with 4 lanes, uncontrolled intersection, collector road, shorter zones and roads within 50m of school and playground zones

Figure 2: Summary of 85th Percentile Speed by Site Characteristics



Besides the mean and 85th percentile speeds, two indicators of speed limit violation rates at sites with different characteristics were computed and presented in Figures 3. The percentages of simple non-compliant of speed limit (over 30 km/h or 18.6 mph) are presented in Figure 3(a) while the proportion of high-end non-compliant (more than 10 km/h over speed limit) was estimated and presented in Figure 2(b). As expected, non-compliance was higher for playground, and at sites with the absence of children, roads with 4 lanes, no fencing, no speed display device, uncontrolled intersection, collector road, longer zones (< 200m) and roads that are not abutting the playground or school. Again, these results are expected and are consistent with previous findings (Tay, forthcoming; Lee et al, 2006; Kelly & Saito, 2006; Lazic, 2003; Chruchill & Tay, 2007; Tay & Li, 2007; Saibel et al, 1999; McCoy & Heimann, 1990).

Figure 3a: Simple Non-Compliance by Site Characteristics

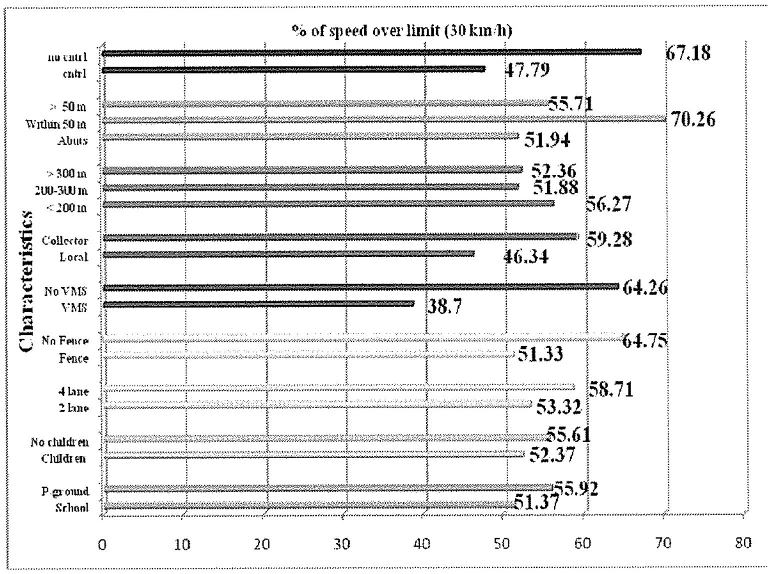
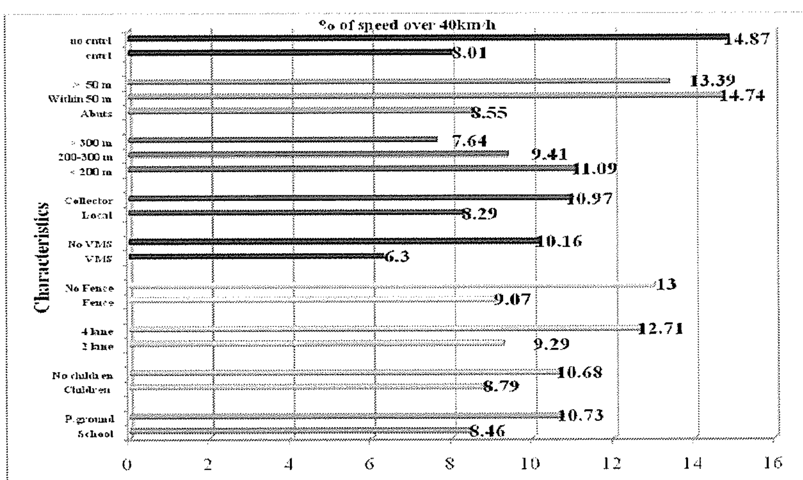


Figure 3b: High-End Non-Compliance by Site Characteristics



In addition to the series of univariate analyses, a multivariate analysis using a linear regression model was conducted to determine the effects of different site characteristics on vehicle speed. The estimation results are reported in Table 1. In general, the model fitted the data fairly well, with a high F-statistic and very small p-value. Although the R-square is relatively small, it is normal for models that attempts to predict individual speed of vehicles without more information on the driver personality.

Table 1: Estimation Results Using Linear Regression

No of Observations	30210	
R-Square	0.0132	
F-Statistics	36.76	
P-value	< 0.0001	
Variables	**Coefficient**	**P - value**
Intercept	32.58	< 0.0001
School Zone	-1.18	< 0.0001
Children Present	-1.05	< 0.0001
2-lane Road	-0.89	< 0.0001
Fence	-1.02	< 0.0001
VMS	-2.59	< 0.0001
Local Road	-1.83	< 0.0001
Length < 200m	-0.36	< 0.0001
Length 200-300m	-0.97	< 0.0001
School/Playground Abut Road	-1.22	< 0.0001
School/Playground within 50m	1.77	< 0.0001
Controlled Intersection	-1.52	< 0.0001

More importantly, all estimated coefficients are higher significant (p-value < 0.0001) and have the expected signs. These findings are consistent with the results obtained from the ANOVA analyses in this study as well as findings from previous studies (Tay, forthcoming; Lee et al, 2006; Kelly & Saito, 2006; Lazic, 2003; Chruchill & Tay, 2007; Tay & Li, 2007; Saibel et al, 1999; McCoy & Heimann, 1990).

DISCUSSION AND CONCLUSION

Our study found that the mean speed in both school (31.4 km/h; 19.5 mph) and playground (32 km/h; 19.9 mph) zones were considerably lower than the default speed limit in urban roads (50 km/h; 31 mph) although they were slightly higher than the reduced speed limit of 30 km/h (18.6 mph) in these zones. These reductions in the mean speed at zones should improve the safety of all road users and the safety of children in particular. Hence, it is recommended that the reduced speed limit at school and playground zones be continued and certain features be added to improve their effectiveness.

The analysis of site characteristics results showed that the mean and 85th percentile speeds as well as the simple and high-end violation rates at school zones were lower than playground zones. These results may be explained by the differences in drivers' expectations, especially with respect to the presence of children (Tay, forthcoming). The presence of children in schools during reduced speed limit hours is much more certain than the presence of children at playgrounds and thus drivers are more likely to slow down in school zones than playground zones. This result is reinforced by our findings that the mean and 85th percentile speeds as well as the violation rates were lower when children were observed to be present at the sites monitored.

The study also found that the use of speed display devices at school and playground zones reduced the mean speed by 9%, simple non-compliance by 40%, and high end violation (10km/h over speed limit) by 38%, which represent substantial improvements in safety. This finding is consistent with the speed study by Lee et al (2006) which found that the implementation of speed monitoring devices (SMD) in Korea significantly reduced speed in school zone and had positive impact on the driver's behaviour. Therefore, it is recommended that the Calgary Board of Education and Calgary Parks and Wildlife acquire a few speed display boards that can be rotated around the different school and playground zones. Financial support for purchasing these speed display boards may be obtained from the Alberta Traffic Safety Fund which has provided funding to many communities for this purpose.

Another hypothesis tested in this study is the safety effect of the presence of fencing. Our results showed that roads in school and playground zones with fencing experienced lower mean and 85th percentile speeds as well as lower violation rates. The presence of chain-linked fence along the road is hypothesized to reduce the drivers' comfort and increase drivers' expectation of the presence of children and other moving objects (pedestrians, cyclists and animal) crossing the roads (Tay, forthcoming; Tay & Churchill, 2007; Tay & Li, 2007). Chain-link fence can thus serves as a traffic calming device and should be considered in school and playground zones that are experiencing a speeding problem.

Another traffic calming scheme that has been found in this study to be effective in reducing traffic speed is the presence of traffic control devices such as traffic signals and stop signs at intersections. Since stop controls are relatively economical, they should be installed at all intersections in a school or playground zone. Since the legal speed limit in these zones is 30 km/h, requiring vehicles to stop at all intersections in these zone will not significantly disrupt traffic flow but has a demonstrated safety effect.

Our study also found that the mean and 85th percentile speeds as well as the violation rates were lower on 2 lane roads compared to 4 lane roads and on local roads relative to collector roads. These results are expected since wider and higher quality roads give drivers the impression of a safer and higher speed road. Since these road classifications and types are determined mainly by their functions, it is more difficult to change, especially for existing roads. Therefore, it is recommended that more frequent traffic enforcement or speed display devices be targeted at these locations to improve the safety of our children.

Finally, our study found that the mean and 85th percentile speeds as well as the violations rates were lower for zones that are longer (larger school and playground frontage) and zones with schools and playground that are closer to the roads. These results are expected because both of these features increase the conspicuity of the schools and playgrounds in the zones. Although these features are hard to change, other simple measures can be implemented to increase the conspicuity of the schools and playgrounds to drivers. To improve the safety of our children, simple structures, such as signboards displaying the name of school or playground, can be erected closer to the roads and nearer to the start of the zones.

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