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The impact of lowered residential speed limits on vehicle speed behavior

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ABSTRACT

In 2010, the City of Edmonton reduced the posted speed limit (PSL) in six residential communities from 50 to 40 km/h. This study investigates the impact of the reduced PSL on vehicle speeds using a before-and-after experimental design with a control group adjustment. Continuous speed and traffic flow data was collected at 65 locations over a period of 7 months, with the first month representing the before period and the following 6 months representing the after period. Speed evaluation was performed on several levels, ranging from individual speed survey locations to an overall aggregate analysis. Several performance indicators, such as mean free-flow speed, speed variance, level of compliance, and percentile speed profile, were considered. The results revealed a statistically significant reduction in mean free-flow speed and speed variances for all combinations of time-of-day and day-of-week classifications. Though absolute compliance to the reduced PSL was low, compliance to a 15 km/h threshold above the PSL was significantly high. Moreover, the analysis showed that the effectiveness of the reduced PSL improved with time.

1. Introduction

Speeding, as defined by excessive speed (driving above the speed limit) or inappropriate speed (driving too fast for the prevailing road and traffic conditions, but within the speed limit), is the number one road safety problem in many countries (OECD/ECMT, 2006). Speeding contributes to as many as one third of all fatal crashes, and is considered an aggravating factor in crash severity (OECD/ECMT, 2006; WHO, 2008). Speed is related to traffic safety in two ways: (i) speeding increases the possibility of crash incidence, as high speeds adversely affect the stopping sight distance, allowing less time for error correction; and (ii) crash severity is directly related to vehicle speed because of the physical relationship of mass and speed to energy.

Although the above rationale will hold for any speeding vehicle, drivers' choice of speed is different in an urban setting than in a rural setting. It is expected that speed behavior varies by road classification (i.e., local, collector, and arterial roads) within an urban area. Often, community residents have the misperception that speeding is a problem only for high speed roads, when in reality, speeding is a safety concern on all roads, regardless of their speed limit or type. Urban roads account for up to 40% of the roadways involved in speed-related fatalities and serious injuries (Road Safety and Motor Vehicle Regulation Directorate, 2008). In fact, approximately 50% of speeding-related fatalities occur on low speed collector and local roads, which make up only a quarter of the total vehicle miles traveled (Federal Highway Administration, 2012).

As a result, safety research related to speed and speed management in urban areas has attracted attention from researchers who have a specific interest in developing sustainable speed management strategies. Although various traffic calming tools, such as geometry change, roadway narrowing, and speed humps, are typically employed to manage speeds in urban areas, the most direct and cost-effective way of managing speed has been to reduce the posted speed limit (PSL) (Archer et al., 2008).

Setting appropriate speed limits is considered to be the backbone of any speed management strategy. PSLs generally serve two purposes: i) improve safety by reducing the risks imposed by drivers' speed choice; and ii) provide the basis for enforcement (TRB, 1998). By limiting drivers to a maximum speed, the risk imposed by driver's speed choice is reduced, thus, improving safety. Additionally, PSLs allow agencies to monitor and penalize those who drive at excessive speeds and potentially endanger others (US DOT, 2002). Although PSLs provide valuable information to the driver about the appropriate driving speed in favorable conditions (e.g., mild weather, and minimal traffic), setting a speed limit does not automatically result in the desired speeding behavior; exceeding the speed limit is relatively common, and many drivers

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have cited the speed limit being too low as a reason to speed (Haglund and Åberg, 2000, 2002).

Thus, it appears that the majority of drivers do not consider PSLs to be the maximum driving speed, but rather a recommended driving speed, and many view driving approximately 5–10 kilometres per hour (km/h) over the PSL as acceptable behavior (EKOS Research Associates Inc., 2005; Goldenbeld and van Schagen, 2007). Moreover, if a road and its PSL are mismatched, lowering the PSL may not result in a reduced driving speed, as drivers tend to respond poorly to such incompatible interventions (Morrison et al., 2003). Recent research suggests that to maximize the effectiveness of any existing or newly implemented speed limit, the road environment should be designed to fit the designated speed limit, while enforcement and road safety advertising campaigns should be integrated (Archer et al., 2008).

Still, many countries and communities around the world are implementing reduced speed limits as a means of improving roadway safety. Specifically, speed limit reduction in urban residential areas has been recommended by researchers and practitioners alike (Archer et al., 2008; Kallberg et al., 1999). There are increasing concerns among both residents and road safety professionals that a typical speed limit of 50 km/h or 60 km/h in residential neighborhoods is inappropriately high, considering the types of activities that occur on these streets (high rate of human interaction with traffic, i.e., non-commuter travel, children playing, people frequently crossing the street, jogging or cycling, etc.). Therefore, through empirical analysis and to strengthen potential reduced PSL recommendations, there is a need to investigate the impact of residential speed limit reduction.

The primary objective of this study is to evaluate the effectiveness of speed limit reduction in urban residential areas on vehicle speed reduction. The basic premise is that a reduction in speed would improve the overall level of safety by reducing crash frequency and severity. The paper analyzes a case study where six communities in the City of Edmonton had their PSLs reduced from 50 km/h to 40 km/h. Since the aggregation of speed data obscures important insight about speed behavior, a secondary objective involves examining the speed data at various levels of disaggregation. In addition, the paper attempts to investigate the effects of time of day, day of week, vehicle type, and road type on speed. These objectives were accomplished by analyzing spot speed data in a before-and-after experimental design with a control group to correct for time trend effects.

2. Literature review

A significant number of studies have been conducted to evaluate the safety impact of speed limit changes. Most studies used a before-and-after evaluation method with a control group, though the compatibility between the treated and control group was not always ensured. Stuster et al. (1998) prepared a review of 19 studies on changing speed limits. Mixed results were found: some studies reported no significant safety benefits, while others reported safety improvements after a speed limit reduction. Most of the studies summarized by Stuster et al. were conducted for high speed roads. Focusing on the actual change of speed due to the change in PSL, Stuster et al. concluded that PSL changes on low and moderate speed roads had little or no effect on travel speed. Drivers only travel at speeds they feel are reasonable and suitable to their driving environment, regardless of the PSL. On freeways and other high-speed roads, the change in actual speed is roughly one-fourth the change in the PSL.

A series of studies has been conducted to evaluate the safety effect of the national maximum speed limit (NMSL) changes in the United States. Conflicting findings among these studies keep the effects of speed limit changes a controversial topic (Kweon and Kockelman, 2005). Further, the effect of the speed limit change on interstate highways might be quite different from that in urban residential areas. Thus, the detailed literature review in this study focuses on only those studies conducted for urban areas and that evaluated the impact of speed limit reduction without any other supplementary engineering treatments.

In 2006, Kloeden et al. (2006) conducted a comprehensive investigation of the impact of on vehicle speed of reducing the PSL from 60 km/h to 50 km/h. On roads where the speed limit was reduced, the average vehicle speed decreased by 3.8 km/h after 3 years. On controlled roads, where the PSL remained at 60 km/h, the average vehicle speed decreased by 2.1 km/h after 3 years. Thus, the net impact of speed limit reduction by 10 km/h was estimated as a reduction of 1.7 km/h in mean speed.

A study of the impact of speed limit reduction from 60 km/h to 50 km/h in urban areas in Victoria, Australia, found a 2–3 km/h reduction of the mean and 85th percentile speed (Hoareau et al., 2006). Due to the small sample size, this reduction was found statistically insignificant. A group of studies reported that speed limit reduction has a positive impact on reducing vehicle speed for low-speed urban roads. However, the actual reduction of speed was found to vary significantly from one study to another. Kamya-Lukoda (2010) found that the speed limit reduction from 30 miles per hour (mph) (48 km/h) to 20 mph (32 km/h) on residential roads resulted in an average reduction of 1.3 mph (2 km/h) in the mean speed on all roads.

Parker (1997) examined the effect on driver speed behavior of raising and lowering PSLs on urban and rural non-limited access highways. The data was collected from sites where speed limits were either raised or lowered and from comparison sites where no changes in the PSLs were made. The statistical results suggested that raising or lowering PSLs alone had no effect on driver traveling speeds. Without additional enforcement, educational programs, or other engineering measures, changing the PSLs alone was found to have a minor effect on driver behavior.

Banawiroon and Yue (2003) evaluated the effectiveness of reducing PSLs from 60 km/h to 40 km/h on local residential roads in the city of Unley, Australia during rush hour. The new PSL of 40 km/h was reported successful in slowing the travel speed to acceptable levels (mean travel speed close to 40 km/h and 85th percentile speed below 50 km/h). However, no statistical test was conducted to examine the statistical significance of the results.

Rossy et al. (2011) investigated the effect of reducing the speed limit from 30 mph (48 km/h) to 25 mph (40 km/h) on residential streets in two neighborhoods in the city of Columbia, USA. Forty-eight hours of continuous speed and volume data was collected for a before-and-after analysis. Average speed and standard deviations were compared during the before and after periods. Statistically significant speed reductions ranging from 1 to 6.21 mph (1.61–10 km/h) were reported at different sites. These results support the hypothesis that significant speed reductions are attainable without additional measures. The addition of an educational campaign resulted in further but smaller reductions in travel speed. However, the study did not account for the change in traffic volume nor for the time trend in the speeding behavior.

In summary, although a number of studies have evaluated the impact of speed limit reduction on vehicle speed, the issue is still debated because of inconsistent and contradictory research findings. In the literature, limited data availability was reported as a major drawback to the evaluation of PSL reduction. Moreover, only a limited number of studies focused their evaluation on urban collector and local residential roads. Furthermore, confounding factors were often not addressed and accounted for in previous analyses, which may have caused biased results. This paper aims to investigate the impact of reducing the PSL from 50 km/h to 40 km/h on