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Drivers involved in crashes killing older road users

Leonard Evans
Science Serving Society

ABSTRACT

5,032 people aged 70 or older were killed on US roads in 2005. Of these, 827 were drivers killed in single-vehicle crashes. The remaining 4,205 were all killed in crashes involving at least one other driver. While a vast body of literature has focused on older drivers, this paper addresses the other drivers involved in the crashes that account for 84% of the deaths of road users 70 and over. The other drivers can be placed into three categories.

1. Drivers of vehicles involved in crashes in which pedestrians aged 70 or older are killed.
2. Drivers involved in two-vehicle crashes in which drivers aged 70 or older are killed.
3. Drivers of vehicles in which passengers aged 70 or older are killed, and drivers of vehicles involved in crashes with vehicles transporting such passengers.

Analysis using data for 2000-2005 finds that 89% of pedestrian fatalities aged 70 or older occurred in crashes in which the driver was aged 69 or younger. For all categories combined it is found that 77% of the crashes that annually kill more than 5,000 road users aged 70 or older involve a driver 69 or younger. Countermeasures that target older road users specifically have limited potential. Reducing crash risk for drivers who are not old has far greater potential to reduce casualties to the elderly. To do so requires the US to adopt effective traffic safety policies and abandon its present focus on methods that have been shown repeatedly to not work. Effective policies are available, proven, and already saving large numbers of lives of road users of all ages outside the US.

INTRODUCTION

5,032 people aged 70 years or older were killed on US roads in 2005. Of these, 827 were drivers killed in single-vehicle crashes. The remaining 4,205 were all killed in crashes in which at least one other driver was involved. While a vast body of literature[1-7] has focused on older drivers, here we address the *other* drivers involved in the crashes that account for the more than eighty percent of the deaths of road users 70 and older. This paper builds upon the material in Ref 1, particularly the chapter *Older Drivers*.

AGE CATEGORIES

For many analyses we classify all road users into one of the following two age categories.

1. Those aged 70 years or older, designated as aged ≥ 70, or *older*
2. Those aged 69 or younger, designated as aged ≤ 69, or *not-older*

No additional age categories are introduced in order to avoid undue complexity in some of the analyses. For example, we examine crashes killing passengers of a given age driven by drivers of a given age crashing into other vehicles with drivers of a given age. This already complex structure would become unwieldy for additional age categories.

Census data[8] for 2002 show that the average age of US residents aged ≥ 70 is 79.0 years, compared to an average age of 32.5 for those aged ≤ 69. No category of road user killed is a random sample by age from the population. For example, the average age of people aged 16 to 69, which is a better indication of drivers aged ≤ 69, is 40.5. The average age of a fatally injured driver is less than this because of the over-involvement of younger drivers, and so on.

TRENDS AND DATA YEARS USED

While the introductory numerical examples are for 2005, the analysis in this paper requires larger sample sizes than provided by a single year. Table 1 shows data averaged over the six years 2000-2005 computed from the Fatality Analysis Reporting System (FARS).[9] Because in some cases sample sizes are relatively small, the annualized values are presented to one decimal place. Calculations are based on raw data, so calculations using from values presented in the text may differ in the last decimal place from those in the tables.

Of the 5,265.2 road users aged ≥ 70 killed annually, 2,152.3, or 40.9%, were not drivers. 84.0% of the road users aged ≥ 70 killed were killed in crashes involving another driver.

The values in Table 1 differ little from the 2005 illustrative values mentioned in the introduction, and indeed the patterns have remained remarkably stable, as is apparent by the lack of any large trends in the longer time series plotted in Fig. 1 (the 2004 and 2005 values were somewhat lower than the multi-year averages). The relative stability in the number of fatalities contrasts with an increase of 22.8% in the number of licensed drivers aged ≥ 70 (from 16.26 million in 1994 to 19.97 million in 2004, the latest available data year at time of writing).[10] During this same 11-year period the US human population aged ≥ 70 increased by 12.4%, (from 23.19 million in 1994 to 26.06 million in 2004).[8]

Table 1. The number of road-users aged ≥ 70 killed per year in traffic crashes. The values are the averages for the six years 2000-2005. The percents of each column are indicated in italics under the numbers of fatalities (FARS 2000-2005).

Road user (aged ≥ 70) killed	*Male*	*Female*	*Total*	*Another driver involved*
Drivers in single-vehicle crashes	611.5 *(20.6)*	229.2 *(10.0)*	840.7 *(16.0)*	no
Drivers in multiple-vehicle crashes	1470.3 *(49.6)*	801.8 *(34.9)*	2272.2 *(43.2)*	yes
Passengers	370.0 *(12.5)*	910.2 *(39.6)*	1280.2 *(24.3)*	yes
Pedestrians	456.3 *(15.4)*	348.5 *(15.2)*	804.8 *(15.3)*	yes
Bicyclists, etc.	59.0 *(2.0)*	8.3 *(0.4)*	67.3 *(1.3)*	yes
TOTAL	2967.2 *(100.0)*	2298.0 *(100.0)*	5265.2 *(100.0)*	

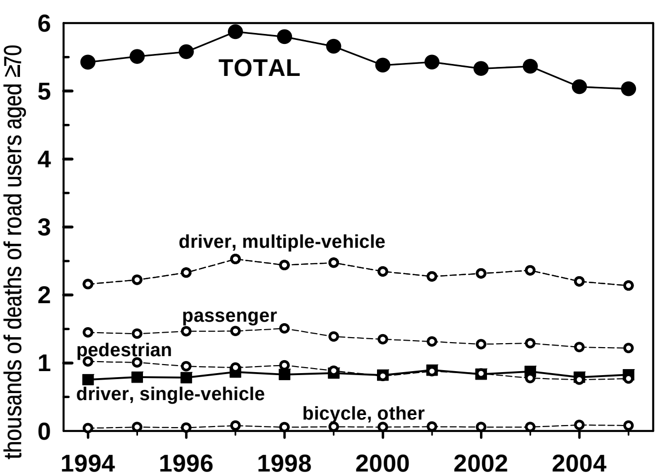

Figure 1. Fatalities to road users aged ≥ 70. Average values for 2000-2005 are displayed in Table 1, and some illustrative values for 2005 given in the introduction.

ROAD-USERS ANALYZED

The *other* drivers involved in the crashes that account for 84.0% of the deaths to older road users can be considered in three categories:

1) Drivers of vehicles involved in crashes in which pedestrians aged ≥ 70 years are killed.

2) Drivers involved in multiple-vehicle crashes in which drivers aged ≥ 70 are killed.

3) Drivers of vehicles in which passengers aged ≥ 70 are killed, and drivers of vehicles involved in crashes with vehicles transporting such passengers.

These are analyzed according to the age and gender of the involved drivers.

This process does not include all 5,265.2 road user fatalities listed in Table 1. Sample sizes for the *bicyclists and other* category are insufficient for useful analyses. In addition, we cannot analyze all cases in each of the above three categories. For example, we include pedestrians killed only in single-vehicle crashes. There are various cases of drivers with unknown age, such as when surviving drivers abscond from the scene of the fatal crash in which they were involved.

Results from the cases we can analyze are used to infer estimates for cases that cannot be analyzed directly in order to make inferences relative to the entire population of fatally injured older road users.

DRIVERS OF VEHICLES INVOLVED IN CRASHES IN WHICH OLDER PEDESTRIANS ARE KILLED

Fig. 2 shows the number of pedestrians aged ≥ 70 killed per year versus the age and gender of the involved driver. Comparing this to the corresponding graph for all pedestrian fatalities (regardless of age)[1(p 156)] shows less pronounced over-involvement of young drivers. This is because older pedestrian fatalities differ from typical pedestrian fatalities. A substantial proportion of all pedestrian fatalities occur late at night, some involving pedestrians with higher levels of intoxication than the highest levels recorded for drivers.[1(p 249)] Older pedestrians are less likely to share such characteristics.

Fig. 2 and the cited figure in Ref. 1 include only pedestrians killed in single-vehicle crashes. This avoids complexities for the few cases in which more than one driver is involved in a pedestrian fatality.

Table 2 provides additional information from the data in Fig. 2. About eight out of nine aged ≥ 70 pedestrian fatalities are killed in crashes with vehicles driven by drivers aged ≤ 69. At all driver ages, about twice as many male drivers as female drivers are involved.

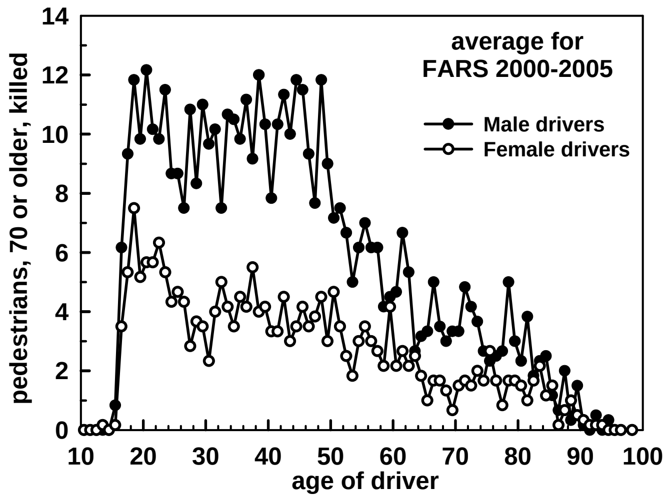

Figure 2. Number of pedestrians aged ≥ 70 killed per year in single-vehicle crashes versus the age and gender of the involved driver. The values are averages over the years 2000-2005. (FARS 2000-2005).

Table 2. Additional information for the involved drivers in Fig. 2. The percents of each column are indicated in italics under the numbers of drivers.

Driver characteristic	*Male drivers*	*Female drivers*	*Total*
All with known age	493.3 *(100.0)*	223.8 *(100.0)*	717.2 *(100.0)*
Aged ≥ 70	53.7 *(10.9)*	29.0 *(13.0)*	82.7 *(11.5)*
Average age	43.3 years	43.6 years	43.4 years
No valid driver license	37.8 *(7.7)*	15.3 *(6.9)*	53.2 *(7.4)*
Driver killed	0.3 *(0.1)*	0 *(0.0)*	0.3 *(0.0)*
Driver uninjured	461.3 *(93.5)*	199.8 *(89.3)*	661.2 *(92.2)*

Over 7% of pedestrians killed are killed in crashes with vehicles driven by drivers without valid driver licenses.

Drivers involved in crashes in which older pedestrians are killed suffer little harm. More than 90% are coded in FARS as uninjured. In the six year period 2000-2005, the crashes that killed 4,309 older pedestrians led to the deaths of two drivers (both male). This does not mean that the impact with the pedestrian generated the crash forces that killed the driver, but that the crash was of such severity that more solid objects than pedestrians were also struck.

Fig. 2A shows the number of pedestrians aged ≥ 70 killed per year per million licensed drivers versus the number of involved drivers per million licensed drivers. Unlike Fig. 2, this is more U-shaped because those under 20 are less likely to be drivers, while at older ages the number of people of a given age decreases with age. Comparing to the case for all pedestrians killed (regardless of age)[1(p 158)] confirms that, although younger male drivers provide the highest threat to older pedestrians, the effect is not as pronounced as for the all pedestrians case.

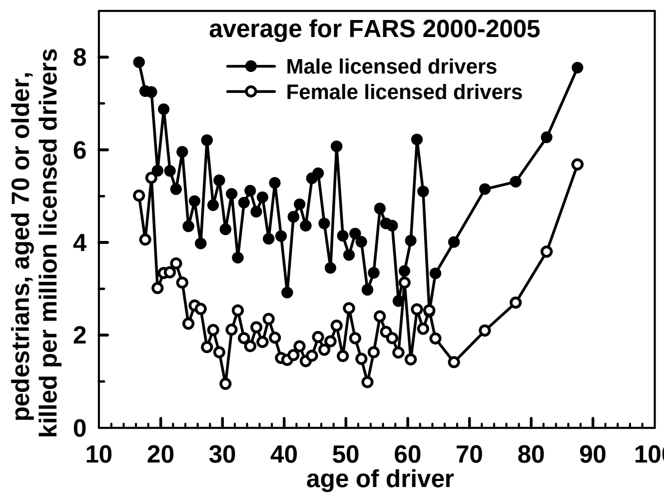

Figure 2A. Number of pedestrians aged ≥ 70 killed per year in single-vehicle crashes per licensed driver. The values are the average over the years 2000-2005. (FARS 2000-2005 and FHWA data).

DRIVERS INVOLVED IN TWO-VEHICLE CRASHES IN WHICH OLDER DRIVERS ARE KILLED

The types of crashes in which older drivers are killed differ markedly from the types in which young drivers are killed. Comparing aged ≥ 70 driver fatalities to those of drivers aged ≤ 21 provides the following contrasts. Multiple vehicle crashes (from Table 1) account for 73% of the older driver deaths compared to 41% of those aged ≤ 21. When older drivers are killed in two-vehicle crashes, their vehicles are more likely to receive side impacts (52% compared to 38%). Given a death, rollover is less likely to be involved for an older person driving a light truck (including an SUV) than a driver aged ≤ 21 driving a car.[1(p 50)]

Given the large role that multiple-vehicle crashes play in the deaths of older drivers, we here examine the characteristics of the other involved driver. We designate the vehicle in which the fatality to the older person occurred as the *subject* vehicle and the other vehicle as the *other* vehicle, with corresponding terms applied to their respective drivers. These designations are purely for expository convenience – in a two-vehicle crash the vehicles are assumed to have symmetric roles.

The analysis is confined to two-vehicle crashes in the same spirit that the pedestrian analysis was confined to single-vehicle crashes. Crashes involving three or more vehicles add interpretive difficulties but little additional data.

Fig. 3 shows the number of older drivers killed in two vehicle crashes versus the gender and age of the other involved driver. Additional details are provided in Table 3.

When a driver aged ≥ 70 is killed in a two-vehicle crash, the probability that the other involved driver is killed is 4.1%. While this value may seem low, it is in fact remarkably similar to the 3.9% for all two-vehicle crashes. It is rare for there to be more than one driver fatality in any type of fatal crash.

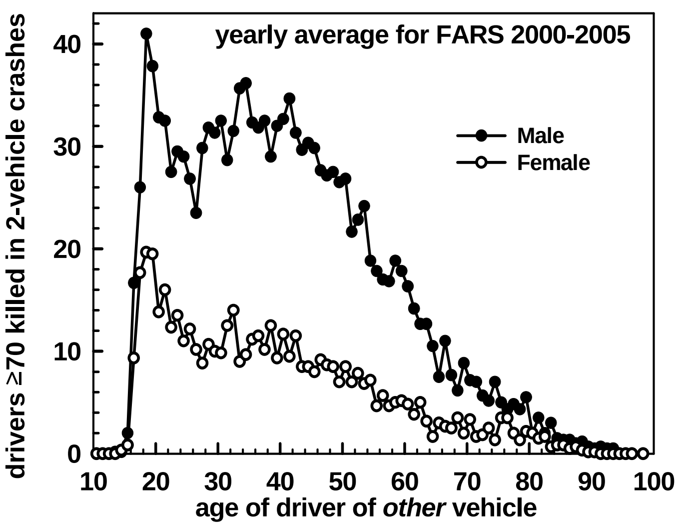

Figure 3. Number of drivers aged 70 or older killed per year in two-vehicle crashes versus the age of the driver of the other vehicle involved in the crash. The values are the average over the years 2000-2005. (FARS 2000-2005).

Table 3. Additional information for the involved drivers in Fig. 3. The percents of each column are indicated in italics under the numbers of drivers.

Driver characteristic	*Male drivers*	*Female drivers*	*Total*
All with known age	1425.3 *(100.0)*	514.0 *(100.0)*	1939.3 *(100.0)*
Aged ≥ 70	75.7 *(5.3)*	32.5 *(6.3)*	108.2 *(5.6)*
Average age	40.7 years	39.0 years	40.2 years
No valid driver license	89.7 *(6.3)*	23.8 *(4.6)*	113.5 *(5.9)*
Driver killed	54.5 *(3.8)*	25.0 *(4.9)*	79.5 *(4.1)*
Driver uninjured	581.5 *(40.8)*	104.2 *(20.3)*	685.7 *(35.4)*

In crashes that killed older *subject* drivers, female *other* drivers were 4.9% likely to be killed, compared to 3.8% for males. This 29% higher value for females is close to the difference expected because of greater female risk of death in the same severity crash.[1(p 128)]

Fig. 4 and Table 4 show corresponding information for the subset of data in which the subject vehicle was struck on the side, defined as FARS variable *initial impact* at clock points 2,3,4 (right impact) or 8,9,10 (left impact). Of the drivers aged ≥ 70 killed in two-vehicle crashes, 51% were killed as a result of side impact (compared to 38% for all drivers).

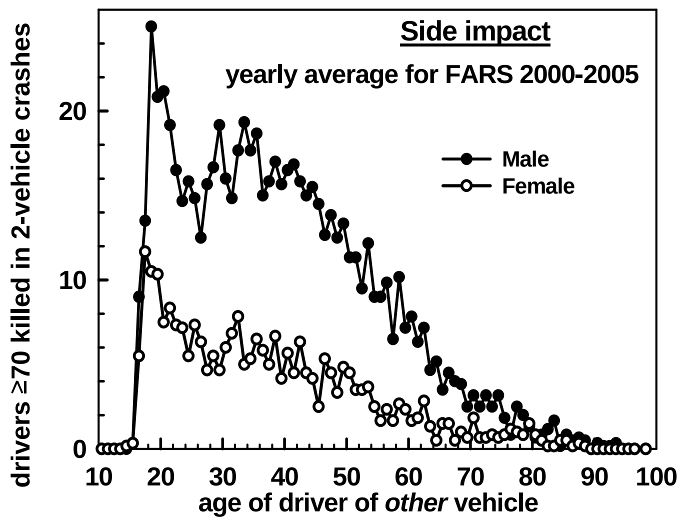

Figure 4. The data in Fig. 3, but restricted to the subject vehicle sustaining a side impact. The criterion for side impact was initial impact at 2,3,4 (right impact) or 8,9,10 (left impact).

Table 4. Additional information for the involved drivers in Fig. 4 showing side impact crashes (compare to Table 3 for all impact directions).

Driver characteristic	*Male drivers*	*Female drivers*	*Total*
All with known age	726.2 *(100.0)*	262.8 *(100.0)*	989.0 *(100.0)*
Aged ≥ 70	31.0 *(4.3)*	13.3 *(5.1)*	44.3 *(4.5)*
Average age	39.4 years	37.3 years	38.8 years
No valid driver license	39.7 *(5.5)*	10.8 *(4.1)*	50.5 *(5.1)*
Driver killed	6.2 *(0.8)*	2.3 *(0.9)*	8.5 *(0.9)*
Driver uninjured	304.0 *(41.9)*	54.3 *(20.7)*	358.3 *(36.2)*

While Figs 3 and 4 show similar features, the more detailed characteristics displayed in Tables 3 and 4 indicate some clear differences.

The probability that the *other* driver dies is under 1% for the side impact case compared to 4.1% for the all-directions case. 94% of the *other* vehicles had pure frontal impacts (12 o'clock) when the subject vehicle was side impacted.

More surprising is the enormous difference in the probability that a male compared to a female driver is uninjured (40.8% compared to 20.3% in Table 3 and 41.9% versus 20.7% in Table 4). This may reflect a hitherto unrecognized effect in which the risk of minor injury from minor crash forces is far larger for females than males, the difference being much larger than the already well recognized large effect for fatalities.[1(p 128)] A gender-dependent difference in the risk of being uninjured in this same direction also applies to drivers involved in pedestrian fatality crashes (93.5% compared to 89.3% from Table 2), but the probability of a driver sustaining no injury is such crashes is so high that any differential susceptibility cannot produce large outcome differences.

The nominal indication that females may be about twice as likely to be injured from minor physical insults could be important and worth pursuing. Doing so is beyond the scope of this paper.

DRIVERS OF VEHICLES IN WHICH OLDER PASSENGERS ARE KILLED

The analysis of drivers involved in older-passenger deaths is more complex than the above cases for two reasons.

1. Much depends on the gender of the victim. The gender and age characteristics of, say, drivers involved in male pedestrian deaths are not particularly different from those of drivers involved in female pedestrian deaths. However, the characteristics of drivers transporting male passengers who are killed are markedly different from those of drivers transporting the much larger of numbers of female passengers who are killed.

2. If the passenger killed is being transported by a *subject* driver aged ≥ 70, the crash is very likely a two-vehicle crash, and thus involves an *other* driver. If the *other* driver is aged ≤ 69, then this passenger is killed in a crash involving a non-old driver.

GENDER OF PASSENGERS AND *SUBJECT* DRIVERS

Fig. 5 and Table 5 present data for male passengers aged ≥ 70 versus the characteristics of the *subject* driver of the *subject* vehicle in which they were traveling. When the subject driver is under 40, that driver is 1.8 times as likely to be male as female; when the subject driver is aged ≥ 70 , that driver is 3.6 times as likely to be female.

The pattern for fatally injured female passengers aged ≥ 70 (Fig. 6 and Table 6) is markedly different. The scale in Fig. 6 is different from Fig. 5 because of the much larger number of female passenger deaths (908.2 compared to 368.8). While the general shapes of Figs 5 and 6 have features in common, note that the gender roles are reversed. Older male drivers transport older female passengers, and *vice versa*.

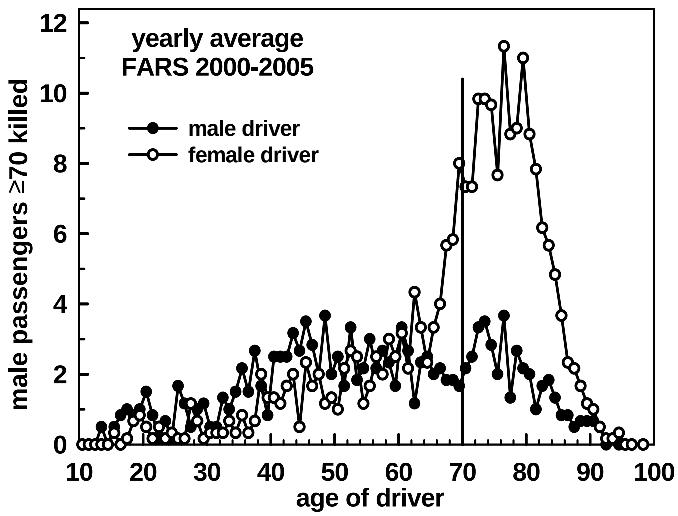

Figure 5. Male passengers aged ≥ 70 killed versus the age of the driver of vehicle in which they were traveling.

Table 5. Additional data relating to the <u>male</u> passenger fatalities plotted in Fig. 5.

Driver characteristic	*Male drivers*	*Female drivers*	*Total*
All with known age	138.7 *(100.0)*	230.2 *(100.0)*	368.8 *(100.0)*
Aged ≥ 70	38.8 *(28.0)*	138.3 *(60.1)*	177.2 *(48.0)*
Average age	57.7 years	68.8 years	63.9 years
No valid driver license	9.33 *(6.7)*	9.50 *(4.1)*	18.83 *(5.1)*
Driver killed	24.2 *(17.4)*	50.3 *(21.9)*	74.5 *(20.2)*
Driver uninjured	16.7 *(12.0)*	15.2 *(6.6)*	31.8 *(8.6)*

The only demographic variables available in FARS are gender and age – there is no information about family relationships. Figure 6 shows local maxima at mid 20s and mid 50s. This invites the interpretation that a grandmother is being driven by her granddaughter or daughter. Fig. 5 shows corresponding, but weaker, indications that men are transporting fathers and grandfathers.

Figs 5 and 6 show consistently that when an older passenger is killed in a vehicle, in the majority of cases the driver of that vehicle is an older driver of the opposite gender (presumably in most cases the spouse). 413.8 female passengers aged ≥ 70 were killed traveling with male drivers aged ≥ 70. This exceeds the 368.8 male passengers aged ≥ 70 killed traveling with drivers of any age or gender.

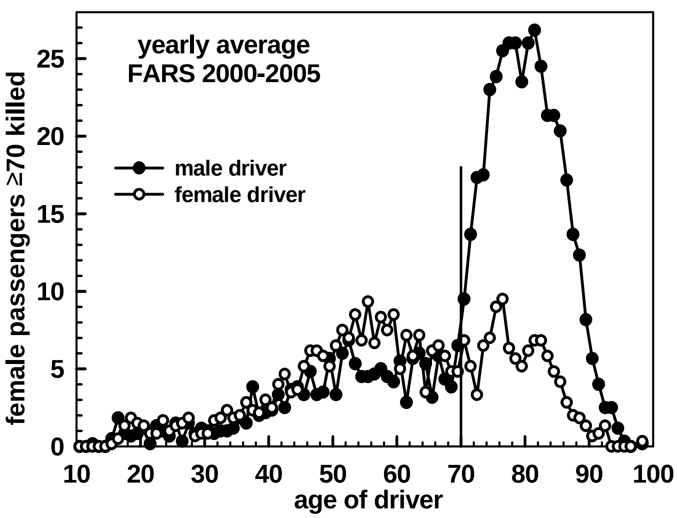

Figure 6. Female passengers aged ≥ 70 killed versus the age of the driver of vehicle in which they were traveling.

Table 6. Additional data relating to <u>female</u> passenger fatalities plotted in Fig. 6.

Driver characteristic	*Male drivers*	*Female drivers*	*Total*
All with known age	579.5 *(100.0)*	328.7 *(100.0)*	908.2 *(100.0)*
Aged ≥ 70	413.8 *(71.4)*	110.3 *(33.6)*	524.2 *(57.7)*
Average age	71.9 years	60.5 years	67.8 years
No valid driver license	25.2 *(4.3)*	13.7 *(4.2)*	38.8 *(4.3)*
Driver killed	164.8 *(28.4)*	63.8 *(19.4)*	228.7 *(25.2)*
Driver uninjured	38.7 *(6.7)*	23.0 *(7.0)*	61.7 *(6.8)*

SUBJECT DRIVERS AND *OTHER* DRIVERS INVOLVED IN PASSENGER FATALITIES

The majority of drivers transporting fatally injured passengers aged ≥ 70 are themselves aged ≥ 70, so their crashes have characteristics of older driver crashes. In particular, multiple-vehicle crashes involving other drivers predominate. We again confine the analysis to two-vehicle crashes.

Our aim is to identify how many of the 1,280.2 fatally injured passengers ≥ 70 were killed in crashes involving drivers aged ≤ 69. The analysis to determine this is shown schematically in Fig. 7.

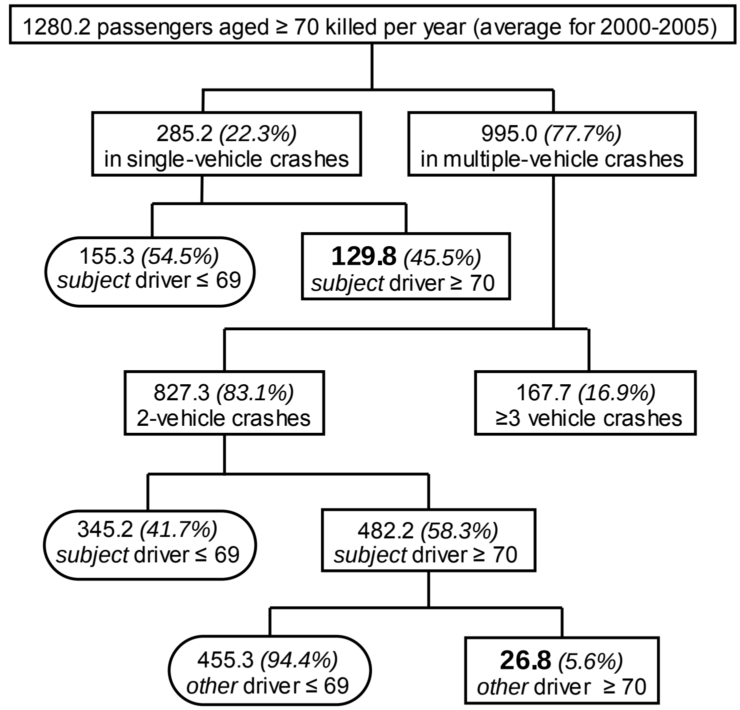

Figure 7. Drivers involved in the crashes that killed 1,280.2 passengers aged ≥ 70 per year. The three components surrounded by ovals represent passengers killed in crashes involving drivers aged ≤ 69. The two components using bold type represent passengers killed in crashes in which no driver ≤ 69 was involved.

129.8 passengers were killed in single vehicle crashes in which the driver was aged ≥ 70. As no other drivers are involved, these fatalities can be unambiguously attributed to older drivers.

345.2 passengers were killed in two-vehicle crashes while traveling with subject drivers aged ≤ 69, so that these deaths involved a driver who was *not older*. The majority (58.3%) of passengers aged ≥ 70 killed in two-vehicle crashes were being transported by drivers who were also aged ≥ 70. In 94.4% of the cases the *other* driver was aged ≤ 69.

The 827.3 two-vehicle crashes consisted of 345.2 + 455.3 = 800.5 (96.7%) that involved a driver aged ≤ 69. Let us assume that this same 96.7% applies to all 995.0 passengers killed in multi-vehicle crashes. The actual percent is almost certainly even higher than this, because with each additional involved driver the probability that at least one of them is ≤ 69 increases. We therefore conclude that 995.0 x 0.967 = 962.8 passengers aged ≥ 70 were killed in multi-vehicle crashes in which a driver aged ≤ 69 was involved.

SUMMARY OF ANALYSES

In order to estimate the number of older road users killed in crashes involving drivers aged ≤ 69, we apply a process parallel to that above to all road user categories.

NON-OCCUPANTS AND PEDESTRIANS

The FARS category *non-occupants* is overwhelmingly pedestrians, but also includes pedal cyclists and a few other categories providing very few cases. The analysis here did not address all pedestrians killed, but only those killed in single-vehicle crashes by vehicles with drivers of known gender and age. For this sub group we found that 88.5% of the drivers involved in crashes killing 717.2 pedestrians were age ≤ 69 (because, from Table 2, 11.5% were not age ≤ 69).

Let us assume that this same 88.5% applies to the drivers involved in the crashes killing all 872.1 non-occupants. This assumption is plausible, but the actual percent is likely to be higher. *Hit and run* crashes provide many of the unknown driver age cases. Drivers in such crashes are likely to be young. When more than one vehicle is involved, each additional vehicle increases the probability that at least one driver is ≤ 69.

Applying the 88.5% to all 872.1 non-occupants implies that 771.5 non-occupants, mainly pedestrians, were killed in crashes involving drivers ≤ 69 (Table 7).

Table 7. The numbers of road users aged ≥ 70 killed in crashes involving drivers aged ≤ 69.

Road users aged 70 or older killed (annual averages 2000-2005)	*Number killed*	*Subset analyzed*	*drivers ≤ 69 in subset*	*% ≤ 69 in subset*	*apply same % to all*
Non-occupants	872.1	717.2[a]	634.5	88.5	771.5
Drivers					
1-vehicle crashes	840.7	840.7	0.0	0.0	0.0
multi-vehicle	2272.2	1939.3[b]	1831.1	94.4	2145.4
Passengers					
1-vehicle crashes	285.2	285.2	155.3	54.5	155.3
multi-vehicle.	995.0	827.3[c]	800.5[d]	96.8	962.8
TOTALS	**5265.2**	4650.8	3457.4		**4035.0**

% of total involving drivers aged ≤ 69 = **4035.0/5265.2 = 76.6%**

[a] Pedestrians killed in single-vehicle crashes, driver age known
[b] Drivers killed in two vehicle crashes, *other* driver age known
[c] Passengers killed in two vehicle crashes, *other* driver age known
[d] computed as 345.2 + 455.3.0 from Fig. 7.

DRIVERS

840.7 drivers aged ≥ 70 were killed per year in single-vehicle crashes (Table 1). None of these deaths involved any driver ≤ 69.

94.4% of the *subject* drivers killed in two-vehicle crashes were killed in crashes involving an *other* driver aged ≤ 69. This percent is similar (identical to one decimal place) to the percent found for passenger fatalities when the driver was aged ≥ 70. Similar values are expected as older drivers are likely to be involved in the same types of crashes that kill themselves as those that kill their passengers. The data for passenger fatalities is largely independent from that for driver fatalities, because it is fairly uncommon for there to be more than one fatality in a fatal crash..

Applying the same 94.4% to all 2,272.2 multiple-vehicle crashes gives that 2,145.4 drivers were killed in multiple-vehicle crashes involving *other* drivers aged ≤ 69.

PASSENGERS

The results previously derived in the text are presented in Table 7.

MAIN FINDING

The main finding from this study is from Table 7. It is that 77% of the more than 5,000 road users aged ≥ 70 killed in US traffic annually are killed in crashes involving drivers aged ≤ 69.

DISCUSSION

All the fatality totals presented are influenced greatly by the greater risk older road users face of dying simply by having older bodies. That is, increasing fragility with increasing age.[1(p 120-146),11] Quantitatively, a 79-year-old man (the average age of people aged ≥ 70) is 3.2 times as likely to die as a 32-year-old man in the same severity crash.[1(p 134)] A 79-year-old woman is 2.7 times as likely to die as a 32-year-old woman. [1(p 137)] This indicates that half of the deaths to those over 70 would not occur if they could survive crash impact forces as well as those 69 and younger.

This analysis focused on driver *involvement* without regard to questions of legal fault, responsibility, road-user error, or the like. While important in many contexts, too much focus can be placed on these formal and legal distinctions. Individual drivers have near-total control over their risk of involvement in all types of crashes, including *not at fault* involvement. This is easily proved when we realize how easy it would be to accumulate a dozen crashes in an afternoon without being at fault in any of them, assuming such a bizarre goal.[1(p 365)] If one can consciously become involved as a *not-at-fault* driver, it follows that one can consciously avoid being a *not-at-fault* driver in a crash.

As people age their sensory and information processing abilities decline. This increases the risk that they will crash. When making a left turn as a driver, or crossing a road as a pedestrian, an older person may not be aware of an approaching vehicle with as much advanced warning as a younger person. However, the drivers who are most likely to convert such situations into crashes are far from a random selection of drivers.

All the material in this paper shows far greater involvement of male than female drivers in older road-user deaths, with young males being particularly over involved (though not as much as for all crashes not focusing on older victims). About 5% of the involved drivers had no valid driver license. Older drivers also drive without licenses. Indeed, the probability of this increases with increasing age, possibly reflecting a response to medically-based license revocation.[1(p 151)]

Driver behavior is the dominant factor in the crashes of younger drivers, compared to driver performance for older drivers.[1(p 147-205)] While countermeasures aimed specifically at older drivers have produced some safety gains, their potential is limited. There seems only modest potential to arrest the changes that accompany ageing.

However, older road-user traffic deaths can be reduced by large amounts by other means. Suppose that road users aged ≥ 70 changed nothing, but better traffic safety policy reduced crash risk by, say 20%, but only for road users aged ≤ 69. This would reduce the number of road users aged ≥ 70 killed per year by 15.3%, or by 807 deaths per year.

A 20% reduction is not an overly ambitious goal. Other countries with *ordinarily* foolish safety policy have achieved far larger reductions, including reducing traffic deaths by more than 50%. This is discussed in detail in the chapter *The Dramatic Failure of US Safety Policy* in Ref 1 which demonstrates that US policy is not *ordinarily* foolish. It is *extraordinarily* foolish.

US policy continues to be obsessed with vehicle factors, so called *safety devices*, and gadgets. Research has persistently demonstrated that such vehicle-born technology provides little or no safety benefits to anybody, but even less to older road users. The overall low effectiveness of airbags is even lower, perhaps negative, for older occupants. A NHTSA report states "air bags may have diminished, or even negligible benefits for drivers age 70."[12]

Even safety belts are far less effective for older occupants then for younger occupants.[1(p 282)] Fatality-reducing effectiveness declines with increasing driver age, from about 50% in late teens to about half that value at age 80. This occurs because belt-effectiveness is high in rollover crashes but low in the multiple-vehicle crashes that constitute so large a proportion of all older driver severe crashes.

Technology aimed at reducing rollover risk is of little relevance to older drivers who largely manage to not overturn their vehicles without it.[1(p 164)] In 2004 more than 30 million vehicle recall notices were issued (about 1.7 recalls for every new vehicle sold). The agency responsible has provided no evidence of any safety benefit – and the research problem is not one of limited sample sizes.[13]

Other countries have already reduced their traffic deaths by more than half, while the US has produced only modest reductions. It is driver behavior, and government policies addressing driver behavior (belt-wearing, drunk driving, running red lights, speeding, etc.) that substantially affect casualties.[1(p 332-58)] If US safety policy had simply matched that in better performing countries, this paper would have been about the annual deaths of 3,000 older people, and not 5,000. Even such a lower toll would be no cause for celebration. The better performing countries continue to achieve additional safety progress while the US does not.

The US belief that vehicle technology is the key to safety has a long history. Readers may find fascinating the safety claims made almost seven decades ago in the movie accompanying the GM ***Futurama*** exhibit at the 1939 World's Fair. Safety relevant portions are available on the web.[14]

Casualties can be sharply reduced by simple effective policies provided that the public can be persuaded to embrace them. The public will be persuaded only after they are convinced that the policies have a single purpose – to prevent their children, parents, and grandparents from being killed. The key is non-punitive automatic enforcement of sensible traffic law.[1(p 412-425)]

The most important factor is travel speed.[1(p 209-216,15] A reduction in travel speed of 3 mph reduces by 50% the probability of involvement in an injury-producing crash.[16] If drivers aged ≥ 70 did not change their driving in any way, such a modest speed change by other drivers would reduce deaths to road users aged ≥ 70 by 38%, or a reduction of more than 2,000 deaths annually. No countermeasure aimed at older drivers (plus older pedestrians) can come close to achieving such reductions.

CONCLUSIONS

- 77% of the more than 5,000 road users aged 70 or older killed annually on US roads are killed in crashes in which drivers aged 69 or younger are involved.
- While countermeasures aimed at older road users have the potential to make modest reductions in older road-user casualties, large reductions can be achieved only through policies that address crash-involvement rates of drivers who are not old.
- Such policies are already known and applied successfully outside the US. For example, if older

drivers (and other older road users) did not change their behavior in any way, a 3 mph reduction in average travel speed by all other drivers would prevent the annual deaths of about 2,000 elderly road users, far more than possible from any countermeasure aimed specifically at older road users.

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CONTACT

Dr. Leonard Evans
President, *Science Serving Society*
973 Satterlee Road, Bloomfield Hills, MI 48304-3153
USA

Email: LE@ScienceServingSociety.com

Web: http://www.ScienceServingSociety.com