Car Design and Risk of Pedestrian Deaths

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Abstract: Fatal pedestrian injury rates by cars with relatively sharp front-corner designs were compared to such rates by cars of similar-size with relatively smooth front-corner designs. The relative risk of death by front-corner impact was 26 percent greater among the sharp-cornered cars. Pedestrian death rates from impact with other points on the cars and insurance claim frequencies among the studied cars were similar between the two sets of cars. (*Am J Public Health* 1990; 80:609–610.)

Introduction

In 1967, William Haddon, Jr., sent letters to 38 manufacturers of motor vehicles and their suppliers with pictures of designs that increased the severity of collisions with pedestrians.[1] In 1971, Haddon showed a committee of Congress the design of front ends of cars that resembled the design of ancient weapons—spears and battle axes.[2]

Despite Haddon's warnings, in the 1980s a number of large cars featured sharp protrusions as part of the design of their front corners. In impacts with pedestrians, these designs would be expected to increase the severity of injury because of their shearing effect.[3] The purpose of the research reported here was to investigate the extent to which such designs were associated with increased risk of pedestrian mortality in comparison with similar-sized cars that had relatively smooth front-corner designs.

Methods

A trade magazine with pictures of new cars introduced for sale in the United States during the model years 1980 through 1985 was examined to identify those that had sharp edges on their front corners.[4] Since all of the vehicles with sharp corners weighed more than 3,000 pounds, all cars from the same manufacturers that had relatively smooth front corners and weighed more than 3,000 pounds were chosen for comparison. The compared vehicles are listed in the Appendix.

Data on pedestrian fatalities in which the pedestrians were struck by the listed cars during the calendar years 1982–87 were obtained from the Fatal Accident Reporting System (FARS) computer files. These files contain data on virtually every fatal motor-vehicle injury in the US. The data include clock position of principal impact, eleven and one o'clock for front-corner impacts. Rates of pedestrian fatalities per vehicle years of use by principal point of impact were calculated using sales data[4] to estimate vehicle years of use.

To estimate vehicle use of vehicles sold during the calendar years of the study as accurately as possible, monthly sales data were used to calculate months of use during the year in which a given model was sold. The total years of use was thus the number of months from the sale in the first year divided by 12 plus the total number sold in the year times the number of years subsequently through 1987.

The rates of pedestrian deaths per 100,000 years of use from front-corner impacts and impacts at other points on the vehicles of the sharp-cornered relative to the smooth-cornered vehicles were compared. If differences in the pedestrian death rates in front-corner impacts of the two sets of vehicles were due to differences in driver factors, vehicle factors other than front-corner designs, or use in different environments, a similar difference in non-corner impacts should be found between the two sets of vehicles. There is no reason to believe that other risk factors would increase front-corner impacts but have no effect on pedestrian impacts at other points on the same vehicles.

Also, if the sharp-cornered vehicles were driven differently or had more defects that would increase their risk of collisions generally relative to the comparison vehicles, the insurance claim frequency for those vehicles should be higher. Therefore, the average insurance claim frequency of the two sets of vehicles was also compared using published data from insurance claims.

Results

The numbers of pedestrian deaths and deaths rates per years used in front-corner and other-point impacts of the cars with relatively sharp and relatively smooth front corners are presented in Table 1. The death rate of the relatively sharp-cornered cars in front-cornered impacts was 1.26 times that of the relatively smooth-cornered cars (95% CI = 1.05, 1.50). Thus the sharp-cornered vehicles had an average of 26 percent greater risk of pedestrian deaths in front-cornered impacts. In impacts with other points on the vehicles, the sharp-cornered cars had a relative risk of 0.98 compared to the smooth-cornered cars (95% CI = 0.86, 1.11), that is, virtually the same rates in non-cornered cars.

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TABLE 1—Relative Risk of Fatal Pedestrian Injury By Front-corner Design and Point of Impact—Large US Cars, 1982–87

Front-Corner Design	Deaths			Death Rate		Relative Risk	
	Front Corner	Other	100,000 Years Used	Front Corner	Other	Front Corner	Other
Smooth	589	1403	641.9	0.91	2.19	1.00	1.00
Sharp	160	296	138.8	1.15	2.13	1.26	0.98

95 percent confidence intervals (log odds method) (Front corner 1.05, 1.50) (Other 0.86, 1.11).

The insurance claim data were relative claim frequencies standardized so that the all-car average equals 100.[6] The smooth-cornered cars in this study had an average relative claim frequency of 86. The claim frequencies of the sharp-cornered cars had an average of 87, little different from the smooth-cornered cars' average.

Discussion

As physics and biomechanics predict, moving objects with sharp points do more damage when they strike people than do smooth objects.[3] The 26 percent average greater risk of fatal pedestrian injury from sharp-cornered compared to smooth-cornered cars is consistent with that knowledge. The rate of fatal non-corner impacts, comparing the same vehicles, were similar, suggesting that the major difference among the vehicles in risk to pedestrians is the sharpness of their front corners. The average insurance claim frequency of the two sets of vehicles were nearly the same. Therefore, it is unlikely that driver, environmental, or other vehicle factors accounted for the differences in pedestrian death rates from front-corner impacts.

Vehicle manufacturers often cite costs as the reason for refusing to design and build safer vehicles. Yet the sharp corners on the vehicles in this study require more material than would smooth corners.

The lack of difference in rates of non-corner impacts does not necessarily mean that other points on the vehicles were optimally designed. They were just not different, on average, among these two sets of vehicles. Low bumpers and hoods in combination with smooth, sloped hoods and energy absorbing material in the bumpers and windshield rims are the most efficacious designs.[7]

APPENDIX

Vehicles Studied

Sharp Corners	*Smooth Corners*
Buick Riviera	Buick Electra
Cadillac Eldorado	Buick LeSabre
Chrysler Cordoba	Buick Regal
Chrysler New Yorker	Cadillac Deville
Chrysler Fifth Avenue	Cadillac Fleetwood
Chrysler Imperial	Cadillac Seville
Dodge Diplomat	Chevrolet Caprice
All Lincolns except the 1983–85 Continental and Mark VII	Chevrolet Impala
Mercury Marquis	Chevrolet Malibu
Plymouth Fury	Chevrolet Monte Carlo
	Ford LTD
	Ford Crown Victoria
	1983-1985 Lincoln Continental and Mark VII
	1980–1982 Mercury XR-7
	1983–1985 Mercury Cougar
	Oldsmobile 88 and 98
	Oldsmobile Cutless (except Ciera)
	Pontiac Bonneville
	Pontiac Gran Prix

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APHA Epidemiology Section Invites Abstracts for Poster Session

The Epidemiology Section of APHA will again be sponsoring a "Late-Breaker" poster session at the upcoming annual meeting. The session will take place on Wednesday, October 3, 1990, 12:30–2:00 p.m. Work completed in 1990 is eligible for consideration. Abstracts must be *received* by September 7 at the address given below. Students and recent graduates are particularly encouraged to submit abstracts. Submit an abstract of less than 200 words (any format) and a return envelope to:

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