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## Automobile Weight and Safety


Statement of
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Committee on Commerce, Science, and
Transportation
United States Senate


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Good morning, Mr. Chairman and Members of the Subcommittee:

The GAO is pleased to respond to your invitation to testify this morning about the work we are doing concerning the relationship between automobile size and safety. While our investigation of this subject is still in progress, I believe we have reached some important preliminary conclusions that will help to shed some light on the current debate. I would like to share these with you this morning.

My primary message to you today is that this issue is not as straightforward as it may appear at first glance: there is not a simple linear relationship between automobile size and occupant safety. Car size must be thought of from the viewpoints of both protection and risk. That is, the safety provided to the occupants of a large car must be considered together with the risk posed by that same car to passengers in other automobiles. In addition, car size has different effects in different types of accidents.

Our major conclusion is that it is not true that cars become more dangerous simply by getting lighter. The highest fatality rates occur in cars in the middle of the weight spectrum, particularly in single-car crashes. In two-car collisions, the occupants of the lighter car are at greater risk than the occupants of the heavier vehicle. However, our analysis suggests that if all cars became lighter, the increased vulnerability of lighter cars in two-car crashes would be more than offset -- all things being equal -- by the reduced threat to them from heavier cars.

Let me begin by recognizing the professional and timely assistance that we have received from the National Highway Traffic Safety Administration. NHTSA has given us access to the data sets we need for our work and has provided extremely competent technical assistance in the use of those data sets. Also, we look forward to reading NHTSA's forthcoming report on the effects of vehicle weight in multi-vehicle accidents that is, I understand, to be released quite soon.

GAO undertook this work because of the heightened attention given to the safety aspects of small cars stemming from S. 279 and other recent proposals to dramatically increase corporate average fuel economy (CAFE) standards. As you know, it has been argued that stricter fuel efficiency standards can only be achieved -- at least in the short term -- if automobile manufacturers build and sell lighter cars than they do now. And it is further claimed that lighter cars are inherently less safe than heavier cars. Indeed, in prior testimony to this subcommittee, it has been stated that "over 1300 fatalities" annually can be attributed to the downsizing of America's automobile fleet during the 1970s.

We will not address the question today of whether it is true that more stringent CAFE standards can only be achieved by building lighter cars. Nor can we speak to automobile design features that may make cars safer in the future. Instead our work to date has been directed specifically at testing the contention that lighter cars are more dangerous.

Background

Two potential sources of ambiguity exist in this area. One concerns the car weight and safety relationship. There are at least three different ways that car weight can affect occupant safety. The first relates to stability, or the propensity to roll over. Some analysts maintain that lighter automobiles cause more occupant injuries and deaths because they are less stable than heavier cars, and thus roll over more easily. The second effect of size is the one that comes most easily to mind: occupant protection, or crashworthiness. It is clear that heavier automobiles offer more protection to their occupants in the event of a collision than do lighter cars. The third effect of size is as a force initiator that acts in much the same way as a weapon. Heavier cars subject their own occupants to more force at a given velocity than do smaller automobiles when they hit a fixed object. Just as importantly, in the case of multi-car collisions, they impact the other vehicles with more force than would a smaller car. For example, a 2000 pound car needs to achieve a speed of 46 miles per hour in order to generate as much force at impact as a 3500 pound automobile traveling 35 miles per hour.

The second possible ambiguity stems from the imprecise use of terms like "downsizing" or "car size." For our purposes here, car size refers only to car weight, not to length and width or other possible measures of size. Weight is the aspect of automobile size that is the most closely related to fuel efficiency.

For our data analyses, we asked NHTSA to make available to us the data from their Fatal Accident Reporting System (FARS)--which contains details of every highway fatality since 1975--together with information on the types of cars registered each year since then. From these data we developed fatality rates for different weight categories of passenger cars and different types of accidents. Fatality rate is defined here as the number of persons killed in a given category of passenger car for every 100,000 of those vehicles registered.

This said, let me move to a more detailed discussion of our work to date.

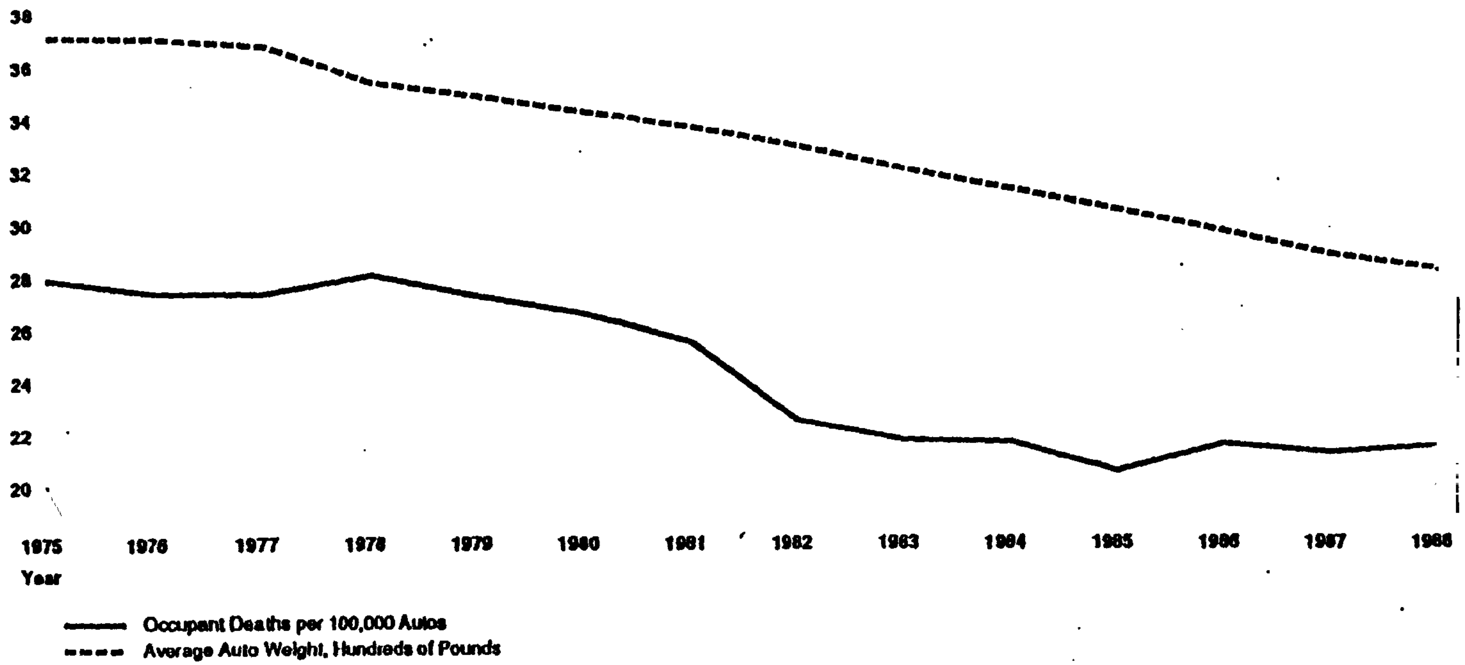
## Preliminary Findings

As you can see from Figure 1, there are two clear historical trends since the mid-1970s: highway fatality rates have decreased at the same time that the mean weight of cars has become smaller. The solid line on the graph shows that the fatality rate for passenger car occupants decreased from approximately 28 deaths per 100,000 registered autos in 1975 to roughly 22 per 100,000 registrations in 1988. Since 1988, highway fatality rates have continued to decline. And on average, as the dashed line illustrates, cars on the road in the late 1980s weighed about 800 pounds less than cars on the road in 1975. No one should conclude from these trends that the move toward lighter cars has actually saved lives, but these trends do make it more difficult to support the case that car weight reductions have increased fatalities.

### Single-Car Accidents

We first examined single vehicle accidents. We restricted our analysis to one to two-year old passenger cars involved in fatal accidents from 1986 to 1988, the latest year for which data were readily available to us. Single car accidents accounted for 39 percent of the fatalities in these automobiles (51 percent were in two-vehicle crashes and 10 percent in accidents with three or more vehicles).

Figure 1: Auto Occupant Fatalities and Car Weight, 1975-1988

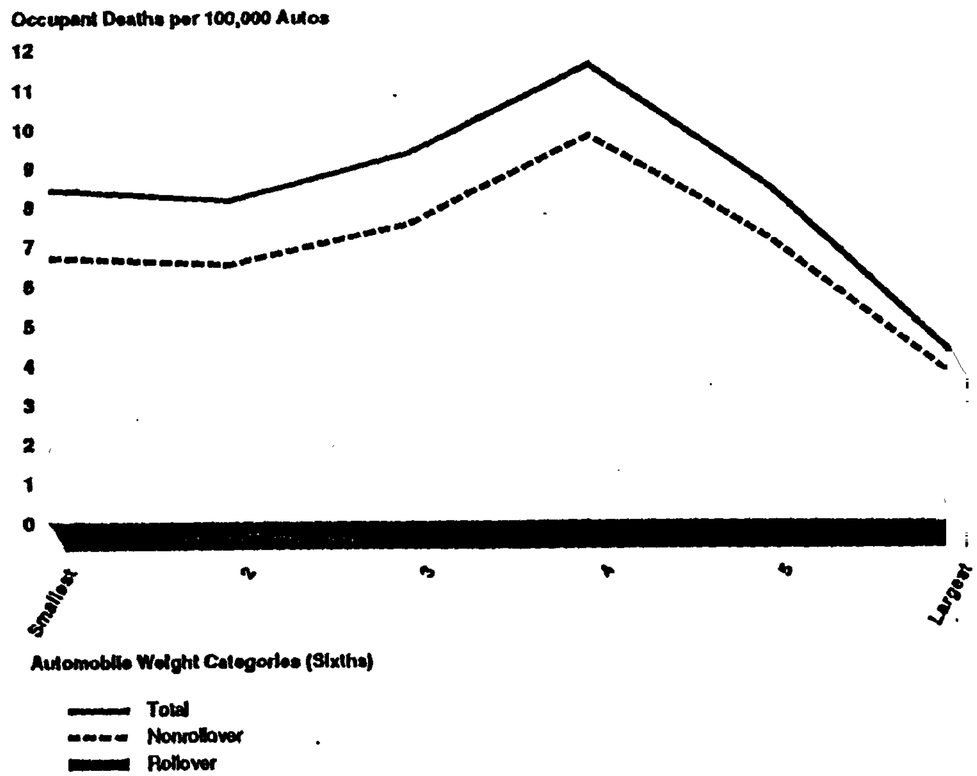


The weight categories on Figure 2 delineate six equal-sized divisions of the population distribution of car weights (i.e., the number of cars in each category is roughly equal), with the smallest cars in the weight category to the extreme left, the next smallest group just to the right of that, and so on to the weight category with the largest cars on the far right. The top line on the graph charts the overall fatality rate for single car accidents, while the other two lines represent subsets of the total: the lower line for rollover accidents, and the middle line for nonrollover accidents.

As you can see, fatality rates do not appear to be a simple linear function of car weight. The lowest fatality rates do occur in the largest car category, but the highest fatality rates occur in cars in the fourth weight category, not in the smallest weight group. The pattern is the same for nonrollover crashes, with the highest fatality rate again in the fourth category. For rollover crashes, the fatality rate in the four smallest weight categories is approximately equal, while the heaviest cars have a much lower fatality rate, only about one-third that of the other categories. Less than 20 percent of the fatalities in single car accidents occur in rollover crashes.

Within this context, let us return to the statistic we cited earlier, that "over 1300 fatalities" annually are due to automobile

Figure 2: Deaths in One Car Accidents



crashes. The statistic was drawn from a study that modeled the effects of several design and policy changes during the 1970s on car safety, in particular on the propensity of vehicles to roll over. What the study found is that the relationship among all the changes to vehicles during the 1970-82 period is very complex, and that several factors appear to be related to rollover propensity. According to the model which best fits the data, car weight is one of these factors, but not the most important. To quote the study: "the model shows that rollover propensity decreases as cars get wider, heavier, and longer. Track width, however, has by far the highest correlation. For a typical car with a track width of 55 inches, curb weight of 3000 pounds and wheelbase of 105 inches, a 1 percent increase in track width is associated with a 5 percent decrease in rollover propensity. A 1 percent increase in curb weight is associated with a 0.6 percent decrease in rollover propensity."[1]

The logical conclusion from this analysis is not that a given number of fatalities can be associated with changes in the weight of cars, but that track width is a critical factor affecting rollovers. First, if we accept the validity of this NHTSA model, manufacturers could offset the increased rollover propensity associated with making a car 150 pounds lighter by increasing its

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[1] Kahane, Charles J. An Evaluation of Door Locks and Roof Crush Resistance of Passenger Cars - Federal Motor Vehicle Safety Standards 206 and 216. Report DOT HS 807 489. Washington, D.C.: National Highway Traffic Safety Administration, 1989, p. 111.

track width one-third of an inch. Second, we would like to make a cautionary point about the use of such models, a point that has been well-stated by NHTSA: "While the methods of this report are appropriate for estimating the effect of historical changes in car size on rollover fatality risk, it would be inadvisable to use them to predict what might happen in the future if a single parameter (say, curb weight) is changed while others are held constant."[2] While no one has predicted in so many words that 1300 more deaths <u>will</u> occur in the future if cars become lighter, still, calling attention to that estimate in a discussion of prospective changes to the future automobile fleet could lead others to misinterpret NHTSA's findings.

Two-Car Accidents

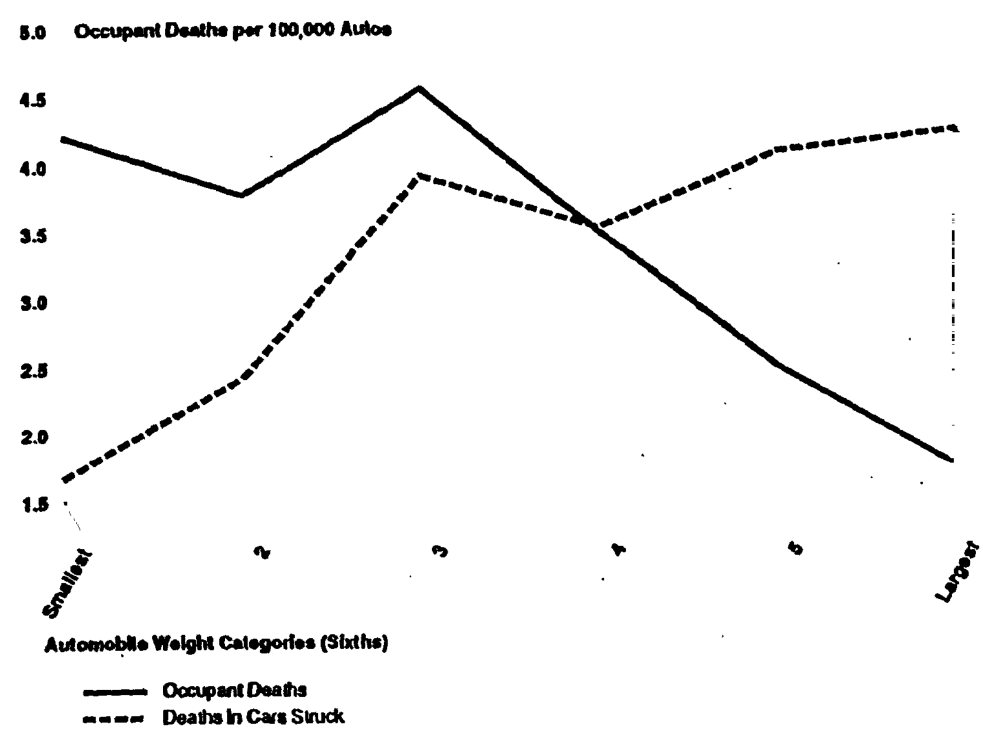
We turn now to two-vehicle accidents. We restricted our analysis here to accidents between two passenger cars, in order to simplify the task of examining the interactive effects of the weights of both involved vehicles. We also were able to look only at accidents involving the cars in our sample and other cars that were less than 10 years old, because we did not have valid data about the weight of older vehicles. Two-car collisions accounted for approximately 54 percent of all two-vehicle accidents for our 1986-1988 sample.

[2] Kahane, Charles J. Effect of Car Size on Fatality and Injury

The _solid_ line on Figure 3 describes the effects of car size in the second meaning we described earlier, as occupant protection. As you can see, occupant fatality rates do generally decline as weight increases, with the largest cars providing the most protection. However, once again, the smallest cars are not the most dangerous; the cars with the highest occupant fatality rates occupy intermediate positions in the weight distribution.

To this picture, the _dashed_ line on the chart adds the effects of car size in its third role, as an initiator of force. It shows the death rate for occupants of the "other" car in each accident; that is, for the vehicles that receive the force conveyed by different sized cars. Not surprisingly, there is a clear effect of automobile weight -- the number of "other" vehicle fatalities increases as the weight of one's own car gets larger. In this perspective, the smallest cars are the safest for the occupants of other vehicles, while the largest cars are the most dangerous.

Taken together, these findings have two implications. The first is straightforward: in accidents involving two cars, occupants of the heavier car are safer than those in the lighter automobile. Second, the comparatively small amount of force that light cars generate when they impact another vehicle means that the overall fatality rate in two-car accidents may actually decrease slightly if the percentage of small cars in the population is aths In Two Car Accidents



fatalities in two-car accidents for our 1986-1988 data set would have been approximately 5 percent <u>lower</u> if the percentage of all cars in the two smallest weight categories (below 2420 pounds in our definition) had been 50 percent greater, all other factors remaining the same. This is because the percentage of relatively deadly accidents between large and small cars would have decreased, while the percentage of somewhat less injurious accidents between two small cars would have been larger.

This difference in perspective is an important one for policy. From the standpoint of an individual traveling in an auto that is involved in a two-car collision, it is safer to be in the heavier car. However, from the perspective of all passenger car occupants collectively, it is the <u>overall</u> fatality rate in two-car accidents that needs to be considered, and that rate could be at least somewhat reduced if the percentage of small cars on the road were increased.

## Preliminary Conclusions

In summary, the relationship between car size and safety is not a simple one. We found that heavier cars are not invariably safer than lighter ones; indeed, the highest fatality rates are in cars in the middle of the weight distribution. When two cars of damage than the larger one. However, we estimate that if the proportion of small cars on the road were to grow substantially, the total fatality rate in two-car accidents would decline slightly due to the decreased likelihood of comparatively deadly collisions between large and small cars.

## Future Research

As we stated at the beginning, our work is not yet complete. Over the next few months, we plan to analyze data from state accident data bases in order to look at nonfatal injuries and to investigate how different driver characteristics affect safety. We also plan to take a comprehensive look at automobile characteristics other than weight (e.g., engine capacity, wheelbase, and cost) that may be related to car size, fuel efficiency, and safety.

This concludes my remarks, Mr. Chairman. I would be happy to answer any questions that you or Members of the Subcommittee may have.