FOUNDATION FOR TRAFFIC SAFETY

A Multi-site Examination for the Impact of Changes in Posted Speed Limit on Traffic Safety

Despite numerous studies reporting the negative impacts of increased speeds on traffic safety, many states have steadily raised their posted speed limits. In response to these concerns, in 2018, the AAA Foundation for Traffic Safety (AAA Foundation) initiated a multi-phased study to investigate the effect of posted speed limit changes on traffic safety. The first phase entailed gathering feedback from traffic engineers on how posted speed limits are set and what factors they consider in changing posted speed limits (Kim et al., 2019). The second phase entailed a collaborative effort with the Insurance Institute for Highway Safety (IIHS) and Humanetics Innovative Solutions to examine how vehicle crashworthiness and occupant protection degrade as impact speed increases (Kim et al., 2021). The final phase, which is the subject of this study, aimed to (1) conduct before-and-after assessments that analyze crash and speed profile data collected from multiple sites where posted speed limits were changed (raised or lowered), and (2) examine differences, if any, from one site to the other. In general, the results showed that the impact of changes in posted speed limit varied across all sites examined. Safety and operational effects varied in the sites within the same state and within the same road functional class (e.g., Interstate Highways, principal arterials). In some cases, results were mixed across different measures gathered at the same site. These varying results suggest that changes in speed limits need to take into consideration a variety of factors (beyond the 85th percentile operating speeds) and contexts using an integrated and holistic approach.

METHOD

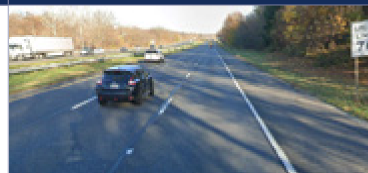
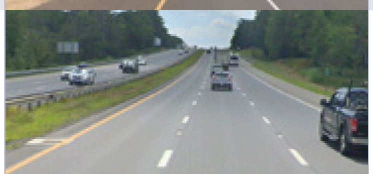
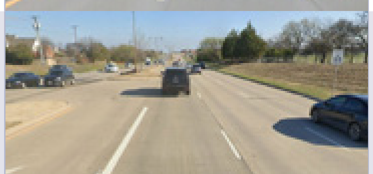
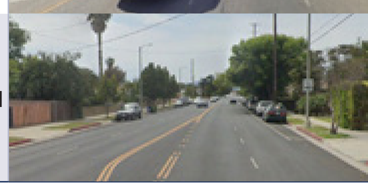
Site Selection and Description

This study selected 12 roadway segments to conduct the before-and-after study. These sites implemented new posted speed limits—six raised and six lowered—between 2014 and 2018. Sites were in multiple states, ranged in length from about 1 mile to nearly 300 miles, and included a variety of road functional classes (e.g., freeways, arterials, collectors) to compare and contrast results across different geographical characteristics. The most critical criterion for site selection was the availability of geocoded data of crash, speed, travel time, and traffic volume for multiple years before and after the new speed limits were implemented. Table 1 summarizes the characteristics and implementation dates of new posted speed limits for selected sites.

Data Acquisition

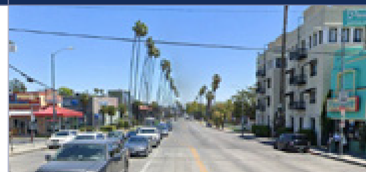
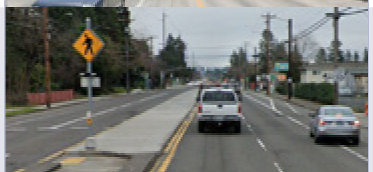
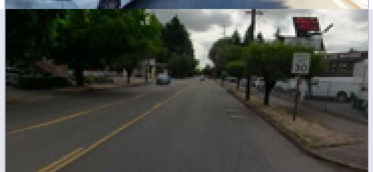
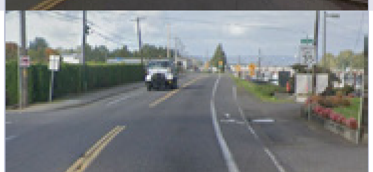
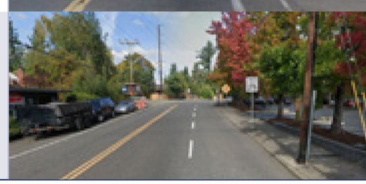
For the analyses, each roadway segment required geospatial data in shapefile format (i.e., vector data format) for four attributes: crashes, speeds, travel times, and traffic volumes. Crash data were obtained from web-based mapping tools released by public entities, such as state Department of Transportation (DOT) and the Federal Highway Administration (FHWA), among others. Speeds and travel times were based on third-party data hosted in the Regional Integrated Transportation Information System

Table 1. Characteristics, implementation years of new posted speed limits, and assessment periods of study sites

	ID	Functional Class	Roadway Segment	Image[1]	Area	Length (miles)	Before (mph)	After (mph)	State	Effective Year	Total Evaluation Period[2]	
											Crash	Speed & Volume
Raised PSL	I1	Interstate	I-70		Urban	31	65	70	MD	2016	2 yrs.	5 yrs. 4 mo.
Raised PSL	I2	Interstate	I-84		Rural	291	65	70	OR	2017	4 yrs.	5 yrs.
Raised PSL	I3	Interstate	I-95		Urban	42	65	70	ME	2014	6 yrs. 10 mo.	7 yrs
Raised PSL	P1	Principal Arterial	Preston Rd (TX 289)		Rural	2	50	55	TX	2014	NA[3]	1 yrs. 4 mo.
Raised PSL	P2	Principal Arterial	Victory Bl		Urban	6.6	35	40	CA	2017	4 yrs. 10 mo.	4 yrs. 10 mo.
Raised PSL	M1	Minor Arterial	Obama Blvd		Urban	2.46	35	40	CA	2017	4 yrs. 10 mo.	4 yrs. 10 mo.

[1] They are recent views acquired from Google StreetView.
[2] Including before and after periods.
[3] Insufficient data available.

(continued)

	ID	Functional Class	Roadway Segment	Image[1]	Area	Length (miles)	Before (mph)	After (mph)	State	Effective Year	Total Evaluation Period[2]	
											Crash	Speed & Volume
Lowered PSL	P3	Principal Arterial	Sunset Bl		Urban	4.5	35	30	CA	2017	4 yrs. 10 mo.	4 yrs. 10 mo.
	P4	Principal Arterial	Division St		Urban	4.5	35	30	OR	2017	3 yrs.	5 yrs. 10 mo.
	M2	Minor Arterial	Parthenia St		Urban	1.5	40	35	CA	2017	4 yrs. 10 mo.	NA[3]
	M3	Minor Arterial	BYP 30B Lombard		Urban	1.96	35	30	OR	2018	4 yrs.	3 yrs. 10 mo.
	C1	Collector	NE Marine Drive		Urban	2.2	40	35	OR	2018	4 yrs.	2 yrs. 4 mo.
	C2	Collector	SW Capitol Highway		Urban	0.9	35	25	OR	2018	4 yrs.	4 yrs. 10 mo.

[1] They are recent views acquired from Google StreetView.
[2] Including before and after periods.
[3] Insufficient data available.

(RITIS). This study only included speed and travel time data from passenger vehicles (i.e., heavier vehicles were excluded). Traffic volume data (i.e., Annual Average Daily Traffic) were retrieved primarily from the archive of FHWA's Office of Highway Policy Information and partially from state DOTs' web-based Automatic Traffic Recorder maps and RITIS.

For some sites, a state law regarding a five-year record retention requirement limited the crash data availability. In addition, all data collected from 2020 were excluded from analyses due to the impact of the COVID-19 pandemic on traffic conditions, travel patterns, and driving behaviors. Consequently, this study used two to five years of data (including both before and after periods) for most sites, and each site used data collected during the equivalent pre- and post-intervals in analyses.

Data Process

This study used data fusion techniques to generate working datasets for in-depth analyses, which included comprehensive attributes related to each reported crash by merging datasets of crash, speed, travel time, and traffic volume. The data fusion techniques consisted of data filtering/cleaning, data value re-coding, data type reformatting, spatial joins in geographic information system (GIS) platforms, and deriving new variables.

Variables and Analyses

Using the fused datasets, this study conducted descriptive analysis and logistic regression models based on numerous measures. With respect to safety, crash counts and crash rates per vehicle mile traveled (Golembiewski & Chandler, 2011) were examined for each crash type (i.e., fatal, injury, and property damage only). Also, changes in likelihoods of crash occurrence from the before to after period were estimated for each crash type using logistic regression models. With respect to driver behavior, key statistics such as the mean and 85th percentile speed were estimated using speed data. Additionally, changes in likelihoods of speed limit violation were estimated using logistic regression models. From an operational perspective, changes in travel times and traffic volumes were estimated. All analyses were conducted under the assumption that road design characteristics such as number of lanes, lane and shoulder widths, and presence of medians remained consistent over the study periods for all sites.

RESULTS

This section summarizes results from descriptive analyses and regression models, organized by the direction of the speed limit change (raising or lowering) and by road functional class to examine whether any consistent findings exist within the class.

Raising Posted Speed Limits

Interstate (3 sites)

All three Interstate Highways examined in this study raised posted speed limits from 65 mph to 70 mph. Descriptive analyses, shown in Table 2, showed an upward trend in crash frequencies across all examined crash types for two of the three sites (I1 & I3). Likewise, crash rates increased in two of three sites (I1 & I3). However, the changes of likelihoods of crash occurrence for each crash type were not statistically significant across all three Interstate Highways.

Regarding vehicle speed data, the key statistics (e.g., means and 85th percentile speeds) showed an upward trend. There were, however, significant decreases in the likelihoods of speed limit violations after increasing posted speed limits by 5 mph across all three sites.

For traffic operation, most sites demonstrated comparable performance in terms of travel time and traffic volume during the after period in comparison with the before period.

Principal arterial (2 sites)

The two principal arterial study sites that raised speed limits by 5 mph had limited crash data, and the descriptive analyses, shown in Table 2, showed inconsistent results: one site had a marginal increase in crash count (P1), while the other site showed a noticeable decrease in injury crash count (P2). The crash rates decreased, although the likelihoods of crash occurrence for all crash types were not significantly changed for both roadways.

For both sites, the means and 85th percentile operating speeds increased, and the likelihoods of speed limit violations significantly decreased after raising posted speed limits.

For traffic operation, the two sites demonstrated decreased travel time but varying performance pertaining to traffic volume during the after period in comparison with the before period.

Minor arterial (1 site)

The minor arterial site increased the posted speed limit by 5 mph; as shown in Table 2, for this site there was an increase in fatal crash count and rate, but a decrease in injury crash count and rate (M1). However, the likelihoods of crash occurrence did not significantly vary from pre- to post-speed limit change for both crash types.

The mean and 85th percentile operating speed increased after raising the posted speed limit. The likelihood of speed limit violations significantly decreased during post-speed limit change period.

Regarding traffic operation, the site showed reduced travel times, but the change in traffic volume was minimal after implementing the new posted speed limit.

Lowering Posted Speed Limits

Principal arterial (2 sites)

Two principal arterial sites lowered the posted speed limit by 5 mph. As shown in Table 3, one site showed mixed results in crash count and rate (P3); in contrast, the other site showed a downward trend in both measures regardless of crash type (P4). Changes in the likelihoods of crash occurrence, however, were not significant for both sites.

The mean speed for both sites slightly increased even after lowering the posted speed limit, while the change in 85th percentile operating speed was inconsistent across two sites. The likelihood of speed limit violations was significantly increased.

With respect to traffic operation, both sites showed a decrease in both travel time and traffic volume after implementing the new posted speed limit.

Minor arterial (2 sites)

Two minor arterial sites lowered speed limits by 5 mph and showed mixed results in crash count and rate across different crash types (M2 & M3), as shown in Table 3. The likelihoods of crash occurrence for all crash types, however, were not significantly changed for both sites.

With regard to speed, only one site had sufficient speed data for analyses and showed an increase in mean and 85th percentile speed (M3). The likelihood of speed limit violations was also significantly increased.

For traffic operation, both sites mostly demonstrated comparable performance in terms of travel time and traffic volume during the after period in comparison with the before period.

Collector (2 sites)

Among two sites examined in the collector road class, only one site demonstrated a downward trend in crash count after implementing new posted speed limits (C1 & C2), as shown in Table 3. Likewise, the crash rates of all crash types decreased for that site. Site C2, where the posted speed limit was lowered by the greatest magnitude (10 mph) among all 12 sites examined in this study, showed an increase in crash count and rate. The regression

Table 2. Analysis results of the sites that raised posted speed limits

ID	Crash related[1]			Speed Related[2]			Travel time	Traffic volume
	Type	Δ Count[3]	Rate	Δ Mean speed (mph)	Δ 85th percentile speed (mph)	Likelihood of speed limit violation		
I1	Fatalities	5	Increased	1.3	1.2	Decreased	Similar	Similar
	Injuries	105	Increased					
	PDO	297	Increased					
I2	Fatalities	−5	Unchanged	4.0	2.8	Decreased	Similar	Similar
	Injuries	−43	Decreased					
	PDO	−88	Decreased					
I3	Fatalities	9	Increased	1.3	2.0	Decreased	Similar	Similar
	Injuries	226	Increased					
	PDO	592	Increased					
P1	Fatalities	0[4]	NA[5]	4.2	2.1	Decreased	Decreased	Increased
	Injuries	3	NA[5]					
	PDO	3	Decreased					
P2	Fatalities	−1	Decreased	3.9	2.4	Decreased	Decreased	Similar
	Injuries	−141	Decreased					
	PDO	0[4]	NA[5]					
M1	Fatalities	1	Increased	4.0	1.6	Decreased	Decreased	Similar
	Injuries	−38	Decreased					
	PDO	0[4]	NA[5]					

[1] The logistic regression results for likelihoods of crash occurrence were not significant across all examined sites and excluded in this table.
[2] The logistic regression results for likelihoods of presence of higher speeds than typical condition before a crash were not significant across all examined sites and excluded in this table.
[3] Crash counts are not normalized across site and do not account for differences in time, segment length, and volume.
[4] There were no related crash records in police crash files over the specified study period.
[5] Insufficient data available for further analysis.

Table 3. Analysis results of the sites that lowered posted speed limits

ID	Crash related[1]			Speed Related[2]			Travel time	Traffic volume
	Type	Δ Count[3]	Rate	Δ Mean speed (mph)	Δ 85th percentile speed (mph)	Likelihood of speed limit violation		
P3	Fatalities	3	Increased	1.1	0.9	Increased	Decreased	Decreased
	Injuries	−145	Decreased					
	PDO	0[4]	NA[5]					
P4	Fatalities	−1	Decreased	0.8	−2.2	Increased	Decreased	Decreased
	Injuries	−320	Decreased					
	PDO	−219	Decreased					
M2	Fatalities	1	Similar	NA	NA	NA	NA	Similar
	Injuries	−5	Increased					
	PDO	0[4]	NA[5]					
M3	Fatalities	0[4]	NA[5]	2.0	0.3	Increased	Decreased	Similar
	Injuries	−2	Increased					
	PDO	−10	Decreased					
C1	Fatalities	−1	Decreased	−0.3	−1.5	Increased	Decreased	Similar
	Injuries	−19	Decreased					
	PDO	−9	Decreased					
C2	Fatalities	0[4]	NA[5]	−1.5	0.4	Increased	Decreased	Similar
	Injuries	3	Increased					
	PDO	4	Increased					

[1] The logistic regression results for likelihoods of crash occurrence were not significant across all examined sites and excluded in this table.
[2] The logistic regression results for likelihoods of presence of higher speeds than typical condition before a crash were not significant across all examined sites and excluded in this table.
[3] Crash counts are not normalized across site and do not account for differences in time, segment length, and volume.
[4] There were no related crash records in police crash files over the specified study period.
[5] Insufficient data available for further analysis.

analysis results, however, suggested that changes in the likelihoods of crash occurrence were not statistically significant for both sites.

For speed data, the mean speeds in both sites decreased after lowering posted speed limits (C1 & C2). Both sites had a significant increase in the likelihood of speed limit violations during the post-change period.

Even though both sites lowered posted speed limits, the travel times were reduced, and traffic volumes were analogous compared to those prior to the change.

DISCUSSION

This study examined the impact of changes in posted speed limits on traffic safety on 12 roadways. Toward this goal, data fusion techniques were used to merge crash, speed, travel time, and traffic volume data from multiple sources for more comprehensive and in-depth analyses. Additionally, numerous measures along multiple dimensions were considered, such as crash counts and rates, likelihoods of speed limit violation, travel time, and others. In general, the results varied across all sites examined. Inconsistent results were found in the sites within the same state and within the same road functional class (e.g., Interstate Highways, principal arterials). Even within the site, the results were sometimes mixed across different measures. For example, among sites where posted speed limits were raised, the crash rates increased at some sites but decreased at other sites after implementing new posted speed limits. Similarly, the direction of changes in crash rates varied among sites in the same state where speed limits were lowered. The only consistent results were found regarding the likelihood of speed limit violations: after raising posted speed limits, vehicle speeds were less likely to exceed the speed limits, while they were more likely to exceed the speed limits after lowering speed limits. With regard to traffic operation (i.e., travel times and traffic volumes), no consistent associations with changes of posted speed limit were found.

For the past decades, many studies have examined the impact of changes in posted speed limit and similar to the findings in this study, the results varied from site to site (Castillo-Manzano et al., 2019; Zhai et al., 2022). The reasons may include the differences in characteristics of each roadway (e.g., road geometric designs, environmental factors), driving behaviors, and traffic safety culture, among many other factors (Archer et al., 2008). Castillo-Manzano et al. (2019) also cited differences in data quality, availability, and collecting system. Interestingly, throughout all sites in the current study, likelihoods of speed limit violations decreased as the speed limits raised, whereas the likelihoods increased as the speed limits lowered. Since the changes in the 85th percentile operating speeds were small (< 3 mph) across all sites, these changes in violations may be more a function of the new compliance benchmark (i.e., new speed limits; e.g., Parker, 1997) as opposed to changes in drivers' behaviors. It is also noteworthy that changes in travel times were small in response to both raised and lowered speed limits—especially considering that local or state jurisdictions often raise posted speed limits in order to improve mobility. Conversely, the public are often concerned about downgraded mobility as speed limits are lowered. Archer et al. (2008) also indicated similar findings of marginal increases in travel times after lowering speed limits (2008).

A variety of issues and challenges were identified over the course of the study due to the limited data availability, poor data quality, and inconsistent data collection and reporting over time, not to mention different definitions of data values across states. For example, the format and variables in crash data of a particular year in Oregon were inconsistent with those in other timeframes. For some states, crash and speed data were available for a sufficient time period before and after the change in speed limit; however, traffic volume data were available only for limited timeframes. These limitations restricted the data available for statistical analyses. Additionally, the level of detail or operational definitions for certain data variables varied from state to state (e.g., some used FHWA's KABCO injury classification scale to define severity, but others did not). This hindered an apples-to-apples comparison of safety performance across states. Moreover, traffic volume data were obtained primarily from FHWA, but other sources were used for years or locations when or where data were not available. For most sites, speed, travel time, and traffic volume data were collected at different locations along the corridor of a given roadway. These spatial differences in data collection resulted in a complex data fusion process.

To improve assessments in the future, data quality and collection systems should be enhanced and consistency in data format, elements, and attributes across local and state jurisdictions should be prioritized. Such enhancements will produce more reliable, consistent results and allow researchers and practitioners to conduct more comparable evaluations across sites in different states. Additionally, coordination between different types of data collection systems (e.g., crash, speed, volume) is recommended for more efficient and higher quality data fusion. Traffic crashes are strongly associated with other factors such as vehicle speed, prevailing travel conditions, traffic volumes, road geometric designs, and other environmental factors. To examine how these factors are associated with changes in posted speed limits, a comprehensive dataset containing such potentially contributing factors is necessary. To this end, a relational database, which stores and provides access to data points that are related to one another, would greatly improve the efficiency and quality of alignments between different types of data. Further, as crashes are rare events in general, researchers and practitioners need several years to collect enough crash data. Even with sufficient crash data, they often do not directly reflect the potential safety issues in relation to speed limit changes. Near-miss crashes can help augment safety measures, since their occurrences are more frequent, and they still capture important conflicts between road users' movements. However, the system to detect and record near-miss crashes is limited. Further research for such system development, therefore, would be needed.

The 2019 study by AAA Foundation found that the practices used in the U.S. to determine speed limits often relied highly on the 85th percentile operating speed (Kim et al., 2019). This practice mainly focuses on faster movement and often leads to an increase in a speed limit. In the follow-on work, the AAA Foundation showed that increased vehicle speed would increase the driver's injury risk when crashes do occur. Despite the varying results found in the current study in relation to the impact of changes in posted speed limits, the AAA Foundation's past studies, along with other literature, suggest that practitioners should apply integrated or holistic approaches when setting or changing posted speed limits. Such approaches should take into consideration a variety of factors, beyond the 85th percentile operating speeds, and contexts to guide the selection of safe, credible, and enforceable speed limits for various facility types. For the past several years, efforts have been made to develop such approaches (National Cooperative Highway Research Program Project 3-139). Additionally, the emerging Safe System approach also supports these efforts by promoting safer speeds through context-appropriate roadway design and speed-limit setting. Furthermore, a rigorous assessment using multiple and coordinated measures is critical after implementing a new speed limit, since the results may vary by measure and site as in the current analysis. The findings from those assessments will inform the development or revision of the current practices or approaches to setting speed limits, and over time this process can lead to greater acceptance of and compliance with speed limits. Most importantly, efforts from various stakeholders should continue to advocate for establishing a safe roadway for all road users, with safer speeds and increased public awareness regarding the dangers of speeding.

REFERENCES

Archer, J., Fotheringham, N., Symmons, M., & Corben, B. (2008). *The impact of lowered speed limits in urban/metropolitan areas* (Report No. 276). Monash University Accident Research Centre. https://www.monash.edu/__data/assets/pdf_file/0007/216736/The-impact-of-lowered-speed-limits-in-urban-and-metropolitan-areas.pdf

Castillo-Manzano, J. I., Castro-Nuño, M., Lopez-Valpuesta, L., & Vassallo, F. V. (2019). The complex relationship between increases to speed limits and traffic fatalities: Evidence from a meta-analysis. *Safety science, 111,* 287–297. https://doi.org/10.1016/j.ssci.2018.08.030

Golembiewski, G., & Chandler, B. E. (2011). *Roadway Safety Information Analysis: A Manual for Local Rural Road Owners* (No. FHWA-SA-11-10). United States. Federal Highway Administration. Office of Safety.

Kim, W., Kelley-Baker, T., Arbelaez, R., O'Malley, S. & Jensen, J. (2021). *Impact of Speeds on Drivers and Vehicles – Results from Crash Tests* (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety. https://aaafoundation.org/impact-of-speeds-on-drivers-and-vehicles-results-from-crash-tests/

Kim, W., Kelley-Baker, T. & Chen, K.T. (2019). *Review of Current Practices for Setting Posted Speed Limits* (Research Brief). Washington, D.C.: AAA Foundation for Traffic Safety. https://aaafoundation.org/review-of-current-practice-for-setting-posted-speed-limits/

Parker Jr, M. R., & Parker, M. R. (1997). *Effects of raising and lowering speed limits on selected roadway sections* (No. FHWA-RD-97-084). United States. Federal Highway Administration.

Zhai, G., Xie, K., Yang, D., & Yang, H. (2022). Assessing the safety effectiveness of citywide speed limit reduction: A causal inference approach integrating propensity score matching and spatial difference-in-differences. *Transportation research part A: policy and practice, 157,* 94–106. https://doi.org/10.1016/j.tra.2022.01.004

ABOUT THE AAA FOUNDATION FOR TRAFFIC SAFETY

The AAA Foundation for Traffic Safety is a 501(c)(3) nonprofit, publicly supported charitable research and education organization. It was founded in 1947 by the American Automobile Association to conduct research to address growing highway safety issues. The organization's mission is to identify traffic safety problems, foster research that seeks solutions, and disseminate information and educational materials. AAA Foundation funding comes from voluntary, tax-deductible contributions from motor clubs associated with the American Automobile Association and the Canadian Automobile Association, individual AAA club members, insurance companies and other individuals or groups.

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