Automobile Safety Regulations and Death Reductions in the United States

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Abstract: The effectiveness of federal automobile safety standards was examined using detailed data on 236,000 vehicles in fatal crashes in the United States during 1975–1978. Controlling statistically for type of regulation, types of vehicles, and ages of vehicles, the federal motor vehicle safety standards were associated with substantial reductions in car occupant deaths per 100 million vehicle miles travelled, and some reductions in fatal collisions of the federally regulated vehicles with pedestrians, motorcyclists, and bicyclists. Some 37,000 fewer deaths occurred in 1975–1978 than would have been expected without the federal standards. (*Am J Public Health* 1981;71:818–822.)

In 1964, when 14 states required lap seat belts in front outboard seating positions of automobiles, manufacturers installed them in all cars as standard equipment.[1] Also in that year the General Services Administration (GSA) was authorized to issue safety standards for vehicles purchased by the federal government. The GSA issued standards applicable to 1966 model vehicles and the required equipment—such as energy absorbing steering assemblies and high penetration resistant windshields—was made part of certain 1966 and subsequent models sold to the public as well as to the government.

The National Traffic and Motor Vehicle Safety Act of 1966 directed that "initial" safety standards, based on existent standards, be required on all automobiles manufactured in 1968. In addition to vehicle crashworthiness standards, the federal standards included criteria for crash avoidance equipment, such as redundant braking systems, side running lights, and reduced light reflection in drivers' eyes.[2] Most of the initial and subsequent standards applied only to cars; trucks, for the most part, have remained exempt.

A number of studies have found reduced occupant deaths and non-fatal severe injuries associated with the state and federal regulations.[3–7] However, the effect of the standards on pedestrians has been questioned by Peltzman on theoretical grounds and limited data analysis.[5] Since Peltzman's own analysis did not separate regulated cars from unregulated trucks, counted motorcyclists as pedestrians, and contained numerous other problems, it cannot be accepted as the definitive study of the regulations.[8] The only study to separate regulated from unregulated cars in relation to pedestrian deaths found no significant effect of regulation on pedestrian deaths.[7] However, that study used data from one of the smaller states and the pedestrian death rates were relatively unstable statistically because of small numbers.

Definitive information on the relative fatality rates of occupants of particular vehicles and nonoccupants (pedestrians, motorcyclists, bicyclists) in collisions with those vehicles is now available. Data on virtually all the motor vehicle related deaths in the United States has been accumulated for the calendar years 1975–1978. The purpose of this report is to examine the relative effects of safety regulations, types of vehicles, and vehicle age on deaths per miles driven by the vehicles during those years.

Materials and Method

Data on characteristics of vehicles and drivers in fatal crashes were collected by the state governments under contract with the National Highway Traffic Safety Administration for its Fatal Accident Reporting System (FARS). The data were obtained on each crash in which someone who was injured died within 30 days of the crash. Data sources included police reports, driver license files, vehicle registration files, vital statistics, and records of state highway departments.[9]

At the time that computer tapes containing the data were made available to the author, the files for 1975–1977 were virtually complete and the 1978 file was about 95 per cent complete. These files contained data on 236,205 vehicles, their drivers, and occupants and the nonoccupants killed in crash impacts involving the vehicles.

The numbers of vehicles registered for each of 15 model years were obtained for each of the calendar years 1975–1978.[10] The estimated miles driven by vehicle age was obtained from 1977 survey data.[11–12] Such data are not collected every year but average miles per vehicle are estimated yearly.[13] The latter estimates were used to increase or decrease the mileage estimates for 1977 to other calendar years. For example, average car miles were 9,839 in 1977 and 10,046 in 1978, 2.1 per cent higher than 1977.

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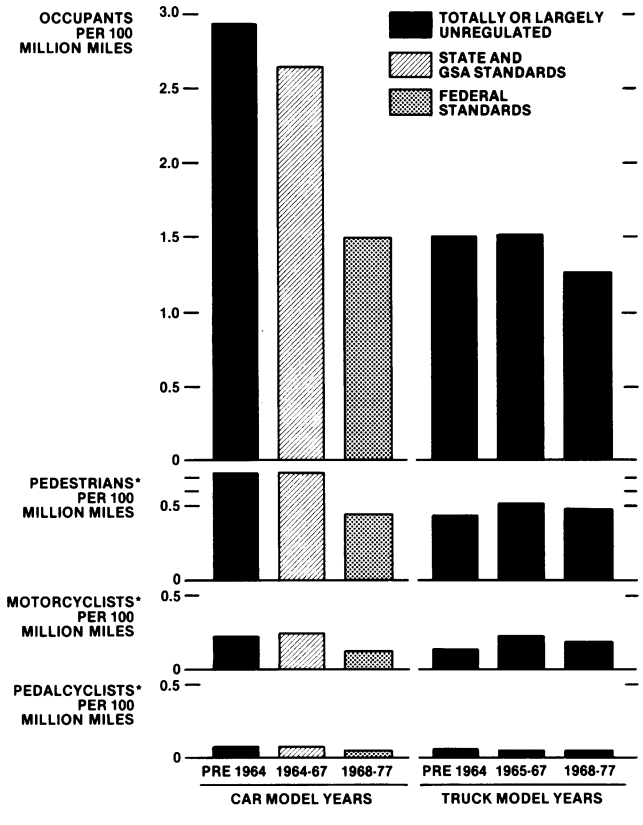
TABLE 1—Average Annual Fatal Crashes per 100 Million Vehicle Miles ± Standard Deviations by Vehicle Type, Model Years, and Road Users Involved, United States, 1975–1978

	Car Model Years			Truck Model Years		
	Pre 1964	1964–67*	1968–77**	Pre 1964	1964–67	1968–77
Occupants	2.92 ± 0.15	2.63 ± 0.26	1.50 ± 0.42	1.50 ± 0.22	1.51 ± 0.17	1.26 ± 0.16
Pedestrians***	0.72 ± 0.09	0.72 ± 0.05	0.45 ± 0.12	0.44 ± 0.11	0.51 ± 0.07	0.48 ± 0.06
Motorcyclists***	0.22 ± 0.15	0.23 ± 0.04	0.14 ± 0.05	0.14 ± 0.04	0.22 ± 0.05	0.19 ± 0.05
Pedalcyclists***	0.09 ± 0.03	0.09 ± 0.02	0.05 ± 0.02	0.06 ± 0.05	0.05 ± 0.02	0.05 ± 0.01
All Fatal Involvements	5.50 ± 0.45	5.16 ± 1.29	3.40 ± 0.94	3.45 ± 0.24	4.01 ± 0.33	3.87 ± 0.40

*State and GSA regulated.
**Federal Motor Vehicle Safety Standards.
***In collisions with car and truck models of the years specified.

Therefore, the miles for cars of each model year in 1977 were multiplied by 1.021 to estimate their use in 1978.

The numbers of deaths were divided by the average miles driven times registered vehicles for each model year in each calendar year separately for cars and trucks and multiplied by 100 million to give death rates per 100 million miles. These rates were calculated for each group of fatally injured persons—pedestrians, bicyclists, and motorcyclists in collisions with the vehicles as well as occupants fatally injured in or ejected from cars and trucks, separately, of particular model years in crashes in each calendar year. A total fatal crash involvement rate of each set of vehicles was also calculated. The data set for each group contained 120 death rates: 15 model years × 4 calendar years × 2 types of vehicles—cars and trucks. The model years included were 1960–74 in 1975, 1961–75 in 1976, 1962–76 in 1977, and 1963–77 in 1978.



*In collisions with car and truck models in the years specified.

FIGURE 1—Average Annual Fatal Crashes per 100 Million Miles, United States 1975–1978

To estimate the relative effects of regulation, types of vehicles, and ages of vehicles on each group of fatalities, a least squares regression analysis was used. For each group of fatalities, parameters b_i were estimated for the equation:

$$D = a + b_1F + b_2S + b_3T + b_4A + b_5A^2 + b_6A^3$$

where D = deaths per 100 million vehicle miles.

- a = constant
- b_i = estimated effects
- F = federal regulation (1 = 1968–1977 cars; otherwise 0)
- S = state and GSA regulation (1 = 1964–1977 cars; otherwise 0)
- T = type vehicles (0 = truck; 1 = car)
- A = age of vehicles in years
- e = residual variation

Vehicle age squared and cubed was introduced to test for possible non-linear effects. Although denominators of miles driven were not available for other known correlates of fatal crash involvement—such as driver age, driver sex, driver's prior convictions for violations, driver's prior crashes, and time of day—these variables were cross-tabulated with vehicle type and applicable regulatory categories in a search for evidence of confounding of the observed effects of regulation by these variables.

Results

The unadjusted annual average fatal crash involvement per 100 million vehicle miles by type of vehicle and applicable regulations are presented in Figure 1 with standard deviations in Table 1. Occupant death rates were somewhat lower in cars meeting state and GSA standards and substantially lower in cars meeting federal standards than in pre-regulation cars. A slightly lower rate of deaths of pedestri-

TABLE 2—Regression Analysis of Effects of Safety Regulations, Type Vehicle, and Vehicle Age on Motor Vehicle Deaths per 100 Million Vehicle Miles

	Federal Regulations	State and GSA Regulations	Type Vehicle	Vehicle Age (A)			R^2
				A	A^2	A^3	
Occupants	− 0.72	−0.36	1.35	0.027	0.012	−0.0008	0.91
t	−10.30	−4.04	17.55		F(3,113) = 50.11		
Pedestrians*	− 0.21	−0.07	0.26	0.004	0.004	−0.0003	0.71
t	− 7.62	−2.14	8.60		F(3,113) = 18.27		
Motorcyclists*	− 0.06	−0.01	0.02	0.009	0.001	−0.0001	0.30
t	− 2.55	−0.26	0.94		F(3,113) = 5.91		
Pedalcyclists*	− 0.02	−0.00	0.03	0.001	0.000	0.000	0.31
t	− 3.27	−0.37	3.59		F(3,113) = 1.47		
All Involvements	− 1.30	−0.77	1.70	0.178	0.007	−0.0011	0.59
t	− 5.36	−2.49	6.32		F(3,113) = 11.31		

*In collisions with cars and trucks.
$|t| > 2.00$, $p < 0.05$ (two-tailed test)
$F > 2.66$, $p < 0.05$

ans, motorcyclists, and pedalcyclists was found in collisions with federally regulated cars compared to those of prior model years. Trucks, which were mainly unregulated, had only slightly lower occupant deaths and no consistent difference in deaths in collisions with nonoccupants in model years comparable to those for regulated and unregulated automobiles.

The regression coefficients, t and F values, and proportion of variance explained in the regression analyses are listed in Table 2. Adjusting for age and types of vehicles, the coefficients show a substantial reducing effect of federal safety standards on occupant, pedestrian, and total death involvement rates, and some reduction in pedalcyclist and motorcyclist death rates. The state and GSA regulations had some effect on occupant death rates but little or no effect on those of nonoccupants. Cars were generally involved more frequently than trucks. Linear, squared, and cubed terms for vehicle age were collectively significant except in the case of pedalcycles.

The included variables explain 91 per cent of the variation in occupant death rates and 71 per cent of the variation in pedestrian death rates, indicating a good fit of the data, but explain less than one-third of variation in bicyclist and motorcyclist death rates. About 59 per cent of the total fatal crash involvement of the vehicles is explained by the variables specified, with state and federal regulation each contributing to a significant reduction in total involvement.

If the obtained coefficients are applied to the numbers of registered, regulated automobiles and the miles they were driven in each of the included calendar years, the numbers of deaths avoided by the federal safety standards amount to 26,500 occupants, 7,600 pedestrians, 1,000 pedalcyclists and 2,000 motorcyclists—for a total of about 37,000 people who would have died without the standards in those years.

Driver characteristics and time of day associated with higher involvements in fatal crashes are presented in Table 3 for cars in the model years with different degrees of regulation and for trucks in the same model years. Cars had greater

TABLE 3—Per Cent Driver Characteristics and Crashes at Night Associated with Cars and Trucks by Model Years

	Car Model Years			Truck Model Years		
	Pre 1964	1964–1967	1968–1978	Pre 1964	1964–1967	1968–1978
Driver < 26 Years Old	44	48	44	36	31	31
Male	82	80	75	96	96	94
Previous Crash or Violation	48	48	49	56	56	57
8:00pm–4:00am	41	44	42	35	32	33
N * ~	6,620	26,140	122,479	3,498	5,740	45,106

*Varies slightly because of missing data on some factors. Does not add to the 236,205 total vehicles because motorcycles, buses, and miscellaneous vehicles (e.g., road surfacing equipment, farm tractors) are excluded.

proportions of youthful drivers and crashes at night than trucks, while trucks had greater proportions of male drivers and drivers with previous crashes or convictions for a violation. Differences among cars with varying degree of regulation on these factors were small and of similar magnitude to those of trucks (although in a somewhat different pattern) which were largely unregulated.

Discussion

The results of this research indicate that a large reduction in loss of human life was associated with the federal motor vehicle safety standards that were applied to automobiles beginning with the 1968 model year—some 37,000 fewer deaths than would have occurred in the calendar years 1975–78 without the federal standards.

The higher death rates in cars relative to trucks is probably the result of more passengers per mile traveled in cars, and the disadvantage of car occupants in car-truck collisions because of size and weight differences. In crashes in which someone died involving collisions of cars and trucks, the dead person is three times more likely to be a car occupant if the car is large (> 115-inch wheel base) and six times more likely to be a car occupant if the car is smaller.[14] It should be noted that the observed reduction in occupant deaths associated with federal safety standards occurred despite the fact that the average size of cars on the road was becoming smaller during part of the period that vehicles were regulated.

The results on the effectiveness of regulation are very unlikely to be the result of some uncontrolled correlate of vehicle age. By controlling for age and its square and cube, any reasonably expected, smooth function of variation in age is controlled. The regulation effect is a discrete, substantial reduction in death rates that occurred at four different points of vehicle age in the four calendar years observed. Such abrupt changes in miles driven or quality of exposure so perfectly coordinated with the model years in which the regulations occurred are highly unlikely. The calendar years studied were after the OPEC (Organization of Petroleum Exporting Countries) embargo but before the Iranian revolution when gasoline supplies and economic conditions were relatively stable. Average miles driven were very stable in 1975–78, deviating from the 1977 averages in any one of the other years no more than 2.1 per cent in the case of cars and no more than 4.1 per cent in the case of trucks.

Denominators in miles driven for known correlates of fatal crash involvement—youths, males, drivers with prior crashes and violations, time of day—are not known by age of vehicle driven but the proportion of fatal crashes involving such people or conditions was not correlated with regulation of the vehicles involved. For one of these factors to have contributed to the observed regulatory effects, a large shift in use of vehicles by driver factors and/or time of day would have had to occur in association with regulation of the vehicles—a very unlikely phenomenon.

The death reductions associated with federal regulations were found among pedestrians, bicyclists, and motorcyclists in collisions with regulated cars as well as occupants of those cars, providing no support for the theory that occupant death reductions were offset by increased risk to pedestrians or other nonoccupants of the regulated cars.

The debate about future crashworthiness and other standards—e.g., the extension of the initial standards to trucks and further improvements in car crashworthiness—has been mainly focused on the economic and philosophical issues involved. Analyses of the economic savings alone, not to mention the intrinsic value of life and limb, have indicated that the savings realized by the "initial" standards[6] and those to be realized by adopted future standards[15] are substantially greater than their costs. A former automobile company executive who developed a research safety vehicle that provides crashworthiness far in excess of any proposed standard has estimated that, in mass production, the car could be profitably marketed at about the cost of currently priced compact cars.[16] Apparently, the cost of these innovations does not explain their lack of availability in the market. Other explanations involving ideology[17] and management norms[18] may be more plausible.

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Entries Invited for 1981 Community Preventive Dentistry Award

The American Dental Association has announced that entries now are being accepted for the annual ADA Community Preventive Denistry Award.

The program, funded by the Johnson & Johnson Company, recognizes and rewards those who have developed and/or implemented significant community preventive dentistry projects. A $2000 award will be presented to the winner; $300 awards may be granted for other meritorious entries.

Eligibility is not limited to dental personnel. Any individual or organization responsible for creating and implementing a community program concerned with some aspect of preventive dentistry may enter. Audiovisuals, such as motion pictures, videotapes, slides, tapes, filmstrips, and records, may be used to illustrate the program. Audiovisuals must be accompanied by a typed outline and/or transcript of their contents, and will be returned after the judging.

Evaluation will be based on:

Impact of Program: Number of people served by the program, dental need that is filled or progress in special area of concern that otherwise receives little attention.

Quality of Program: Accomplishment of goals, efficiency of procedures, originality and creativity, ease of duplication by other communities.

Form of Entry: Organization, completeness, neatness.

Additional information brochures and entry applications are available on request from the Council on Dental Health and Health Planning, American Dental Association, 211 East Chicago Avenue, Chicago, IL 60611. Entries must be submitted through a state or local dental society, dental school, or dental director and must be postmarked by August 15, 1981.

On Job/On Campus MPH Program in Medical Care Administration Recruits New Class

The Department of Medical Care Organization and the Program in Dental Public Health in the School of Public Health, University of Michigan are now accepting application for enrollment into the seventh On Job/On Campus (OJ/OC) class which will begin in January 1982. The OJ/OC Master of Public Health program is offered to employed professionals in the health delivery system. Former participants have been employed in ambulatory services management, HMO development and operations, health planning, dental public health administration, hospital administration, third party services and health manpower training.

Students attend classes in Ann Arbor for one four-day period every four to five weeks for 25 sessions. Between these monthly meetings, students prepare for class and do work related projects at their site of employment. The program provides 47-49 credit hours of coursework covering: managerial tools and approaches useful in health care incuding financial management, operations research and organizational behavior; background disciplines to health care administration including health economics, health behavior and politics of health care; statistics, epidemiology and demography; and medical care organization, administration and financing, ambulatory care, health insurance and medical care law.

Some financial assistance may be available from the University of Michigan. In addition, loans may be available through the guaranteed student loan program. When in Ann Arbor, students stay in local hotels or in University guest housing. For additional information, contact David Perlman, Student Services Coordinator, On Job/On Campus Program, Department of Medical Care Organization, University of Michigan, Ann Arbor, MI 48109, 313/764-5432.