

AN ASSESSMENT OF THE EFFECTS OF  
VEHICLE WEIGHT ON FATALITY RISK  
IN MODEL YEAR 1985-98 PASSENGER CARS  
AND 1985-97 LIGHT TRUCKS

Volume I: Executive Summary

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## EXECUTIVE SUMMARY

The effects of vehicle weight on overall safety have been assessed, in terms of the net change in the number of US fatalities, based on 1995-99 calendar year accident data<sup>1</sup> involving 1985-98 passenger cars and 1985-97 light trucks<sup>2</sup>. These results represent an update of the results for 1985-93 passenger cars and light trucks in 1989-93 calendar year accident data reported by Kahane of NHTSA in 1997 (Ref 1), using the same methodology.

The methodology used by Kahane in Ref 1 was selected because it was the broadest and most inclusive of any analysis to date on this subject. The Kahane 1997 analysis was widely referenced, used and relied upon, with some reservations, by both the majority and minority viewpoints in the National Academy of Sciences 2001 report on fuel economy measures (Ref 2), for example. The majority opinion stated that *"NHTSA's fatality analyses were most complete, in that they accounted for all crash types in which vehicles might be involved, for all involved road users, and for changes in crash likelihood as well as crashworthiness"* (p 2-24). The minority opinion stated that *"The most comprehensive assessment of the impacts of vehicle weight and size on traffic safety was undertaken by the National Highway Traffic Safety Administration, ... Because of its thoroughness, technical merit and comprehensiveness, it stands as the most substantial contribution to this issue to date."* (p A-5).

The updated analyses are based on the most recent available data, and are presented in detail in Volumes II and III of this report, to enable

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<sup>1</sup> This was the most recent 5 year period for which US fatal (FARS) and state accident data were available during the time period of the data analysis (June 2001-January 2002). Five years of data were used, in accordance with the Kahane (1997) methodology, in order to obtain a large enough statistical sample to accurately assess the traffic fatality risk in six crash types by vehicle weight and other factors.

<sup>2</sup> The range of vehicle model years was determined by the vehicle identification and classification algorithms that were used. C. Kahane of NHTSA supplied these algorithms. The range of model years includes all of the vehicles included in Ref 1, plus 1994-98 passenger cars and 1994-97 light trucks.

verification by others.

The results, which are based on analysis of the six fatal crash types used by Kahane in Ref 1, and controlling for driver, environmental, and additional vehicle factors according to Ref 1, indicate that a 100 lb vehicle weight reduction for all passenger cars and light trucks would have resulted in a net decrease of 2 fatalities out of a total of 37,633 US fatalities that occurred in 1999<sup>3</sup>. The estimated effect of a 100 lb weight reduction by vehicle type is summarized in Table 1.

Table 1. Estimated Effect of a 100 lb Passenger Vehicle Weight Reduction on 1999 US Fatalities

Vehicle Type	Fatalities in 1999 Crashes <sup>4</sup>	Effect of a 100 Pound Weight Reduction	Net Fatality Change	± 3-sigma confidence bounds
Passenger Cars	25,335	0.13%	34	-80 to + 148
Light Trucks	19,179	-0.19%	-36	-125 to + 53
Total	37,633	-0.00%	-2	-146 to + 142

These results indicate that the overall net effect of a 100 pound reduction in passenger vehicle weight on the number of traffic fatalities is small and statistically insignificant.

The methodology used (i.e., that of Ref 1) indicates that weight changes larger or smaller than 100 lb would also have statistically insignificant effects on overall fatalities, based on the latest accident data.<sup>5</sup>

<sup>3</sup> There were 41,611 US traffic fatalities in 1999 (Ref 3), including collisions involving three or more vehicles, two or more vehicles and pedestrians or bicyclists, and also collisions not involving passenger cars or light trucks (i.e., collisions involving motorcycles or larger trucks but not passenger cars or light trucks). The 37,633 fatalities analyzed herein were only those involving passenger cars or light trucks, or both, in one or two vehicle collisions.

<sup>4</sup> Source: Table 2-3 of Ref 2. Calculated by the Insurance Institute for Highway Safety using algorithms supplied by C. Kahane. The distribution of fatalities in the last calendar year was used, in accordance with the methodology used in Ref 1. There were 6,881 fatalities involving both cars and light trucks, which are affected by both passenger car and light truck weight reduction, but which were counted only once in the total.

<sup>5</sup> This result is based on a linear assumption that should be reexamined for weight changes

The statistically non-significant effect of weight reduction is not due to large uncertainty in the data, but rather to the effects of opposing trends in the data. Regarding the uncertainty level, the  $\pm 3$  standard deviations confidence interval used by Kahane and in this analysis is equivalent to just  $\pm 0.4\%$  of the total number of fatalities. Regarding the opposing trends, the results in Tables 2 and 3 indicate that a 100 lb reduction in vehicle weight would significantly increase the number of fatalities associated with some types of crashes, and significantly decrease the number of fatalities with other types of crashes. For example, a 100 lb reduction in passenger car weight: 1) would significantly increase fatalities associated with principle rollovers and collisions with trucks; and 2) would significantly decrease fatalities associated with collisions with other passenger cars, pedestrians, bicycles, and motorcycles. These and other trends in the data effectively cancel, resulting in no significant overall effect of weight, at current levels of safety technology, and with the current distribution of vehicle types in use.

Table 2. Estimated Effect of a 100 lb Passenger Car Weight Reduction on 1999 US Fatalities

Crash Type	Fatalities in 1999 Crashes <sup>4</sup>	Effect of 100 Pound Weight Red.	Net Fatality Change	One Standard Deviation
Principal rollover	1,663	3.77%	63	11.6
Hit object	7,003	0.03%	2	17.4
Ped-bike-motorcycle	3,245	-2.39%	-77	9.3
Hit big truck	2,496	1.20%	30	9.6
Hit passenger car	4,047	-2.42%	-98	19.4
Hit light truck	6,881	1.67%	115	21.0
Overall	25,335	0.13%	34 *	37.9 **
$\pm 3$ -sigma confidence bounds			-80 to + 148	

\*Overall is calculated from the net fatality changes before rounding to the nearest integer value.

\*\*Standard deviation for "overall" is the square root of the sum of the squares of the 6 individual standard deviations.

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much larger than 100 lb.

Table 3. Estimated Effect of a 100 lb Light Truck Weight Reduction on 1999 US Fatalities

Crash Type	Fatalities in 1999 Crashes <sup>4</sup>	Effect of 100 Pound Weight Red.	Net Fatality Change	One Standard Deviation
Principal rollover	2,605	1.42%	37	13.3
Hit object	3,974	1.23%	49	12.4
Ped-bike-motorcycle	2,432	-0.79%	-19	8.5
Hit big truck	1,506	1.50%	23	8.6
Hit passenger car	6,881	-1.55%	-106	16.0
Hit light truck	1,781	-1.06%	-19	12.1
Overall	19,179	-0.19%	-36 *	29.6 **
± 3-sigma confidence bounds			-125 to +53	

\*Overall is calculated from the net fatality changes before rounding to the nearest integer value.

\*\*Standard deviation for "overall" is the square root of the sum of the squares of the 6 individual standard deviations.

Sensitivity analyses indicate results that are similar to those of Kahane in Ref 1. The sensitivity results indicate that the estimated net effects of vehicle weight reduction are within  $\pm 3$  standard deviations for a reasonable range of driver age and gender effects, based on the similarity of the driver coefficients in this study to those in Ref 1; and with regard to the inclusion or exclusion of sporty vehicles. The results therefore appear to be stable with regard to such variations.

## REFERENCES

1. Kahane, C. J., Relationships Between Vehicle Size and Fatality Risk in Model Year 1985-93 Passenger Cars and Light Trucks, DOT HS 808 570, National Highway Traffic Safety Administration, Washington, D.C., January 1997.
2. Anon., Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards, National Academy of Sciences, National Academy Press, Washington, D.C., June 2001.
3. Anon., Traffic Safety Facts 1999, DOT HS 809 100, National Highway Traffic Safety Administration, Washington, D.C., December 2000.