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Exploring the Impact of Select Speed-Reducing Countermeasures on Pedestrian and Bicyclist Safety

Background

Fatalities involving bicyclists and pedestrians continue to rise. Over the decade 2012 to 2021, the number of bicyclist fatalities increased 34% and pedestrian fatalities increased 52% (NCSA, 2022a, 2022b, 2022c). Pedestrians and bicyclists have made up an increasing share of fatal crashes since 2011. In 2012 pedestrians made up 14% of those killed in crashes. By 2021, that share had increased to 17%.

Speed contributes to around 30% of fatal crashes overall and around 9% of crashes involving pedestrians as well as bicyclists (NCSA, 2022d). Speed also contributes to both a greater chance of serious injury and greater chance of fatality for a pedestrian or bicyclist struck by a vehicle. For pedestrians, the chance of serious injury rises from 25% at 23 mph to 50% with an increase of only 8 mph to 31 mph (Tefft, 2011). Similarly, the chance of a pedestrian fatality when struck by a vehicle, grows from 25% at 32 mph to 50% with an increase to 42 mph. Chance of serious injury or fatality reach 90% with speeds of 46 mph and 58 mph, respectively. As with pedestrians, bicyclists also see increased likelihood of death at higher speeds.

States and municipalities use different countermeasures aimed at reducing speed on the roadway. These can involve behavioral campaigns, enforcement methods, changes to signing, or changes to the physical roadway. Some efforts aim to have a direct impact on speed, while others have several effects, such as allocating space for other road users, that include speed reduction.

This project explores efforts to reduce speed and their impact on the safety of bicyclists and pedestrians. The project was divided into two phases with the results from Phase 1 guiding the efforts in Phase 2. Phase 1 included a scan of localities implementing speed-reducing treatments and an evaluation of the speed reduction countermeasures for pedestrian and bicyclist safety benefits. Phase 2 involved a scan for localities with temporary road conversions in response to the COVID-19 pandemic followed by several case studies of two selected countermeasures, speed safety cameras (SSC) and road conversions, with evaluation of available crash data. (For full details on the research study, see the final report by the same name available soon at https://rosap.ntl.bts.gov.)

Phase 1

Method

The study began with a program scan of efforts across the United States to reduce vehicle speeds. The team identified a selection of speed-reducing countermeasures and found localities that had previous or ongoing programs. The most typical countermeasures included SSC, high-visibility enforcement, speed limit reductions, road conversions, and traffic calming. Researchers selected two countermeasures and five localities for the evaluation: SSC in Boulder, Colorado; Seattle, Washington; and Washington, DC; and road conversions in Minneapolis, Minnesota; San Francisco, California; and Seattle, Washington.

For SSC, data was selected for roadway segments with cameras (treatment segments), sites adjacent to segments (near-treatment segments), and reference segments (similar segments not near treatment segments used as a control comparison to evaluate changes). For road conversions, the team collected data for treatment segments and reference segments. In the evaluation, the team first developed safety performance factors (SPFs) to estimate expected safety outcomes on each segment. The SPFs were then used to generate crash modification factors (CMFs), estimates of the impact of a treatment on crash outcomes based on a comparison between actual crash numbers and what would be expected given past trends.

Results

The two common methods for estimating CMFs are cross-sectional and the empirical Bayes (EB) before-after with the EB method accepted as one way of addressing the potential bias due to regression to the mean (Hauer, 1997). However, there are some treatments for which before-after studies may not be possible due to unavailability of data from the before or after period. In those cases, researchers rely on cross-sectional studies to develop CMFs. These two methods were used to evaluate the SSC and road conversion treatments according to the available data.

For the Boulder SSC treatment evaluation, the EB method could not be applied since there was not clear before and after data, thus the cross-sectional method was applied instead. On the other hand, researchers used the EB method to evaluate the safety effects of the road conversion treatment in Seattle, Minneapolis, and San Francisco and the SSC treatment in Seattle and Washington, DC.

Results for each countermeasure are briefly discussed here. Specific results for each locality are available in the full report.

SSC

The three localities selected for SSC evaluation had programs with different deployment methods – mobile camera program, school zones only, and fixed cameras. Due to these differences, each program was evaluated separately.

Using the available data, the SSC model developed for Boulder did not identify camera presence as a factor in safety. For Seattle camera sites, a CMF of 0.82 (18% decrease) for pedestrian and bicyclist injury crashes was computed with a 95% confidence interval of 0.27 to 1.37. Washington, DC, camera sites produced a CMF of 1.37 (37% increase) for total injury crashes, with a 95% confidence interval of 1.04 to 1.70.

Road Conversions

Road conversion treatments were evaluated in two groups: four lanes to two lanes with a center left turn lane, and three lanes to two lanes. For each treatment category, the effect on total crashes resulting in injury and total pedestrian and bicycle crashes resulting in injury were evaluated.

Four-lane to two-lane road conversions had a CMF of 0.95 for total injury crashes with a 95% confidence interval between 0.82 and 1.07, or not significant. Pedestrian and bicycle injury crashes had a CMF of 0.90 with a 95% confidence interval between 0.64 and 1.17, or not significant. For three-lane to two-lane conversions all injury crashes had a CMF of 1.26 with a 95% confidence interval from 0.93 to 1.59, or not significant. The pedestrian and bicycle injury crash analysis resulted in a CMF of 0.81 with a 95% confidence interval from 0.45 to 1.16, or not significant.

Phase 2

Phase 2 of the project built upon the findings of Phase 1 on road conversion crash impacts, recognizing speed's role in crash outcomes, and the potential for road conversions to reduce speeds and crashes. In early 2020 the COVID-19 pandemic spread throughout the United States leading to a series of shutdowns and traffic and mode changes. Cities large and small began responding to these changes by making accommodations on the roadway for different uses. In some cases this included creating extra space for pedestrians and in other cases these efforts resulted in temporary lanes for bicyclists (Steckler et al., n.d.). This phase investigated what safety benefits these changes might have had for pedestrians and bicyclists.

Method

The crowdsourced *Shifting Streets* dataset (Combs & Pardo, 2020) was used to identify sites where lanes were reallocated to provide space for pedestrians and bicyclists. The focus on the list was any description of a place that created bike lanes, on-street multiuse lanes, or some other accommodation that removed a travel lane normally used for motor vehicles and provided more space for other modes of travel. After contacting several agencies and determining willingness to participate and data availability, Atlanta, Georgia; Chapel Hill, North Carolina; and Los Angeles, California, were selected.

Results

Atlanta

A five-lane road had one lane closed to create a pop-up, temporary shared-use lane. Speed increased slightly from before to after installation of the shared use lane, but was still below the posted speed. Pedestrian and bicyclist volumes decreased as did the number of total crashes and fatal/serious injury crashes.

Table 1: Lee Street SW, Atlanta, Before and After Installation

Lane Reallocation (2,150 ft segment length)		
	Before installation (278 days)	After installation (300 days)
Speed limit (mph)	30	30
Average travel speed (mph)	19.5	22.4
Average daily vehicle volume	13,100	13,800
Average daily pedestrian volume	3,500	2,750
Average daily bicycle volume	100	70
Total crashes	14	12
Killed/serious injury crashes	1	0

Chapel Hill

The road reconfiguration involved changing a four-lane road with parallel parking on each side to create a multiuse path on each side of the road by closing one lane of travel in each direction. Fewer crashes occurred and average daily vehicle volumes decreased after the reconfiguration.

Table 2: Franklin Street, Chapel Hill, Before and After Installation

Lane Reallocation (3,950 ft segment length)		
	Before installation (1 year)	After installation (1 year)
Average daily vehicle volume	13,500	10,750
Total crashes	62	46
Pedestrian crashes	1	0
Bicycle crashes	2	2

Los Angeles

The pre-project street had two vehicle lanes in each direction. After reallocating lanes with striping in the summer of 2020, the road had one vehicle travel lane in each direction, a center two-way left turn lane, and bike lanes on each side. Based on the crash data provided, naïve CMFs were calculated without the prediction of crash numbers because of shorter before periods and reflect the change in crashes between study periods. These provide an estimate of the change in crash rates over time between the changes in lane allocation. For total crashes the naïve CMF was 0.39. For injury-related crashes, the naïve CMF was 0.41. For pedestrian or bicycle crashes, the naïve CMF was 0.57. After reallocation, the 85th percentile speed decreased from 38.5 mph to 34.1 mph on the 35-mph road.

Table 3: Avalon Blvd, Los Angeles, Before and After Installation

Lane Reallocation (6 mi segment length)		
	Before installation (1 year)	After installation (1 year)
Speed limit (mph)	35	30 to 35
Average travel speed (mph)	38.5	34.1
Average daily vehicle volume	22,824	15,467
Total crashes	318	125
Killed/serious injury crashes	221	91
Bicycle/pedestrian crashes	53	30

Discussion and Conclusion

Vehicle speed increases both the likelihood and severity of crashes, especially those involving pedestrians and bicyclists, some of our most vulnerable road users. In Phase 1, both road conversions and SSC showed potential for crash reduction for pedestrian and bicycle injury-related crashes. However, some sites experienced increases in overall crashes. While the CMFs reveal mixed results, more data would inform the reasons for the changes. Unlike the road conversion results, SSC only had one site where a crash-reduction CMF was generated, with Seattle seeing some reduction for pedestrian and bicyclist crashes. The CMF for Washington, DC, SSC, indicated an increase in total injury crashes. The results presented are not necessarily reliable enough to generalize to other locations given each locality's program particulars. In addition, more complete volume data for vehicles, bicyclists, and pedestrians, may add insight to fluctuations in use on the roads being evaluated. Although implemented with the intent to reduce speeds, in many cases speed data are not available to analyze pre/post countermeasure speed changes so there is no way to determine if speeds decreased. Among some segments with available speed data, analyses showed increased speeds after countermeasure installation. With speed data, the evaluation could go further to link these treatments with speed reductions and any improvements in safety.

Phase 2 of the project presented case studies of quick-build transportation projects in response to the COVID-19 pandemic. Based on the available data, these projects combined show the potential short-term benefits in terms of crash reduction from quick-build projects. In addition, quick-build projects offer the chance to test designs that could lead to longer-term changes.

As more agencies focus on ways to reduce and eliminate crashes, including efforts such as the Safe System Approach, countermeasures that make travel safer for all road users are increasingly discussed and implemented. Individual countermeasures become part of the transportation system and help build layers of protection to prevent crashes from happening and minimize harm in the event of a crash. Reducing vehicle speeds is one part of the system and a frequently used solution to reduce crash severity and decrease the likelihood of fatal and severe injury pedestrian and bicyclist crashes.

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How to Order

The final report *Exploring the Impact of Select Speed-Reducing Countermeasures on Pedestrian and Bicyclist Safety* (Report No. DOT HS 813 446) can be downloaded at https://rosap.ntl.bts.gov. Kristie Johnson, Ph.D., was the task order manager for this project.

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