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Identifying Behaviors and Situations Associated With Increased Crash Risk for Older Drivers

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16. Abstract

This report reviews published literature and analyzes the most recent Fatality Analysis Reporting System (FARS) and National Automotive Sampling System (NASS)/General Estimates System (GES) data to identify specific driving behaviors (performance errors), and combinations of driver, vehicle, and roadway/environmental characteristics associated with increased crash involvement by older drivers. The analyses reveal, in considerable detail, the contemporary (2002–2006) crash experience of older drivers on streets and highways in the United States. The over- and under-involvement of drivers ages 60-69, 70-79, and 80+ in various crash types has been highlighted through tabular summaries, graphs, and accompanying discussion. For subsets of the two-vehicle crash data within each national database, crash involvement ratios based on comparisons of at-fault to not-at-fault drivers within groups of drivers from 20 to 80 and older, segregated in 10-year cohorts, provide further exposure-adjusted estimates of the magnitude of particular risk factors.

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EXECUTIVE SUMMARY

This report presents findings from analyses that highlight driver, vehicle, roadway and environmental characteristics associated with increased crash involvement by older drivers. Fatality Analysis Reporting System (FARS) and National Automotive Sampling System (NASS)/General Estimates System (GES) data from 2002 through 2006 were included in the study. The findings will be useful in developing countermeasures for lowering this risk.

The data were analyzed using two different approaches. Descriptive analyses of single-vehicle and two-vehicle crashes, using FARS and GES data, identified situations in which older drivers were overrepresented compared to younger drivers. A more in-depth, "induced exposure" analysis was undertaken for the two-vehicle crashes in the databases to compare the ratios of at-fault to not-at-fault drivers within age groups. This technique compared the ratios of at-fault to not-at-fault drivers within age groups, producing a crash involvement ratio (CIR) that signifies the degree of over- or under-involvement of each group with respect to particular risk factors. This approach uses each group as its own control, thus taking into account differences in driving exposure across age groups with respect to a particular factor such as driving at nighttime, or on Interstate highways.

METHODS

Development of Data Files

The 2002-2006 FARS and GES crash data were analyzed to identify factors contributing to older driver crashes. For both the FARS and GES data, the analyses were restricted to single- and two-vehicle crashes involving passenger cars, sport utility vehicles, light vans, pickups, and other light trucks.

Two-vehicle crashes included in the induced exposure analyses were those in which *both vehicles* were one of these body types and only one of the drivers had a contributing factor or moving violation. Crashes in which both drivers had contributing factors, or in which neither was identified with a contributing factor, were excluded from the analysis (see Reinfurt et al., 2000). Non-performance-related violations (e.g., driving with a suspended or revoked license) were not considered in determining fault. Following this approach, 88.5% of the two-vehicle crashes involving eligible vehicle types in the FARS data and 52% of those in the GES data were coded as having one at-fault and one not-at-fault driver.

Data Analysis

Descriptive analyses of single-vehicle and two-vehicle crashes highlighted the factors that most strongly characterize older driver crashes. Crosstabulations based on age and crash descriptors focused on identifying vehicle maneuvers, crash types or situations where older drivers were over-represented compared to other age groups. The age groups of interest in these analyses were *60 to 69, 70 to 79,* and *80 and older*.

For two-vehicle crashes, an additional set of analyses compared at-fault versus not-at-fault crash involvement ratios across driver age categories. This approach controls for potentially different exposure levels across different age groups, and is useful for pinpointing situations that pose the greatest risks to older drivers. Analysis results include full data tables and graphs showing the calculated crash involvement ratio (CIR) values illustrate which factors were most problematic for drivers of different ages.

RESULTS

The descriptive analyses of the FARS and GES data are presented in a series of tables that present crash rates according to characteristics of the driver, vehicle, roadway and environment, the crash, and the condition of the driver. Older drivers were overrepresented in a variety of types of crashes; however, in most situations the overrepresentation was not evident in drivers younger than 70. Drivers 60 and older were less likely than other drivers to be involved in alcohol-related, speed-related, or nighttime-related crashes.

Drivers 60 to 69 had crash rates similar to those of middle-aged drivers under most conditions, although their crash risk was elevated during daylight hours (which may reflect this group's avoidance of night driving) and at intersections. Left turns in general proved risky for older drivers. In two-vehicle crashes, those 60 and older were more likely to be the struck (as opposed to the striking) vehicle, to be involved in angle crashes, and to have received citations for failure to yield. In single-vehicle crashes, drivers 60 and older were more likely to have been alone in the vehicle, and to crash into a parked car and were less likely to have made a maneuver to avoid the collision. Drivers 70 and older had elevated risk levels under additional conditions including driveways, alleys, and at intersections controlled by stop or yield signs.

As expected, the oldest group, drivers 80 and older, were overrepresented in crashes. This group generally differed from those 70 to 79 more in terms of degree of risk elevation, than in number of conditions under which risk was elevated. This was particularly the case under conditions that required navigating complex situations such as intersections, left turns, and reacting to an imminent crash.

The induced exposure analyses added further insight to these findings by providing the ratio of at-fault to not-at-fault drivers (the crash involvement ratio, or CIR) for various crash types for each age group. Values lower than 1.0 indicate lower than average rates of at-fault crashes, and higher than 1.0 represent higher at-fault rates. Overall, FARS data indicate that drivers 60 to 69 had a CIR of 0.75, indicating a below-average risk of being found at fault in a crash. This risk increased to 1.75 for drivers 70 to 79, and to 4.0 for those 80 and older.

Results based on GES data differed in that the increase in CIR with age was less extreme. The CIR for the 60-to-69 age group was similar to that for the FARS data at 0.73. The values for the two older groups were 1.14 for drivers 70 to 79 and 1.91 for those 80 and older. While these scores are higher than average, they are well below those based on the FARS data. The results suggest that at least some of the increase in crash risk seen in the FARS analyses may result from older adults' increased risk of dying in a crash. Thus, the degree of discrepancy may vary with crash type; for example, side impact crash analyses may be more impacted by older driver frailty than rear-end crashes.

Both the FARS and GES analyses demonstrate that drivers 60 to 69 managed most traffic situations nearly as well as their middle-aged counterparts, with only slight elevations in CIRs when navigating intersections controlled by flashing lights and when turning left at intersections with traffic signals. CIRs increased somewhat for drivers 70 to 79 under complex driving conditions such as navigating higher speed, multiple lane roadways, particularly at junctions. While the 70- to 79-year-olds managed most driving tasks nearly as well as their 60- to 69-year-old counterparts, the oldest group generally had substantially higher CIRs under a variety of conditions, indicating higher proportions of at-fault crashes. Driving alone or with one passenger was associated with increased at-fault crashes with increasing age.

INTRODUCTION AND BACKGROUND

This report reviews published literature and analyzes the most recent Fatality Analysis Reporting System (FARS) and National Automotive Sampling System (NASS)/General Estimates System (GES) data to identify specific driving behaviors (performance errors), and combinations of driver, vehicle, and roadway/environmental characteristics associated with increased crash involvement by older drivers. These project activities were designed to prioritize the situations causing problems for older drivers based on the magnitude of the crash problem, older drivers' degree of over-representation, the likelihood of serious injury, or other criteria of interest. The resulting list of the most problematic situations will frame the later discussion of how age-related functional decline can mediate increased crash risk for older drivers and, hopefully, point to potential countermeasures for lowering this risk.

Two analytic approaches were undertaken. The first approach was to carry out separate descriptive analyses of single-vehicle and two-vehicle crashes, looking for situations where older drivers were overrepresented compared to younger drivers. This relied on crosstabulations of FARS and GES data for the 5-year period 2002-2006. A more in-depth, "induced exposure" analysis was undertaken for the two-vehicle crashes. This technique compared the ratios of at-fault to not-at-fault drivers within age groups, producing a crash involvement ratio (CIR) that signifies the degree of over- or under-involvement of each group with respect to particular risk factors. While feasible only with large data sets, this approach is notable in that it seeks to use each group as its own control, thus taking into account differences in driving exposure across age groups with respect to a particular factor such as driving at nighttime, or on Interstate highways.

Previous work in this area has highlighted a number of older driver difficulties related to specific traffic maneuvers and roadway conditions. Two studies in particular served as models for the current effort. One was an analysis by Staplin and Lyles (1991) that used 1986-1988 Michigan crash data to examine five specific vehicle maneuver patterns: merging and weaving on limited-access highways, lane changes on limited-access highways, left turns against traffic, crossing-gap-acceptance maneuvers, and overtaking on two-lane rural roadways. A sample table from the analysis results for one of these maneuvers is shown below, where Driver 1 is the at-fault driver and Driver 2 the not-at-fault driver in two-vehicle crashes:

Driver 1 Age	Driver 2 Age [1]				
	≤26	27-55	56-75	76-98	Totals
≤26	232 (28.5)	501 (61.5)	79 (9.7)	3 (0.4)	815 (32.5)
27-55	380 (27.1)	872 (62.2)	139 (9.9)	11 (0.8)	1,402 (55.9)
56-75	65 (24.3)	177 (66.3)	24 (9.0)	1 (0.4)	267 (10.7)
76-98	5 (22.7)	16 (72.7)	1 (4.5)	0 (0.0)	**22** (0.9)
Totals	682 (27.2)	1,566 (62.5)	243 (9.7)	**15** (0.6)	2,506

[1] Number of accidents (row percentage)
From Staplin and Lyles (1991).

Based on the ratio of at-fault to not-at-fault drivers in each age category, the authors concluded that drivers 76 and older were overrepresented in crashes associated with this specific type of maneuver (involvement ratio = 22/15 = 1.47). Using similarly formatted Pennsylvania crash data, the authors also examined specific operator performance failure categories, showing, for example, that adults 76 and older were much more likely to be cited for making improper exits from a roadway, proceeding without clearance after stopping at an intersection, improper turning, and careless lane changes (Staplin and Lyles, 1991).

The second study that helped guide the current effort was an analysis of North Carolina, FARS, and GES crash data carried out by Reinfurt, Stewart, Stutts, and Rodgman (2000). The goal of this study was to identify driver maneuvers, crash types, or situations that account for an increasing share of at-fault crashes as drivers age. Fault status was determined based on contributing factors cited by the investigating officer. Specifically, in two-vehicle crashes, if one driver was cited for one or more contributing factors and the other driver was not cited for any contributing factors, the first driver was deemed at-fault in the crash. Logistic models were then developed to examine factors associated with being at-fault in a particular type of crash. For example, it was found that with increasing age, drivers were more likely to be at-fault in left-turn crashes involving frontal and right-side impact, and when the traffic control was a stop or yield sign versus a traffic signal.

Others have also used induced exposure techniques to examine the safety of older drivers. Garber and Srinivasan (1991) used an approach similar to Staplin and Lyles (1991) to examine characteristics of elderly driver intersection crashes in Virginia. Variables examined included age, gender, location, type of collision, vehicle maneuver, driver action, type of intersection, and traffic control. The significance of computed crash involvement ratios was tested using t-tests. Results showed older drivers significantly more likely to be involved in intersection crashes in both urban and rural areas, with higher rates of angle, sideswipe, and head-on collision types; left turn maneuvers; and stop sign control intersections. Involvement ratios were higher for female than male drivers.

More recently, Chandraratna and Stamatiadis (2003) used induced exposure to study problem driving maneuvers of older drivers. Of particular relevance methodologically to the current effort, the authors found that including more than two drivers in multi-vehicle crashes did not significantly affect the distribution of not-at-fault driver age (i.e., the distribution of exposed drivers). Consequently, in their study using 1995-1999 Kentucky crash data, the authors only used the first two drivers in multi-vehicle crashes for classifying at-fault versus not-at-fault drivers. Their results showed that older drivers, and especially female older drivers, were significantly more likely to be involved in crashes involving left turns against oncoming traffic, high-speed lane changes, and gap acceptance when crossing a non-limited access highway.

There are numerous other studies, most of a more descriptive nature, that examine the characteristics of older driver crashes compared to those of younger or middle-age drivers. Several of the most recent and relevant are briefly summarized below.

- Mayhew, Simpson, and Ferguson (2006) published a comprehensive review of the literature on the topic of high-risk conditions and locations for older driver crashes. More recent study results were summarized with respect to environmental and weather conditions, illness and medical conditions, alcohol, driving errors, responsibility, crash characteristics, and intersection crashes. Older drivers were found more likely to crash at intersections, especially when making a left turn and as a result of failing to yield the right-of-way, disregarding the traffic signal, or committing some other traffic violation. The authors concluded that *"the extent to which the distinctive characteristics of senior drivers' crashes may be due to changing travel patterns associated with aging, or physical or cognitive impairments related to the aging process, is unclear. Further research is needed to understand the pre-crash circumstances of older drivers' intersection crashes."*

- Braitman, Kirley, Ferguson and Chaudhary (2007) interviewed older drivers involved in recent intersection crashes in Connecticut and took photos of the intersections to obtain additional detail on factors contributing to the crashes. The study involved two samples of at-fault older drivers (ages 70 to 79 and 80 and older) and a comparison sample of at-fault drivers 35 to 54 years old. Findings were especially enlightening with regard to failure to yield crashes, where there were differences even between the two oldest groups of drivers. Drivers ages 70 to 79 were more likely to make errors in gap acceptance, while drivers 80 and older were more likely to fail to see or detect an approaching vehicle.
- A number of recent Australian studies (cf. Langford and Koppel, 2006; Langford, Koppel, Andrea, & Fildes, 2006; and Oxley, Fildes, Corben, & Langford, 2006) have focused on older driver crash characteristics, potential contributing factors, and crash reduction measures. Based on an analysis of 1996-1999 fatal Australian crash data, older adults were twice as likely to be involved in right turn crashes (equivalent to left turn crashes in the United States) into the paths of oncoming vehicles; twice as likely to be involved in right-angle collisions when traveling through intersections; and five times as likely to be involved in perpendicular path collisions at intersections where the older drivers were making right turns (left turns in the United States). And based on Tasmania crash data, the odds of being at fault in a multi-vehicle non-intersection crash were 1.78, compared to 3.55 for a multi-vehicle intersection crash. Countermeasures were addressed in all the studies, and included roadway design measures, traffic control measures (including traffic circles and speed lowering measures), training in route selection, and newer cars.
- McGwin and Brown (1999) analyzed a single year of Alabama crash data, combined with National Household Travel Survey licensed driver and vehicle-miles-traveled data, to describe characteristics of older versus younger and middle-age driver crashes that point to factors that can be examined in the current study. The authors also presented a good review of relevant literature, including studies using induced exposure techniques, and discussed functional declines and other risk factors contributing to older driver crashes.

These and other studies were helpful in guiding the current data analysis task and in interpreting the results with respect to developing the most relevant taxonomy of older driver crash characteristics and risk factors. A discussion of analysis methods precedes the results of the descriptive and induced exposure analyses of older drivers' crash experience.

METHOD

Development of Data Files

The current examination of factors contributing to older driver crashes used 2002-2006 FARS and GES crash data. Consideration was given to using Crashworthiness Data System (CDS) data; however, the CDS is based on a much smaller number of actual crashes (less than 5,000 per year, compared to some 56,000 for the GES). For example, a preliminary analysis of 2006 CDS data revealed only three reported crashes involving an older drivers merging in traffic. Although the raw CDS data are weighted to reflect national crash numbers, such small counts can lead to unstable estimates if used in the sort of finely stratified analysis planned for the current project.

For both the FARS and GES data, the data analysis files developed for use in the project were restricted to single- and two-vehicle crashes involving the following vehicle types:

- passenger cars;
- sport utility vehicles;
- light vans;
- pickups; and
- other light trucks (gross vehicle weight rating <10,000 lbs.).

In order for a two-vehicle crash to be included in the database, *both vehicles* needed to be one of these body types. This analysis *excluded* crashes involving large trucks, motorcycles, pedestrians and bicyclists, as well as crashes involving more than two vehicles.

A second step in the preparation of the study files was the assignment of fault or responsibility for the crash. Neither the FARS nor the GES data contains a variable indicating driver fault. In the Reinfurt et al. (2000) study using FARS and GES crash data, fault was determined based on a driver's contributing factors and/or violations. Specifically, in two-vehicle crashes, a driver was deemed at-fault in the crash if the driver had one or more contributing factors or moving violations, and the other driver had no identified contributing factors or moving violations. Crashes in which both drivers had contributing factors, or in which neither driver was identified with a contributing factor, were excluded from the analysis. For the current study, this same approach was followed for assigning fault to drivers involved in fatal two-vehicle crashes, using the FARS variables *Related Factors – Driver Level (P22)* and *Violations Charged (P21)*. As before, non-performance-related factors or violations – such as "driving with a suspended or revoked license," "obscured vision," and "defective vehicle equipment" – were not considered in determining a driver's fault. Following this approach, 88.5% of the two-vehicle crashes involving eligible vehicle types in the FARS data were coded as having one at-fault and one not-at-fault driver.

For a listing of the variables and variable levels used in determining fault for the FARS data cases, see Appendix A. Fault definition rules are presented in Appendix B.

Applying this approach to the GES data was less successful. While there still exists a similar variable (*Critical Event, Precrash 2*) describing contributing pre-crash events in the GES data, this variable has undergone substantial revisions since utilized by Reinfurt et al.; and, documentation for data collectors clearly states that culpability should not be considered a factor in determining pre-crash vehicle events. Indeed, when crosstabulating a potential grouping of the *Critical Event, Precrash 2* variable by violation charged, there was a high level of "disagreement" between this variable and violation charged.

Consequently, a decision was made to assign fault status in the GES datafile based purely on the violation variable (*Violation Charged, D02*). The following variable levels were considered indicative of fault: *alcohol, drugs, speeding, reckless driving, failure to yield right-of-way, running a traffic signal or stop sign, violation charged-no details*, and *other violation*. It should be noted that neither "driving with a suspended or revoked license" nor "hit-and-run" were used to assign fault, along with "unknown if charged" and "not reported." It is likely that driver violations more often go unreported than contributing factors, and a possible bias in officers citing (older) drivers for violation may be acknowledged. Notwithstanding these limitations, the present approach allowed 52% of eligible two-vehicle crashes to be coded as one driver at fault and one not-at-fault for use in the induced exposure analyses in GES. At the same time, the severe restrictions on determining fault for crashes in the GES datafile led to a decision to generate the descriptive two-vehicle crash statistics on *all* crashes involving eligible vehicle types, without regard to fault status.

The total number of crashes utilized in the FARS data analyses was 107,497 (69,846 single-vehicle plus 37,651 two-vehicle, where one vehicle was identified at fault). For the GES data analysis, the raw number of crashes available for analysis was 192,963 (69,689 single-vehicle and 123,065 two-vehicle), which translated into 23.5 million weighted crashes. Table 1 shows the distribution of single- and two-vehicle crashes involving eligible study vehicles, and their at-fault status, for both the FARS and GES datafiles.

Table 1. Eligible single- and two-vehicle crashes for FARS and GES study files.

Crash Type and Fault Status	2002-2006 FARS	2002-2006 GES	
		Unweighted	Weighted
Single-vehicle	72,847	69,689	7,860,000
Two-vehicle, only one driver at-fault	37,090	62,090	8,112,000
Two-vehicle, neither driver at fault	1,624	45,062	6,975,000
Two-vehicle, both drivers at fault	3,195	4,857	567,000
Two-vehicle, without regard to fault	41,909	123,065	15,655,000

Data Analysis

As noted, separate analyses were carried out on single-vehicle and two-vehicle crashes, to identify the factors that most strongly characterize older driver crashes. For the crosstabulations involving age and other crash descriptors, the focus was on identifying specific vehicle maneuvers and crash types or situations where older drivers are over-represented compared to middle-aged drivers, or where there is a pattern of increased involvement with age. Driver gender was examined as a potential mediating variable, along with other situational variables such as light condition, number of travel lanes, and speed limit. These descriptive analyses are important in that they identify crash scenarios that comprise the biggest proportion of the older driver crash "problem." The age groups included in these analyses were: *60 to 69, 70 to 79,* and *80 and older*.

For two-vehicle crashes, an additional set of analyses compared at-fault versus not-at-fault crash involvement ratios across driver age categories, for a particular crash type or crash situation. As previously described, this approach, based on the concept of *induced exposure*, takes into account potentially different exposure levels across different age groups, and is therefore especially useful for pinpointing situations that pose the greatest risks to older drivers. The relative involvement of drivers in at-fault, versus not-at-fault, crashes is expressed as a crash involvement ratio (CIR).

The following eight categories of driver age were used in the induced exposure analyses: *<20, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79,* and *80+*. This differed from the mid-decade grouping initially proposed, as the relatively small number of drivers in the 85-and-older category could hinder valid comparisons in some of the less common crash situations (e.g., changing lanes or merging on freeways).

Table 2 shows the typical table layout for the induced exposure analyses, where $D1_a$ is the number of drivers under 20 who were identified at-fault in the particular two-vehicle crash situation being examined, and $D2_a$ the number of identified not-at-fault drivers under 20. The at-fault CIR for drivers under age 20 is then $D1_a / D2_a$. Similar ratios can be calculated for the other age groups, using row and column totals to indicate which groups are over- (or under-) represented in the particular crash situation under study.

Analysis results include full data tables (as shown below), which were generated to check for adequate sample sizes. Graphs showing the calculated CIR values illustrate which situations and (combinations of) factors were most problematic for drivers of different ages. It may be noted that significance testing on the observed differences was *not* performed, as these descriptive analyses were not initiated with any particular set of hypotheses in mind.

Table 2. Sample induced exposure table for a specified a two-vehicle crash situation.

Driver1 Age (at fault)	Driver2 Age (not-at-fault)								
	<20	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
<20									$D1_a$
20-29									$D1_b$
30-39									$D1_c$
40-49									$D1_d$
50-59									$D1_e$
60-69									$D1_f$
70-79									$D1_g$
80+									$D1_h$
Total	$D2_a$	$D2_b$	$D2_c$	$D2_d$	$D2_e$	$D2_f$	$D2_g$	$D2_h$	Total

RESULTS OF FARS DATA ANALYSIS

Characteristics of Older Driver Fatal Crashes

Descriptive results based on the combined 2002-2006 FARS data have been organized according to *driver, vehicle, roadway/environmental, crash characteristic*, and *contributing factors* variables (Tables 3-7, respectively). For each of the tables, results are presented separately for single-vehicle and two-vehicle crashes. The displayed values represent the percentages of all drivers/crashes for the particular age group (i.e., column percents), although to be concise, not all levels of a variable are presented; "other" and "unknown" levels were always omitted, as were other variable levels having small percentages or little relevance to the topic. As a result, the sum of the percentages for a particular variable and age group is typically slightly less than 100%.

The following material includes a bullet list to summarize key findings with respect to each of the tables. As noted earlier, *both exposure and "increased risk" can contribute to any observed over- or under-representation* in these descriptive data.

Driver Characteristics

Table 3. 2002-2006 FARS descriptive results – driver characteristics[1]

Driver Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Gender								
Male	64.70	62.58	65.08	65.97	71.69	71.34	68.74	74.66
Female	35.30	37.42	34.92	33.70	28.31	28.63	31.15	24.82
Alcohol								
No alcohol	60.65	62.83	64.98	54.62	43.56	51.13	55.33	29.16
Yes alcohol	3.45	2.16	1.00	9.44	13.80	5.76	1.96	30.74
Not reported	35.90	35.02	34.02	35.93	42.63	43.10	42.72	40.10
Occupants								
One	59.67	58.41	63.97	57.96	72.17	70.44	74.44	56.66
Two	30.09	34.37	32.06	25.97	19.75	24.23	22.86	23.98
Three+	10.24	7.23	3.97	15.00	8.08	5.33	2.70	19.35

[1] Percentages of drivers in each age category (column percents); overall includes all age groups.

- Female older drivers were slightly overrepresented, especially in single-vehicle fatal crashes; however, this may be due at least in part to demographic changes with age.
- Alcohol was much less likely to play a role in older driver crashes, and this likelihood decreased with age.
- Older drivers were slightly more likely than younger drivers to be carrying just one passenger when involved in a two-vehicle fatal crash (i.e., two occupants in the vehicle). They were much less likely to be carrying two or more passengers (three+ vehicle occupants). Conversely, they were more likely to be driving alone, especially when involved in a single-vehicle crash.

Vehicle Characteristics

Table 4. 2002-2006 FARS descriptive results – vehicle characteristics.

Vehicle Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Body Type								
Automobile/deriv.	52.77	70.71	81.22	54.40	42.99	56.46	71.62	52.29
Utility vehicle	12.45	6.01	3.67	14.49	18.88	11.67	7.43	18.64
Van-based lt truck	10.26	7.99	4.80	7.96	9.33	7.85	5.35	5.23
Light truck	24.25	15.20	10.24	22.89	28.73	23.98	15.60	23.74
Vehicle Age								
<5 years	34.70	32.66	25.31	31.77	33.71	33.06	27.75	29.38
5-9 years	31.87	30.56	31.43	32.68	30.41	28.92	29.02	32.50
10+ years	33.14	36.66	43.27	35.38	35.74	37.85	42.89	37.89

- Compared to the overall population of drivers involved in two-vehicle fatal crashes, drivers 70 and older (but not those 60 to 69), were more likely to be driving standard automobiles (or automobile derivatives), and less likely to be driving utility vehicles or light trucks. The same trend holds with respect to single-vehicle crashes, although the pattern is less pronounced and more characteristic of the 80-and-older driver group.
- Drivers in the 60-to-69 and 70-to-79 age groups were slightly more likely to be driving a recent model vehicle, while those 80 and older were more likely to be driving vehicles that were 10 years old or older.

Roadway/Environmental Characteristics

Table 5. 2002-2006 FARS descriptive results – roadway and environmental characteristics.

Roadway Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Route signing								
Interstate	7.17	4.66	2.81	7.18	18.95	16.31	10.25	14.83
U.S. highway	23.78	25.96	24.91	21.10	13.98	13.65	11.86	11.02
State highway	35.75	37.05	34.07	34.84	27.41	26.54	29.76	25.54
County road	15.64	14.03	14.16	16.51	21.81	20.63	21.07	26.93
Township	2.81	3.21	3.94	3.43	4.38	5.62	6.33	5.78
Municipality	10.45	10.91	15.79	12.09	7.98	11.78	15.72	10.16
Rural/urban roadway								
Rural	61.93	58.44	49.74	58.02	71.37	67.30	60.44	67.10
Urban	36.57	39.84	48.47	40.49	27.05	30.65	37.30	31.40
Relation to junction								
Non-junction	52.49	39.32	27.17	53.73	88.60	85.92	81.58	89.53
Intersection/int-rel	41.25	51.82	62.21	40.08	5.58	7.63	10.25	5.37

Roadway Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Driveway/alley	2.00	2.96	3.89	1.73	0.40	0.79	1.04	0.39
Interchange-related	2.45	2.47	2.31	2.44	2.60	1.84	2.25	2.65
Railroad crossing	0.02	0.02	0.00	0.03	2.10	3.24	3.80	1.32
Number lanes								
1-2	76.60	75.20	72.03	75.43	83.97	84.99	86.29	84.67
3-4	19.81	21.06	23.73	20.58	13.61	12.28	11.51	12.69
5+	2.81	2.74	2.79	2.99	1.45	1.58	1.04	1.57
Speed limit								
≤ 35 mph	13.76	14.89	21.04	14.98	17.42	20.74	28.16	18.92
40-45 mph	22.69	25.29	28.30	23.18	14.20	15.52	15.32	17.28
50-60 mph	46.82	45.73	38.66	46.23	39.73	37.31	35.35	40.71
65+ mph	15.31	12.13	9.99	14.13	26.41	23.55	16.47	20.51
Roadway alignm'nt								
Straight	81.67	84.87	89.68	81.57	66.97	71.01	70.18	61.39
Curve	17.97	14.75	9.64	18.06	32.53	28.63	29.02	37.94
Traffic Control								
None	60.51	51.68	44.21	61.59	88.80	87.61	84.23	89.25
Signal (all)	12.26	15.00	16.52	12.67	1.61	2.02	3.06	1.47
Stop sign	22.68	28.82	35.88	21.27	2.00	2.48	4.84	2.05
Yield sign	0.72	1.00	0.90	0.69	--	--	--	--
Light Condition								
Daylight	74.27	82.43	88.30	63.39	66.64	76.88	81.98	40.00
Dark	14.97	9.07	5.20	20.10	22.46	14.40	10.31	41.65
Dark, lighted	6.97	5.19	3.97	12.11	6.48	4.97	4.55	13.86
Dawn	1.41	0.76	0.40	1.85	2.08	1.26	0.81	2.07
Dusk	2.24	2.41	1.98	2.44	2.03	1.76	1.84	1.79
Weather								
Normal	85.53	87.93	89.13	85.54	86.45	88.08	89.29	87.74
Rain	9.55	8.60	8.36	9.72	8.08	7.42	6.56	7.78
Sleet/snow/fog/etc.	4.83	3.31	2.26	4.55	4.99	3.86	3.11	3.68

- Two-vehicle older driver fatal crashes were less likely to occur on Interstates (70+), and more likely to occur on U.S. highways. They were also slightly less likely to occur on county roads. Single-vehicle older driver fatal crashes were even more underrepresented on county roads, while becoming overrepresented on municipal roadways. In addition, drivers 60 to 69 were slightly overrepresented in fatal single-vehicle crashes on Interstates, while those 80 and older were underrepresented. In general, however, older drivers' fatal crash locations were not much different from that of the overall driving population.
- With increasing age, older drivers' single- and two-vehicle crashes were increasingly likely to occur in urban areas, although the majority of their fatal crashes still occurred on rural roadways.

- Starting at age 70, older drivers in two-vehicle crashes were especially likely to crash at intersections, with the likelihood of an intersection crash strongly associated with increasing age. Over half of all fatal two-vehicle crashes involving drivers 70+ occurred at intersections. Older adults were also overrepresented in two-vehicle crashes at driveway or alley junctions, but not at interchange junctions.
- Drivers 70+ were overrepresented in single-vehicle fatal crashes at roadway and driveway/alley intersections; and increasingly with age, drivers 60+ were over-represented in single-vehicle crashes at railroad crossing locations.
- Drivers 80 and older were overrepresented in single- and two-vehicle crashes on lower speed roadways, and underrepresented in crashes on higher speed roadways. Still, even for drivers in this oldest age group, nearly half of fatal two-vehicle and single-vehicle crashes occur on roadways with speed limits greater than 45 mph.
- Older drivers were less likely to crash while negotiating a curve in the roadway (a factor likely related to their reduced likelihood of speeding).
- While drivers 70 and older were somewhat overrepresented in two-vehicle crashes at traffic signal locations, they were much more overrepresented in two-vehicle crashes at stop sign locations. Over a third of fatal two-vehicle crashes involving drivers 80 and older occurred at stop sign locations – twice the percentage as at signal locations.
- All age groups of older drivers were overrepresented in daylight fatal crashes; this percentage increased substantially with age for both single- and two-vehicle crashes.
- Older people were increasingly less likely to be driving the striking vehicles in two-vehicle crashes, and more likely to be driving the struck vehicles.

<u>Crash Characteristics</u>

Table 6. 2002-2006 FARS descriptive results – crash characteristics.

Crash Characteristics	Two-Vehicle Crashes (all drivers)				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
First Harmful Event								
Non-collision	0.53	0.24	0.05	0.61	22.76	17.28	10.71	24.83
Coll non-fix obj.	0.21	0.12	0.10	0.20	4.28	5.55	5.99	3.09
Coll mv in transp	96.84	98.35	98.87	96.58	0.10	0.25	0.12	0.07
Coll mv not transp	0.17	0.06	0.15	0.16	2.60	3.02	4.20	2.05
Coll fixed object	2.24	1.23	0.83	2.44	70.19	73.89	78.81	69.90
Vehicle Role								
Striking	42.47	36.68	28.81	51.46	--	--	--	--
Struck	54.29	60.18	67.94	45.46	--	--	--	--
Manner of Collision								
Rear-end	5.90	5.98	5.22	6.40	--	--	--	--
Head-on	31.06	26.61	18.58	30.63	--	--	--	--
F→S, Right angle	36.45	42.75	51.54	35.58	--	--	--	--

Crash Characteristics	Two-Vehicle Crashes (all drivers)				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
F→S, Opp direct.	16.02	16.79	18.05	16.41	--	--	--	--
F→S, Other	3.65	3.54	3.94	3.70	--	--	--	--
Sideswipe	3.48	2.47	1.43	3.52	--	--	--	--
Initial Impact								
Front (12 hour)	59.36	46.06	33.47	62.35	50.61	57.76	63.79	42.09
Right side (1-5hrs)	14.80	19.47	24.91	15.25	12.88	11.30	11.92	15.30
Rear (6 hour)	3.81	3.31	2.31	3.37	0.43	0.72	0.46	0.87
Left side (7-11hrs)	21.58	30.92	38.97	18.35	12.52	11.67	9.97	15.24
Top/undercarriage	0.15	0.06	0.06	0.27	4.13	4.28	4.49	5.16
Non-collision	--	--	--	--	17.25	12.60	8.12	18.39
Vehicle Maneuver								
Going straight	72.32	61.91	51.97	73.06	71.94	75.15	73.29	65.98
Starting in lane	1.98	4.29	6.08	1.48	--	--	--	--
Stopped in lane	1.35	1.47	0.88	1.28	--	--	--	--
Passing	1.07	1.08	0.53	2.25	1.10	0.61	0.63	1.93
Right turn	0.55	0.77	1.23	0.44	0.28	0.22	0.41	0.35
Left turn	10.69	20.26	31.84	8.58	0.55	0.76	1.27	0.50
U-turn	0.81	1.47	1.58	0.57	--	--	--	--
Backing	0.07	0.12	0.13	0.08	0.25	0.40	0.58	0.12
Changing lanes	1.22	1.16	0.60	1.84	1.13	1.26	1.15	1.84
Negotiating curve	7.66	5.60	3.24	8.33	21.78	18.47	18.31	26.13
Avoiding Maneuver								
None	46.97	51.18	52.52	44.34	43.11	46.78	47.15	38.30
Braking	4.84	2.92	1.71	5.68	3.58	3.38	2.54	5.48
Steering	6.12	3.84	2.13	6.70	15.78	13.54	9.84	17.32
Braking + steering	3.59	2.12	0.78	4.10	4.25	3.53	2.99	5.11
(Not reported)	38.32	39.71	42.73	38.93	33.16	32.55	37.25	33.62

- Older drivers were less likely to be involved in non-collision single-vehicle fatal crashes, such as rollovers, and more likely to strike fixed objects, other parked or stopped vehicles, and non-fixed objects. This effect increased with age.
- In two-vehicle fatal crashes, older drivers were more likely to be driving the struck, as opposed to the striking vehicles. The effect increased with age.
- Older drivers were more likely to be struck in the side, particularly the left side, in two-vehicle crashes; both left- and right-side impacts increased sharply with age. In single-vehicle fatal crashes, they are increasingly more likely to experience frontal impact.
- After age 70, drivers were overrepresented in front-to-side collisions with vehicles traveling on perpendicular paths, and underrepresented in head-on collisions. Both left- and right-side initial impacts with other vehicles increased sharply with driver age.
- By far, the maneuver posing greatest problems for older drivers was the left turn. While drivers 60 to 69 were only slightly overrepresented in crashes involving left turns, the percentage doubled to 20% for drivers 70 to 79, and increased to 32% for drivers 80 and

older. Right turns and U-turns became more problematic as drivers aged, but represented only a small proportion of fatal crashes.

- Older drivers involved in single-vehicle fatal crashes were somewhat more likely to be traveling straight ahead, and less likely to be negotiating curves or changing lanes.
- Once a critical event had been initiated, older drivers were less likely to brake, steer, or otherwise maneuver their vehicles to avoid the crashes. *Note:* In the absence of objective signs such as tire skid marks, this information was typically unreported.

<u>Driver-Related Crash Characteristics</u>

Table 7 below summarizes results for up to four factors identified as contributing to each crash. Thus, a driver identified as both drowsy and making an improper lane change would appear twice in the table counts. In the case of two-vehicle crashes, the table reflects related factors for the at-fault driver. Also, it should be noted that the list of factors in this table represents only a partial listing, excluding those not specifically related to driving error (e.g., tire blowout, vision obscured by trees), and those cited very infrequently (such as driving under minimum speed, failure to take prescription medicine, and failure to signal).

Table 7. 2002-2006 FARS descriptive results – driver-related factors (partial list).

Driver Factors	Two-Vehicle Crashes At-fault Driver Only				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Drowsy, fell asleep	1.37	1.11	0.63	1.89	6.83	8.03	6.79	4.96
Ill, blackout	2.91	2.30	1.76	1.10	7.18	11.13	11.57	2.04
Medication/drugs	0.08	0.03	0.00	0.09	0.25	0.22	0.35	0.13
Alcohol/drugs/DUI	4.32	2.15	0.66	11.98	9.08	3.56	1.90	20.57
Inattentive	11.39	9.74	10.46	10.20	10.85	11.06	11.40	9.92
Other physical impairmt	0.36	0.40	0.47	0.18	0.80	1.48	1.55	0.30
Run off road	1.98	1.44	1.26	2.80	24.13	27.87	25.22	26.29
Improper tailing	1.05	1.26	1.04	1.37	0.23	0.32	0.17	0.13
Improper lane change	1.66	0.86	0.41	1.79	0.33	0.32	0.58	0.78
Failure to keep in lane	32.53	22.56	13.16	39.82	38.46	33.17	34.31	36.11
Improper entry/exit	0.44	0.68	0.79	0.29	0.03	0.07	0.35	0.05
Improper start/back	0.20	0.34	0.25	0.17	0.10	0.18	0.35	0.08
Prohibited pass	0.28	0.31	0.13	0.95	0.08	0.00	0.06	0.25
Passing insuf. distance	1.33	0.89	0.25	1.96	0.23	0.14	0.12	0.43
Erratic/reckless	4.08	3.20	2.51	7.25	7.58	5.69	6.91	10.75
Failure to yield	38.79	51.48	61.70	26.89	1.05	1.51	1.78	0.81
Failure to obey signal	18.26	17.27	18.79	17.30	2.23	3.24	5.01	2.12
Driving too fast	8.61	5.53	3.33	19.91	24.61	18.47	16.35	44.41
Wrong lane turn	0.12	0.22	0.19	0.11	0.00	0.00	0.00	0.01
Other improper turn	4.16	5.78	5.44	3.77	4.93	4.97	4.84	5.28
Wrong way	0.32	0.34	0.35	0.43	0.05	0.04	0.06	0.04
Wrong side of road	4.44	4.15	3.46	5.55	0.43	0.65	1.21	0.64
Stopping in road	0.32	0.43	0.19	0.31	0.03	0.07	0.06	0.02
Over-correcting	1.98	1.41	0.75	3.36	12.68	9.47	7.89	13.19

Driver Factors	Two-Vehicle Crashes At-fault Driver Only				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Weather	0.57	0.68	0.41	0.68	0.70	0.68	0.46	0.48
Glare	0.24	0.65	0.50	0.33	0.13	0.22	0.75	0.09
Cellular phone	1.21	0.83	0.72	1.27	1.10	0.76	0.35	1.28

With respect to two-vehicle crashes:

- Failure to yield was the most frequently cited related factor among older drivers. Overall, 27% of drivers failed to yield, but this percentage increased to 39% for drivers 60 to 69, 51% for drivers 70 to 79, and 62% for drivers 80 and older.
- As a group, older drivers were underrepresented in citations for failure to keep in proper lane (e.g., crossing the centerline, going straight in a turn lane), driving too fast, alcohol or drug use, and careless or reckless driving, all of which are important contributors to two-vehicle crashes overall.

With respect to single-vehicle crashes:

- Older drivers were somewhat more likely to be identified as ill or blacking out, drowsy or asleep, using medications or drugs (other than alcohol), and having some other physical impairment (missing limb, hearing loss, etc.). They were less likely to be identified as driving too fast, and somewhat less likely to have overcorrected. Otherwise, their related factor profile does not differ greatly from that of the general driving population.

Exposure-Adjusted Risk Factors for Fatal Two-Vehicle Crashes

This section provides results from the induced exposure analyses of the subset of two-vehicle fatal crashes in which one at-fault and one not-at-fault driver were identified. The not-at-fault driver was assumed to be "an innocent victim," and as such, to represent the exposure level of his/her age group in the driving situation under study. Thus, the ratio of at-fault to not-at-fault drivers (crash involvement ratio, or CIR) represents the degree of over- (if greater than 1.0) or under- (if less than 1.0) involvement with respect to a given risk factor. Data tables supporting the following graphs are included in Appendix C.

Driver Factors

Figure 1 shows that older drivers' risk of involvement in fatal two-vehicle crashes remained "below average" for drivers 60 to 69, but rose sharply for older age groups. For drivers 70 to 79, the risk was nearly equivalent to that of teenage drivers, and for those 80 and older, it was four times higher than expected based on driving exposure. These results may reflect factors in addition to driving performance decrements, such as increased frailty and overall driving exposure characteristics.

The results in Figure 1 also present a "baseline" against which subsequent results in this section can be compared, i.e., unless a given factor produces an effect greater than 0.75 for drivers 60 to 69, 1.75 for drivers 70 to 79, and/or 4.00 for drivers 80 and older, it was

not a strong risk factor for older driver involvement in a fatal two-vehicle crash. Conversely, if a factor produced an effect *lower* than the referenced values, it could be considered protective against crash involvement for a particular age group.

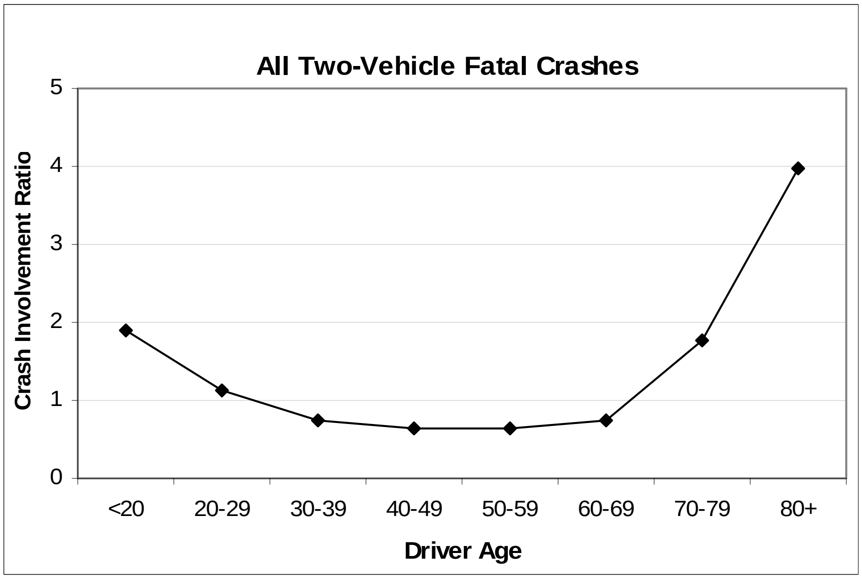

Figure 1. Overall two-vehicle fatal CIRs by driver age group.

Figure 2 shows the same results separately for male and female drivers. The female CIR was somewhat higher at 60 to 69, and even more so at 70 to 79. The male CIR was slightly higher (4.1 to 3.9) among drivers 80 and older.

The effect of number of occupants in the vehicle is shown in Figure 3. Interestingly, an older driver was at greatest risk of crashing when one other occupant was in the vehicle, and at lowest risk when there were two or more other occupants. Although the presence of occupants can increase the likelihood of a crash being fatal (i.e., there are more opportunities for at least one of the occupants to be killed in the crash), without additional information such as passenger age this does not explain why having two or more passengers is "safer" than having just one other passenger. It is noteworthy that this effect increased with age.

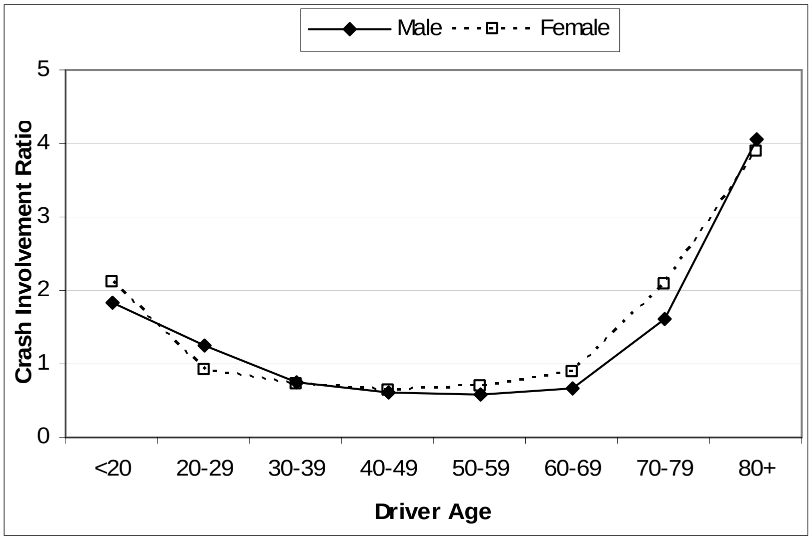

Figure 2. Fatal crash involvement ratios by driver gender.

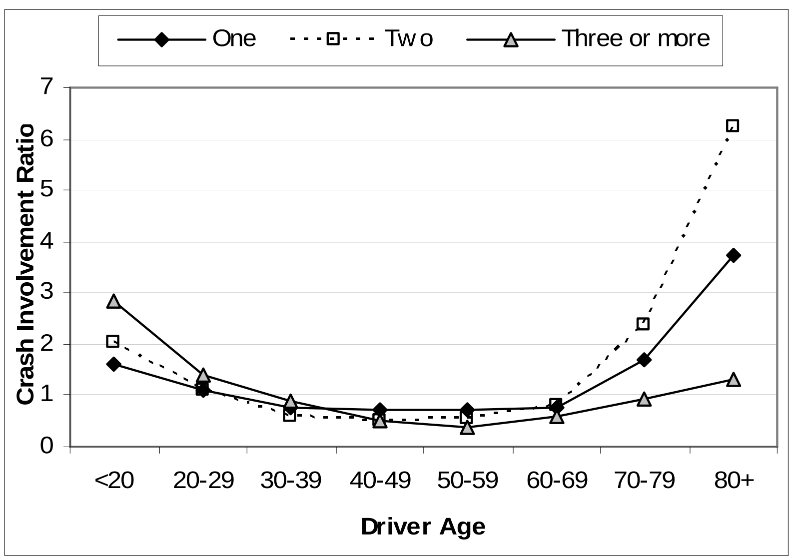

Figure 3. Two-vehicle fatal CIRs by total number of occupants in the vehicle.

Roadway Factors

Figures 4-6 display results for roadway function class, posted speed limit, and number of travel lanes. For drivers 70 and older, the risk of involvement in fatal two-vehicle crashes was elevated when traveling on principal arterial roadways. The oldest drivers had a slight elevation in risk when traveling on higher speed roadways. Otherwise, 40 to 45-mph roadways presented the greatest risk to older drivers, a fact that likely reflects the increased presence of intersections and heavy traffic flow on these sorts of roadways. As might be expected, two-lane roadways were safer for older drivers than multilane roadways; and 5+ lane roadways posed added risk for drivers 80 and older.

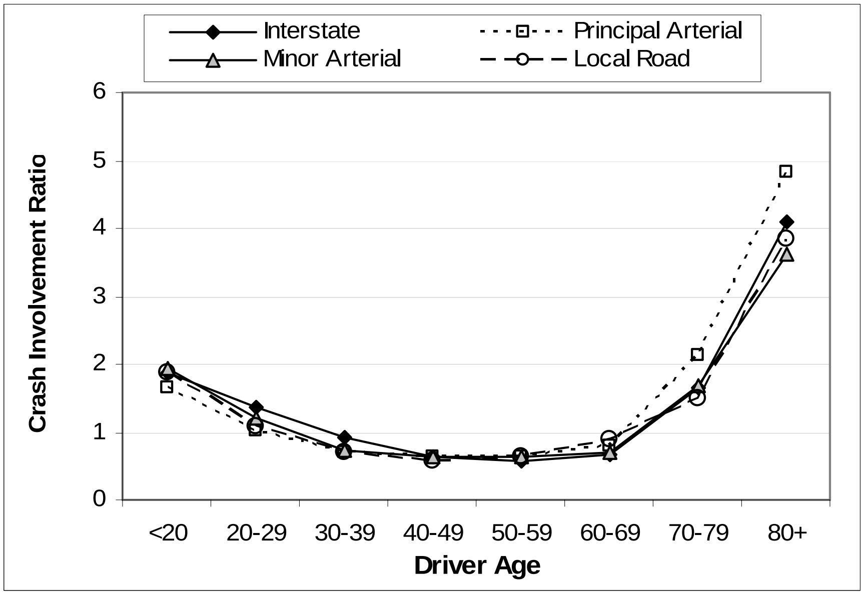

Figure 4. Two-vehicle fatal CIRs by roadway function class.

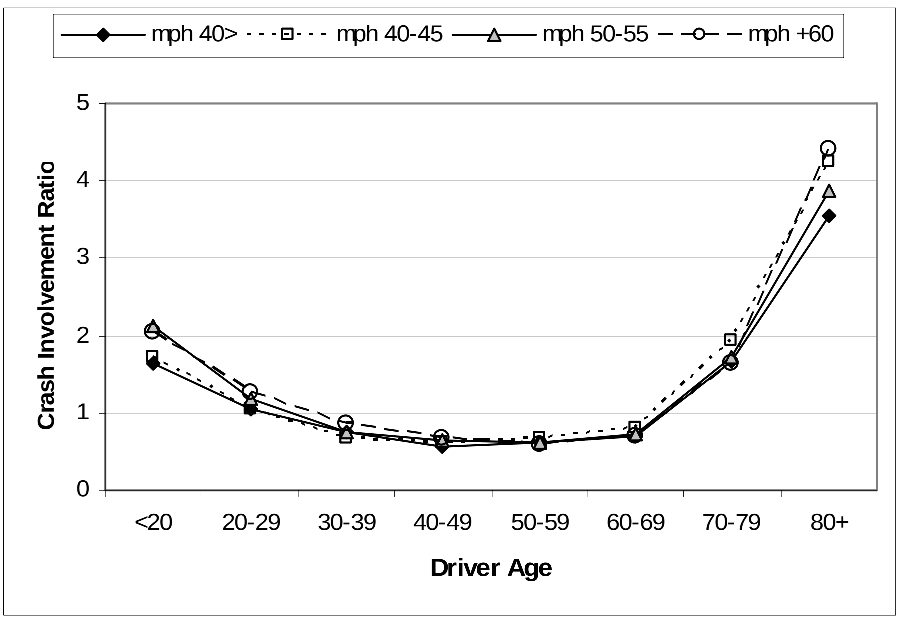

Figure 5. Two-vehicle fatal CIRs by roadway speed limit.

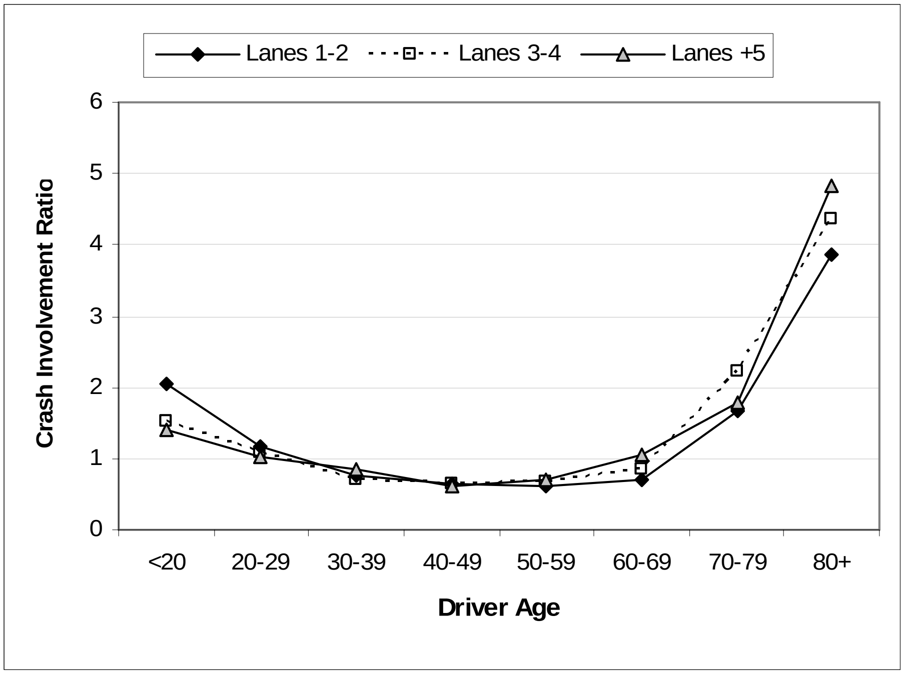

Figure 6. Two-vehicle fatal CIRs by number travel lanes.

More distinct differences emerge when examining specific roadway features and traffic control devices (Figures 7-9). As shown in Figure 7, older drivers, and especially those 70 and older, were at greatest risk of crashing at intersection and driveway locations, but were about as safe as younger drivers at non-junction locations. While these results were not especially surprising given the descriptive findings already reported, they demonstrate that the increased risk remained even when accounting for older drivers' (presumably) greater exposure to intersection locations.

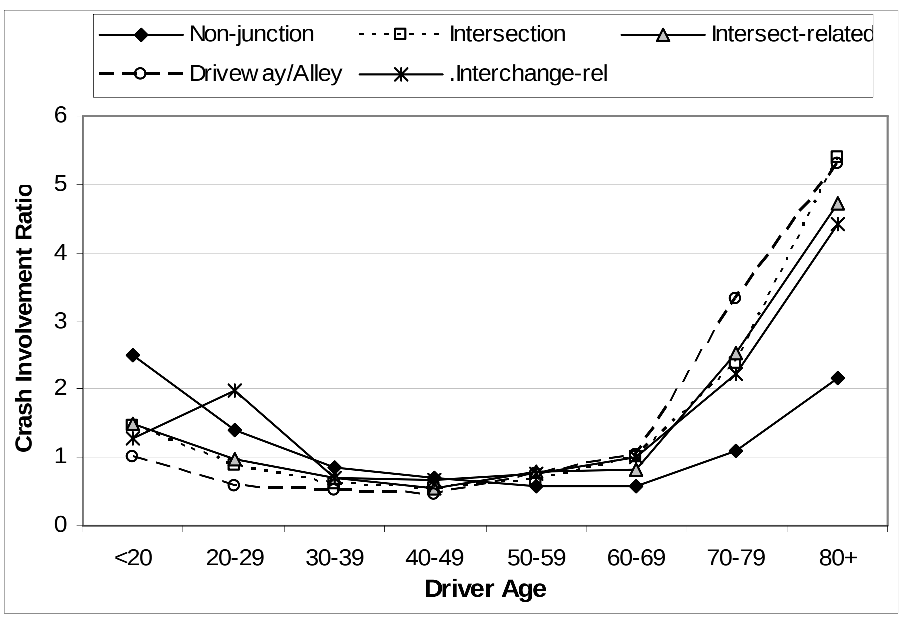

Figure 7. Two-vehicle fatal CIRs by roadway junction type.

Figure 8 provides more detail about interchange locations, where drivers 70 and older demonstrated an elevated crash risk. Older drivers, especially those 70 and older, were most at risk when traveling through an intersection associated with an interchange, followed by negotiating an entrance or exit ramp. Risk levels at these locations were about equal to or greater than that of more standard intersection locations.

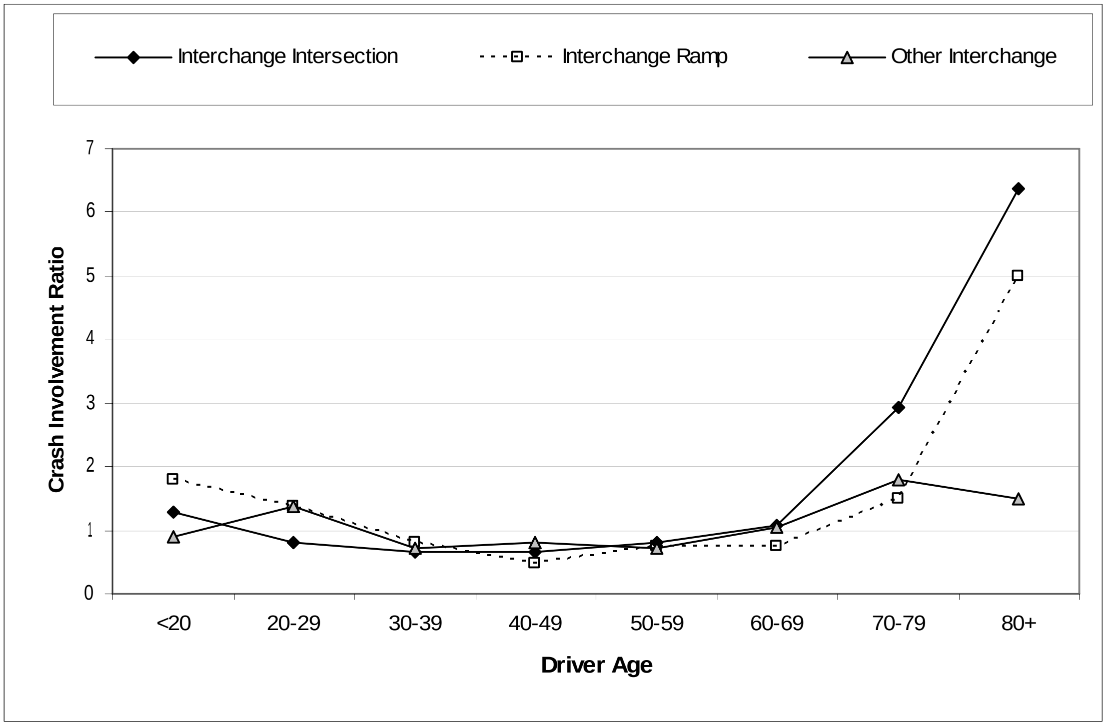

Figure 8. Two-vehicle fatal CIRs by interchange feature.

The greatest risk of a fatal two-vehicle crash occurred at non-signal-controlled intersections. In Figure 9, the overall CIR at intersections was repeated for comparison purposes in the blue diamond pattern. Compared to this overall CIR, the CIR for signal-controlled intersections was actually lower, especially for drivers 80 and older. Among 60 to 69 year-old drivers, the only situation posing increased risk was flashing signals. For 70 to 79 year-old drivers, flashing signals and stop and yield signs were associated with elevated risk (ratios of 2.9 for each, compared to 2.4 for all intersection locations). For drivers 80 and older yield sign locations were by far the most dangerous. Although not depicted in the figure due to scale limitations, the CIR at yield sign locations for drivers 80 and older was 26.0—this was based on 27 crash-involved drivers, *26 of whom were at fault*. Stop sign locations were also associated with a substantial increase in crash risk (CIR=7.5, compared to 5.4 overall).

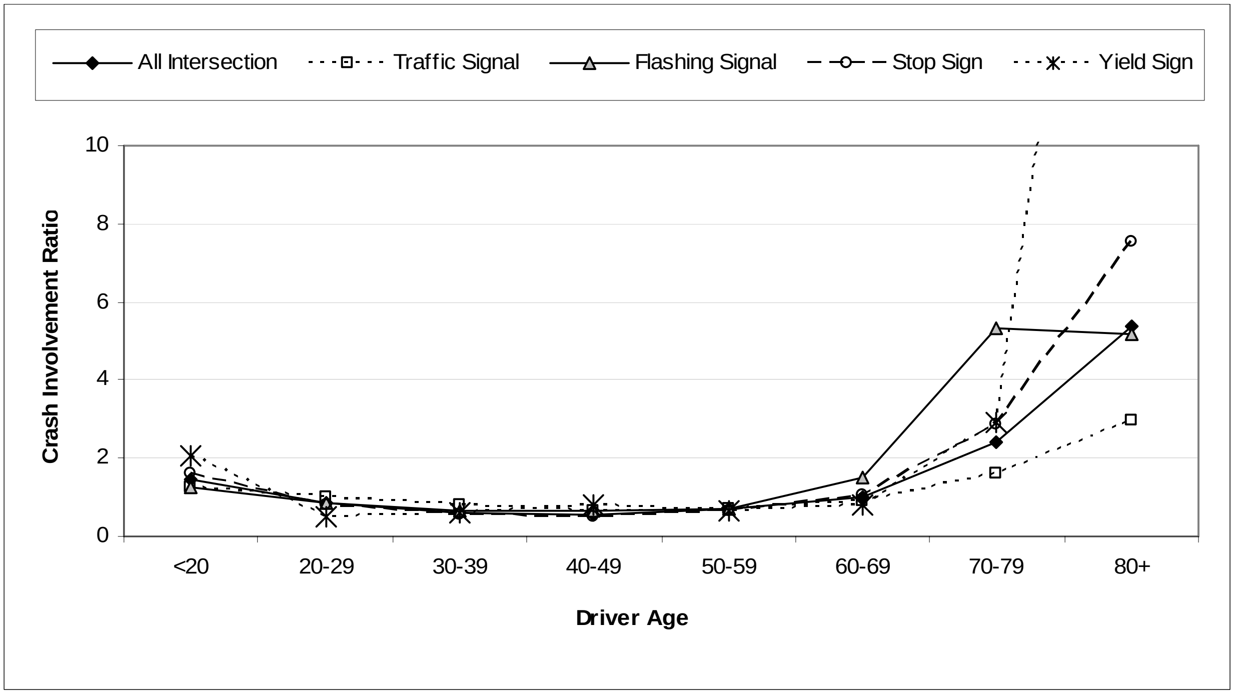

Figure 9. Two-vehicle fatal CIRs by intersection traffic control.

<u>Environmental Factors</u>

Figure 10 presents results for fatal two-vehicle crashes occurring in urban versus rural locations (based on the FARS *Roadway Function Clas*s variable). In contrast to younger drivers, older drivers were at greater risk of involvement in a fatal two-vehicle collision when traveling on urban roadways. However, the increase in risk was relatively small, and likely reflected the increase in intersection crashes (and more dangerous side impacts) in urban areas.

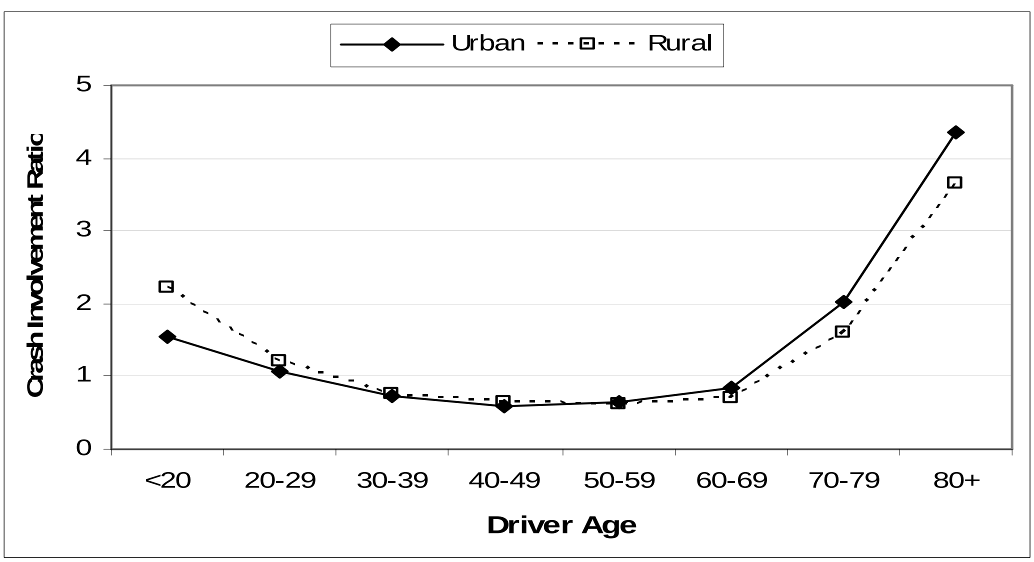

Figure 10. Two-vehicle fatal CIRs on urban versus rural roadways.

The two figures that follow show risks of two-vehicle fatal crashes associated with driving under various light (Figure 11) and weather (Figure 12) conditions. In contrast to young drivers, who were overrepresented when driving at dawn, drivers 70 and over were at greatest risk when driving at dusk. Other lighting conditions did not appear to pose additional risk for older drivers, at least when compared to daytime driving.

In addition, older drivers were not at increased risk when driving in "bad" weather conditions such as rain, snow, or sleet. The absence of an increased at-fault crash risk in situations generally considered to be higher risk (such as nighttime driving or driving in adverse weather conditions) may reflect older drivers' tendency to self-regulate, and not drive under these conditions unless they feel capable.

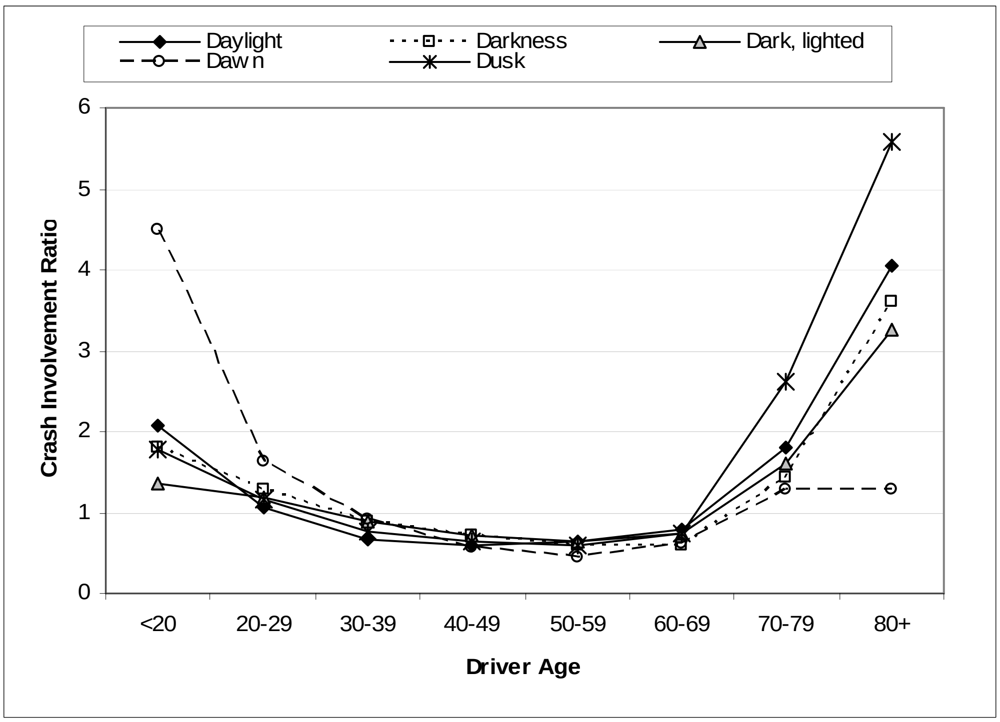

Figure 11. Two-vehicle fatal CIRs for various light conditions.

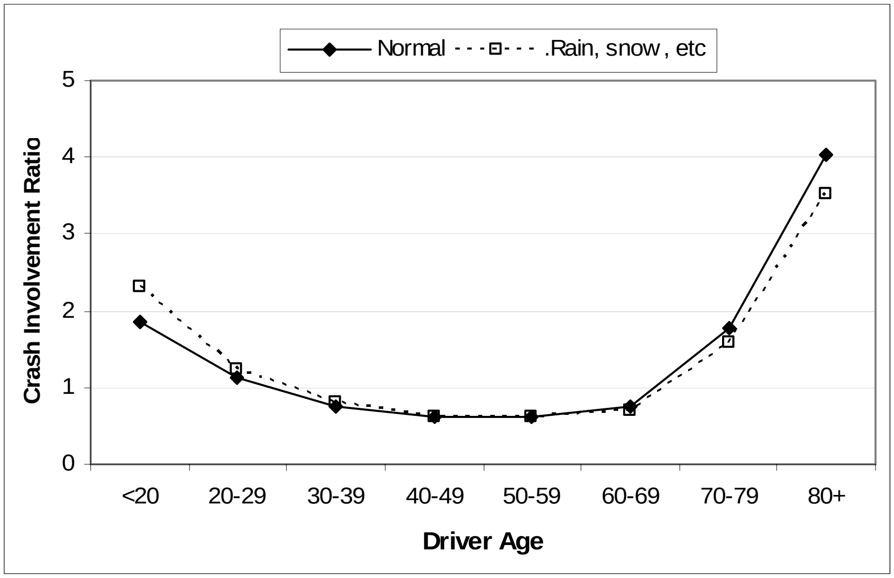

Figure 12. Two-vehicle fatal CIRs for normal and not normal weather conditions.

Crash Factors / Vehicle Maneuvers.

This section examines specific vehicle maneuvers identified in the descriptive results as problematic for older drivers. Results are based on the maneuver of the at-fault driver in the crash. For intersection locations, the maneuvers were examined with respect to the type of traffic control device.

Figure 13 summarizes available results for signal-controlled intersection crashes. Proceeding straight through a signal-controlled intersection posed minimal risk to older drivers, even those 80 and older. Risk was increased when the control was a flashing rather than a steady traffic signal. However, turning left posed the greatest risk to older drivers. Even at a signal-controlled intersection, they had a nine-fold increase in crash risk (compared to all drivers) after adjusting for exposure. Numbers for turning left at a flashing light were too small to analyze (only 55 fatal crashes across all age groups), but indicated substantial increased risk as well: of 11 drivers 70 to 79 involved in fatal two-vehicle crashes when turning left at flashing signals, *all* were at fault. For drivers 80 and older, all 7 drivers involved in this type of crash were at fault. Results with respect to right-turn maneuvers at signal-controlled intersections were too small to report.

Figure 13. Two-vehicle fatal CIRs by vehicle maneuver at signal controlled intersections.

Figure 14, a companion to Figure 13, presents results for various vehicle maneuvers at intersections controlled by a stop or yield sign, as well as driveways and alleyways (which function like yield signs when no control is present). Noting the change in scale for this graph (increasing from 1-10 to 1-20 CIRs), drivers 70 to 79 were most at risk when turning left at a stop-sign controlled intersection or when turning left out of a driveway. They are also at increased risk when first starting up at a stop sign (beginning to move forward without any notation of which way they were proceeding through the intersection). The results with respect to turning at a yield sign are not shown due to small numbers; but 11 of the 12 drivers 70 to 79 turning either left or right at a yield sign were at fault.

For drivers 80 and older, going straight at a yield sign emerged as the most dangerous maneuver. This might occur when merging onto a limited access roadway and having to check behind for traffic. Starting up or turning left at a stop sign increased risk 12 to 14-fold, while turning left out of a driveway or alley increased risk 8-fold. Results are not displayed for turning maneuvers at yield signs due to small cell counts; but all seven drivers 80 and older who were involved in such collisions were judged to be at fault.

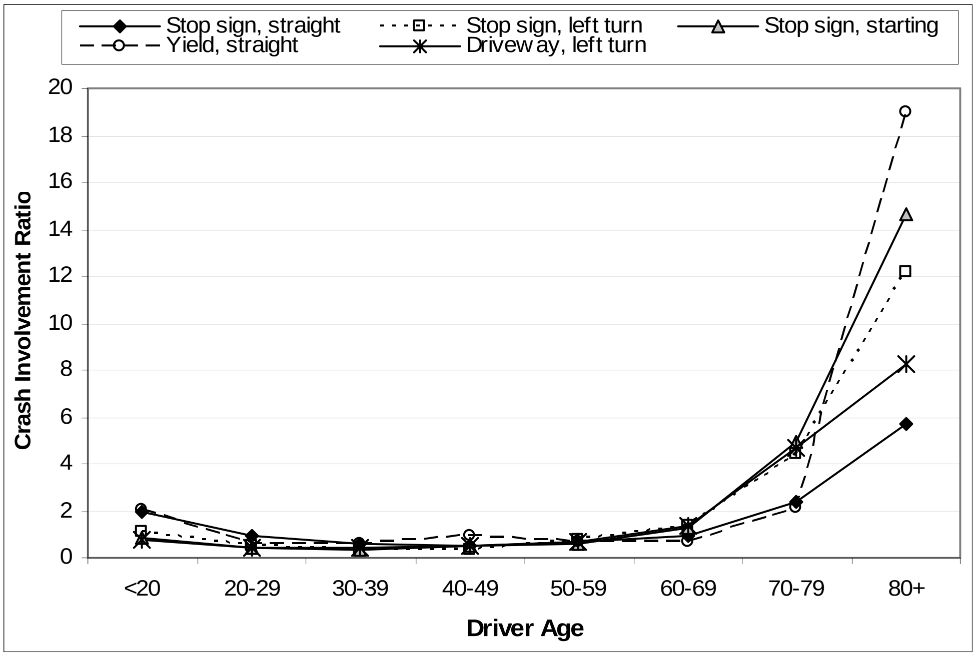

Figure 14. Two-vehicle fatal CIRs by <u>vehicle maneuver at sign controlled intersections and driveways</u>.

Figure 15 shows results for various vehicle maneuvers at non-junction locations. They include situations where the at-fault driver was changing lanes or merging, passing, and starting in the lane. These older drivers were *not* at increased risk when passing, and only at slightly increased risk when changing lanes or merging. Results with respect to starting in the lane were less clear, in part because of smaller cell counts (17, 18, and 20 for 60 to 69, 70 to 79, and 80 and older, respectively), but also because it is not known what precipitated the starting maneuver.

Results with respect to changing lanes or merging were further investigated for various road types in Figure 16. These results show some increase in risk for older drivers 70 and older on certain roadways, the risk does not exceed the average crash risk (4.0, see Figure 1) for this age group. Notwithstanding, changing lanes or merging was most risky for older drivers traveling on multilane roadways. It may be that older adults of all abilities encountered multilane roadways in their everyday driving, whereas only the more competent (and confident) choose to drive on Interstates or busier arterial and collector roadways. Of course, there is some degree of overlap among these various roadway classifications. It should be noted that results with respect to "4+ lane" are based on only 10 total drivers in the 80-and-older category (8 at-fault, 2 not-at-fault).

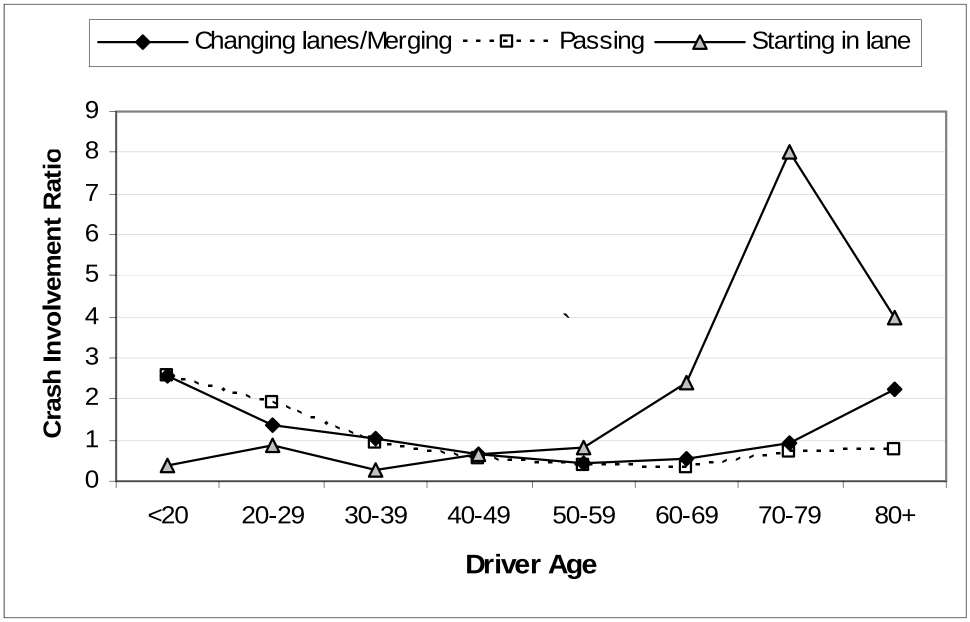

Figure 15. Two-vehicle fatal CIRs for at-fault <u>vehicle maneuvers at non-junction locations</u>.

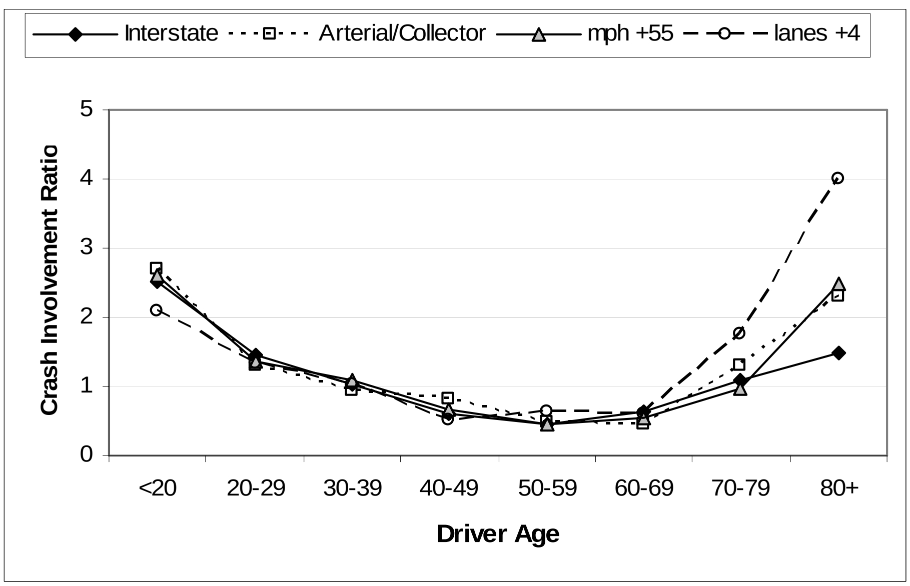

Figure 16. Two-vehicle fatal CIRs for <u>changing lanes or merging</u> on various types of roadways.

RESULTS OF GES DATA ANALYSIS

The NASS General Estimates System, or GES data, is a nationally representative probability sampling of all police-reported motor vehicle crashes in the United States. Approximately 56,000 police crash reports are identified and coded each year, then weighted to reflect an estimated six million total annual crashes. As previously described, the analysis files developed for the current study were restricted to eligible vehicle types (cars, utility vehicles, vans, and light trucks) and to single- and two-vehicle crashes (excluding pedestrian and bicycle crashes).

As with the earlier analyses of FARS data, this analysis was descriptive in nature and involved (1) crosstabulations of relevant driver, vehicle, roadway, environmental, and crash factor variables by driver age, for single- and two-vehicle crashes; and (2) more in-depth analysis of two-vehicle crash factors using the method of induced exposure. Cases with missing variable level values were excluded from the analyses rather than using available imputed values; according to the file documentation, variables containing imputed values are only recommended for use when generating single variable distributions.

Characteristics of Older Driver Crashes (All Severities)

Results in the following tables are based on the combined 2002-2006 weighted GES data and follow a similar format to that used in reporting the FARS results. Available variables are grouped according to driver, vehicle, roadway, environmental, and crash categories, although the specific variables and variable levels often differ. The percentages presented are column percents, and have been calculated with missing cases removed to facilitate comparisons between the single- and two-vehicle crash conditions, as well as with the FARS data.

Driver Characteristics

Table 8. 2002-2006 GES descriptive results – driver characteristics.

Driver Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Injury Severity								
Fatal (K)	0.08	0.22	0.39	0.07	0.83	1.38	1.25	0.53
Incapacitating (A)	1.46	1.86	2.15	1.31	4.32	3.42	5.34	4.26
Non-incap/evid. (B)	3.82	4.06	6.02	3.60	8.29	9.22	10.15	9.60
Possible (C)	11.00	9.85	9.51	10.45	8.49	10.26	11.90	10.28
None (O)	83.41	83.77	81.59	84.35	79.40	74.94	70.54	74.91
Gender								
Male	57.513	56.50	56.31	54.57	62.88	62.84	56.50	61.65
Female	42.49	43.50	43.69	45.43	37.12	37.16	43.50	38.35
Physical Impairment								
None	98.61	98.87	98.63	98.38	86.42	86.37	82.72	85.14
Occupants								
One	73.83	72.10	75.69	69.95	76.57	75.62	77.81	72.45
Two	20.46	23.43	22.37	19.94	18.02	21.01	20.20	18.45
Three+	5.71	4.47	1.94	10.10	5.41	3.36	1.98	9.11

- Only a small percentage of drivers involved in two-vehicle police-reported crashes experienced fatal or incapacitating injuries. The percentages were higher for drivers in single-vehicle crashes, but still represented less than 5% of all crash-involved drivers. These percentages were slightly higher for drivers 60 to 69 and they increased with age.
- Males were overrepresented in both single- and two-vehicle crashes, although not to the extent shown in the FARS data. Similar to FARS, there was no clear trend with respect to age, except that females in the oldest age group were at increased risk of involvement in a single-vehicle collision.
- Older drivers were no more likely than the norm to have some physical impairment (loss of limb, loss of vision in one eye, hearing loss, etc.).
- As a group, older drivers were somewhat more likely to be the sole occupant in the vehicle, and much less likely as they aged to be driving with two or more other passengers. These findings are similar to those reported for the FARS data.

Vehicle Characteristics

Table 9. 2002-2006 GES descriptive results – vehicle characteristics.

Vehicle Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Body Type								
Auto/auto deriv	58.85	69.95	80.19	59.76	53.63	64.00	80.26	58.74
Utility	11.88	7.30	4.25	14.82	11.64	6.70	3.32	14.24
Van	9.99	7.88	5.46	7.75	11.08	11.04	7.17	6.99
Light truck	19.27	14.88	10.11	17.67	23.66	18.26	9.25	20.03
Vehicle age								
Less than 5 years	41.67	37.95	31.85	38.03	40.83	39.59	31.69	36.43
5-9 years	32.20	32.52	32.94	34.06	31.88	31.10	31.55	34.41
10+ years	26.13	29.53	35.20	27.91	27.29	29.30	36.76	29.17

- Consistent with the FARS data, with increasing age, older drivers who crashed were less likely to be driving utility vehicles and light trucks, and more likely to be driving standard automobiles or automobile derivatives.
- Also consistent with the FARS data, those 60 to 69 were more likely to drive newer model vehicles (less than 5 years old), while those 80 and older were more likely to be driving vehicles 10 years old or older.

Roadway Characteristics

Table 10. 2002-2006 GES descriptive results – roadway characteristics.

Roadway Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Interstate								
No	95.85	96.82	98.41	94.77	89.98	92.59	95.36	89.30
Yes	4.15	3.18	1.59	5.23	10.02	7.41	4.64	10.70
Speed Limit								
35 mph or less	48.49	50.18	54.26	48.02	31.87	40.50	55.91	33.91
40-45 mph	32.56	32.62	30.85	31.80	15.64	13.15	10.35	16.48
50-55 mph	13.73	12.90	12.21	13.64	34.38	31.49	22.86	32.40
60+ mph	5.20	4.30	2.68	6.53	18.11	14.86	10.88	17.21
Number of Travel Lanes								
1-2	46.95	46.89	47.57	47.81	85.16	85.87	84.79	83.33
3-4	33.96	33.91	31.72	34.25	11.31	11.25	11.75	13.29
5+	19.09	19.20	20.71	17.94	3.53	2.88	3.46	3.38
Relation to Junction								
Non-junction	22.71	19.34	15.36	25.96	82.99	78.58	73.94	81.58
Intersection	34.59	40.51	45.19	32.24	0.46	0.19	0.07	0.28
Intersection-related	21.93	18.91	16.97	22.56	7.29	8.25	14.34	9.32
Driveway/alley	14.38	15.44	18.61	12.82	4.73	8.11	7.49	3.45
Other non-interchng	2.83	2.80	1.84	2.70	2.45	2.94	2.63	1.91
Interchng-intersect	0.90	0.72	0.84	0.81	0.07	0.00	0.07	0.09
Interchange ramp	2.19	1.74	1.11	2.31	1.45	1.54	0.73	2.64
Interchange other	0.47	0.54	0.07	0.61	0.56	0.39	0.74	0.73
Traffic Control Device								
No device	47.10	45.27	44.94	49.70	91.62	91.51	86.94	92.15
Traffic signal	31.04	30.44	28.55	29.38	2.51	1.76	3.13	2.01
Flashing signal	1.09	1.03	1.00	1.14	0.10	0.15	0.05	0.13
Stop sign	16.68	19.53	22.26	15.86	1.83	2.39	5.33	2.38
Yield sign	2.40	2.42	1.71	2.47	0.08	0.04	0.24	0.21
Warning sign	0.91	0.60	0.73	0.82	3.08	2.67	3.11	2.42
Railroad marking	0.18	0.06	0.02	0.10	0.31	0.59	0.85	0.20

- The only roadway classification information available for the GES data was whether the crash did or did not occur on an Interstate highway. Consistent with the FARS data, older drivers' single- and two-vehicle crashes on Interstate highways decreased sharply with age.
- The same pattern of decreasing crash rates with increasing age was seen in the data for 60+ mph speed limits. In contrast, older adults were increasingly likely to be involved in crashes on roadways with speed limits of 35 mph or less. This was especially true for single-vehicle crashes, which increased from less than a third for drivers 60 to 69 to 56% for drivers 80 and older.

- Older drivers' single- and two-vehicle crash distributions with respect to number of travel lanes were similar to those for the overall driving population.
- As with the fatal crash data, older drivers were overrepresented in two-vehicle crashes at intersection and driveway/alley locations, and underrepresented in crashes at non-junction locations. They were also underrepresented in both single- and two-vehicle crashes occurring on interchange ramps.
- With respect to two-vehicle crashes, older drivers were no more likely than the overall driving population to crash at traffic signal locations, despite the overall increase in proportion of intersection crashes. They were, however, much more likely to crash at intersections controlled by stop signs. Relatively few older driver crashes occurred at yield sign locations, and they were not overrepresented compared to the overall crash-involved population.
- Although most older drivers' single-vehicle crashes occurred at non-junction locations, an increasing percentage with age were intersection-related, or occurred at driveway/alley locations (approximately 20% of the total for drivers 70+). Similar to the FARS data, there was an overrepresentation of single-vehicle crashes at railroad sign locations.

<u>Environmental Characteristics</u>

Table 11. 2002-2006 GES descriptive results – environmental characteristics.

Environmental Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Time of Day								
6:00am – 9:59am	15.88	14.48	13.27	16.41	18.90	15.37	15.06	17.00
10:00am – 1:59pm	31.64	37.89	39.45	24.44	19.73	26.95	30.95	13.84
2:00pm – 5:59pm	36.56	35.33	38.74	36.43	22.04	28.31	32.61	18.42
6:00pm – 9:59pm	12.89	10.49	7.22	16.31	24.87	21.39	17.53	21.63
10:00pm – 1:59am	2.36	1.27	1.15	4.70	9.11	4.54	2.23	16.68
2:00am – 5:59am	0.66	0.56	0.17	1.71	5.45	3.44	1.62	12.42
Light Condition								
Daylight	84.63	87.92	91.07	78.17	58.53	67.59	76.72	46.71
Dark	3.02	2.50	2.16	4.64	26.96	19.83	9.99	31.45
Dark, lighted	9.32	7.09	4.64	13.79	9.33	7.57	9.92	16.36
Dawn	0.96	0.59	0.30	0.95	2.60	1.93	1.30	3.21
Dusk	2.06	1.90	1.83	2.46	2.58	3.08	2.07	2.27
Weather conditions								
No adverse	87.72	87.96	89.40	85.95	83.65	86.57	85.10	78.85
Rain, fog, etc.	12.28	12.04	10.60	14.05	16.35	13.43	14.90	21.15

- Older drivers were substantially overrepresented in both single- and two-vehicle crashes occurring between the hours of 10 a.m. and 2 p.m., a finding likely related to their increased exposure during these hours. With increasing age, older drivers were less likely to crash in the evening hours, between 6 p.m. and 10 p.m.; however, even for the oldest age group a relatively high proportion (nearly 1 in 5) of single-vehicle crashes occurred between 6 p.m. and 10 p.m.

- The data revealed a strong pattern of increased single- and two-vehicle crashes during daylight hours, and decreased dark and dark but lighted crashes with increased driver age. Even drivers 60 to 69 were strongly overrepresented in daylight crashes; and for those 70 to 79, nearly 90% of two-vehicle crashes, and two-thirds of single-vehicle crashes, occurred during daylight hours.
- Older drivers were less likely than the overall driving population to crash during adverse weather, which likely reflects a decrease in driving exposure under these conditions.

Crash Characteristics

Table 12. 2002-2006 GES descriptive results – crash characteristics.

Crash Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Vehicle Role								
Striking	45.83	50.07	54.26	50.88	--	--	--	--
Struck	52.72	48.63	44.05	47.63	--	--	--	--
Both	1.34	1.22	1.69	1.32	--	--	--	--
Initial Impact Point								
Front/corner	41.65	44.09	47.18	46.68	--	--	--	--
Right side	16.24	18.20	21.45	14.61	--	--	--	--
Back/corner	26.53	19.37	13.21	23.04	--	--	--	--
Left side	15.44	18.22	18.16	15.46	--	--	--	--
Top/under	0.02	0.05	0.00	0.04	--	--	--	--
Manner of Collision								
Rear-end	38.29	31.26	24.24	41.65	--	--	--	--
Head-on	3.16	2.91	3.13	3.34	--	--	--	--
Angle	49.57	56.58	64.32	45.29	--	--	--	--
Sideswipe/same directn	6.87	7.60	6.83	7.33	--	--	--	--
Sideswipe/opp directn	1.29	0.91	1.01	1.43	--	--	--	--
First Harmful Event								
Motor vehicle in trnsp.	99.03	99.21	99.35	98.81	--	--	--	--
Non-collision/rollover	--	--	--	--	11.70	7.41	7.30	13.59
Fixed object	--	--	--	--	41.33	44.26	53.04	52.40
Non-fixed object	--	--	--	--	31.50	27.37	13.50	21.58
Parked vehicle	--	--	--	--	15.48	20.96	26.16	12.42
Movement: Crit. Event								
Going straight	45.77	44.39	41.89	49.09	71.84	68.70	64.30	67.56
Decelerating in lane	7.64	5.71	4.31	7.20	0.73	0.69	1.42	0.90
Accelerating in lane	0.13	0.06	0.06	0.16	0.15	0.57	1.42	0.18
Starting in lane	3.49	4.08	4.87	3.38	0.29	0.24	0.03	0.15
Stopped in lane	15.25	10.97	6.37	14.11	0.08	0.01	0.02	0.06
Passing/overtaking	1.05	1.05	1.27	1.19	0.69	0.50	0.79	0.70
Leaving/entering park	0.83	0.60	0.59	0.62	1.98	3.34	4.08	1.12

Crash Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Turning right	3.63	4.86	6.49	3.39	2.00	2.81	3.04	2.45
Turning left	14.52	19.94	25.93	12.93	1.86	2.44	4.37	2.93
U-turn	0.61	0.92	0.92	0.60	0.21	0.23	0.92	0.24
Backing (not parking)	1.85	1.42	1.62	1.36	5.98	7.10	7.85	3.42
Negotiating curve	1.51	1.21	0.95	2.02	11.80	11.22	10.15	17.63
Changing lanes	2.94	3.84	3.96	3.14	0.93	0.62	0.68	1.10
Merging	0.36	0.54	0.29	0.39	0.28	0.24	0.38	0.45

The crash experience of older persons summarized in Table 12 indicates that:

- The modest effect of drivers' increasing likelihood of being the struck, as opposed to the striking vehicle with increasing age was in sharp contrast to the data from fatal crashes. These results may be attributed at least in part to older drivers' increased fragility and likelihood of death, especially when struck in the side.
- Older drivers' two-vehicle crashes were also more likely to involve left or right side impacts, and less likely to involve a rear impact. The percentage of frontal impacts, however, remained high, at nearly half of all initial impacts.
- As with the FARS data, there was a strong pattern of increased involvement in angle collisions with driver age.
- Older driver single-vehicle crashes were more likely to involve an initial collision with a parked vehicle or, for those 60 to 69, another non-fixed object, and they were less likely to involve a non-collision rollover. They were also less likely to involve striking a fixed object, although these types of crashes still characterized nearly half of older drivers' single-vehicle collisions.
- Although not quite as high as with fatal crashes, older drivers were strongly overrepresented in two-vehicle collisions involving a left turn. They were also overrepresented in collisions involving right turns and, to a lesser extent, changing lanes. One out of every five drivers 70 to 79 and one out of four of the 80 and older age group were turning left at the time of their crashes.

Driver Contributing Factors

Table 13. 2002-2006 GES descriptive results – driver contributing factors.

Driver Characteristics	Two-Vehicle Crashes				Single-Vehicle Crashes			
	60-69	70-79	80+	All ages	60-69	70-79	80+	All ages
Driver Distraction[1]								
Not distracted	50.18	46.01	45.18	48.34	46.80	47.02	39.40	46.84
Looked but didn't see	3.57	4.94	6.47	3.06	1.05	1.28	1.25	0.81
Sleepy or fell asleep	0.19	0.11	0.14	0.22	4.02	4.97	5.91	4.21
Inattn., lost in thought	6.47	7.36	9.57	6.45	4.54	7.09	9.88	4.37
Violations Charged[2]								
Alcohol/drugs	3.37	1.01	0.12	4.92	2.12	0.84	0.60	8.65
Speeding	5.74	4.33	4.50	8.31	3.66	4.21	0.64	6.86
Reckless driving	1.08	1.01	0.61	1.75	0.51	0.42	0.25	2.64
Suspended/revoked lic	0.86	0.60	0.49	2.70	0.06	0.28	0.19	1.97
Failure to yield	34.17	42.31	46.02	26.61	0.06	0.00	0.06	0.06
Run light/stop sign	12.56	11.95	12.04	10.14	0.13	0.56	0.00	0.30
Violation, no details	3.30	3.36	2.74	4.04	0.84	0.84	0.16	1.71
Other violation[3]	45.96	40.22	39.33	55.28	13.09	11.31	12.92	20.22

[1] Based on all drivers in two-vehicle crashes. Information was not coded or not available from police crash reports for 35% of single-vehicle and 36% of two-vehicle crash drivers (in addition to ~6% missing). The only variable levels presented are those representing more than 1% of the total coded.

[2] Based on the at-fault driver only in the smaller sample of two-vehicle crashes where one driver was identified as at-fault and the second driver not-at-fault. Computed by combining up to four violations cited for each driver, so that the combined column percentages can total more than 100%.

[3] No further details provided.

Noting the caveats in the footnotes, the results in Table 13 above reveal that:

- Older drivers were more likely to be identified as "inattentive/lost in thought" or "looked but didn't see" at the time of their crash. These two categories of driver distraction applied to 10 to 15% of older drivers in two-vehicle crashes for whom information was available.
- Older drivers were less likely to be cited for use of alcohol/drugs, speeding, reckless driving, or driving with a suspended or revoked license. However, they were much more likely to be cited for failure to yield when at-fault in a two-vehicle collision. Roughly a third of at-fault drivers 60 to 69 were cited for failure to yield in their crash, increasing to 46% for drivers 80 and older.

Exposure-Adjusted Risk Factors for Two-Vehicle Police-Reported Crashes

As with the FARS data, the smaller database of two-vehicle crashes, in which one driver was identified at-fault and one not-at-fault, was used to identify situations in which older drivers were at increased risk of crashing, adjusted for their driving exposure. Specifically, tables of at-fault driver age crosstabulated by not-at-fault driver age were generated for selected variable levels and variable level combinations of interest, and the ratio of at-fault to not-at-fault drivers was computed within age categories. The graphs that follow plot these CIRs. Although the results are based on the weighted GES file, unweighted tables were also generated, and where the raw numbers were found to be small (generally involving cell counts less than 20), notation has been made in the text. The tables used to generate the graphs (based on the weighted GES data) are contained in Appendix D.

Driver Factors

Figure 17 shows changes in the CIR with driver age, both overall and separately for males and females. When comparing these results with those based on the fatal crash data in Figures 1 and 2, the most striking difference is in the shape of the curve. Rather than being "J-shaped," the curve generated by the GES data is decidedly "U-shaped," with older drivers showing increased risk that closely parallel those of younger drivers. Also, the increase in risk is not nearly as great: instead of peaking at 4.0 for drivers 80 and older involved in fatal crashes, the CIR for overall crash involvement was only 1.9 (identical to that of drivers under 20 years old). CIRs for males and females deviate only slightly from this overall trend.

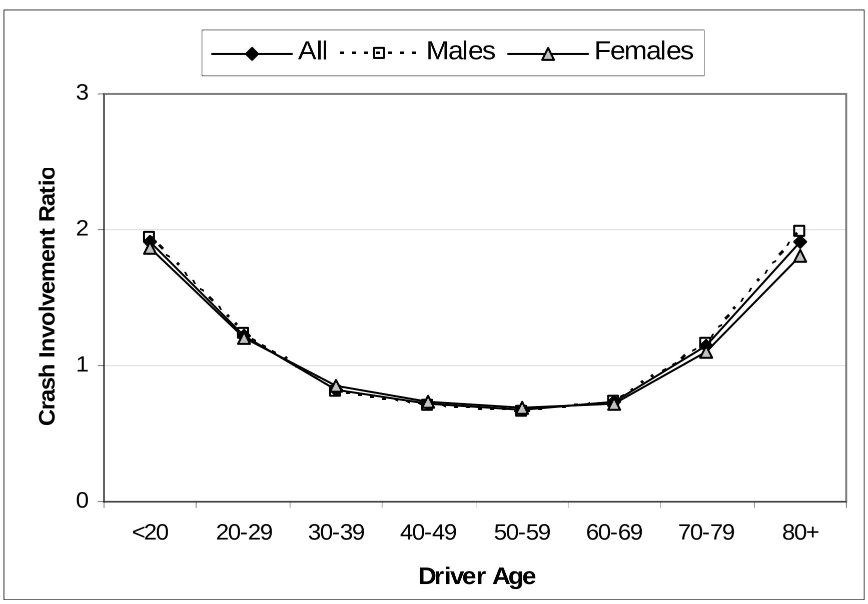

Figure 17. Two-vehicle CIRs for police-reported crashes, overall and by driver sex.

These results suggest that at least some of the increase in crash risk seen in the FARS data is due to older adults' increased risk of dying in a crash, rather than any inherent increase in risk of being involved in a crash. If this is the case, then the degree of discrepancy may vary with the crash situation being examined (e.g., side impact crashes may be more likely to be affected by older drivers' greater fragility than rear-end crashes).

The following discussion will focus on situations where older drivers' risk of crashing was elevated, based on their "baseline" levels in Figure 17 of 0.73 for drivers 60 to 69 (well below "average" risk), 1.14 for drivers 70 to 79 (somewhat higher than average risk), and 1.91 for drivers 80 and older (nearly double the risk).

Figure 18 shows the effect of number of occupants in the vehicle on a driver's likelihood of involvement in a crash. These results are similar to those in Figure 3 for fatal crashes, and suggest a protective effect of having more than one other passenger in the vehicle. Having just one passenger was associated with an increased risk of crashing for the oldest drivers.

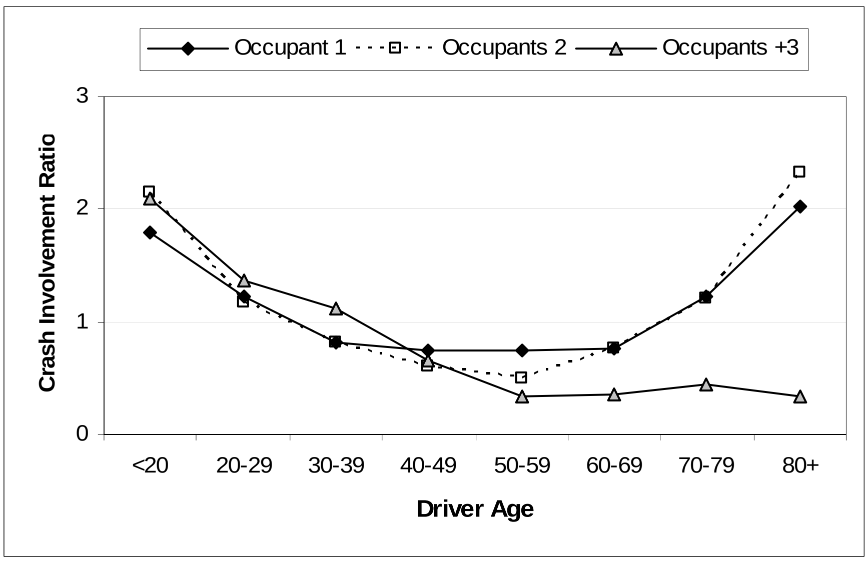

Figure 18. Two-vehicle CIRs for police-reported crashes by <u>number of occupants</u> in the vehicle.

Results with respect to driver injury level are shown in Figure 19. Here, fatal (K) level injuries have been omitted due to small sample sizes in the raw data (31 fatalities). However, the results clearly show that drivers 70 and older were at increased risk of moderate and serious injuries. These trend lines closely mimic the "J-shaped" curve found in Figure 1 based only on fatal crash data.

Roadway Factors

This section summarizes results related to roadway characteristics. In the GES data, the only variable describing roadway type indicates whether the crash occurred on an Interstate roadway. Results for this variable were based on relatively small raw sample sizes for drivers 80 and older. There were 36 drivers 80 and older involved in two-vehicle crashes on Interstate roadways (22 at-fault and 14 not-at-fault). The weighted crash involvement ratio for these drivers was 3.34, unexpectedly high, and much higher than that for other observed CIRs. The CIR for drivers 70 to 79 remained below 1.0.

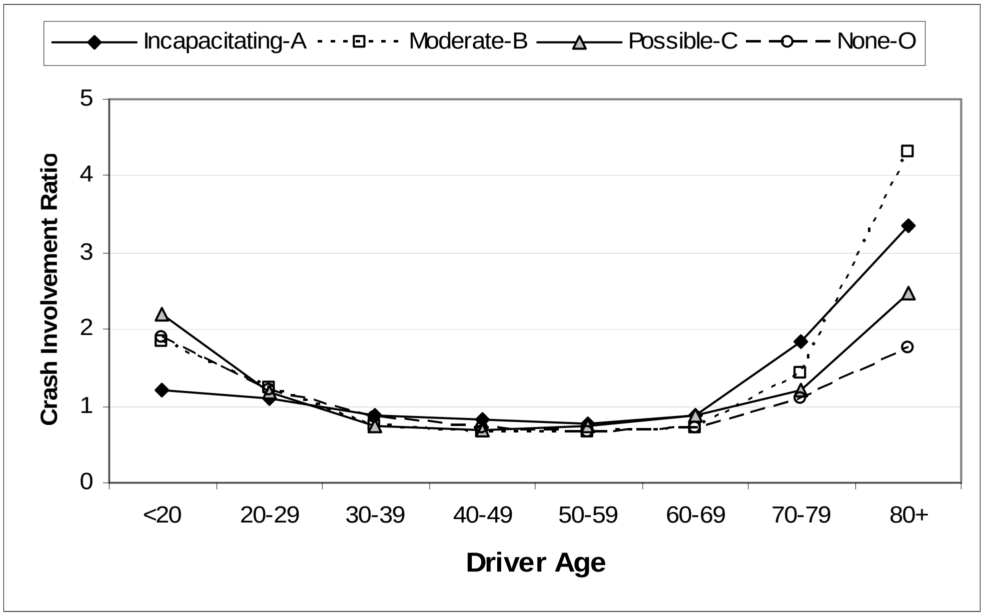

Figure 19. Two-vehicle CIRs for police-reported crashes by driver injury severity.

The results for roadway speed limit in Figure 20 below show that for drivers 80 and older the CIR rose steadily with increased speed limits, peaking at 2.6 on 60+ mph roadways. Meanwhile, there was a conflicting finding for drivers 60 to 69 and 70-79, whereby <40 and 40-45 mph roadways had higher CIRs than 60+ mph roadways. These results were similar to those based on FARS data (see Figure 5), and may be related to the types of crashes that occur on these roadways, and the greater likelihood of an older driver being at fault if the crash involved a turning maneuver.

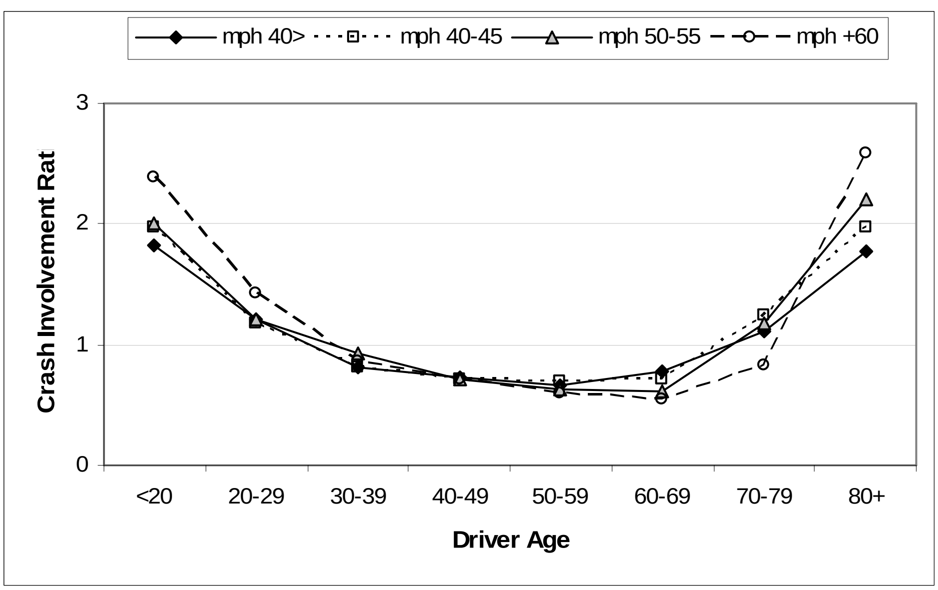

Figure 20. Two-vehicle CIRs for police-reported crashes by roadway speed limit.

Results with respect to number of travel lanes (Figure 21) show an increase in risk for drivers 80 and older traveling on 5+ lane roadways. Otherwise, the results mimic the FARS data results (see Figure 6), with only a slight increase in crash risk associated with multilane roadways beginning at age 70.

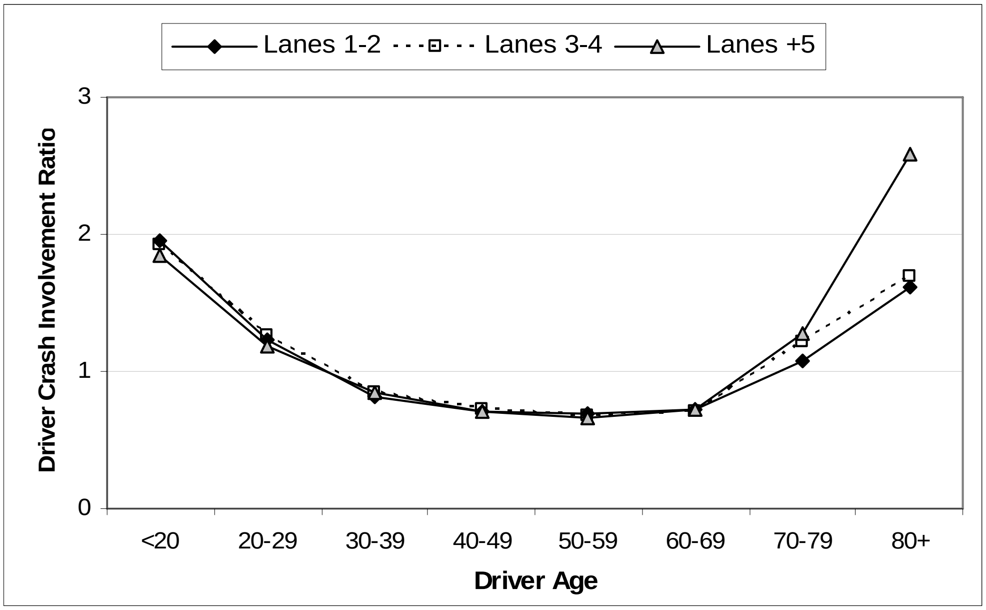

Figure 21. Two-vehicle CIRs for police-reported crashes by number travel lanes.

Figure 22 combines results for speed limit and number of travel lanes. Not shown is the data point for drivers 80 and older, traveling on 5+ lane roadways with speed limits of 50 mph or greater. This data point, 6.34, was based on a raw sample CIR of 31/10, so is somewhat questionable. A second questionable data point in Figure 22 is that for drivers 80 and older traveling on 50-55 mph, 3-4 lane roadways. This data point (0.92) was lower than that for drivers 70 to 79, and was based on a raw sample CIR of 46/23. Anomalies notwithstanding, the two situations that appear to have posed the greatest risks to drivers 70 and older were high-speed 2-lane roadways, and multilane roadways with speed limits of 40-45 mph.

Figure 23, keyed to various roadway junction situations, shows older drivers were under-represented in crashes occurring at non-junction locations and those categorized as intersection-related. The latter might include, for example, rear-end collisions caused by traffic backed up at an intersection, or a driver making a late lane-change maneuver when approaching an intersection. The category of "other non-interchange," which appeared most prominently for drivers 80 and older, refers to crashes that occurred at same-grade lane channels; for example, when there was a left or right turn lane that was not a through lane (often marked by a traffic island). Otherwise, and consistent with the FARS data, intersections and interchanges posed the greatest risk to drivers 70 and above.

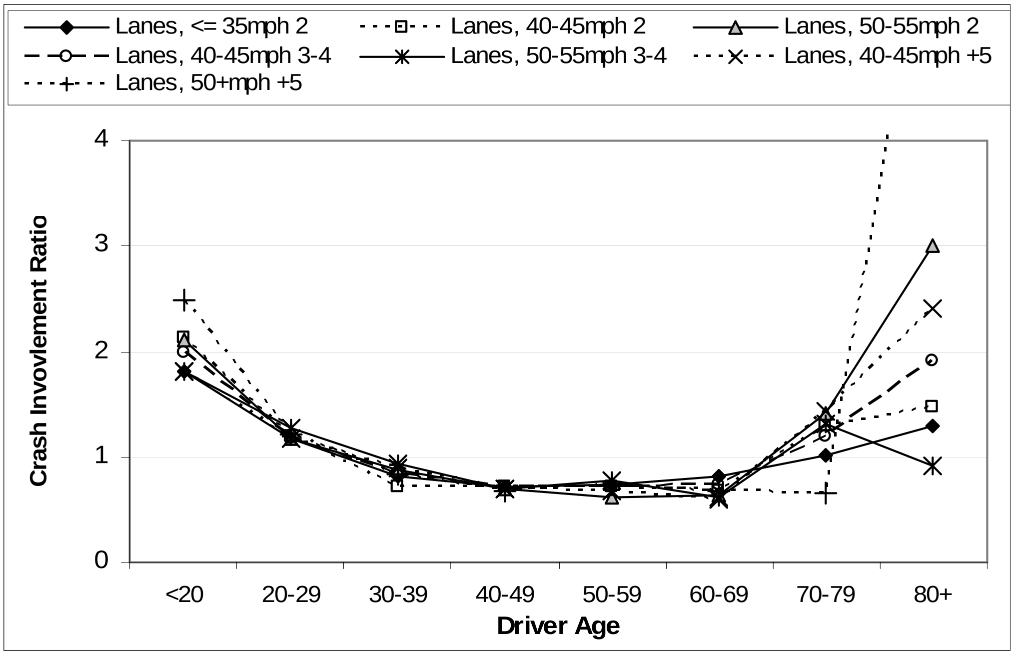

Figure 22. Two-vehicle CIRs for police-reported crashes by number travel lanes combined with speed limit.

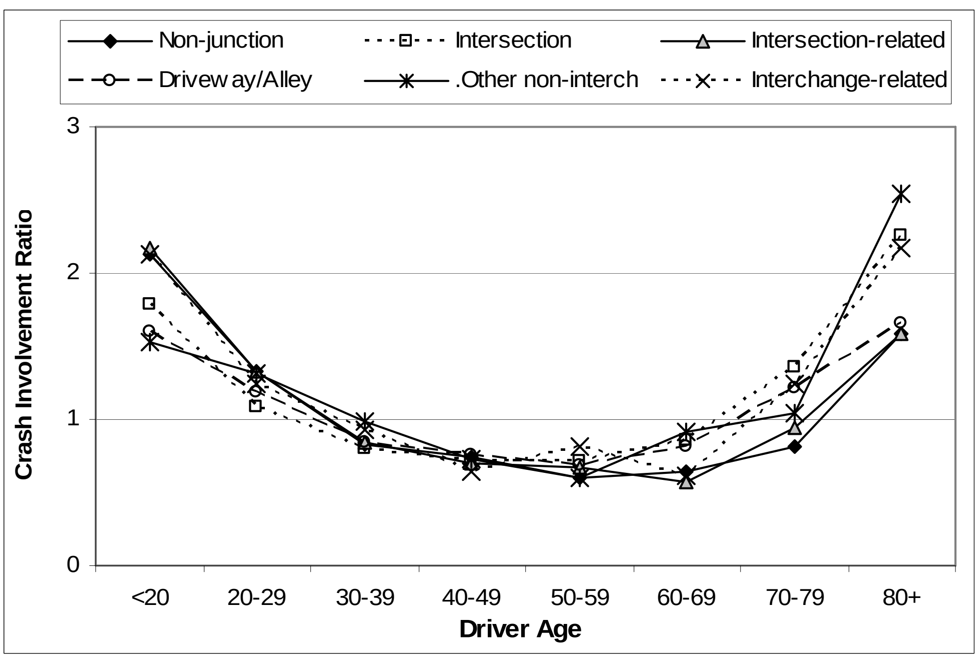

Figure 23. Two-vehicle CIRs for police-reported crashes by roadway junction.

Findings with respect to traffic control device (Figure 24) show an elevated risk at yield sign locations for drivers 80 and older, but not for those 70 to 79. Stop sign and flashing signal controls were associated with higher risk of crashing for drivers in all age groups, but especially those 70 and older. These results, along with the finding that the risk of crashing at a signal-controlled intersection was slightly lower than the overall risk of crashing at an intersection are consistent with the FARS results.

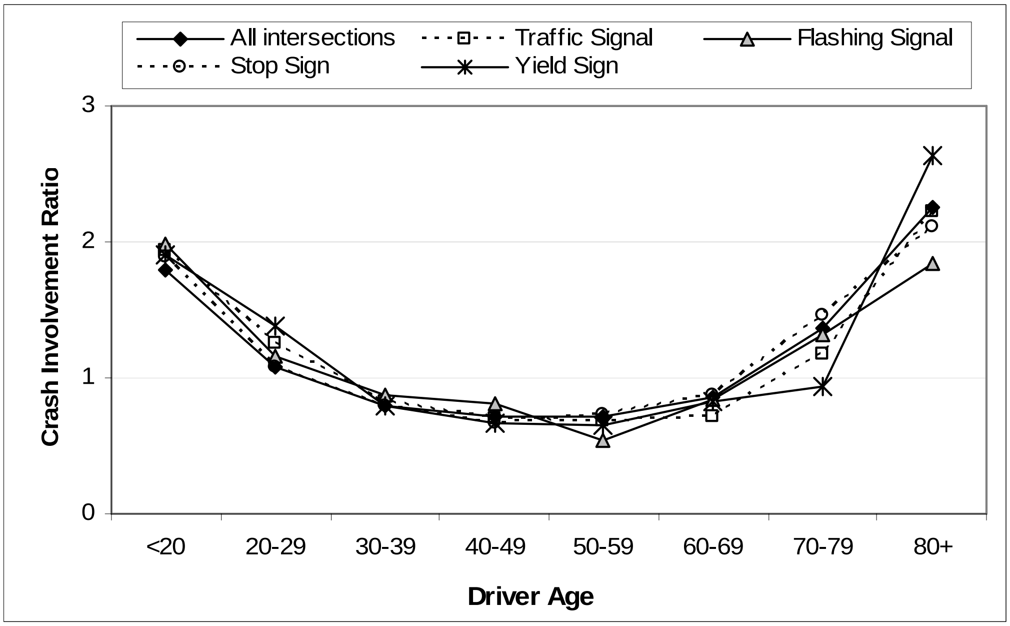

Figure 24. Two-vehicle CIRs for police-reported crashes by traffic control device.

Environmental Factors

Analyses included two environmental-related factors: light conditions and weather conditions at the time of the crash. Results with respect to light conditions (Figure 25) show similarities as well as differences as compared to the fatal crash data in Figure 11. Some of the differences can likely be attributed to low numbers in both datasets, especially for the “dawn” light condition. In the GES data, there were 30 raw cases of drivers 70 to 79, and only 10 for drivers 80 and older (which is why this data point is missing in Figure 25). But the larger categories of dark, and dark-lighted, also show some differences. Although both the FARS and GES data showed only a small increase in risk associated with such nighttime driving for drivers 70 to 79, the GES data showed increases in risk for drivers 80 and older in unlighted darkness. In contrast, the FARS data revealed no such increase in nighttime driving risk. It may be the case that, while nighttime driving was riskier for older drivers, the absence of higher speed nighttime driving reduced their risk of fatal crashes.

The impact of weather conditions (Figure 26) generally mirrored those found in the FARS data (Figure 12), and indicate no increased risk of being at-fault in a crash in unfavorable weather conditions. While this is somewhat counterintuitive, it may reflect older drivers’ tendency to self-regulate and drive only when they feel comfortable doing so.

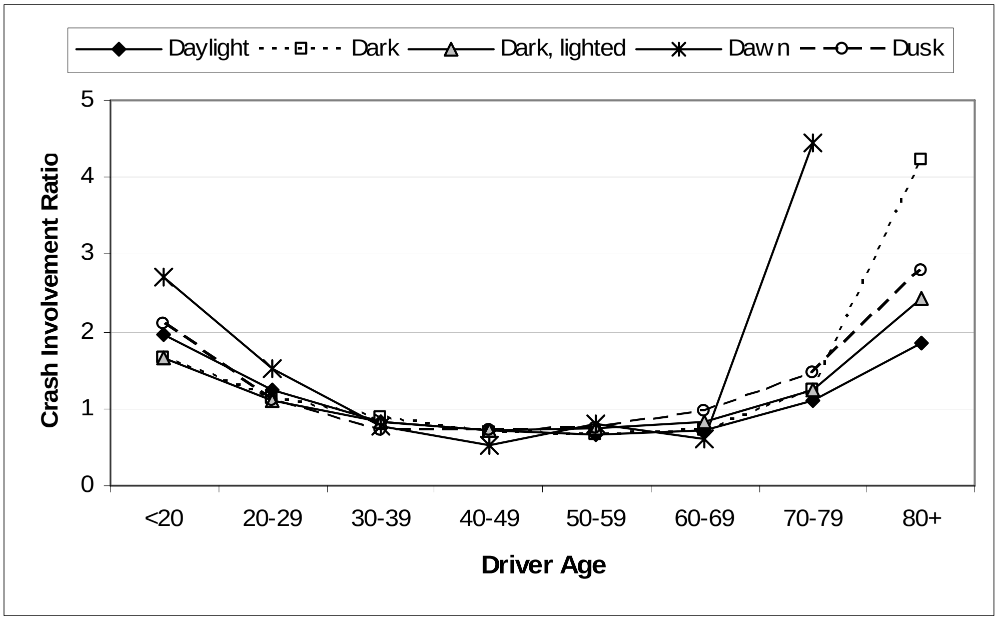

Figure 25. Two-vehicle CIRs for police-reported crashes by light conditions.

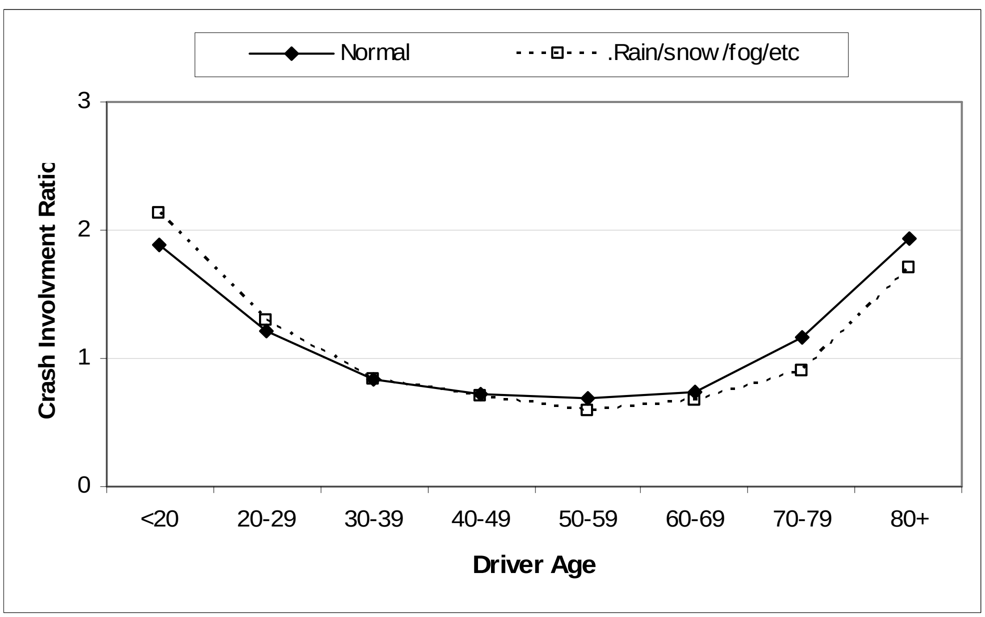

Figure 26. Two-vehicle CIRs for police-reported crashes by weather conditions.

Crash-Related Factors

Crash-related factors examined in this final section include crash configuration or manner of collision; the at-fault vehicle's movement immediately prior to the critical crash event; and the initial point of impact for the at-fault vehicle.

The results in Figure 27 show older drivers to be underrepresented in rear-end collisions, and overrepresented in angle and sideswipe/same direction collisions, compared to other types of crashes. The angle collisions likely reflect their greater involvement in intersection crashes, especially when turning left. Sideswipe same-direction collisions are more difficult to characterize, but may relate to an increased difficulty changing lanes or staying in the proper lane.

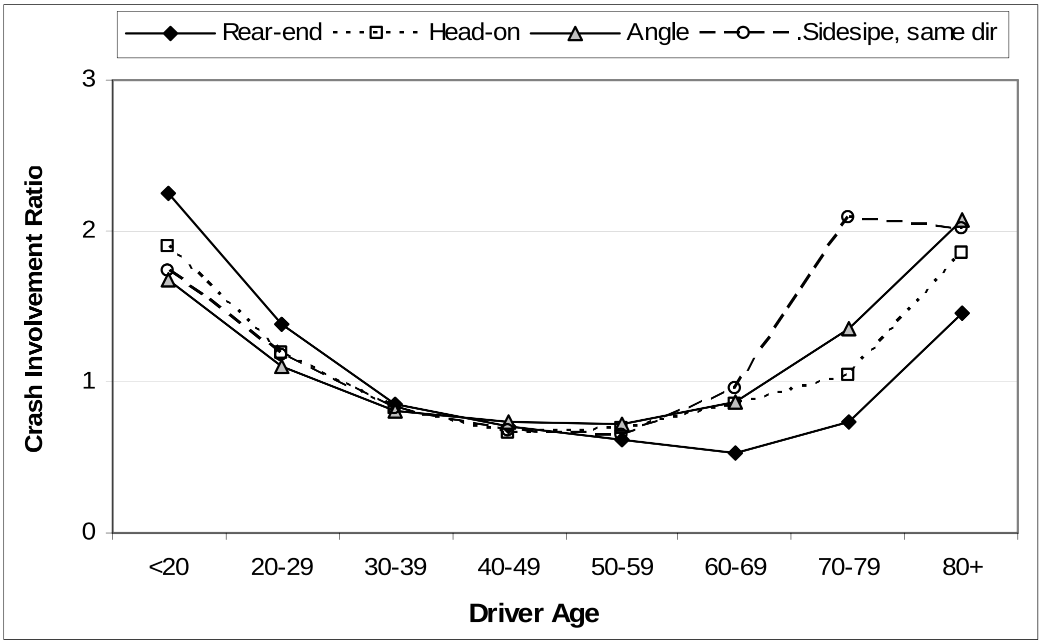

Figure 27. Two-vehicle CIRs for police-reported crashes by manner of collision.

Figure 28 presents information on at-fault vehicle maneuvers. There was a clear increase in crash risk when turning left or starting up in a travel lane. Risk also increased with age when turning right or changing lanes. The only maneuver that does not show a substantial increase relative to going straight ahead is passing/overtaking. As discussed earlier with respect to fatal crashes, this may be because older drivers tend to self-regulate and not pass or overtake other vehicles unless they are confident they can do so in safety.

Results for merging maneuvers are not shown due to small sample sizes in the raw data – only 8 drivers 80 and older and 14 70 to 79. Backing maneuvers and decelerating in travel lane crashes were also omitted from Figure 28, as neither was considerably elevated for older drivers (see Appendix D tables).

Figure 29 shows results for going straight and turning left maneuvers at signal-controlled and stop sign-controlled intersections. Clearly, the most dangerous situation for older drivers was turning left at a signal-controlled intersection, while the least dangerous was going straight at a signal-controlled intersection. Turning left or going straight at a stop sign posed about equal levels of risk, although going straight was slightly more challenging for drivers 80 and older. These results are similar to those presented in Figure 14 for fatal crashes, except that going straight at a stop sign location was found to be less dangerous relative to the other situations examined.

Other combinations of vehicle maneuver and traffic control device were also examined, but results were generally unstable at higher age levels due to small sample sizes in the raw GES data. For example, there were only 10 total incidents of drivers 80 and older turning left at yield sign locations, and 12 total incidents of drivers 80 and older going straight at yield signs.

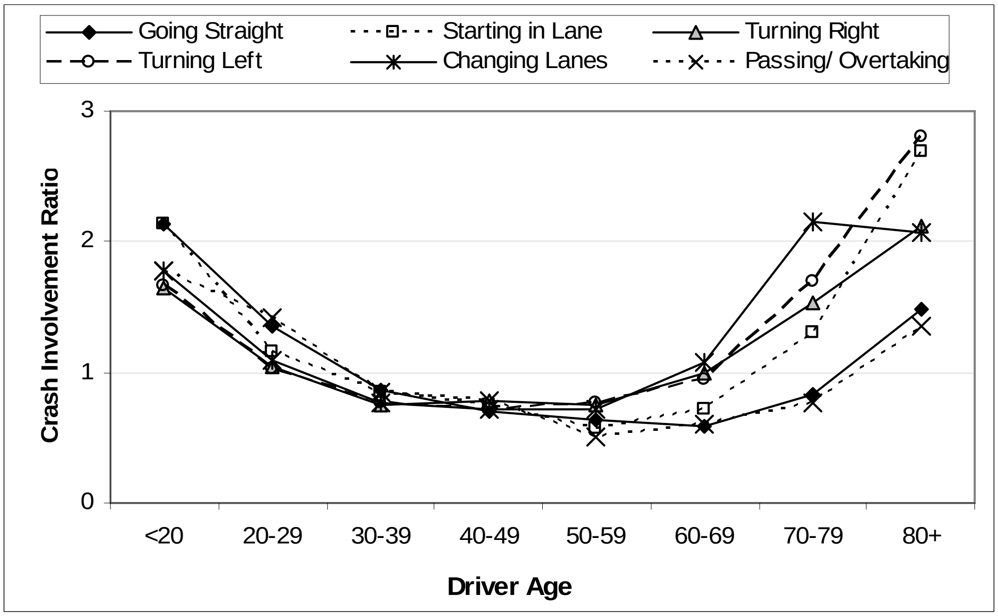

Figure 28. Two-vehicle CIRs for police-reported crashes by at-fault <u>vehicle movement</u> prior to critical event.

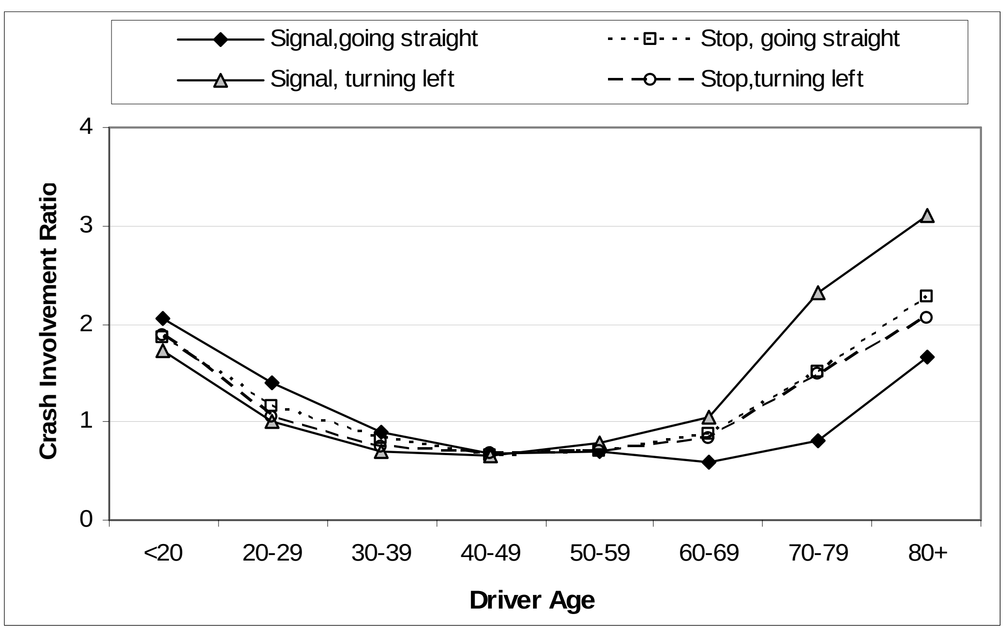

Figure 29. Two-vehicle CIRs for police-reported crashes by at-fault vehicle movement and traffic control device.

Finally, Figure 30, based on data from the initial point of impact for the at-fault vehicle, shows older drivers were at increased risk of being struck in the side. Drivers 80 and older were especially vulnerable to right side impacts. This situation can occur when turning left at a stop sign and being struck by a vehicle approaching from the right – the classic "looked but didn't see" situation.

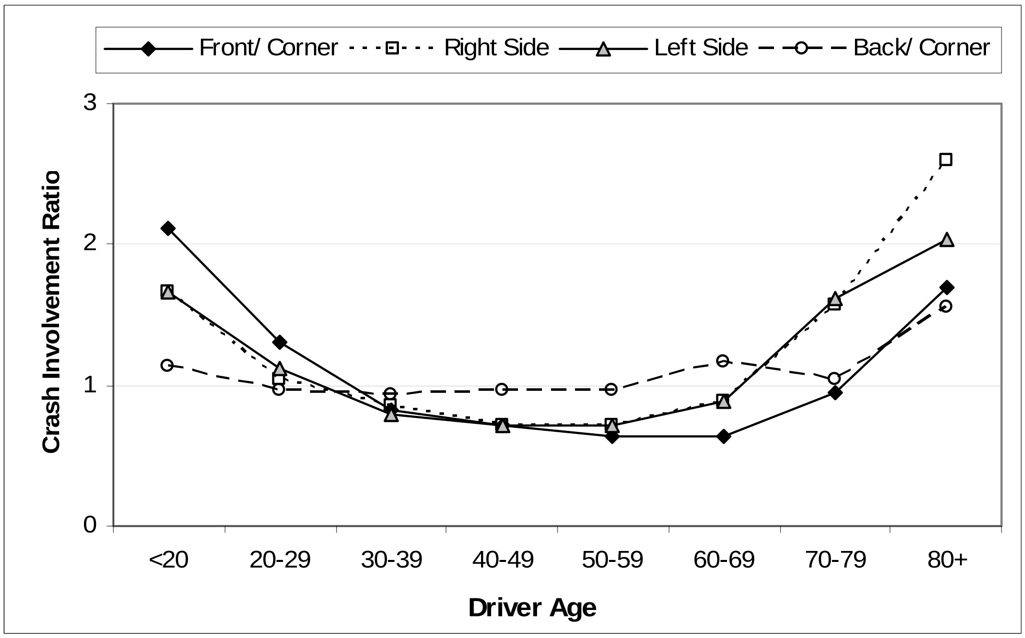

Figure 30. Two-vehicle CIRs for police-reported crashes by initial impact point.

DISCUSSION

The FARS and GES analyses described in this report reveal the contemporary crash experience of older drivers on streets and highways in the United States. The over- and under-involvement of drivers 60 to 69, 70 to 79, and 80 and older in various crash types, reflecting specific maneuvers, traffic situations, and roadway/environmental conditions, has been highlighted through tabular summaries and accompanying discussion. For subsets of the two-vehicle crash data within each national database, crash involvement ratios based on the comparison of at-fault to not-at-fault drivers within groups of drivers younger than 20 to 80 and older, have provided additional, exposure-adjusted estimates of the magnitude of particular risk factors.

Inspection of these findings often reveals a somewhat attenuated U-shaped curve relating crash experience to driver age; this is to be expected when young, novice driver data are collapsed into a single category of under-20s, and when analyses specifically focus on two-vehicle crashes (omitting single-vehicle run-off-road crashes where teens are strongly overrepresented). However, the express purpose of these analyses was to tease out differences among older driver cohorts. In that vein, it is useful to reiterate several broad trends observed in these data.

First, across this entire set of analyses there is little evidence of elevated risk for drivers 60 to 69, the "young-old." Most often, the data only begin to demonstrate a substantial upturn in crash experience for drivers 70 to 79, with over-representation for many crash types then accelerating more sharply for drivers 80 and older. This understanding can help target materials to educate older drivers about particular risk factors to the appropriate age cohorts, and suggests that engagement in health/wellness programs by seniors who are even well into their seventies may be a potent strategy to extend the safe driving years.

Another notable pattern in these data were crash involvement ratios for older age groups that did *not* bear out conventional wisdom about certain situations being especially risky for these drivers, such as merging, changing lanes, driving on Interstate highways, and driving in bad weather. The avoidance of bad weather (and nighttime) driving may be attributed to self-regulation, i.e., older people choosing not to drive in situations where they do not feel comfortable; thus, only the most skillful or confident older drivers may have been represented in the data. For non-discretionary travel, selecting routes that minimize or eliminate requirements for certain high-demand maneuvers may be an effective behavioral countermeasure for older drivers.

In comparing the crash involvement ratios calculated from the two national databases, those generated from FARS data were consistently higher than those generated from GES data. This may be interpreted as evidence of an added contribution of frailty—especially in angle crashes—on top of any risk due to age-related changes in the functional abilities needed to drive safely.

Finally, the handful of situations that appeared most problematic for older drivers reinforce and extend relationships by now well established in the technical literature. Left-turning movements are highlighted in this regard, as are movements at stop-sign-controlled intersections. High-speed 2-lane roadways and multi-lane roads with speed limits of 40 to 45 mi/h (e.g., suburban arterials) were associated with heightened older driver crash involvement. For fatal crashes, both "young-old" and "old-old" drivers were more likely to make errors at intersections controlled by flashing signals; and an error negotiating a yield-sign-controlled intersection was the reason for the crashes in 26 of 27 such incidents for drivers 80 and older.

Situations that have proven risky for older drivers often include complex visual searches, and information from multiple sources that must be processed rapidly under divided attention conditions. These are conditions where context-appropriate driver behavior often depends less upon conformity to formal or informal rules than to judgment or "executive function." This converges substantially with the cluster of cognitive abilities validated as significant predictors of at-fault crashes by older drivers in previous NHTSA research (see Staplin, Gish, and Wagner, 2003). Conceivably, the results of these national crash data analyses will help guide the development of materials and programs that both inform individuals as they seek to self-regulate their exposure to risky situations, and support health care givers as they counsel their older patients about steps they can take to keep driving safely longer.

REFERENCES

Braitman, K. A., Kirley, B. B., Ferguson, S., & Chaudhary N. K. (2007). Factors leading to older drivers' intersection crashes. *Traffic Injury Prevention*, *8*(3), 267-74.

Chandraratn, S. & Stamatiadis, N. (2003). Problem driving maneuvers of elderly drivers. *Transportation Research Record, 1843*, 89-95.

Garber, N. J. & Srinivasan, R. (1991). Characteristics of accidents involving elderly drivers at intersections. *Transportation Research Record, 1325*, 8-16.

Langford, J. & Koppel, S. (2006). Epidemiology of older driver crashes – identifying older driver risk factors and exposure patterns. *Transportation Research Part F, 9*, 309-321.

Langford, J., Koppel, S., Andrea, D., & Fildes, B. (2006). Determining older driver crash responsibility from police and insurance data. *Traffic Injury Prevention, 7*, 343-451.

Mayhew, D. R., Simpson, H. M., & Ferguson, S. A. (2006). Collisions involving senior drivers: high-risk conditions and locations. *Traffic Injury Prevention*, *7*(2), 117-124.

McGwin, G., Jr. & Brown, D. B. (1999). Characteristics of traffic crashes among young, middle-aged, and older drivers. *Accident Analysis and Prevention, 31*, 181-198.

Oxley, J., Fildes, B., Corben, B., & Langford, J. (2006). Intersection design for older drivers. *Transportation Research Part F*, 335-346.

Reinfurt, D. W., Stewart, J. R., Stutts, J. C., & Rodgman, E. A. (2000). *Investigations of Crashes and Casualties Associated with Older Drivers*. Report prepared for General Motors Corporation and the U.S. Department of Transportation. Chapel Hill, NC: University of North Carolina (Highway Safety Research Center). Available at http://www.hsrc.unc.edu/research_library/PDFs/investigations2000.pdf

Staplin, L. and Lyles, R. W. (1991). Age differences in motion perception and specific traffic maneuver problems. *Transportation Research Record, 1325*, 23-33.

Staplin, L., Gish, K., & Wagner, E. (2003). MaryPODS revisited: Updated crash analysis and implications for screening program implementation. *Journal of Safety Research, 34*(4), 389-397.

APPENDIX A
Variable Levels for FARS-Related Factors – Driver Level Variable Used in Determining Fault

Manslaughter/homicide	Yield sign	Wheelchair	Oper Inexperience
Willful reckless	Traffic control dev	Road Rage	Unfamiliar w/ Road
Unsafe reckless	Turn violation not RTOR	Previous Injury	Stopping in Road
Inattentive	Improper turn/method	Other Physical	Underride Truck
Fleeing/eluding police	Fail to signal	Mentally Challenged	Over Correcting
Fail to obey police	Yield to emergency veh	Prohibited Trafficway	
Hit-and-run	Fail to yield	Improper Tailing	
Serious violation	Entering intersection	Improper Lane Change	
Intoxicated	Turn/yield/sig viol	Not in Lane	
Driving impaired	Wrong way/one way rd	Driving Shoulder	
Under Influence	Dr wrong side of rd	Improper Entry/Exit	
Drinking & operating	Unsafe passing	Improper Start/Back	
Detectable alcohol	Pass on right off road	Open Vehicle Closure	
Refused test	Pass stopped school bus	Prohibited Pass	
Alc/drug impairment	Fail to give way	Pass Wrong Side	
Racing	Follow too closely	Pass Insufficient Distance	
Speeding	Passing/following vehicle	Erratic/Reckless	
Unreasonable speed	Unsafe/illegal lane change	Failure to Yield	
Exceed spec speed limit	Improper use of lane	Failure to Obey	
Energy speed	Spec vehicle lane rules	Around Barrier	
Driving too slow	Motorcycle lane viols	Fail to Observe Warn	
Speed related viols	Motorcyc hitched oth veh	Fail to Signal	
Red signal	Any lane violations	Driving too Fast	
Flashing red	Drowsy, asleep	Under Minimum Speed	
Improper turn on red	Ill, blackout	Racing	
Flashing signal	Emotional	Wrong Lane Turn	
Disobey signal	Drugs-medication	Other Improper Turn	
Violate RR X-ing	Other drugs	Wrong Way	
Stop sign	Inattentive	Wrong Side of Road	

APPENDIX B
Fault Definition Rules in FARS and GES Analyses

The FARS fault definitions are as follows:

contributing factor values: 1-9,11,13,18,26,27,28-36,38-42,44-48, 50-55,58
or violation values 1-7,9, 11-14,16, 18, 19, 21-26,29, 31-39, 41-43,45,46,48,49,51-56, 58,59,61-63,66,67,69 earned the designation “at fault.”

We paid attention to how many vehicles were at fault according to the following rules:
update fault2 set type='Single, At Fault' where ve_forms=1 and fault=1;
update fault2 set type='Single, Not At Fault' where ve_forms=1 and fault=0;
update fault2 set type='Two, At Fault' where ve_forms=2 and fault=1 and accfaults=1;
update fault2 set type='Two, Not At Fault' where ve_forms=2 and fault=0 and accfaults=1;
update fault2 set type='Two, Both At Fault' where ve_forms=2 and fault=1 and accfaults=2;
update fault2 set type='Two, None At Fault' where ve_forms=2 and fault=0 and accfaults=0;
update fault2 set type='Multi, At Fault' where ve_forms>2 and fault=1 and accfaults=1;
update fault2 set type='Multi, Not At Fault' where ve_forms>2 and fault=0 and accfaults=1;
update fault2 set type='Multi, None At Fault' where ve_forms>2 and fault=0 and accfaults=0;
update fault2 set type='Multi, Multi At Fault' where ve_forms>2 and accfaults>1;

GES fault definition only used viols:

Violations 1-4,6,7,97,98 ='at fault'
0,5='not at fault'
50='uncertain fault'
95,96,99='unknown'

APPENDIX C
2002-2006 FARS Data
Results Tables for At-Fault Crash Involvement Ratios for Two-Vehicle Crashes*

Driver Characteristics

Driver Age	All	Gender		Driver Drinking	Number Occupants		
	(N=37,090)	Male at Fault (N=24,683)	Female at Fault (N=12,280)	(N=8,408)	1 (N=22,617)	2 (N=9,334)	3+ (N=5,123)
<20	1.91	1.84	2.10	0.99	1.62	2.02	2.84
20-29	1.14	1.25	0.92	1.49	1.09	1.11	1.38
30-39	0.75	0.76	0.73	1.09	0.78	0.59	0.91
40-49	0.63	0.62	0.65	0.91	0.71	0.49	0.53
50-59	0.63	0.59	0.70	0.62	0.71	0.55	0.38
60-69	0.74	0.68	0.88	0.36	0.75	0.81	0.58
70-79	1.76	1.60	2.07	0.63	1.68	2.38	0.94
80+	3.98	4.05	3.89	0.68	3.75	6.24	1.33

Roadway Factors

Driver Age	Speed Limit				Number Traffic Lanes		
	<40 mph (N=5,556)	40-45 mph (8,599)	50-55 mph (N=15,788)	60+ mph (N=6,598)	1-2 Lanes (N=27,977)	3-4 Lanes (N=7,630)	5+ Lanes (N=1,108)
<20	1.65	1.72	2.13	2.04	2.05	1.52	1.40
20-29	1.06	1.05	1.18	1.27	1.17	1.07	1.03
30-39	0.75	0.67	0.74	0.86	0.76	0.70	0.84
40-49	0.57	0.62	0.64	0.67	0.63	0.63	0.62
50-59	0.61	0.66	0.63	0.58	0.61	0.68	0.71
60-69	0.78	0.80	0.72	0.70	0.71	0.84	1.04
70-79	1.68	1.93	1.72	1.65	1.66	2.21	1.80
80+	3.55	4.24	3.86	4.41	3.85	4.37	4.84

Driver Age	Roadway Function Class (combined U/R)				Route Signing (Not in Figures)				
	Interstate (N=4,038)	Prin. Art. (N=11,021)	Minor Art. (N=8,730)	Local Rd (N=4,644)	Interstate (N=2,664)	US Hwy (N=7,827)	State Hwy (N=12,922)	County (N=6,124)	Local 5,908
<20	1.88	1.65	1.95	1.87	2.06	1.73	2.04	2.11	1.63
20-29	1.36	1.03	1.22	1.09	1.40	1.04	1.19	1.11	1.11
30-39	0.92	0.69	0.72	0.69	0.99	0.71	0.72	0.74	0.72
40-49	0.65	0.65	0.63	0.57	0.67	0.65	0.63	0.62	0.59
50-59	0.57	0.64	0.63	0.62	0.57	0.64	0.62	0.64	0.62
60-69	0.67	0.78	0.70	0.89	0.57	0.81	0.74	0.66	0.85
70-79	1.64	2.13	1.69	1.49	1.56	2.03	1.72	1.67	1.65
80+	4.10	4.83	3.61	3.83	3.67	4.84	4.10	3.62	3.39

***** Entries placed in parentheses indicate small cell counts, generally 20 or fewer cases.

Driver Age	Intersection (N=461)	Interchange Related Ramp (N=176)	Other (N=264)
<20	1.30	1.78	0.90
20-29	0.82	1.37	1.38
30-39	0.65	0.80	0.73
40-49	0.66	0.49	0.81
50-59	0.80	0.75	0.73
60-69	1.08	0.75	1.06
70-79	2.94	1.50	1.80
80+	6.38	(5.00)	(1.50)

Roadway Characteristics – Junction

Driver Age	Non-Junction (N=19,929)	Intersection (N=13,743)	Intersection-Related (N=1,124)	Driveway/ Alley (N=1,200)	Interchange-Related (N=905)
<20	2.50	1.47	1.49	1.02	1.27
20-29	1.40	0.87	0.98	0.58	1.07
30-39	0.86	0.61	0.71	0.52	0.70
40-49	0.69	0.55	0.55	0.47	0.67
50-59	0.58	0.68	0.78	0.77	0.75
60-69	0.57	0.99	0.83	1.05	1.00
70-79	1.09	2.39	2.53	3.33	2.23
80+	2.15	5.40	4.72	5.31	4.41

Traffic Control at Intersection Locations

Driver Age	Traffic Signal (N=3,747)	Flashing Signal (N=257)	Stop Sign (N=7,033)	Yield Sign (N=203)
<20	1.26	1.25	1.59	2.06
20-29	1.02	0.84	0.81	0.52
30-39	0.81	0.63	0.54	0.60
40-49	0.63	0.66	0.49	0.81
50-59	0.71	0.71	0.67	0.63
60-69	0.91	1.53	1.04	0.79
70-79	1.63	5.33	2.87	2.90
80+	2.98	5.20	7.53	26.0

Crash Characteristics

Changing Lanes and Merging

Driver Age	Change Lanes/Merge on Interstate (N=612)	Change Lanes/Merge On Arterial/Collector (N=576)	Change Lanes/Merge Speed Limit 55+ (N=911)	Change Lanes/Merge 4+ Lanes (N=355)
<20	2.53	2.70	2.60	2.09
20-29	1.46	1.30	1.35	1.33
30-39	1.03	0.94	1.09	1.02
40-49	0.61	0.81	0.66	0.52
50-59	0.44	0.49	0.45	0.65
60-69	0.64	0.44	0.55	0.60
70-79	1.10	1.29	0.97	1.75
80+	(1.50)	2.29	2.50	(4.00)

Two-Vehicle Crash Configurations (Manner of Collision) at Intersections

(not presented in Figures in this report)

Driver Age	Front to Rear (N=256)	Front to Front (N=894)	Front-to-Side Same Dir. (N=2726)	Front-to-Side Opp Dir (N=2,254)	Front-to-Side Right Angle (N=9,589)
<20	1.05	1.40	2.05	1.21	1.54
20-29	1.07	0.86	0.98	0.72	0.90
30-39	1.14	0.69	0.43	0.57	0.60
40-49	0.63	0.65	0.57	0.55	0.54
50-59	0.64	0.69	0.59	0.76	0.66
60-69	0.96	0.94	1.33	1.04	0.98
70-79	1.41	1.62	2.06	2.76	2.48
80+	1.72	4.89	8.50	5.49	5.83

Two-Vehicle Crash Configurations (Manner of Collision) at Non-Junction Locations

(not presented in Figures in this report)

Driver Age	Front to Rear (N=1,656)	Front to Front (N=10,015)	Front-to-Side Same Dir. (N=484)	Front-to-Side Opp Dir (N=3,129)	Front-to-Side Right Angle (N=2,240)	Sideswipe Same Dir (N=573)	Sideswipe Opp Dir (N=548)
<20	1.79	2.07	1.81	4.05	2.82	2.21	3.15
20-29	1.77	1.41	1.27	1.47	1.17	1.24	1.37
30-39	1.03	0.90	0.76	0.75	0.68	0.95	0.94
40-49	0.74	0.78	0.67	0.56	0.53	0.64	0.77
50-59	0.47	0.64	0.63	0.46	0.51	0.64	0.64
60-69	0.52	0.56	0.79	0.54	0.76	0.62	0.52
70-79	0.86	0.97	1.69	1.19	2.21	1.41	0.82
80+	1.20	1.58	3.29	3.00	5.90	(3.00)	1.15

Vehicle Maneuver and Traffic Control Device for Intersection and Non-Junction Locations
(Other movements – starting in lane, stopping in lane, turning right – insufficient *N*s)

Driver Age	Intersection w/ Signal		Intersection w/ Stop Sign			Intersection w/ Yield Sign
	Going Straight (N=2,491)	Turning Left (N=1,124)	Going Straight (N=4,769)	Turning Left (N=1,458)	Starting (N=578)	Going Straight (N=148)
<20	1.69	0.69	1.94	1.12	0.88	2.08
20-29	1.28	0.51	0.94	0.51	0.46	0.62
30-39	0.99	0.45	0.61	0.37	0.37	0.59
40-49	0.66	0.56	0.52	0.37	0.49	0.92
50-59	0.60	1.16	0.65	0.73	0.63	0.71
60-69	0.70	1.54	0.95	1.34	1.31	0.65
70-79	0.94	4.56	2.35	4.45	4.91	2.13
80+	1.59	9.08	5.69	12.21	14.60	19.00

Driver Age	Intersection w/ Flashing Light	Driveway/Alley	Non-Junction		
	Going Straight (N=176)	Turning Left (N=647)	Passing (N=1,337)	Changing Lanes (N=1,068)	Starting in Lane (N=92)
<20	1.29	0.78	2.54	2.56	(0.36)
20-29	1.12	0.46	1.89	1.39	0.86
30-39	0.74	0.41	0.93	1.03	0.28
40-49	0.67	0.50	0.54	0.66	0.63
50-59	0.68	0.68	0.40	0.46	(0.82)
60-69	1.17	1.36	0.35	0.55	(2.40)
70-79	(2.50)	4.69	0.73	0.93	(8.00)
80+	(4.00)	8.26	0.74	2.25	(4.00)

Environmental Factors

Driver Age	Light Condition					Weather Condition	
	Daylight (N=23,510)	Darkness (N=7,456)	Dark, Lighted (N=4,490)	Dawn (N=685)	Dusk (N=906)	Normal (N=31,726)	Rain, snow, etc. (N=5,140)
<20	2.08	1.81	1.37	4.50	1.77	1.86	2.31
20-29	1.05	1.28	1.18	1.64	1.16	1.12	1.25
30-39	0.67	0.88	0.88	0.91	0.77	0.73	0.80
40-49	0.59	0.71	0.71	0.58	0.63	0.63	0.63
50-59	0.64	0.59	0.63	0.45	0.60	0.63	0.62
60-69	0.78	0.60	0.73	0.61	0.73	0.75	0.69
70-79	1.80	1.44	1.60	1.29	2.62	1.78	1.59
80+	4.04	3.60	3.27	(1.29)	5.58	4.04	3.52

Driver Age	Crash Location	
	Urban (N=15,023)	Rural (N=21,517)
<20	1.55	2.21
20-29	1.08	1.20
30-39	0.72	0.77
40-49	0.59	0.66
50-59	0.65	0.61
60-69	0.83	0.69
70-79	2.01	1.61
80+	4.36	3.66

* Based on Roadway Function Class variable

APPENDIX D
2002-2006 GES Data
Results Tables for At-Fault Crash Involvement Ratios for Two-Vehicle Crashes*

Driver Characteristics

Driver Age	All	Gender		Number Occupants		
		Male	Female	1	2	3+
<20	1.91	1.94	1.87	1.80	2.14	2.10
20-29	1.22	1.23	1.20	1.22	1.17	1.36
30-39	0.83	0.81	0.86	0.81	0.81	1.12
40-49	0.72	0.71	0.74	0.75	0.61	0.65
50-59	0.67	0.66	0.69	0.75	0.50	0.34
60-69	0.73	0.73	0.72	0.76	0.77	0.36
70-79	1.14	1.16	1.11	1.22	1.20	0.44
80+	1.91	1.99	1.81	2.02	2.33	0.34

Driver Injury Severity

Driver Age	Killed (K) *	Incapacit. (A)	Moderate (B)	Possible (C)	None (O)
<20	--	1.20	1.84	2.20	1.90
20-29	--	1.09	1.24	1.17	1.22
30-39	--	0.87	0.73	0.75	0.85
40-49	--	0.82	0.66	0.68	0.72
50-59	--	0.77	0.66	0.74	0.67
60-69	--	0.87	0.72	0.87	0.71
70-79	--	1.85	1.42	1.22	1.10
80+	--	3.34	4.30	2.48	1.75

* Omitted, since only 31 total fatalities in the raw data.

***** Entries placed in parentheses indicate small cell counts in the raw data, generally 30 or fewer cases.

Crash Characteristics

Manner of Collision (Crash Configuration)

Driver Age	Rear-end	Head-on	Angle	Sideswipe, Same Dir.
<20	2.25	1.89	1.67	1.73
20-29	1.38	1.19	1.10	1.17
30-39	0.85	0.82	0.81	0.83
40-49	0.71	0.66	0.74	0.68
50-59	0.62	0.69	0.72	0.65
60-69	0.53	0.85	0.87	0.96
70-79	0.74	1.05	1.36	2.09
80+	1.46	1.85	2.07	2.02

At-fault Vehicle Movement Prior to Critical Event

Driver Age	Going Straight	Decel. in Lane	Starting in lane	Passing/ Overtaking	Turning Right	Turning Left	Backing Up	Changing Lanes	Merging
<20	2.14	1.96	2.13	1.78	1.64	1.67	1.44	1.78	1.52
20-29	1.35	1.28	1.15	1.42	1.04	1.03	1.03	1.09	1.55
30-39	0.86	0.89	0.85	0.85	0.75	0.76	0.83	0.76	0.82
40-49	0.70	0.85	0.75	0.79	0.78	0.71	0.90	0.72	0.62
50-59	0.63	0.68	0.57	0.51	0.75	0.76	1.09	0.72	0.44
60-69	0.58	0.41	0.71	0.60	0.99	0.95	1.24	1.08	1.71
70-79	0.83	1.01	1.31	0.77	1.53	1.70	0.90	2.15	2.47
80+	1.48	1.77	2.69	(1.35)	2.12	2.80	0.99	2.07	0.92

At-fault Vehicle Initial Impact Point

Driver Age	Front/ Corner	Right Side	Left Side	Back/ Corner
<20	2.12	1.66	1.66	1.13
20-29	1.31	1.04	1.12	0.96
30-39	0.83	0.85	0.80	0.94
40-49	0.71	0.72	0.71	0.96
50-59	0.64	0.72	0.72	0.97
60-69	0.64	0.89	0.89	1.17
70-79	0.95	1.57	1.62	1.04
80+	1.69	2.60	2.04	1.56

Roadway Characteristics

Driver Age	Interstate	
	Yes	No
<20	2.31	1.90
20-29	1.38	1.21
30-39	0.89	0.83
40-49	0.71	0.72
50-59	0.63	0.68
60-69	0.66	0.73
70-79	0.70	1.15
80+	3.34	1.89

Driver Age	Speed Limit				Number Traffic Lanes		
	<40 mph	40-45 mph	50-55 mph	60+ mph	1-2 Lanes	3-4 Lanes	5+ Lanes
<20	1.82	1.98	2.01	2.38	1.96	1.93	1.84
20-29	1.21	1.17	1.21	1.43	1.23	1.26	1.19
30-39	0.82	0.81	0.92	0.87	0.81	0.84	0.85
40-49	0.73	0.71	0.71	0.71	0.71	0.72	0.71
50-59	0.67	0.70	0.63	0.60	0.69	0.67	0.66
60-69	0.78	0.72	0.62	0.55	0.73	0.71	0.73
70-79	1.11	1.25	1.18	0.83	1.07	1.21	1.27
80+	1.77	1.98	2.21	2.59	1.62	1.70	2.58

Junction

Driver Age	Non-Junction	Intersection	Intersection-Related	Driveway/ Alley	Other Non-Interchange	Interchange-Related
<20	2.13	1.79	2.17	1.60	1.53	2.13
20-29	1.33	1.08	1.33	1.19	1.31	1.25
30-39	0.83	0.80	0.85	0.84	0.98	0.93
40-49	0.74	0.72	0.70	0.76	0.73	0.65
50-59	0.60	0.72	0.67	0.68	0.60	0.82
60-69	0.64	0.86	0.57	0.81	0.91	0.61
70-79	0.82	1.36	0.95	1.22	1.04	1.25
80+	1.58	2.26	1.59	1.66	(2.55)	(2.17)

Traffic Control

Driver Age	None	Traffic Signal	Flashing Signal	Stop Sign	Yield Sign
<20	1.94	1.94	1.99	1.89	1.90
20-29	1.24	1.26	1.16	1.08	1.38
30-39	0.84	0.83	0.87	0.79	0.80
40-49	0.75	0.70	0.81	0.67	0.67
50-59	0.65	0.69	0.54	0.73	0.65
60-69	0.67	0.72	0.84	0.87	0.82
70-79	0.99	1.17	1.32	1.46	0.93
80+	1.65	2.22	(1.84)	2.11	(2.64)

Environmental Factors

Driver Age	Light Conditions					Weather Conditions	
	Daylight	Dark	Dark, lighted	Dawn	Dusk	Normal	Rain/sleet/ Snow/fog/etc.
<20	1.97	1.67	1.66	2.70	2.11	1.88	2.13
20-29	1.25	1.14	1.11	1.52	1.10	1.21	1.29
30-39	0.84	0.88	0.83	0.78	0.73	0.84	0.83
40-49	0.72	0.69	0.73	0.53	0.73	0.72	0.70
50-59	0.66	0.66	0.75	0.79	0.75	0.69	0.59
60-69	0.71	0.73	0.83	0.60	0.97	0.73	0.68
70-79	1.11	1.25	1.23	(4.46)	1.47	1.17	0.90
80+	1.84	4.22	2.43	(8.57)	2.80	1.93	1.71

Specific Circumstances

Driver Age	2-Lanes			3-4 Lanes		5+ Lanes		Interstate	
	<= 35 mph	40-45 mph	50-55 mph	40-45 mph	50-55 mph	40-45 mph	50+ mph	<65 mph	65+ mph
<20	1.81	2.12	2.11	2.00	1.82	1.81	2.48	2.11	2.73
20-29	1.17	1.20	1.18	1.17	1.28	1.18	1.21	1.32	1.41
30-39	0.82	0.72	0.87	0.83	0.93	0.89	0.84	0.94	0.84
40-49	0.72	0.71	0.69	0.72	0.70	0.69	0.68	0.69	0.76
50-59	0.74	0.72	0.61	0.72	0.77	0.68	0.74	0.66	0.56
60-69	0.81	0.67	0.64	0.74	0.61	0.60	0.67	0.66	0.68
70-79	1.01	1.30	1.42	1.19	1.31	1.44	0.65	0.91	0.56
80+	1.29	1.47	3.00	1.92	(0.91)**	2.40	6.34	(3.79)	(2.38)

** Raw count 46/23

At-Fault Vehicle Maneuver and Traffic Control Device

Driver Age	Going Straight				Turning Left				Turning Right		
	Signal	Flash.	Stop	Yield	Signal	Flash.	Stop	Yield	Signal	Stop	Yield
<20	2.06	2.05	1.86	1.81	1.72	2.10	1.88	1.72	1.53	1.82	1.52
20-29	1.40	1.28	1.16	1.44	1.01	0.89	1.06	0.56	1.10	1.09	1.61
30-39	0.90	0.82	0.82	0.86	0.69	0.81	0.75	0.64	0.63	0.59	0.89
40-49	0.68	0.85	0.65	0.69	0.65	1.17	0.67	0.34	0.99	0.72	0.37
50-59	0.70	0.65	0.70	0.57	0.79	0.53	0.71	2.16	0.55	0.94	(0.35)
60-69	0.59	0.64	0.88	1.40	1.05	(0.92)	0.83	(1.48)	1.11	1.15	(0.98)
70-79	0.81	(0.79)	1.50	0.70	2.32	(2.61)	1.48	(2.08)	1.85	1.37	(1.45)
80+	1.66	(1.60)	2.28	(2.10)	3.11	(3.20)	2.05	(1.10)	(4.82)	(1.27)	(3.48)

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