TECH**BRIEF**

U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology

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The Safety Impacts of Differential Speed Limits on Rural Interstate Highways

BACKGROUND

The Surface Transportation and Uniform Relocation Assistance Act (STURAA), enacted on April 2, 1987, permitted individual States to raise speed limits from the previously mandated national speed limit of 88 kilometers per hour (km/h) to 105 km/h (55 miles per hour (mi/h) to 65 mi/h) on rural interstate highways. After this date, some States uniformly raised their speed limits for passenger cars and trucks. Other States raised the speed limit for passenger cars only while leaving the truck limit at 88 km/h (55 mi/h), creating a Differential Speed Limit (DSL)—different speed limits for cars and heavy trucks traveling on the same roadway. Speed limits that are the same for both passenger cars and trucks are known as Uniform Speed Limits (USL). On November 28, 1995, the national maximum speed limit was repealed, giving States further flexibility in setting their limits. By 2002 several States had experimented with both DSLs and USLs.

OBJECTIVE

Previous studies conducted during the early 1990s that compared USLs and DSLs were constrained because of the limited data available. Over the past decade several States have either eliminated or implemented a lower limit for trucks providing the opportunity for a before and after study that might provide more reliable results. In 1994, Virginia switched from a differential speed limit of 105 km/h (65 mi/h) for cars and 88 km/h (55 mi/h) for trucks to a uniform speed limit of 105 km/h (65 mi/h) for all vehicles. In 1996, Arkansas adopted a differential speed limit by raising the speed limit for cars to 113 km/h (70 mi/h) but maintaining 105 km/h (65 mi/h) for trucks. In 1998, Idaho changed from a uniform speed limit of 121 km/h (75 mi/h) for all vehicles to a 105 km/h (65 mi/h) limit for trucks. With more than a decade having elapsed since the passage of the STURAA, the Federal Highway Administration (FHWA) sponsored a long-term study to investigate the effect of USLs and DSLs on vehicle speeds and crashes on rural interstates nationwide.

TABLE 1. *Accident Proportions by Speed Limit, Collision Type, and Vehicle Involvement.*
(Adapted from table 32, reference 1)

Speed Limit	Rear End		Sideswipe		Other	
	Car-Into-Truck	Truck-Into-Car	Car-Into-Truck	Truck-Into-Car	Car-Into-Truck	Truck-Into-Car
USL: 105 km/h and 88 km/h (65 mi/h and 55 mi/h)	10.91	10.78	22.12	21.07	2.57	2.01
DSL: 105/88 km/h and 105/97 km/h (65/55 mi/h and 65/60 mi/h)	13.70	6.86	21.52	14.96	2.07	0.99

LITERATURE REVIEW

The safety effects of differential speed limits for cars and trucks have been inconclusive in previous studies. Some studies found no difference between USL and DSL (references 1, 2, 3, and 4). Other studies found one or the other to be a better policy choice.[5,6] The studies were mainly cross-sectional comparisons of speed or crashes in States with different speed limits for cars and trucks to those in nearby States with uniform speed limits. The differences (or lack thereof) observed between States could be due to variations in traffic density, weather, and many other factors.

Impact of DSL on Mean Speed

In 1990, Freedman and Williams analyzed speed data collected at 54 sites in 11 Northeastern States to determine the effect of DSL on mean and 85th percentile speeds.[5] Six States had retained a USL of 88 km/h (55 mi/h), three had raised USLs to 105 km/h (65 mi/h), and two States employed a DSL of 105 km/h (65 mi/h) for cars and 88 km/h (55 mi/h) for trucks. For *passenger cars* in the DSL States, the mean speed and 85th percentile speeds were not significantly different from the 105 km/h (65 mi/h) USL States. For *trucks* in the DSL States, the mean and 85th percentile speeds were not significantly different from those of the 105 km/h (65 mi/h) USL States. Similar results were obtained when comparing the percentage of vehicles complying with the speed limit.

In 1994 Harkey and Mera found no significant difference between passenger car and truck mean speeds when comparing USLs and DSLs.[1]

Impact of DSL on Speed Variance

The implication of increased speed variance is an increase in interactions between vehicles, leading to a potential increase in crashes. Council et al. in 1998 found that for rear-end collisions between cars and trucks, a high-speed differential increases the severity of the crash.[6] However, Harkey and Mera found no significant differences between car speed variances at the USL and DSL sites.[1] Furthermore, they found no difference between the speed distributions for both cars and trucks for the 105/97 km/h (65/60 mi/h) and 105/105 km/h (65/65 mi/h) speed limits.

A 1974 study by Hall and Dickinson showed that speed differences contributed to crashes, primarily rear end and lane change collisions.[2]

Impact of DSL on Crashes

Harkey and Mera investigated crash results from 26 sites in 11 States.[1] The study investigated the percentage of three different crash types (rear-end, sideswipe, and all other) for USLs and DSLs. Table 1 shows that a higher proportion of car-into-truck and truck-into-car crashes occurred in USL States, except for rear end crashes where more car-into-truck collisions happened in the DSL group.

A study by Garber and Gadiraju conducted in 1991 compared

TABLE 2. *Types of Speed Limits Throughout the 1990s on Rural Interstate Highways.*

Maintained USL	Maintained DSL	Changed from USL to DSL	Changed from DSL to USL
Arizona Iowa North Carolina	Illinois Indiana Washington	Arkansas Idaho	Virginia

crash rates in the adjacent States of Virginia (DSL) and West Virginia (USL).[3] The increase in the posted speed limit for trucks to 105 km/h (65 mi/h) did not result in a significant increase in fatal, injury, and overall accident rates. There was, however, some evidence that the DSL may increase some types of crash rates while reducing others.

According to Hall and Dickinson, the existence of a posted DSL, however, was not related to the occurrence of truck crashes.[2] Finally, an evaluation conducted by the Idaho Department of Transportation found that a change from USL to DSL did not increase crashes.[4]

Caveats to the Following Study

There are six limitations that may apply to the speed and crash rates results of this study:

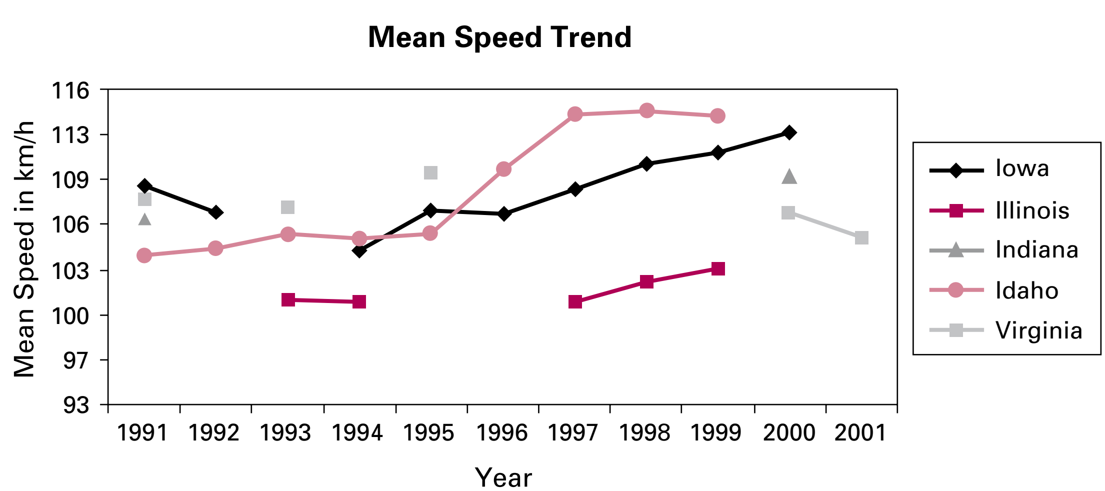
- Selected sites may be a biased sample.
- It was not possible to obtain speeds by vehicle type (passenger cars and truck).
- Durations used in this study are relatively short.
- Rural interstates were analyzed at an annual level of detail.
- Sample size used in the statistical tests associated with the speed analysis was defined as the number of speed monitoring sites and varied by state.
- Law enforcement patterns during these time periods are unknown.

METHODOLOGY

Three general steps comprised the methodology used in this research:

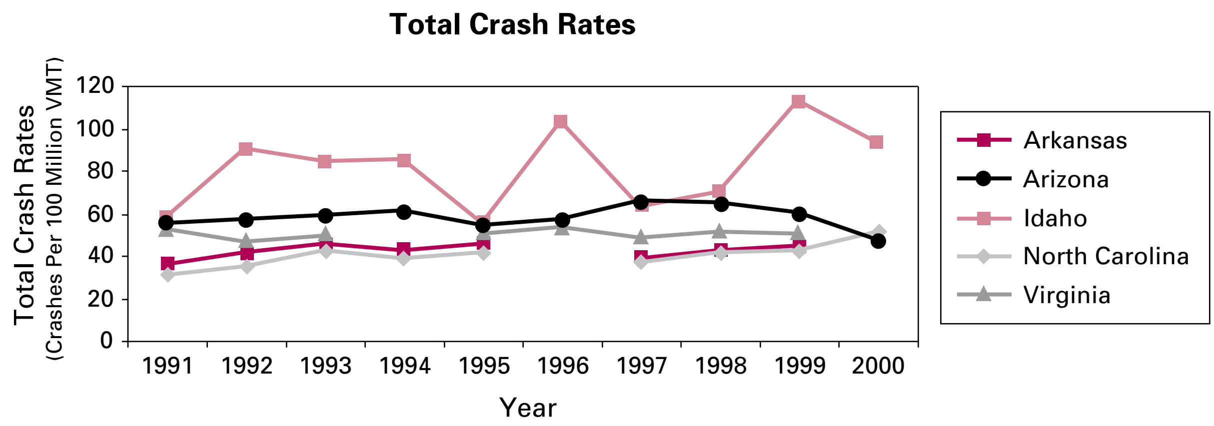
- Speed and crash data were collected from States that had been identified as having changed their speed limits at least once during the 1990s from USL to DSL or vice versa.

Figure 1. *Mean Speed for All Vehicles.*



1 mi/h = 1.6 km/h

Figure 2. *Total Crash Rates per million vehicle-miles traveled (VMT). Note that speed limits changed in Idaho (1996, 1998), Arkansas (1996), and Virginia (1994)*



- Conventional statistical approaches (analysis of variance – Tukey's and Dunnett's tests) were used to analyze speed and crash data from these States.

- Empirical Bayes procedure was applied to these crash data.

Nine States were selected so they could be divided into four policy groups based on the type of speed limit employed during the period, as shown in table 2.

RESULTS

Vehicle Speeds

Five speed measures (mean speeds, speed variance, 85th percentile speeds, median speeds, and noncompliance rates) were analyzed for the five States where such speed monitoring data were readily available. Speed data were generated from speed monitoring stations throughout the States; individual speeds on specific interstates were not always available. It was not possible to obtain speeds by vehicle type (passenger cars and trucks).

Figure 1 illustrates the trends in mean speeds, for all vehicle types, among the five States with speed data. Data could not be obtained for all years during the time periods. Except for Virginia, the main observation is that all speeds appear to be increasing over time, regardless of speed limit type.

Crashes

Figure 2 presents an overall representation of crash data from the various States. While the data in figure 2 are based on crash rates and validates the results generated by the Empirical Bayes method, it should be noted that the Empirical Bayes method did not use crash rate in the modeling process but included annual average daily traffic (AADT) and section length as independent variables. Only North Carolina showed a significant increase in the total crash rate; the other States showed no significant change in the total crash rate.

Caveats to the Use of Empirical Bayes Method

Several data limitations might have influenced the results of the Empirical Bayes analysis.

- Comparison groups were imperfect. Ideally, the comparison group would have been selected from the same State at the same time as the studied group.

- Although speed monitoring data were available to understand statewide speed trends, specific speeds for every interstate section used in the crash analysis were not available.

- The crash estimation model used only two variables—AADT and section length. There may have been other relevant variables that were not included in the model.

TABLE 3. *Impact of Speed Limit Changes, Confidence Intervals and Crash Increases According to the Empirical Bayes formulation.*

Crash Type	Ratio θ	Confidence Interval Lower Bound Increase	Confidence Interval Upper Bound Increase	Crash Effect
Maintained a uniform limit (Arizona)				
Total crashes	1.26	24.2%	28.6%	Increase
Total crashes with truck involved	1.16	12.1%	20.7%	Increase
Maintained a uniform limit (North Carolina)*				
Total crashes	1.26	19.9%	31.9%	Increase
Total crashes with truck involved	0.91	-19.7%	1.5%	No change
Maintained a differential limit (Washington)				
Total crashes	0.99	-6.6%	5.0%	No change
Changed from uniform to differential (Arkansas)				
Total crashes	1.07	0.4%	13.4%	Increase
Total crashes with truck involved	1.31	18.9%	42.8%	Increase
Changed from uniform to differential (Idaho)				
Total crashes	1.29	13.2%	46.7%	Increase
Total crashes with truck involved	2.46	68.6%	224.9%	Increase
Changed from differential to uniform (Virginia)				
Total crashes	1.15	12.9%	17.2%	Increase
Total crashes with truck involved	1.25	20.0%	29.8%	Increase

*North Carolina maintained their uniform limit but also raised this limit for both passenger car and trucks

FINDINGS

To evaluate how a treatment affects safety, the Empirical Bayes method predicts what the expected crash frequency *would have been* during the after period had there been no such treatment and then compares it to the actual number of crashes that occurred during the after period. Using the Empirical Bayes technique, the ratio θ of the "actual" after crashes to the "would have been" after crashes is calculated. If the ratio θ is greater than 1.0, then the treatment (e.g., a change from one type of speed limit to another) resulted in an increase in the number of crashes.

In most cases, θ was greater than 1.0, as shown in table 3, indicating an increase in crashes. However, the data in table 3 are not consistent. The ratio θ for total crashes in Virginia, which changed from DSL to USL, is higher than one of the States that changed from USL to DSL (Arkansas) but lower than the other state that changed from USL to DSL (Idaho). The table also shows that for total crashes, θ was approximately 1.0 for the State that maintained DSL (Washington) while it was greater than 1.0 for States that maintained USL (Arizona and North Carolina).

Additional crash types, such as rear-end type crashes, are discussed in the final report.

CONCLUSIONS

The results presented in table 3 are on a State-by-State basis. Overall, the study was not able to isolate or measure the effect of USL/DSL changes. The effect of the DSL, if any, is not enough to be detected in the aggregate speed data that were analyzed.

Speed characteristics were generally unaffected by a USL or DSL policy. Except for Virginia, mean speeds tended to increase over the 1990s regardless of whether the State maintained a USL, maintained a DSL, or changed from one to the other. In some cases the increase in speed was significant, in other cases it was not.

No consistent safety effects of DSL as opposed to USL were observed within the scope of the study. The mean speed and crash rates tended to increase over the 10-year period, regardless of whether a USL or DSL limit was employed. The Empirical Bayes methodology suggested that crash risk during the study period increased for all four policy groups.

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Researcher—This study was performed by the Virginia Transportation Research Council.

Distribution—This TechBrief is being distributed according to a standard distribution. Direct distribution is being made to the Divisions and Resource Centers.

Availability—The report will be available in Fall 2004 and may be obtained from the FHWA Report Center by e-mail to report.center@fhwa.dot.gov, by fax to 301–577–1421, by phone to 301–577–0818, or online at www.tfhrc.gov/safety/intersect.htm.

Key Words—Differential speed limit, universal speed limit, truck speed limit, speed limit