EPIDEMIOLOGY OF THE OLDER DRIVER -- SOME PRELIMINARY FINDINGS FROM DATA THROUGH 1996

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ABSTRACT

Although there is an ever increasing literature on older drivers, there is not available a comprehensive up-to-date epidemiologic presentation of the salient characteristics of how older drivers are impacted by traffic safety, and how they impact road safety for others. This paper presents preliminary results for such an undertaking, using data through 1996. The approach is to examine how many different measures (fatalities, fatalities per licensed driver, etc.) depend on age and gender. Risks drivers pose to other road users are estimated by driver involvement in pedestrian fatality crashes. It is found that renewing the license of a 70-year-old male driver for another year poses, on average, 40% less risk to other road users than renewing the license of a 40-year-old male driver. The fatality risks drivers themselves face generally increase as they age, with the increased risk of death in the same severity crash being a major contributor. If this factor is removed, crash risks for 70-year-old male drivers are not materially higher than for 40-year-old male drivers; for female drivers they are. For all drivers most risk measures increase substantially by age 80, in many cases to values higher than those for 20-year-olds. Given that a death occurs, the probability that it is a traffic fatality declines steeply with age, from well over 20% for late teens through mid twenties, to under one percent at age 65, and under half a percent at age 80.

INTRODUCTION

A comprehensive overview of how the risks faced by drivers change as they age, and the risks they impose on others change as they age, is the subject of Chapter 2 of Ref. [1]. The results presented there were based on data from the mid 1980's. Because of substantial demographic and other changes in US society, there is a need to examine how the effects reported in [1] may have changed. This paper uses data through 1996 to present how various rates related to safety depend on age (broken down by gender). In order to facilitate easy comparison of the present relationships with those of the mid 1980s, the present paper introduces topics in the same order as in [1].

Changes in driving risk with increasing age are best separated into two distinct components:-

Changing risks to the drivers themselves,

and

Changing risks they impose on other road users.

These risks are of a different nature. There is near universal agreement that society should take stronger measures to prevent its members from doing things that endanger others than to prevent them from doing things that endanger only themselves. Public safety makes a stronger claim on public resources than does personal safety, which can be supported often using personal resources. Differences between the risks we assume ourselves and those we impose on others impact on legislation, licensing policy, police enforcement, and so on.

These questions are addressed by plotting a number of rates versus age and gender (almost everything examined in traffic safety is a rate -- for example, the number of traffic fatalities per year, or per three years).

Data

The following data sets are used:

1. Fatality Analysis Reporting System (FARS), a census of all traffic crashes in the United States since 1975 in which anyone was killed on a public road [2].
2. Bureau of the Census estimates of the resident population on July 1 by age (in 1 year increments) and gender [3].
3. Federal Highway Administration (FHWA) data giving numbers of driver licenses [4].
4. National Personal Transportation Study (NPTS, run by FHWA) giving estimates of travel based on a diary approach [5].
5. Deaths from all causes [6].
6. Relationships between the risk of death from the same physical insult and gender and age, as presented in [1].

Relationships using the NPTS data will be for 1995. For all other cases averages over the three years 1994-1996 are computed. The resulting relationships have a center year of 1995, so that all the material presented may be interpreted as referring to 1995.

Unless stated otherwise, "driver" means a driver of any motorized vehicle, including a motorcycle, truck, bus, etc. This choice insures a simple categorization of all traffic fatalities as either drivers or non-drivers; pedalcyclists are considered non-drivers. The dependence of driver fatalities on age and gender examined below thus reflects choice of vehicle, how it is used and what the consequences of a crash are, given that one occurs, all factors which are themselves strongly influenced by age and gender.

Data for, say, 70-year-olds, is plotted at the (approximate) average age of 70-year-olds, namely 70.5 years, a practice that will be followed when the modes and medians of distributions are presented.

Some characteristics of the rates are displayed directly on the graph. The maximum value, and the age at which it occurs (the mode age), is given only if there is a clear maximum not at the extremes of very young or very old values. The median age, say, for driver fatalities, is defined such that half of fatalities occur to drivers of younger age and half to drivers of older age. This is estimated by linear interpolatioon between the cumulative distribution values just less than 0.5 and just greater than 0.5.

This paper relies exclusively on cross-sectional analysis, in which consecutive points refer to a different set of people, not to the same set, or cohort, growing older. Examining cohorts as they age (longitudinal analysis) requires collecting data over as many years as the age dependence is examined. In keeping with the practice in epidemiology, cross-sectional points are not generally joined by lines. However, the points are joined in a few cases to assist the eye in following the relationships.

CHANGING RISKS DRIVERS FACE AS THEY AGE

Fig. 1 shows the average number of driver fatalities per year versus age and gender for the three years 1994-1996. Fig. 1 exhibits the same general characteristics as Fig. 2-5 of [1], which showed data summed for the five years 1981-1985.

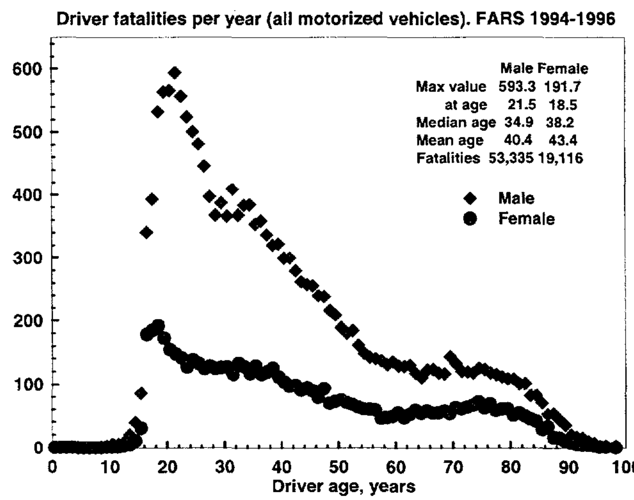


Fig. 1. Average number of driver fatalities per year (all motorized vehicles) versus gender and age, based on FARS 1994-1996

Fig. 2 shows the data in Fig. 1 normalized for population. The point plotted in Fig. 2 at (say) age 70 is the number of 70-year-old drivers killed from 1994-1996 divided by the sum of the number of 70-year-olds in each of these years. This plot is therefore an average, weighted by population, of graphs for individual years, all of which look similar (with more noise) to Fig. 2. Fig. 2 shows driver deaths per capita increase with age for males over about age 65 much more steeply than observed in 1980s data [1]. The moderate increase for females over about age 65 in Fig. 2 does not occur in the 1980 data.

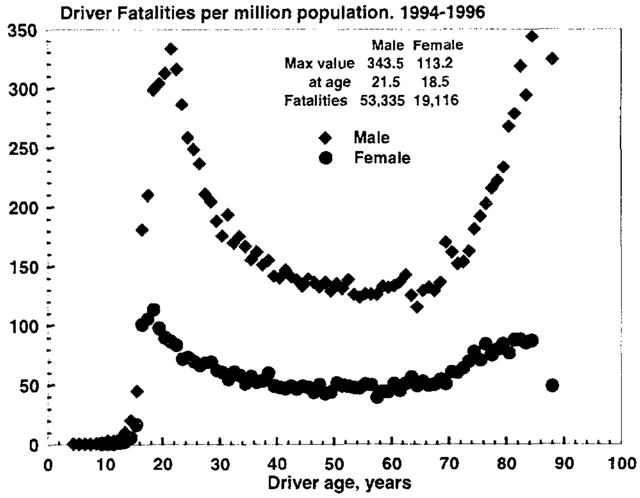


Fig. 2. Driver fatalities (all motorized vehicles) per million population versus gender and age. Based on FARS and US Bureau of the Census data, 1994-1996.

Fig. 3 shows driver fatalities per licensed driver. The general pattern differs from that in Fig. 2 only insofar as the fraction of the population holding driving licenses varies with age. In particular, older females are less likely than those in mid life to have driver licenses. Thus, in contrast to Fig. 2, the rates in Fig. 3 increase similarly with age for males and females older than about 65.

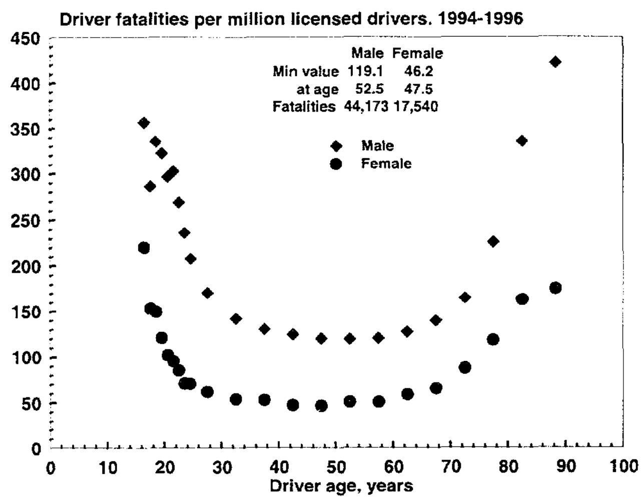


Fig. 3. Fatally injured drivers (all motorized vehicles) with valid driver licenses per million licensed drivers versus gender and age. Based on FARS and Federal Highway Administration data, 1994-1996

Fig. 3 reflects only fatally injured drivers with valid licenses. The percent of fatally injured drivers lacking a valid driver license depends strongly on driver age. This is shown in Fig. 4, in which a log scale shows that at very young and very old ages, a substantial majority of fatally injured drivers are unlicensed. As 15-year-olds cannot generally obtain licenses, nearly all 15-year-old drivers killed will not have licenses. The increase at older ages is consistent with the interpretation that as licenses are revoked, many older drivers continue to drive and are killed as a consequence.

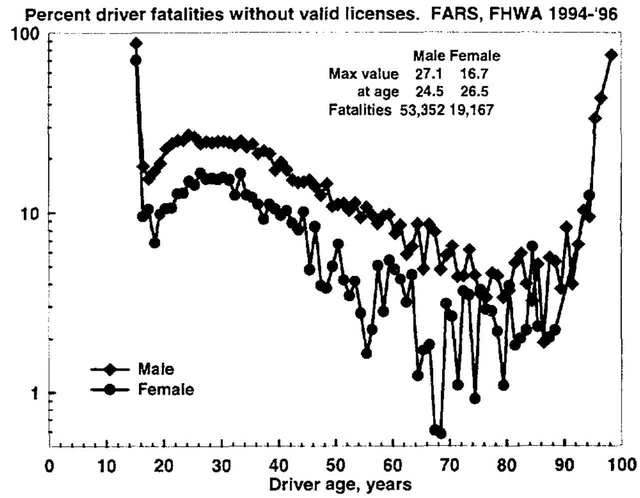


Fig. 4. The percent of fatally injured drivers without valid driver licenses at the time of their fatal crash. The denominator is those with valid or unknown license status. Based on FHWA, 1994-1996.

The number of driver fatalities per unit distance travelled, plotted on a log scale in Fig. 5, shows further elevation for older and younger ages above the average. The increases at older ages and younger ages are so much larger than the increasses in fatalities per licensed driver (Fig. 3) because older and younger drivers travel less than average drivers do (Fig. 6).

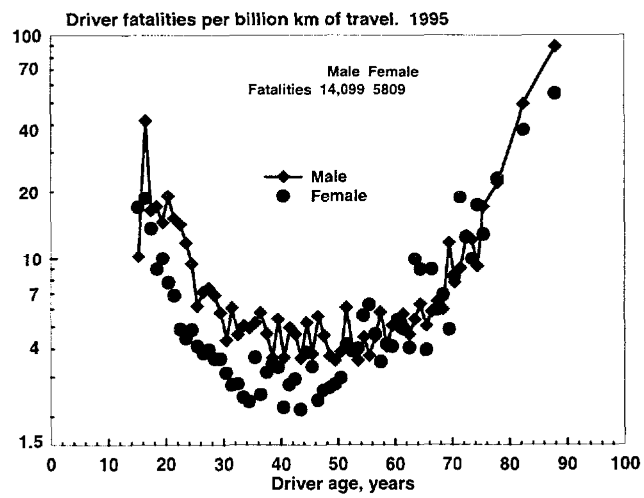


Fig. 5. Driver fatalities (all motorized vehicles except large commercial trucks) per billion km of travel versus gender and age. Based on FARS 1995, NPTS 1995.

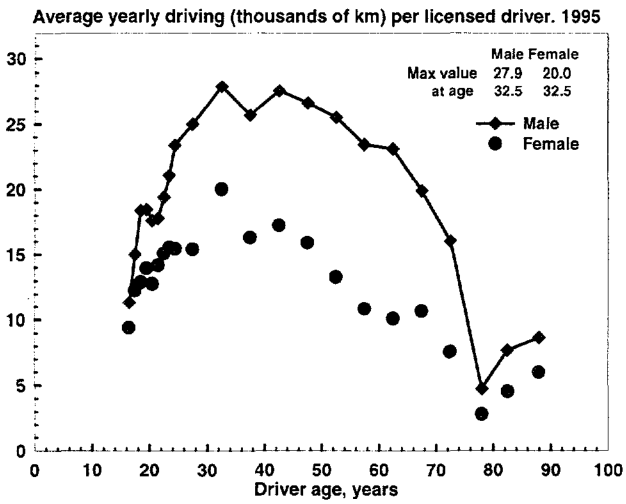


Fig. 6. Estimates of distance driven per year, based on FHWA 1995 and NPTS 1995.

Involvement rates in severe crashes

Increases with age like those in Figs 2, 3 and 5 have often been interpreted in terms of the drivers' risk of getting involved in a crash. Such an interpretation misses the crucial point that the number of drivers of given age and gender killed is the product of two factors:

1. The number of involvements in very serious crashes

and

2. The probability that involvement proves fatal.

The first factor reflects influences due to all use and behavioral factors, such as amount and type of driving, driver capabilities, type of vehicle driven, time of day, degree of intoxication, and driving risks. The second factor can be influenced also by such behavioral factors as safety belt wearing and alcohol consumption. Apart from such considerations, the probability that a given crash results in death is essentially physiological rather than behavioral in nature, and for the present purposes can be adequately approximated by the relationships given on page 26 of [1], which are:

$$R_{males}(A) = \exp 0.0231\,(A - 20) = 0.630 \exp(0.0231\,A) \qquad \text{Eqn 1}$$

and

$$R_{females}(A) = 1.3 \exp 0.0197\,(A - 20) = 0.877 \exp(0.0197\,A) \qquad \text{Eqn 2}$$

where R(A) is the fatality risk to an individual of age A compared to the risk to an individual of age 20 when both are subject to the same physical insult, or impact. When driver age is 16 to 20, we assume R = 1 for males and R = 1.3 for females; that is, the fatality risk from the same severity crash is the same as for a 20-year-old driver of the same gender.

Equations 1 and 2 are based on analyzing 80,000 fatalities in FARS 1975-1983. An update using recent data is planned as part of the ongoing work in this area.

Fatality rates focus on the outcome, not the severity of the crash that led to the death. Here we examine involvement rates in crashes of similar severity by considering crashes in a severity range greater than or equal to that sufficient to likely kill 80-year-old male drivers, for which case R has a value of 4.0 (Eqn 1). Consider the mix of crashes in which N fatalities occur to 80-year-old males. If these crashes were repeated keeping all factors the same except the drivers, then we would expect 0.25N fatalities for 20-year-old male drivers and 0.325N fatalities for 20-year-old female drivers (Eqn 2). In order to obtain the same number of fatalities, 4.0 times as many crashes by 20-year-old drivers, and 3.1 times as many crashes by 20-year-old female drivers are required. In this way we can use the observed numbers of fatalities to infer involvement rates in crashes in the severity range sufficient to likely kill 80-year-old male drivers.

Fig. 7 shows the number of involvements in crashes in the same severity range per licensed driver versus age and gender. In contrast to the earlier figures, the increase at older ages is much less, showing that a major component of increasing risk with increasing age is due to greater risk of being killed in the same crash.

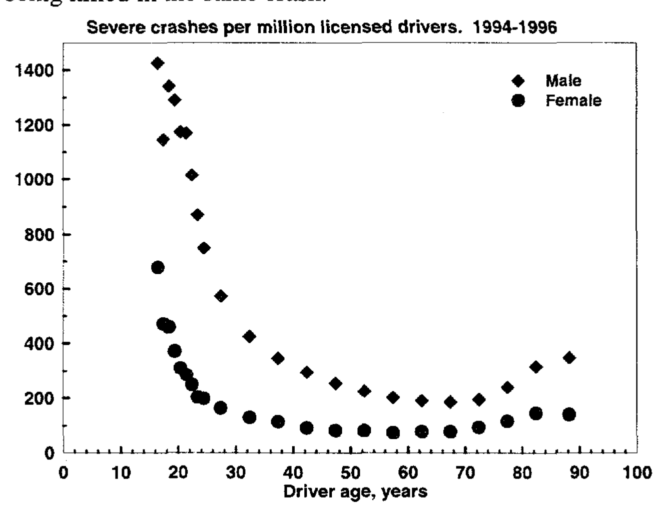


Fig. 7. Estimated licensed driver involvements (all motorized vehicles) per million licensed drivers in crashes of sufficient severity to likely kill 80-year-old-male drivers versus gender and age.

Severe crash involvements per unit distance of travel (Fig. 8) increase with increasing driver age for ages above about 60. However, the increase is smaller than in Fig. 5; even at the oldest age plotted, the rates for males and females are still less than those for male drivers under 30.

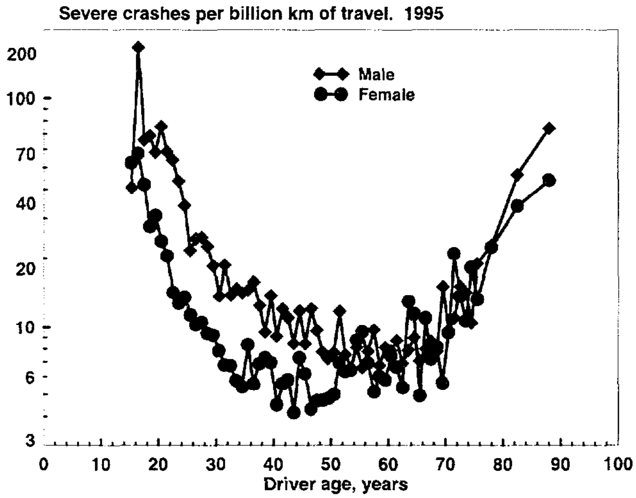


Fig. 8. Estimated driver involvements (all motorized vehicles) per billion km of travel in single-vehicle crashes of sufficient severity to likely kill 80-year-old-male drivers versus gender and age.

THREAT TO OTHER ROAD USERS

All the above focused on how the age and gender of a driver influence the threat to the driver's own life. In many ways this risk is presumed to be largely under the control of the driver. Here we address how the risk a driver poses to other road users depends on the driver's age and gender. This question raises a host of different issues which are relevant to discussion of driver licensing policy, in particular licensing test procedures that may make it more difficult for the elderly to obtain licenses. We investigate the threat to other road users by examining the number of crashes in which pedestrians are killed as a function of the age and gender of drivers (of any type of motorized vehicle) involved in the crashes. Attention is confined to single-vehicle crashes because when more than one vehicle is involved it is not always possible to determine from the FARS data which vehicle struck the pedestrian. In addition, involvement in multiple-vehicle crashes poses threats to drivers different from those of single vehicle crashes in which pedestrians are killed; the drivers of cars in single-vehicle pedestrian-fatality crashes are themselves usually not injured. No assumption is made regarding responsibility in pedestrian fatality crashes; the FARS data show about one third of fatally injured pedestrians have blood alcohol concentrations in excess of 0.1 percent by volume, the legal limit for intoxication in most US states.

Figs 9 through 12 show the variables for crashes involving pedestrian fatalities corresponding to those above for driver fatalities. The similarity between each corresponding set of curves reflects the extent to which driver involvement in pedestrian fatality crashes is proportional to driver fatalities, the basis of the pedestrian fatality exposure approach discussed in Chapter 4 of [1]. Only one of the four relationships, namely Fig. 12, which shows pedestrian fatality crashes per unit distance of travel, indicates an increase with age for older drivers.

Note particularly that the number of pedestrian fatality crashes per licensed driver does not increase at older ages. In terms of the decision to grant a license for a fixed period of time, a 20-year-old male is over 100% more likely to be involved in a crash in which a pedestrian is killed than is a male driver older than 70 years.

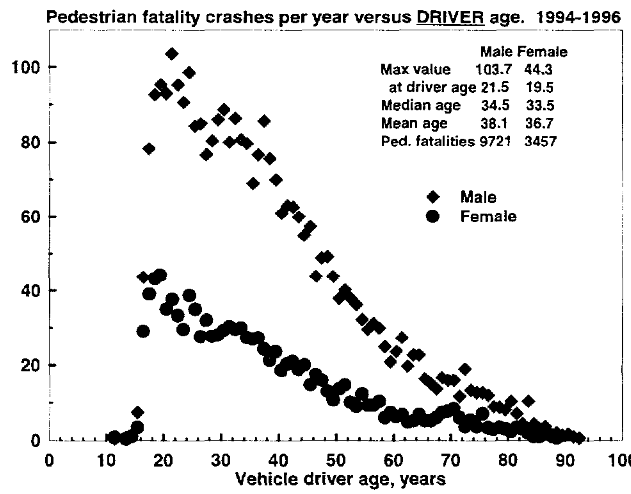


Fig. 9. Number of single vehicle crashes per year in which one or more pedestrians were killed versus the age and gender of the driver. FARS 1994-1996

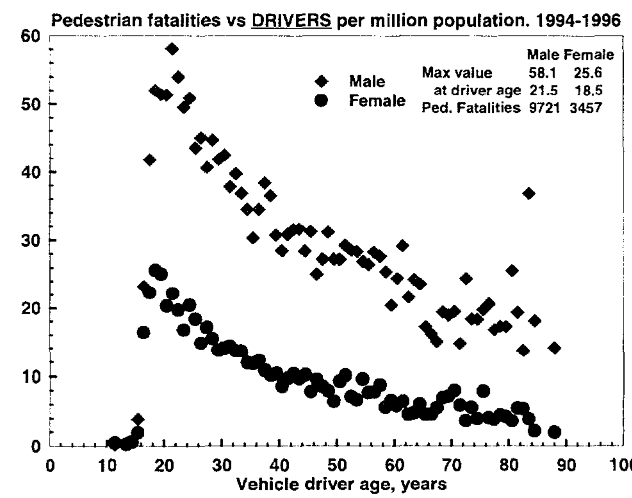


Fig. 10. Number of single vehicle crashes per million population in which one or more pedestrians were killed versus the age and gender of the driver. Based on FARS and census data for 1994-1996.

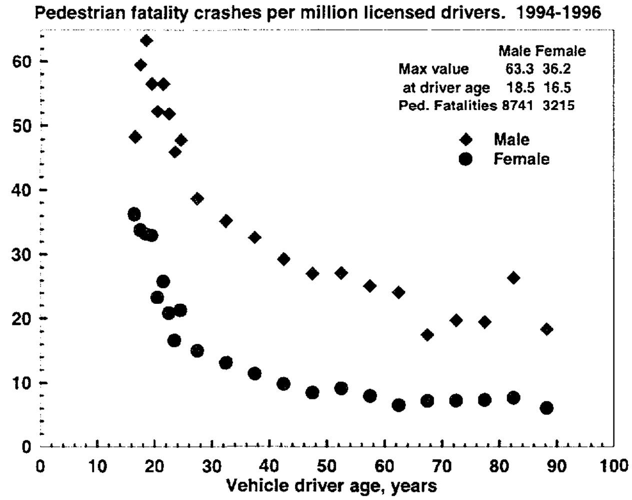


Fig. 11. Number of single vehicle crashes per million licensed drivers in which one or more pedestrians were killed versus the age and gender of the driver. Based on FARS and Federal Highway Administration data for 1994-1996.

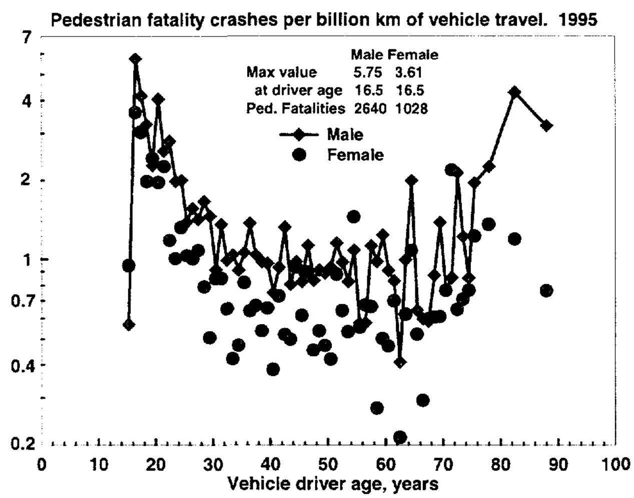


Fig. 12. Number of single vehicle crashes per billion km of travel in which one or more pedestrians were killed versus the age and gender of the driver. Based on FARS, and Nationwide Personal Transportation Study data for 1995.

PEDESTRIAN INVOLVEMENTS IN FATAL AND SEVERE CRASHES

Above we examined the age and gender of drivers involved in crashes in which pedestrians were killed. We now examine the age and gender of the pedestrians involved without regard to the characteristics of the involved drivers

Fig. 13 shows the distribution of pedestrian fatalities by pedestrian age and gender. The same data normalized by population are shown in Fig. 14.

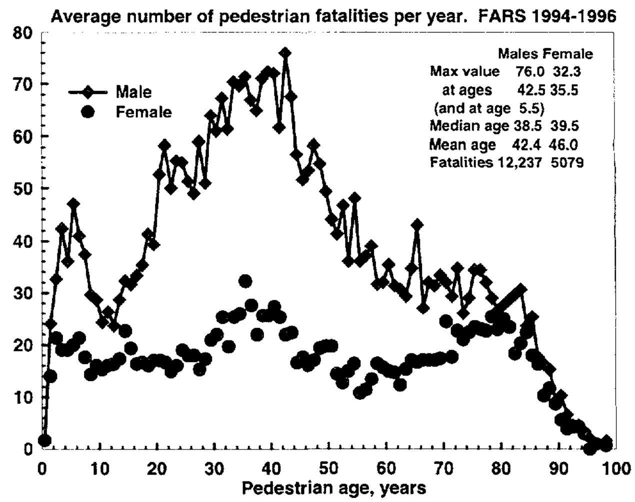


Fig. 13. Average number of pedestrian fatalities per year versus gender and age, based on FARS 1994-1996. Distinct maximum values occur males at ages 5 and 42.

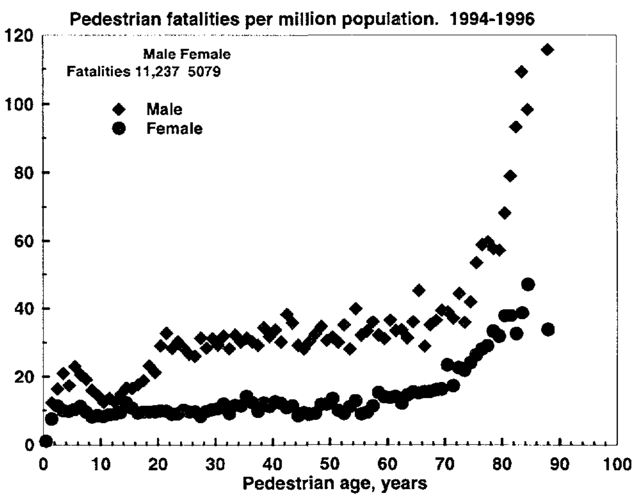


Fig. 14. Pedestrian fatalities per million population versus gender and age. Based on FARS and US Bureau of the Census data for 1994-1996.

Fig. 15 shows the ratio of male pedestrian deaths per capita to female pedestrian fatalities per capita. This figure, which uses FARS and Census data 1986-1996, is remarkably similar to Fig. 6-5 (p. 139) of [1], thereby offering additional support for the interpretation given there. Fig. 15 and Fig. 6-5 of [1] are derived using independent, non-overlapping data, and consequently reveal stable intrinsic behavioral differences at a fundamental level between the genders.

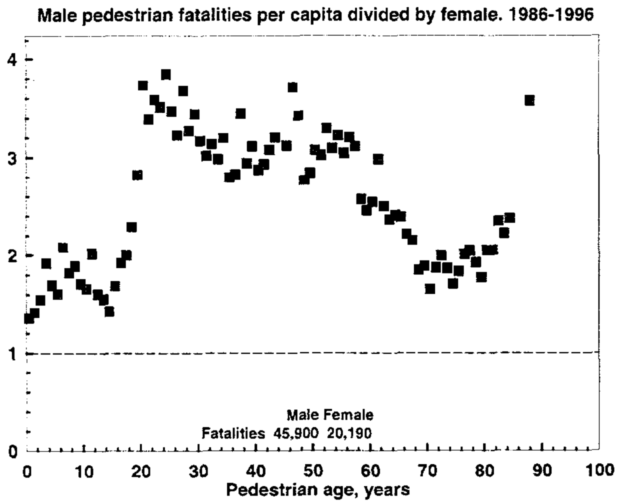


Fig. 15. **Number of male pedestrian fatalities per capita divided by female pedestrian fatalities (of the same age) per capita based on FARS and census data for 1986 through 1996.**

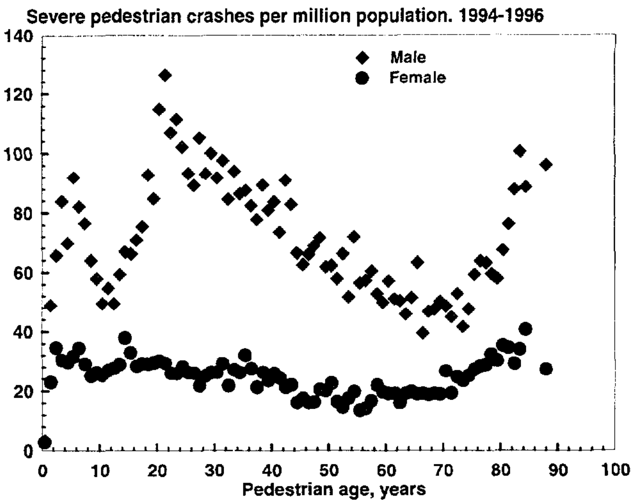


Fig. 16. **Estimated pedestrian involvements per million population in crashes of sufficient severity to likely kill 80-year-old male pedestrians versus gender and age.**

Part of the large increase in pedestrian fatalities per capita with increasing older ages in Fig. 14 is due to the greater likelihood that the older person is killed in a crash which a younger one would survive. In order to estimate the risk of involvement in a severe crash, as distinct from the outcome, we again use the relationships between risk of death from the same impact and gender and age given in Eqns 1 and 2. Fig. 16 shows the number of pedestrian involvements in crashes in the severity range equal to or greater than that necessary to kill an 80-year-old male pedestrian. Like the driver fatality data, the pedestrian fatality data show peaks at about age 21 for males. The increasing involvement in severe pedestrian crashes with increasing age at ages above about 65 is probably reflecting decreasing perceptual and agility skills, and also perhaps increased pedestrian exposure related to driving less.

TYPES OF CRASHES IN WHICH OCCUPANTS OF DIFFERENT AGES ARE KILLED

Over 90% of the 35,579 vehicle occupants killed in 1996 were occupants of cars or light trucks [7, page 18]. We here examine how the mix of crashes for these vehicles depends on occupant age.

Table 1 shows the number of occupants aged between 68 through 72 years old who were killed in crashes according to vehicle and crash type. We refer to this group as 70-year-old occupants (strictly, the center of the range is much closer to 70.5). Corresponding information is presented for 40-year-old (Table 2) and 20-year-old (Table 3) occupants. Table 4 shows the information for all occupants, regardless of age.

The fatality counts in tables 1-4 facilitate many comparisons. For example, substantially more 70-year-old occupants die in multiple-vehicle crashes than in single-vehicle crashes, the difference being so for cars and for light trucks. The effect is similarly consistent, but in the opposite direction for 20-year-old-occupants. Such comparisons cannot determine whether, say, the 70-year-olds are more involved in multiple vehicle crashes or less involved in single-vehicle crashes.

Given that a 70-year-old occupant is killed, the probability that the crash was a non-collision (most non-collisions are rollovers) is 2.3% for cars, and 7.6% for light trucks. The corresponding estimates for 20-year-olds are 10.1% for cars and 27.0% for light trucks. The larger values for light trucks reflects that in a given set of crashes, the portion that are rollovers tends to be greater for vehicles with higher centers of gravity. However, note that given that a fatality occurs, the probability that it is a rollover is lower for a 70-year-old in a truck than for a 20-yea-old in a car. This is likely a reflection of the overriding importance of driver behavior.

Table 1.
Distribution of vehicle occupants age 68, 69, 70, 71 or 72 (five year range centered at 70) killed in crashes in 1996.

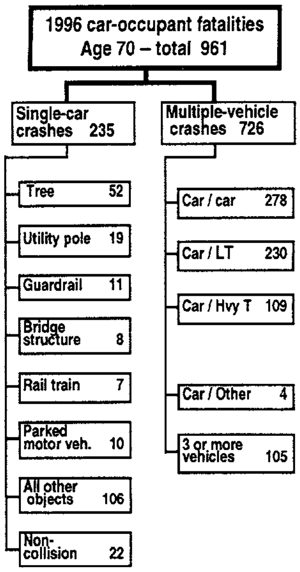


Table 2.
Distribution of vehicle occupants age 38, 39, 40, 41 or 42 (five year range centered at 40) killed in crashes in 1996.

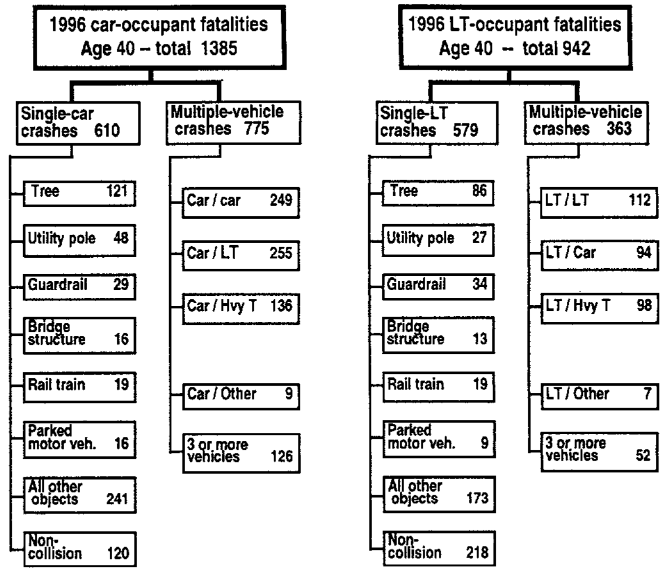


Table 3.
Distribution of vehicle occupants age 18, 19, 20, 21 or 22 (five year range centered at 20) killed in crashes in 1996.

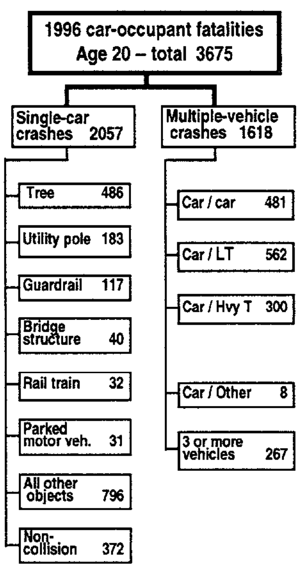
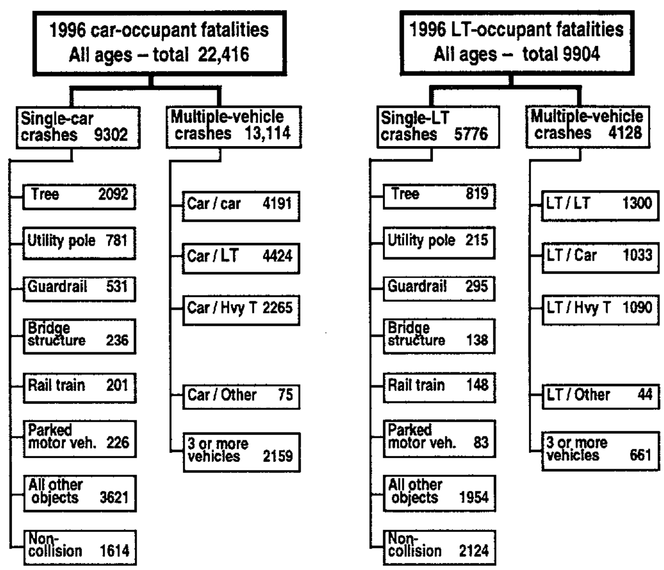


Table 4.
Distribution of vehicle occupants of all ages killed in crashes in 1996.



TOTAL TRAFFIC FATALITIES

Fig. 17 shows the average number of people killed per year in the United States in traffic crashes (sum of FARS values for 1994-1996 divided by 3). The total number of data, 123,842, differs from the total number of fatalities [7] in the three-year period, 40,716 + 41,817 + 41,907 = 124440 by the very small percent of occupants for which either age or gender was uncoded. The percent of all fatalities which were driver fatalities is shown in Fig. 18.

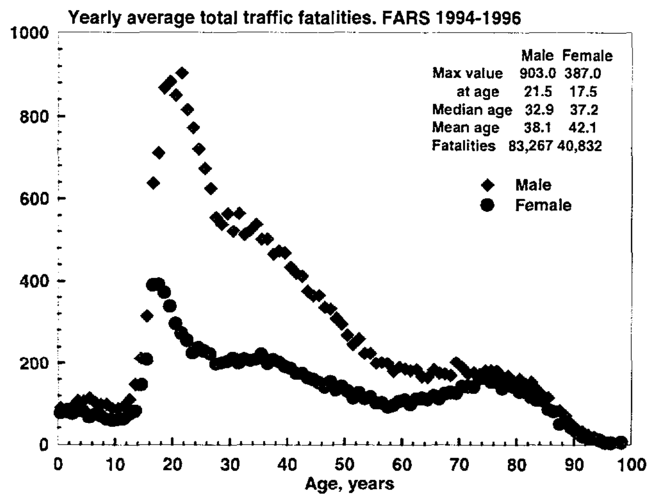


Fig. 17. **The average number of people killed per year in US traffic crashes.**

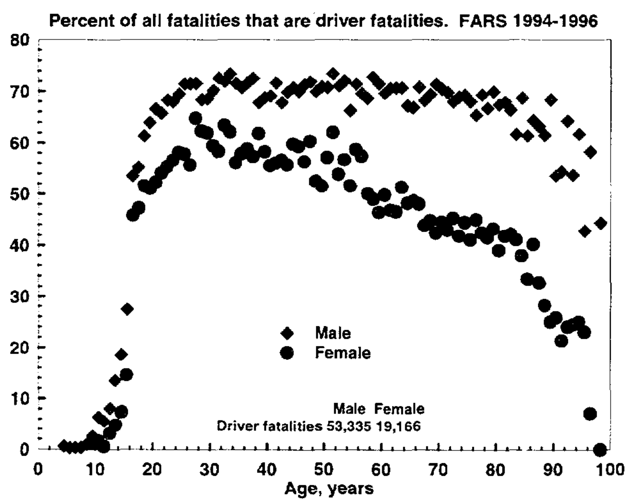


Fig. 18. **The percent of all traffic fatalities (Fig. 17) that are driver fatalities. FARS 1994-1996.**

Table 5 presents some of the actual fatality counts that contributed to the distribution in Fig. 17. One year, 1996, is selected to avoid the ackwardness of fractional fatalities per year; the values in 1994 and 1995 are quite similar.

Table 5

Number of 1996 traffic fatalities in Fig. 17 at selected specific ages. The first row refers to babies from birth to just prior to their first birthday (plotted at age = 0.5), the second row refers to children from their 5th birthday to just prior to their 6th birthday (plotted at age 5.5), and so on.

Age	Number of fatalities		
	Male	Female	Total
0	96	71	167
5	114	62	176
10	81	69	150
15	310	229	539
18	890	386	1276
25	716	237	953
30	449	231	680
40	439	201	640
50	262	122	384
60	168	117	285
70	196	145	341
80	153	139	292
90	39	39	78
95	5	6	11

Table 5 shows that 114 five-year-old boys and 62 five-year-old girls were killed in 1996 traffic crashes (over a thousand children aged 3 through 9 were killed.). One hundred sixty seven babies were killed before their first birthday.

TRAFFIC DEATHS RELATIVE TO ALL DEATHS

A noticeable feature of the ratio of traffic deaths to all deaths (Fig. 19) is the lack of a clear difference between the genders. Indeed, from the 20s through the 70s the fraction of all deaths that are traffic deaths declines at an approximately constant rate of 8 % per year for both genders. The percent of all deaths that are traffic fatalities fit extremely well the relationships 143.0 exp (-0.0775 age) for males and 135.8 exp (-0.0788 age) for females for ages from ages 27 to 70.

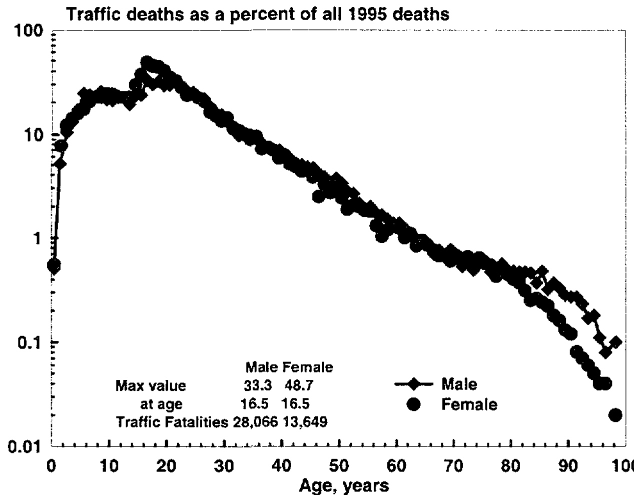


Fig. 19. Traffic deaths expressed as a percentage (on a logarithmic scale) of total deaths from all causes (including traffic). All data are for 1995.

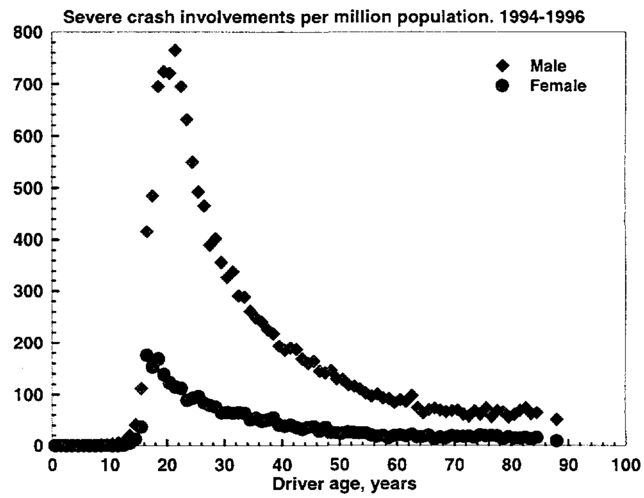
Table 6 shows illustrative ages selected from the plotted data. Given that a death occurs in the teens through the twenties, the probability that it is a traffic fatality is over 20%. As drivers age, the risks from other causes of death increase much more rapidly than any increases of risk in traffic. Given that a 65-year-old dies, the probability that death is due to a traffic crash is less than one percent. For an 80-year-old it is less than half a percent.

Table 6
The percent probability that a death is a traffic fatality in 1995. Illustrative values from Fig. 19.

Age	Male	Female	Total
0	0.51	0.55	0.53
5	24.61	17.27	21.57
10	20.72	24.21	22.19
15	23.77	37.06	28.09
18	32.24	43.62	35.03
25	22.63	22.21	22.52
30	13.13	14.13	13.40
40	6.33	6.18	6.28
50	3.32	2.42	2.99
60	1.39	1.24	1.33
65	0.88	0.85	0.87
70	0.66	0.67	0.66
80	0.48	0.40	0.44
90	0.27	0.12	0.17
95	0.11	0.04	0.05

Traffic rates compared to crime rates

The top graph in Fig. 20 shows number of drivers involved in crashes of sufficient severity to likely kill 80 year-old drivers (computed as for Fig. 7 etc.). The bottom graph has nothing to do with traffic -- it is based on FBI compilations of arrests for all crimes except those relating to traffic. Figure 20 may be compared to Fig. 6-7, p. 142, of [1]. The interpretation presented there applies also to the present figure.



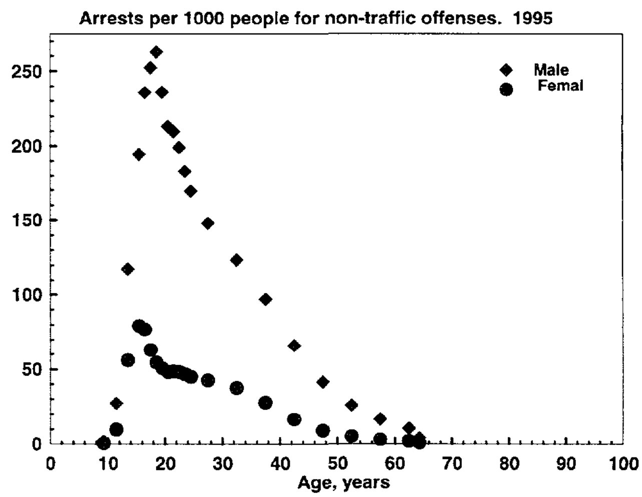


Fig. 20. *Top:* Estimated driver involvements per capita in severe single-vehicle crashes. *Bottom:* Number of arrests per capita for non-traffic-related offenses.

SUMMARY OF MAIN FINDINGS

Summary information from the graphs is presented below. When data are available in one year increments, the values are computed by averaging over three years (that is, the value for 70-year-olds is the average of the values at 69.5, 70.5 and 71.5. When data are available only in 5 year increments, the average of two values is used (the value for 70-year-olds is the average of the values for 67.5 and 72.5. In some cases the estimates at age 80 are based on relatively small sample sizes.

Risks older drivers impose on others

The risks that 70-year-old drivers impose on other road users is compared in Table 7 to the risks imposed on others by 40-year-old drivers and by 20-year-old drivers. The ages 40 and 20 were chosen to typify the generally safest age and a high risk age, respectively.

Table 7.

Risks 70-year-old drivers pose to other road users compared to the risks posed by 40- and 20-year-old drivers, as measured by involvement in single-vehicle crashes killing pedestrians. The first entry indicates that, on average, licensing a 70-year-old male poses 40% less risk than licensing a 40-year-old. Compared to licensing a 70-year-old male, licensing a 20-year -old poses 198% more risk to others.

	Male		Female	
	Age 70 / Age 40	Age 20 / Age 70	Age 70 / Age 40	Age 20 / Age 70
Per licensed driver (Fig. 11)	**0.60**	**2.96**	**0.68**	**3.81**
For same distance of driving (Fig. 12)	**1.14**	**2.98**	**2.02**	**1.87**

Renewing the license of a 70-year-old male driver for another year imposes, on average, 40% less risk to other road users than renewing the license of a random 40-year-old male driver. Renewing the license of a 20-year-old male driver compared to a 70-year-old male driver imposes an increased risk to others of 196%.

One of the reasons older drivers pose less of a threat per year to others is that they drive less (Fig. 6). In terms of risks for the same distance traveled, the 70-year-old driver poses a 14% higher risk than the 40-year-old. The female risks, with values much lower at 40, proportionally increase more even though their values are lower than for males at essentially all ages.

Table 8 shows information parallel to that in Table 7, but for 80-year-old drivers. Granting a license for another year to an 80-year-old driver poses substantially less risk to other road users than granting a license to a 40-year-old driver.

Table 8.

Risks 80-year-old drivers pose to other road users compared to the risks posed by 40-year-old and 20-year-old drivers, as measured by involvement in single-vehicle crashes killing pedestrians.

	Male		Female	
	Age 80 / Age 40	Age 20 / Age 80	Age 80 / Age 40	Age 20 / Age 80
Per licensed driver (Fig. 11)	**0.74**	**2.40**	**0.70**	**3.67**
For same distance of driving ((Fig. 12)	**3.71**	**0.91**	**1.88**	**2.01**

Risks older drivers themselves face

In general, as drivers become older, most measures indicate increases in risk as they age. A major contributor to this is that the same severity crash is more likely to lead to the death of an older person. In terms of the measures which best reflect the behavioral aspects of driving, namely, driver involvements in severe crashes per unit distance of travel (Table 9), and crashes in which pedestrians were killed per unit distance of travel (Table 7), the values for 70-year-old male drivers are not particularly different from those of 40-year-old male drivers. (Many factors could contribute to a lack of difference, such as the older drivers confining driving to safer periods, less alcohol use, etc.). By age 80 (Tables 8 and 10) there is a substantial increase in risk of involvement; for female drivers increases are also substantial by age 70.

The above discussion has focused on how various measures depend on average chronological age. Not only do various measures of driver performance decline with age, but variability among individuals also increases, underlying the importance of not judging an individual's fitness to drive on the basis of chronological age.

Table 9.

Risks faced by 70-year-olds compared to risks faced by 40- and 20-year-olds. The first entries indicates that, for males, a random 70-year-old in the population is 13% more likely to become a driver fatality than is a random 40-year-old, but a 20-year-old is 196% more likely than is a 70-year-old.

	Male		Female	
	Age 70 / Age 40	Age 20 / Age 70	Age 70 / Age 40	Age 20 / Age 70
Driver fatalities per head of population (Fig. 2)	**1.13**	**1.96**	**1.19**	**1.61**
Fatalities per licensed driver (Fig. 3)	**1.20**	**2.02**	**1.53**	**1.39**
Fatalities for the same travel distance (Fig. 5)	**2.05**	**1.70**	**3.86**	**0.77**
Severe crashes per licensed driver (Fig. 7)	**0.59**	**6.35**	**0.84**	**3.71**
Severe crashes for same travel distance (Fig. 8)	**1.02**	**5.38**	**2.11**	**2.09**

Table 10.

Risks faced by 80-year-olds compared to risks faced by 40- and 20-year-olds.

	Male		Female	
	Age 80 / Age 40	Age 20 / Age 80	Age 80 / Age 40	Age 20 / Age 80
Driver fatalities per head of population (Fig. 2)	**1.82**	**1.22**	**1.75**	**1.10**
Fatalities per licensed driver (Fig. 3)	**2.21**	**1.10**	**2.82**	**0.76**
Fatalities for the same travel distance (Fig. 5)	**7.62**	**0.46**	**11.0**	**0.27**
Severe crashes per licensed driver (Fig. 7)	**0.87**	**4.36**	**1.27**	**2.45**
Severe crashes for same travel distance (Fig. 8)	**2.98**	**1.85**	**4.97**	**0.89**

CONCLUSIONS

The relationships presented here suggest:

1. Licensing an older driver (data goes up to age 80) does not pose a greater threat to other road users than licensing younger drivers -- indeed it poses substantially less risk than licensing a 20-year-old.
2. As drivers age, most measures indicate that they face an increased risk of becoming a traffic fatality, with the increase accelerating at very old ages.
3. Given that a death occurs, the probability that it is a traffic fatality declines steeply with age, from well over 20% for late teens through mid twenties, to under one percent at age 65, and under half a percent at age 80.

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