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A BRIEF ORIGINAL CONTRIBUTION

How Safe Were Today's Older Drivers When They Were Younger?

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Data from the Fatal Accident Reporting System for 1975–1990 were used to perform longitudinal analyses of car driver fatality rates (driver fatalities per million population) for a 16-year period; for example, the fatality rate of drivers born in 1960 was examined for ages 15 years through 30 years. It was found that fatality rates for male drivers of a given age systematically decline with increasing birth year; for example, 20-year-olds born in 1970 have lower fatality rates than do 20-year-olds born in 1960. The fatality rates for cohorts of drivers of either sex do not begin to increase appreciably until about age 70 years, and then they approximately double by age 80 years. These increases are of a lesser magnitude, and occur later, than those found in the earlier cross-sectional analyses that identified the "older driver problem." *Am J Epidemiol* 1993;137:769–75.

accidents, traffic; aged; aging; automobile driving; mortality; safety

The widespread belief that there is a serious "older driver problem" is based mainly on cross-sectional analyses which have shown that the car crash rates of older drivers are higher than those of somewhat younger drivers observed during the same time interval (1, pp. 30–34). Such findings do not necessarily imply that risk of a crash increases as a driver ages. The same observations would be generated if every driver had an unchanging risk but drivers born a long time ago had higher rates than those born recently. To determine whether crash rates change with aging, it is necessary to monitor the same group of drivers as they age rather than compare the rates for different groups of drivers of different ages. This study did this by means of a longitudinal analysis of driver fatalities per million population in which the same cohorts, or groups, of drivers were monitored as they aged over a 16-year period.

MATERIALS AND METHODS

This study examined only one rate: the number of fatally injured drivers per head of population. "Driver" means a driver of a car; drivers of motorcycles, trucks, etc., were excluded. Fatality counts were extracted from the Fatal Accident Reporting System, a file maintained by the National Highway Traffic Safety Administration containing detailed information on all fatal traffic crashes that have occurred in the United States since January 1, 1975 (1, pp. 19 and 20; 2). Data from the Fatal Accident Reporting System for the 16-year period 1975–1990 were used.

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The population data were estimates of the US resident population on July 1 for each of the years 1975 through 1990 as compiled by the Bureau of the Census (3–5).

RESULTS

Cross-sectional analyses

Although the purpose of this paper is to present the results of longitudinal analyses of the variation in fatality rates with driver age, we first performed cross-sectional analyses in more detail than has hitherto been done to provide an appropriate background. We examined the relation between fatality rates and driver age for each of the 16 Fatal Accident Reporting System calendar years. Plots for four of those years are shown in figure 1. All 16 relations are distinctly U-shaped for male drivers. All 32 relations (16 for each sex) have maxima at either age 18 years or age 19 years, with rates for males consistently being far higher than those for females. The male rate typically begins to increase steeply at about age 65 years, reaching about three times its minimum value by age 80, thereby suggesting an older driver problem of considerable magnitude.

Longitudinal analyses

Data for drivers were combined to form 5-year birth cohorts. Drivers born in 1967–1971 (inclusive) formed the first of 16 cohorts, and those born in 1892–1896 formed the last cohort. The average fatality rate for each cohort was determined for each of the Fatal Accident Reporting System calendar years. Figure 2 shows results for half of the cohorts. We omitted every other cohort to enhance clarity. (A separate graph of the missing alternate cohorts shows essentially the same features as figure 2.)

The cohorts shown in figure 2 have different overlapping age ranges, because information about how drivers born recently will drive when they become old will be known only in the future, while the Fatal Accident Reporting System files, first available for 1975, provide no data on today's old drivers when they were young. While nearly all of the points plotted in figure 2 reflect averaging over five individual rates, we included cases with three or more individual values to extend the age range to higher and lower values. For example, the point plotted for 21-year-old drivers born in 1967–1971 is the average of three rates—those for 21-year-old

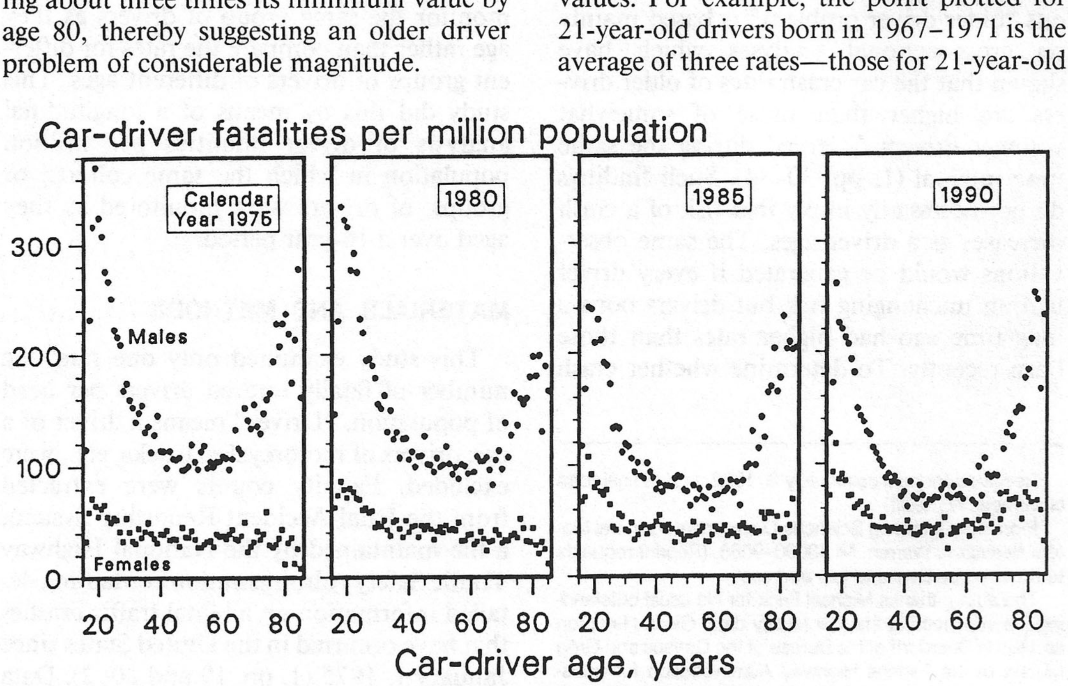

FIGURE 1. Car driver fatalities per million population, by driver's age, for illustrative calendar years (cross-sectional analysis). The first point in each graph is at age 16 years. The point plotted at age 85 years includes ages 85 years and older. The graphs for the years not included show similar driver-age dependence and fit along the time trends apparent in the graphs above. (United States data for 1975–1990).

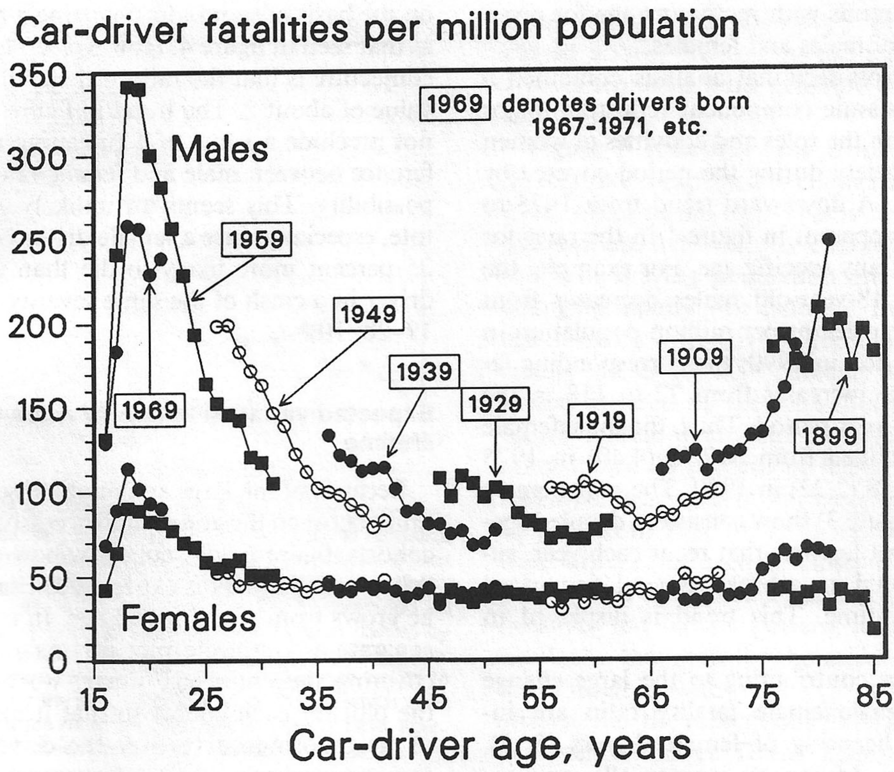

FIGURE 2. Car driver fatalities per million population, by driver's age, for cohorts of individuals born in specified 5-year intervals (longitudinal analysis). A graph of the missing alternate cohorts (for drivers born in 1962–1966, 1952–1956, ... 1892–1896) shows the same patterns. (United States data for 1975–1990).

drivers born in 1967 and observed in 1988, those for drivers born in 1968 and observed in 1989, and those for drivers born in 1969 and observed in 1990. The rates for drivers born in the other two years defining the youngest cohort, namely 1970 and 1971, require data for 1991 and 1992, which were not available at the time of this writing.

A striking feature of figure 2 is that when rates are available at the same age for male drivers from different cohorts, the more recently born drivers have lower rates. This effect is clear-cut and systematic for all drivers born in this century, and is similarly clearly apparent in the alternate cohorts omitted from figure 2. In contrast, for female drivers, there is no systematic discontinuity between one cohort and another. Indeed, the data for females overlap sufficiently to give an appearance of one continuous curve rather than distinct curves.

Figure 2 shows no indication of the types of rate increases occurring by age 65 years in figure 1. Indeed, it is only after age 70 years that any appreciable increase is apparent, and then the increases are of modest magnitude compared with those in figure 1. For female drivers, the cross-sectional data (figure 1) show that, in most cases, the rate continues to decline with age at all ages.

Differences between male and female fatality rates

In the cross-sectional analyses, the male and female patterns were quite different in that all of the male relations were distinctly U-shaped, whereas the female relations were not. In contrast, the longitudinal analyses showed a female age dependence that was not particularly different from that for males. The longitudinal analysis indicated similar trends with increasing age for given cohorts of males and females.

The cross-sectional analysis contained a large dynamic component reflecting major changes in the roles and activities of women in US society during the period covered by the data. A downward trend from 1975 to 1990 is apparent in figure 1 in the rates for males of any specific age. For example, the rate for 18-year-old males decreases from 317 driver deaths per million population in 1975 to 262 in 1990; the corresponding female rate increases from 72 to 118 in the same 16-year period. Thus, the male:female ratio declined from 317:72 (4.40) in 1975 to 262:118 (2.22) in 1990. The male:female ratios (figure 3) show consistent detailed age-dependent features that recur each year, superimposed on a broad general downward trend in time. This trend is displayed in figure 4.

Factors contributing to the large change in the male:female fatality ratio are increased licensing of female drivers (6, 7), increased driving by women (8), and increased female involvement in higher-risk behaviors, such as alcohol consumption (9). It is not possible to determine future trends on the basis of so rapidly changing a pattern as that seen in figure 4. However, a plausible conjecture is that the ratio will stabilize at a value of about 2. The trend in figure 4 does not preclude a value of 1 (meaning no difference between male and female rates) as a possibility. This seems an unlikely asymptote, especially since a female driver is about 25 percent more likely to die than a male driver in a crash of the same severity (1, pp. 19–28; 10).

Expected variation in fatality rates over a lifetime

Because of the large systematic discontinuities between the graphs for successive male cohorts, figure 2 does not show how a male driver's fatality risk is expected to change as he grows from youth to old age. In order to generate a composite plot for male drivers covering the entire age range, we rescaled the plot for each cohort so that it matched its neighboring curve over the driver ages common to both curves. The second cohort (drivers born in 1962–1966) and the first cohort (1967–1971) each had data for ages 16 years through 21 years. The ratio of the

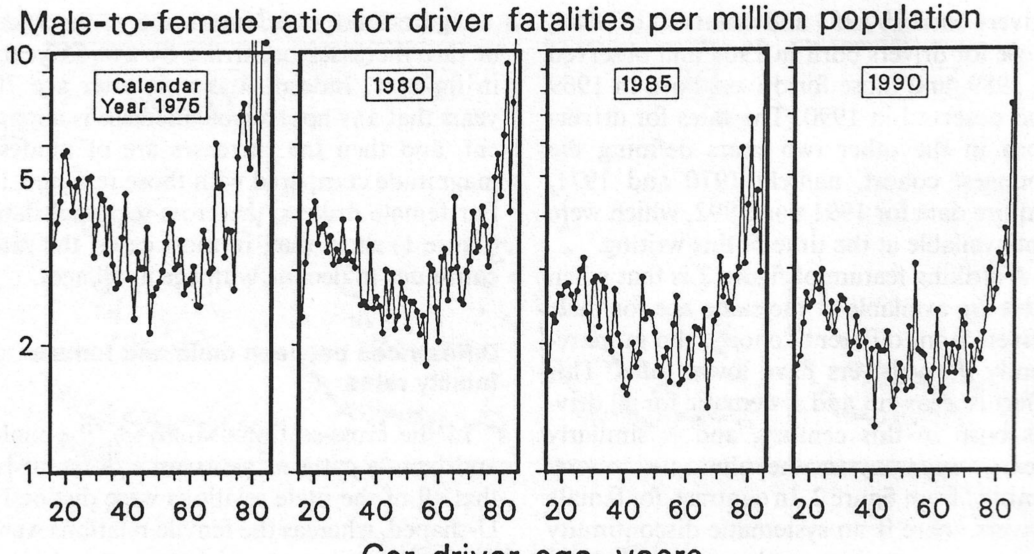

FIGURE 3. Male:female car driver fatality rate ratios, by driver's age, for data in illustrative calendar years. Each point is the ratio of the upper value in figure 1 to the lower value. The graphs for the years not included show similar driver-age dependence, and fit along the time trends apparent in the graphs above. (United States data for 1975–1990).

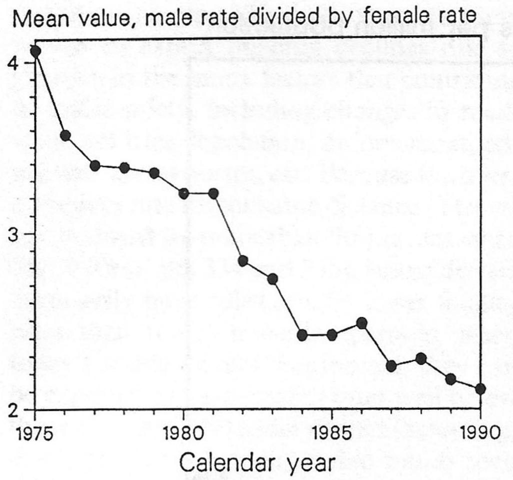

FIGURE 4. Mean male:female ratio of car driver fatality rates, by calendar year. Each point is the harmonic mean of the 70 individual values shown in figure 3 (that is, the antilogarithm of the average of the logarithmic values, as plotted). The simple mean, computed as number of fatalities summed over all ages divided by total population, generates a similar curve but is a less appropriate measure because it gives undue weight to values for the late teens and early 20s, at which ages fatalities are much more numerous than at older ages. (United States data for 1975–1990).

rate for the second cohort to that for the first cohort was computed for each of the six ages. We then divided all rates for the second cohort by a constant scaling factor equal to the harmonic mean of these six values, thereby rescaling the second cohort curve so that it optimally matched the first cohort curve over the ages for which both curves had data. The third cohort curve was then similarly rescaled to match the already rescaled second cohort curve, and so on for all of the cohort curves, leading to the result shown in figure 5.

Because there was no systematic discontinuity in the female data between successive cohorts, the data in figure 2 already give a plot that is in some ways comparable to that of figure 5. However, rather than indicating a steady-state situation, the absence of discontinuities between successive female cohorts reflects a balancing of two opposing effects. For the same amount and type of driving, there is every reason to expect female rates to decline in time in a manner similar to the stable declines observed for male populations. However, as was discussed above, changes in the amount and type of female driving generate increases in fatality rates.

Figure 5 indicates how a male driver's fatality rate is expected to change as he grows from youth to old age. This is based on an assumption that various characteristics of the male driving population are no longer changing rapidly. For example, the percentage of males with driver's licenses was sufficiently close to 100 percent during the period covered by the data that important future increases are not possible. On the other hand, 28 percent of females over 70 had driver's licenses in 1975, compared with 51 percent in 1990 (6, 7). It seems plausible that, when rates become closer to 100 percent so that additional large changes are not possible, the female pattern will be more similar to that seen for the males. Data are not available with which to perform an analysis like the present one in terms of rates per licensed driver. Driver license data are available only aggregated into 5-year categories, and all drivers over age 70 years are placed into a single category. Because of the many changes currently under way in the female driving population, it is not possible to provide an estimate of how a female driver's fatality risk is likely to vary from youth to old age.

DISCUSSION

This study focused exclusively on one rate: driver fatalities per head of population. Different rates illuminate different aspects of traffic safety; there is no one best, or "correct," rate. The goal of "correcting for exposure" is unattainable, for reasons that are much more basic than data limitations (1, pp. 12 and 13), formidable though these are. Even if we had detailed estimates of distance traveled (which we do not), this would still not come close to providing a measure of fatality risk for the same "exposure." Older drivers drive at less risky times (in daylight rather than in darkness), are less likely to drive for prolonged periods, speed less, tailgate less, and are much less likely to

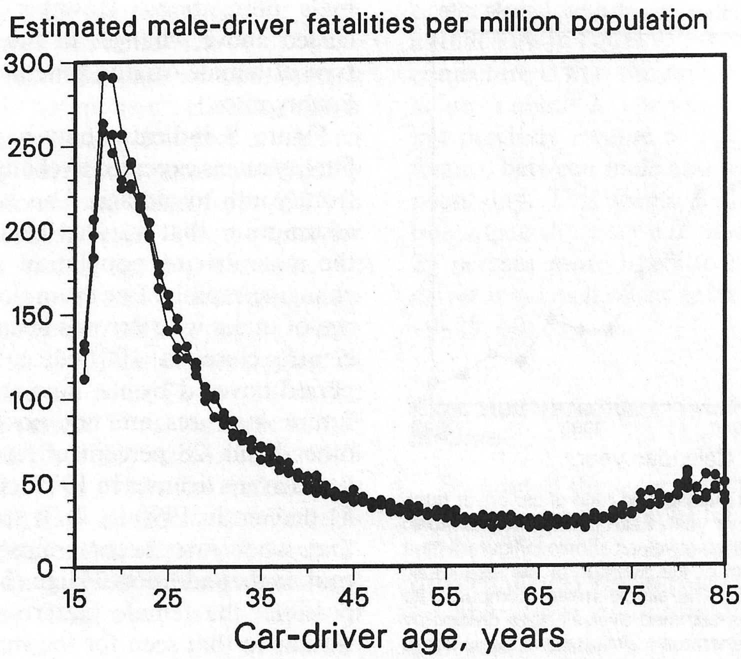

FIGURE 5. Estimate of how the car driver fatality rates of a group of presently young male drivers will depend on age as they grow to old age.

consume alcohol prior to driving (1). The present measure of deaths per head of population is one used in many health contexts. For example, there is obvious interest in lung cancer deaths per head of population. The fact that there may also be interest in deaths per smoker, or deaths per cigarette smoked, or deaths per puff deeply inhaled does not diminish the value of knowing the number of deaths per capita.

As US drivers age, their mobility and amount of travel, especially under more hazardous conditions (at night, in inclement weather), decline. In 1990, males aged 20–24 years drove, on average, 16,784 miles (26,854 km), compared with 8,298 miles (13,277 km) for males over 70; the corresponding figures for females are 11,807 miles (18,891 km) and 3,976 miles (6,362 km), respectively (8). (Note that these cross-sectional data do not address directly how driving decreases as a cohort of individuals ages.) Another factor that was not incorporated into the rates used in this paper is that, as drivers age, a crash is more likely to prove fatal; for example, other factors being equal, an 80-year-old male is four times as likely to die as a 20-year-old male in a crash of the same severity (10). If our focus had been on severe crashes, the curves analogous to those shown in figures 2 and 5 would have shown continuing declines with increasing age at all ages (1, pp. 30–34). This assumption agrees with findings from an analysis parallel to that performed here that was applied to car drivers involved in crashes in which pedestrians were killed (see reference 1, pp. 34–42; 11, 12). The clear finding was that as people age, they pose ever declining threats to other road users, as measured by their role as drivers in crashes in which pedestrians are killed.

The reason why cross-sectional and longitudinal analyses give different dependencies on age is that fatality rates for drivers of a given age do not remain constant but show ongoing declines when normalized for the same distance of travel (the decline in male rates dominates the overall rate). Such declines are due to behavioral and engineering evolution (1, pp. 332–338); there is every reason to expect ongoing declines due to changes in the many factors that contribute to traffic safety, including changes in roadways, vehicles, legislation, enforcement, education, social norms, etc. Because the overall fatality rate for the same distance of travel has declined by more than 90 percent since the 1920s (1, pp. 334 and 335), young drivers necessarily have substantially lower fatality rates than those in earlier periods; when today's young drivers become old, they can be expected to have fatality rates well below those of present-day older drivers (assuming, as seems likely, that the stable trends seen over the last six decades will continue into the future). The present increases in female fatality rates with increasing calendar time are probably a transitory phenomenon as the role of women as drivers approaches that of men. It seems likely that eventually female rates will acquire a time dependency similar to that observed for males.

The fatality rate (driver fatalities per head of population) for a cohort of drivers does not begin to increase appreciably until about age 70, and then it approximately doubles by age 80. In contrast, examination of male drivers in a population over a fixed time interval indicates increases by age 65 and a tripling by age 80. Inappropriately interpreting cross-sectional data as indicating what happens to driver crash rates with aging overestimates the magnitude of the older driver problem and underestimates the age of its onset. This occurs because fatality rates for male drivers of a given age have consistently declined over time. The onset of the older driver problem occurs about 5 years later, and is of substantially less magnitude, than previously thought.

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