CONTRIBUTION OF BEHAVIORAL ASPECTS OF OLDER DRIVERS TO FATAL TRAFFIC CRASHES IN FLORIDA

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ABSTRACT

This study examined fault in a set of fatal traffic crashes that occurred on state roadways in Florida, primarily in the year 2000. A case-study approach by a team of trained investigators examined data compiled from a variety of sources, including traffic homicide reports and crash scene photographs. Crash types were identified in which older drivers were significantly over- and underrepresented in fault. Finally, for crashes in which older drivers were at fault, various contributing factors were identified, including driver errors. Older drivers were over-represented in fault by a factor of 1.37 when compared to younger drivers in the data set. Older drivers were significantly over-represented in fault in left turn crashes versus oncoming traffic and cross traffic. Consistent with other work, older drivers were responsible for more intersection than non-intersection crashes. Among other factors, misjudging speeds of other vehicles, failure to observe other vehicles, disregarding traffic signals, and improper (disallowed) left turns were the major driver errors in intersection crashes. Sudden loss of control and driving under the influence of alcohol were the major contributing factors in non-intersection crashes. Around 10 percent of crash contributing factors indicated confusion, inappropriate action, or illegal maneuvers; with over two-thirds of these cases being attributed to drivers aged 75 and up. Another important finding of the study is that investigating officers have a tendency to frequently use the term “failure to yield right of way,” rather than identifying more specific contributing factors. Because of limitations of the research methodology, additional study is recommended.

WORD COUNT = 250

INTRODUCTION

The U.S. has experienced a tremendous demographic transition in recent decades. The elderly constitute nearly thirteen percent of the population of the United States. This group of people, aged 65 and above, is increasing in percent of the population every year (*1, 2*). By 2030, there will be about 70 million older people, that is, 20% of the entire population and more than twice the number in 1999 (*3, 4*). Senior citizens now constitute the fastest growing segment of the United States population. Similarly, trends toward an increasing number of older drivers have been well documented in the recent past and are expected to continue in the future (*2, 5, 6*).

A rapidly increasing number of older people may require the urban landscape and transportation systems to be reinvented to cope with the demographic transition of society. How to design more accessible living environments and to help the elderly maintain mobility in the wake of their growing number are significant challenges to society. In 1995, the average older American made 3.4 trips per day, totaling 24.4 miles per day, which works out to be about 7.2 miles per trip (*4*). An increasing number of older adults will continue to travel, both as drivers and as pedestrians, as they age. Age related changes could be relevant to safe driving performance. From an older traveler’s perspective, highway signs and other traffic control devices are frequently not large enough, not bright enough or not properly located (*7, 8*). Complex intersections can be too confusing and required walking speeds can be too fast for many older pedestrians (*4*).

To investigate various factors potentially affecting older drivers, this paper examines contributing factors of fatal crashes in which the older drivers were involved as at-fault drivers. The analysis involved investigating the crashes on a case-by-case basis, looking for driver, vehicle, environment and roadway factors that might have contributed to the fatal crashes. Individual data elements plus photographic evidence were compiled to assess whether more general deficiencies such as inadequate sight distances, inadequate pavement markings, inadequate pedestrian safety measures, etc. existed at a specific site. Driver behavior and driver errors were noted, and vehicle speeds were reconstructed where possible. The goal of the research was to identify crash types in which older drivers were more frequently at fault, and then examine contributing factors in those crashes. A better understanding of factors contributing to older drivers’ crashes will help engineers and policy makers to create a more accessible transportation system.

LITERATURE REVIEW

Motor vehicle crash rate comparisons by age and gender are usually based on the extent to which drivers in a particular age/gender category are injured or involved in crashes. A number of studies have identified high crash rates or certain prevalent crash types among older drivers (*2, 9*). Owsley *et al* find that older drivers have among the highest rates of motor vehicle collision involvement per mile driven of all age groups (*10*), and McGwin and Brown conclude that both younger (15-34) and older drivers (65+) have higher rates of fault in traffic crashes (*11*). In this study, failure to yield to the right of way was the leading contributor of crashes caused by older drivers, followed by lack of vehicle control and then misjudging of stopping distance. Older drivers had higher fault rates when turning maneuvers were involved, particularly left-hand turns (*11*).

However, others argue that older drivers are not at higher risk for traffic crashes, even when exposure measures such as number of driver licenses are considered. In a study of driver licensing rates in Australia, Tay found that increasing the number of licenses issued to drivers in age cohorts of 60-69 and 70 and above had little to no impact on increasing the number of fatal crashes (*12*). A Finnish study also showed no significant increase in crashes per kilometer when older drivers (65+) driving habits and crash rates were compared to a control group of younger (25-40) drivers (*13*). Janke argues that the use of accidents per mile as a measure of risk exaggerates the apparent risk of low-mileage groups, including older drivers, because people driving low mileages tend to accumulate much of their mileage on congested city streets with two-way traffic and no restriction of access, while high-mileage drivers typically accumulate most of those miles on freeways or other limited access roadways where the driving task is simpler (*14*). Langford *et al* echo this conclusion by showing that, regardless of age, a lower annual distance traveled increased the chances of being involved in crashes by six-fold (*15*).

While some studies show that older drivers cause fewer crashes that are severe in nature (*5, 10, 16*), other studies show that their age-related vulnerability results in a higher risk of fatality. Li *et al* conclude that drivers older than 74 years have much higher driver death rates per VMT compared with drivers aged 30–59. This study also shows that age-related fragility begins to increase between ages 60–64 and increase steadily with advancing age, accounting for about 60–95% of the excess death rates per VMT in older drivers, depending on age group and gender (*17*). A study by Zhang indicates that physical disabilities increase the risk of fatality by a factor of 5 for drivers 75–79 years of age and a factor of 3.5 for those 80 years and over. However, in the age group 65–74, the same study shows that medical/physical condition does not appear to be related to risk of fatality (*18*).

Pending roadway and environmental causative factors, drivers in fatal single-vehicle crashes are generally assumed to have responsibility for the crash. However, older drivers are characterized by crashes involving more than one car, especially at intersections. In general, the literature (*17*, *18*, *19*, *20*) suggests that older drivers are more frequently involved in intersection crashes than other age-specific driver groups. These drivers usually enter into the intersection violating the right-of-way of oncoming vehicles from other directions and thereby involved in fatal crashes (*16*). Thus other vehicles hit the vehicles of older drivers more than the vehicles of older drivers hit other vehicles (*16*, *20, 21*, *22*). When considering crash prevention among older drivers, Daigneault concludes that prior crashes are a better predictor for crash risk than prior convictions. These trends steadily increase with each age group, from 65 years old to 80 years or more (*19*).

A number of potential factors have been cited among studies investigating the causes of traffic crashes among elderly drivers. Hu finds that a number of factors correlate with increased crash involvement by older drivers, including demographic attributes, limitations in performing physical activities, chronic conditions, physical features, psychosocial characteristics, symptoms, drug use and other health-related factors (*23*). Owsley suggests that visual processing impairments increase crash risk among older drivers. The study shows that many older drivers meet the legal requirements for licensing despite having vision impairments that elevate crash risk (*10*). A study by Mortimer indicates that there is a substantial increase in risk of fatal crash involvement by older male drivers in darkness. The crash involvement for these drivers is greater in multi-vehicle crashes where they are struck in the side or rear by another vehicle, and single-vehicle crashes where they run off the road on a straight section (*24*).

Educational programs that promote safe driving strategies among seniors are a popular approach for addressing driving safety, but their safety benefit has yet to be demonstrated. A study by Nasvadi looking at crash rates following attendance at a mature driver education program found that drivers 75 years and older, surprisingly, had an increased rate of crashes following attendance of the program. Further, there was no effect on subsequent crashes for younger men and women of all ages (*25*). Roenker *et al* showed that older drivers' field of vision can be improved by training in a driving simulator, but that results were only durable for about 18 months without retraining (*26*).

The effect of driving cessation on older drivers has generally been shown to be negative. Fonda et al showed worsening depressive symptoms in older adults when driving stopped or lessened (*27*). Freeman et al correlated driving cessation with entry into long term care. In this study, elderly who had recently ceased driving and those who had never driven showed higher hazards of long-term care entry. Furthermore, for the elderly in a household with no other drivers, this became an independent risk for long-term care entry (*28*).

METHODOLOGY AND DATA SET

The research presented herein is part of a larger study investigating contributing causes of fatal traffic crashes involving drivers of all ages. A major objective of the research was to provide an in-depth analysis of the relationships between the ages of the at-fault drivers and different aspects of roadway, traffic, weather, and other related contributing factors. This portion of the study focuses only on crashes involving older drivers. The scope is limited to fatal traffic crashes because of the importance of ameliorating such serious crashes, to which older drivers have been shown to be more vulnerable (*5, 17, 18)*, and because of the wealth of additional data available on fatal crashes.

A goal of the research, therefore, was to go beyond the data currently available from the Florida Traffic Crash Report (FTCR), incorporating data from additional resources. Crash reports are often lacking in detail, especially regarding driver attitudes and actions, making it difficult to differentiate causative factors and assign fault. A key source of information was obtained from the Florida Highway Patrol (FHP) and local law enforcement agencies in the form of Traffic Homicide Investigating (THI) reports. Photographs of the crash scenes were obtained from the law enforcement agencies and/or from FDOT's video log system. Where necessary, site visits were conducted to gain better insight into questionable sites.

The data set originally consisted of 2080 fatal crashes that occurred on state roadways of Florida, primarily in the year 2000. A total of 3,825 drivers were involved in these crashes, of which 3585 were reviewed as part of the study of at-fault drivers; the remaining cases were eliminated either because age or fault status could not be identified. Of the 3585 drivers of known age and fault status, 1764 were at fault, and 1821 were not at fault. The median age of the at-fault drivers was 38 years. The mode of the ages was 19 years indicating that most of the at-fault drivers were very young. The kurtosis is negative, which indicates that the age data has a flat distribution with short tails. Overall, 474 older drivers were involved in fatal crashes and at 301 were found to be at fault (64%).

To identify contributing factors, the study used a case-based approach where available data for each crash was examined in great detail by a diverse team of homicide investigators, researchers, traffic engineers, and safety engineers. Contributing causes were identified based on the detail investigation of the photographs of the intersections, officer and witness statements, posted speed limits at the intersections, actual speeds, positions and travel lanes of the vehicles, etc. A simplified, yet statistically significant approach of frequency distributions, called overrepresentation factors (ORF) was used to examine the results of the case studies. This method is based on the approach used in the Crash Analysis Reporting Environment (CARE) software (*29*). An ORF indicates whether a factor occurs more or less frequently in a subset of crashes than in its complement. The ORF was computed for various crash sub-types as follows:

$$ORF = \frac{R\_set}{R\_comp} = \frac{\frac{A}{A+B}}{\frac{C}{C+D}}$$

Where:
A = number of positive outcomes for the set
B = number of negative outcomes for the set
C = number of positive outcomes for the set's complement
D = number of negative outcomes for the set's complement
R_set = proportion of positive outcomes for the set
R_comp = proportion of positive outcomes for the set's complement

For instance, given the 3585 drivers in the study set (of which 474 were older and 3111 were not), sixty-four percent of the 474 older drivers (*R_set* = 301/(301+173)=0.64) were found to be at fault, while only forty-seven percent of the 3111 younger drivers (*R_comp* = 1463/(1463+1648)=0.47) were found to be at fault. This implies that fault was overrepresented in older drivers with an ORF of 1.35 (*ORF* = 0.64/0.47).

An ORF of 1.0 indicates that the characteristic occurs in the crash subset at the same rate that it does in the complement of the set. An ORF higher than one means that the characteristic occurs more frequently in the subset (i.e. is overrepresented), and an ORF less than one means that it occurs less frequently in the set than in its complement. The default overrepresentation threshold used by the CARE researchers for high levels of over- or under-representation are 1.5 and 0.667, respectively. These numbers mean that a characteristic can be said to be highly over- or underrepresented in a data set if the characteristic occurs 50% more or less frequently in the observed set than in the complement. The basis of the overrepresentation method is that it is unlikely that a countermeasure will reduce the crash rate of a set (e.g. alcohol-related crashes) below that of its complement (non-alcohol-related crashes). Thus by focusing on highly overrepresented characteristics within a set, there is an increased chance of having a productive result.

The overrepresentation method is very useful in differentiating trends between two different crash subsets. However, the reliability of this factor depends on the sample sizes of the two subsets in consideration. The smaller the sample size, the less significant the result. To improve its usefulness in looking at smaller data sets, such as those involved when examining only fatal crashes, the researchers in this project have extended the concept of overrepresentation to include confidence intervals (CI's). The overrepresentation factor is very similar to a relative risk, which is the ratio of percentage of positive cases from the total population to the non-positive cases from the total population. Hence the CI for an overrepresentation factor was computed using techniques similar to those used for relative risk factors.

$$Var = \frac{\left(\frac{B}{A}\right)}{(A+B)} + \frac{\left(\frac{D}{C}\right)}{(C+D)}$$

$$LL = ORF * e^{-z*\sqrt{Var}}$$

$$UL = ORF * e^{z*\sqrt{Var}}$$

Where:
LL = Lower limit of confidence interval
UL = Upper limit of confidence interval
z = z-statistic given the selected confidence interval, e.g. 1.96 for 95% confidence
Var = *Var* (ln *ORF*) = Variance of the natural log of the overrepresentation factor

Using this approach, one can be 95 percent confident that the true overrepresentation of fault in older drivers is between 1.249 and 1.460.

RESULTS AND DISCUSSION

Figure 1 examines the distribution of at-fault and not-at-fault drivers in the data set by age. In Figure 1, bars are used to represent the percent of drivers in each age cohort, while lines are used to indicate the number of drivers in each cohort when normalized by the total population in the state within that cohort. For drivers younger than 25 and older than 64, at-fault drivers outnumber not-at-fault drivers within each age group, while not-at-fault drivers outnumber at-fault drivers for age groups between 25 and 64. When the driver ages are normalized by the total population within each age group, the not-at-fault drivers follow a bell-shaped curve, with the highest crash involvement of not-at-fault drivers per population steady in the 25 to 54 year old range, and lower for older and younger drivers. However, for at-fault drivers, the trend is generally reversed, with the rate of crash involvement per population higher for younger drivers, decreasing for drivers up to age 74, and then increasing again for the oldest drivers. This implies that extreme older and younger drivers are much more likely to be at-fault when involved in a fatal traffic crash.

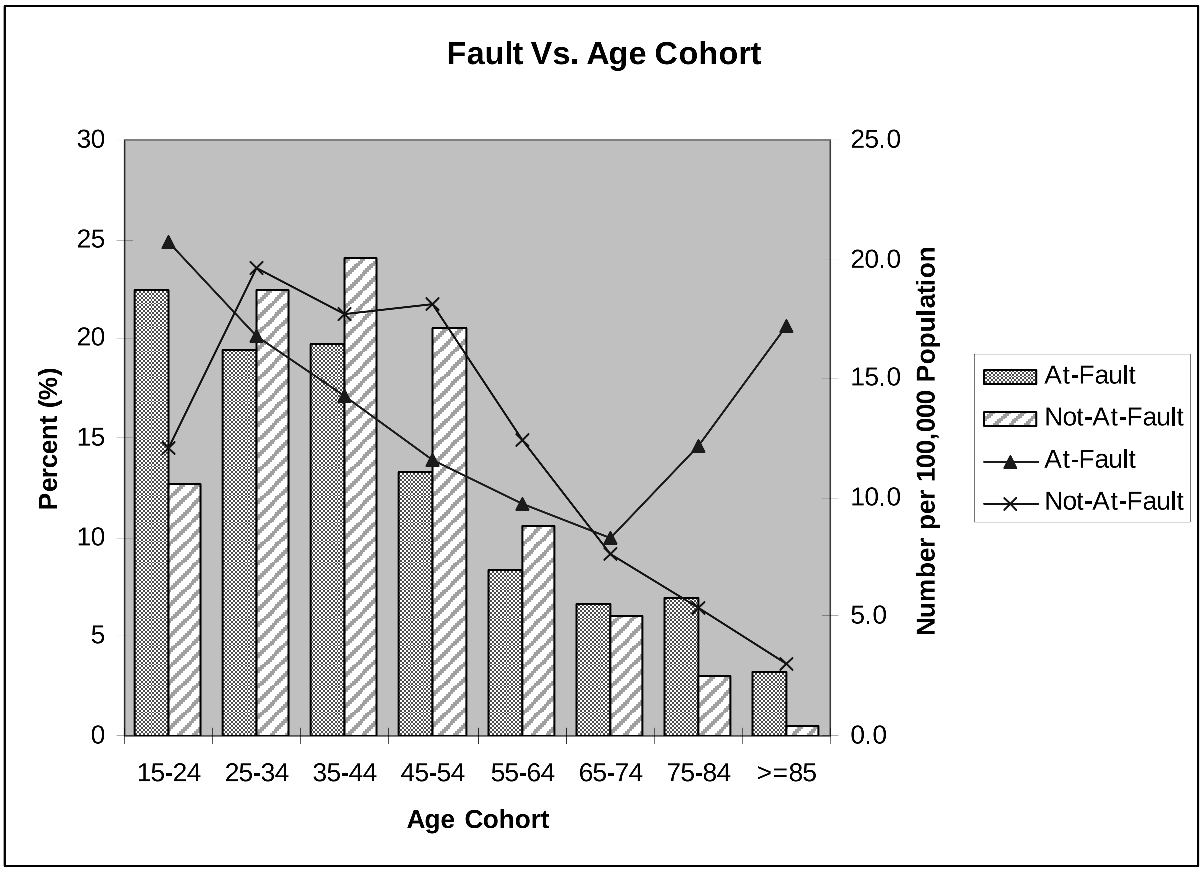

FIGURE 1 Distribution of at-fault and not-at-fault drivers according to age

As stated previously, older drivers were involved in 474 fatal crashes and were responsible for 301 fatal crashes (64%). Table 1 shows crash types and sub-types of the crashes in which older drivers were at fault. The categorization scheme was develop following an initial review of all the cases in the study, and a literature review of related studies wherein crash data is being summarized by crash type codes (*4, 30, 31, 32, 33*). It is primarily based on crash types used in the General Estimates System (GES) crash database (*4*), with enhancements for classifying

TABLE 1 Crash Types of Crashes Caused by Older Drivers

Type	Sub-Type	Older At-Fault		Other At-Fault		ORF	Min CI (LL)	Max CI (UL)	95% Confidence Level
		No.	Percent	No.	Percent				
Change Trafficway/Turning	**Initial Same Direction**	**9**	**3.0%**	**13**	**0.9%**	**3.365**	**1.452**	**7.801**	**Over**
	Single Vehicle Control Loss While Turning	0	0.0%	2	0.1%	0.000	N/A	N/A	N/A
	Turn Into Opposite Directions/Cross Traffic	**66**	**21.9%**	**72**	**4.9%**	**4.455**	**3.267**	**6.075**	**Over**
	Turn/Merge Into Same Direction	5	1.7%	18	1.2%	1.350	0.505	3.608	Unsure
	Evasive Action To Avoid Turning/Merging Vehicle	0	0.0%	2	0.1%	0.000	N/A	N/A	N/A
	Initial Opposite Directions/Oncoming Traffic	**62**	**20.6%**	**130**	**8.9%**	**2.318**	**1.759**	**3.055**	**Over**
Intersecting Paths	Backing	1	0.3%	3	0.2%	1.620	0.169	15.52	Unsure
	Not At Fault From Left	21	7.0%	64	4.4%	1.595	0.990	2.570	Unsure
	Not At Fault From Right	20	6.6%	71	4.9%	1.369	0.847	2.214	Unsure
	Not At Fault Unknown Direction	1	0.3%	4	0.3%	1.215	0.136	10.83	Unsure
Opposite Direction	*Forward Impact With Control Loss*	*1*	*0.3%*	*37*	*2.5%*	*0.131*	*0.018*	*0.954*	*Under*
	Sideswipe Angle	0	0.0%	3	0.2%	0.000	N/A	N/A	N/A
	Head-On	16	5.3%	121	8.3%	0.643	0.387	1.066	Unsure
Run Off Road/Single Vehicle	Ramp Departure	1	0.3%	30	2.1%	0.162	0.022	1.183	Unsure
	Forward Impact	2	0.7%	9	0.6%	1.080	0.235	4.974	Unsure
	Left Roadside Departure	*11*	*3.7%*	*127*	*8.7%*	*0.421*	*0.230*	*0.770*	*Under*
	Left Roadside Departure With Control Loss	*12*	*4.0%*	*144*	*9.8%*	*0.405*	*0.228*	*0.720*	*Under*
	Other	0	0.0%	2	0.1%	0.000	N/A	N/A	N/A
	Right Roadside Departure	*26*	*8.6%*	*194*	*13.3%*	*0.651*	*0.441*	*0.962*	*Under*
	Right Roadside Departure With Control Loss	*6*	*2.0%*	*95*	*6.5%*	*0.307*	*0.136*	*0.694*	*Under*
Same Direction	Sideswipe Angle With Control Loss	1	0.3%	14	1.0%	0.347	0.046	2.630	Unsure
	Rear End	*20*	*6.6%*	*175*	*12.0%*	*0.555*	*0.356*	*0.867*	*Under*
	Rear End With Avoid Impact	4	1.3%	33	2.3%	0.589	0.210	1.651	Unsure
	Sideswipe Angle	7	2.3%	30	2.1%	1.134	0.503	2.558	Unsure
Pedestrian	Exit Vehicle	1	0.3%	9	0.6%	0.540	0.069	4.247	Unsure
	Walking Along Road Against Traffic	0	0.0%	1	0.1%	0.000	N/A	N/A	N/A
	Crossing At Intersection In Crosswalk	0	0.0%	6	0.4%	0.000	N/A	N/A	N/A
	Crossing Not At Intersection--First Half	3	1.0%	10	0.7%	1.458	0.404	5.267	Unsure
	Crossing Not At Intersection--Second Half	0	0.0%	18	1.2%	0.000	N/A	N/A	N/A
	Other In Road	0	0.0%	7	0.5%	0.000	N/A	N/A	N/A
	Vehicle Turn/Merge	1	0.3%	7	0.5%	0.694	0.086	5.623	Unsure
	Walking Along Road With Traffic	1	0.3%	3	0.2%	1.620	0.169	15.52	Unsure
Other/Unknown		3	1.0%	9	0.6%	1.620	0.441	5.949	Unsure
Total		301	100%	1463	100%				

pedestrian crashes. The first two categories are intersection crashes involving turning and intersecting paths, respectively, while the next three categories are non-intersection crashes. Pedestrian crashes include both intersection and non-intersection crashes. Within each crash type, the crashes are broken into mutually exclusive categories according to The confidence level is stated as “over” when the lower limit of the 95% confidence interval is above 1.0 and “under” when the upper limit is below 1.0. Crash types in which older drivers were significantly overrepresented are indicated by bold-face type; those in which older drivers were significantly underrepresented are indicated by italics.

Older drivers were significantly overrepresented in three crash types, all of which involved turning movements at intersections. The overrepresented types involved vehicles heading initially in opposite directions (oncoming traffic), turning into opposite directions (cross traffic), and initially headed in the same direction. The first two crash types generally involved older drivers that had difficulty judging gaps in crossing and oncoming traffic, especially at busy intersections on stop-sign controlled movements, uncontrolled movements, or signalized movements with permissive phasing. The “initial same direction” crashes tend to involve confusion and/or late decisions by the driver, including turns from the wrong lane. However, while older drivers were significantly overrepresented in this crash type, it still represented only 3% of all crashes where an older driver was at fault. Case studies showed that most of these crashes occurred at intersections with no advance street name signs and/or less visible signs. Older drivers were highly underrepresented in fault in most other crash types.

In 96% of the cases in which older drivers were at fault, the primary contributing factor was a human factor: inattention in one-third of the cases, followed by decision errors and perception errors. Alcohol and/or drug use was the primary factor in almost 10% of the cases. Looking at all contributing factors, not just primary factors, the broad category of age was cited by the case reviewers in about 15% of the cases. This indicates that the age of a driver affected his or her ability to complete the driving task; because of lack of mobility and increased perception-reaction time. Other than the factors mentioned above, crash contributing factors included confusion, longer perception-reaction time, illegal maneuvers (e.g., wrong way or left-turn where not permitted) or inappropriate actions (e.g. stop on interstate, drive around train crossing gates). Over two-thirds of the confusion cases were attributed to drivers aged 75 and up. The most common non-human factor was roadway design/geometry, which tended to be applied to wide, non-signalized intersections or those with complicated geometry.

Driver errors were identified for all fatal crashes in which older drivers were at fault; because of the differences in error types between intersection and non-intersection crashes, they are presented separately. A total of 203 intersection crashes in the data set were caused by older drivers, out of which the causes of nine crashes could not be identified. This represents two-thirds of the crashes in which an older driver was at fault, a much higher percent than was seen with the younger drivers (35.5% for the drivers of age 24 years or younger). Figure 2 depicts the major contributing factors of intersection crashes caused by the older drivers. For this research, the term “misjudgment of speeds” is used for the crashes in which the case review showed that the at-fault driver failed to properly judge the speeds of the vehicles approaching from other directions. This also includes those crashes in which the vehicles were coming at a speed higher than the posted maximum speed, which the older drivers could not judge properly. “Failed to observe” indicates a failure to observe other vehicles/all sides before entering the intersection. “Improper left turn” includes those crashes in which the at-fault driver attempted a left turn although s/he did not have permission to make a left turn. Examples include turning from an incorrect lane and turning where no left turns are allowed. The “improper left turn” category does not include “misjudgment of speed” or “failed to observe.”

The figure shows that misjudgment of speeds of other vehicles, failure to observe other vehicles/all sides before approaching the intersection, disregarding traffic signals and signs, and improper left turn were four major contributing factors, each of which contributed to more than 10% of the intersection crashes caused by the older drivers. Other driver errors causing intersection crashes involving older drivers were disregarding stop signs, driving under the influence of alcohol/drugs, confusion caused by the complexity of the intersection and traffic/billboard signs, loss of control, exceeding safe speed limits, and road crossing at unauthorized location. Other factors, including inability to see other vehicles/signage, improper U-turn, stopped improperly on the road, mechanical problems, unconsciousness, improper passing, improper lane change, etc. each contributed to less than one percent of the intersection crashes.

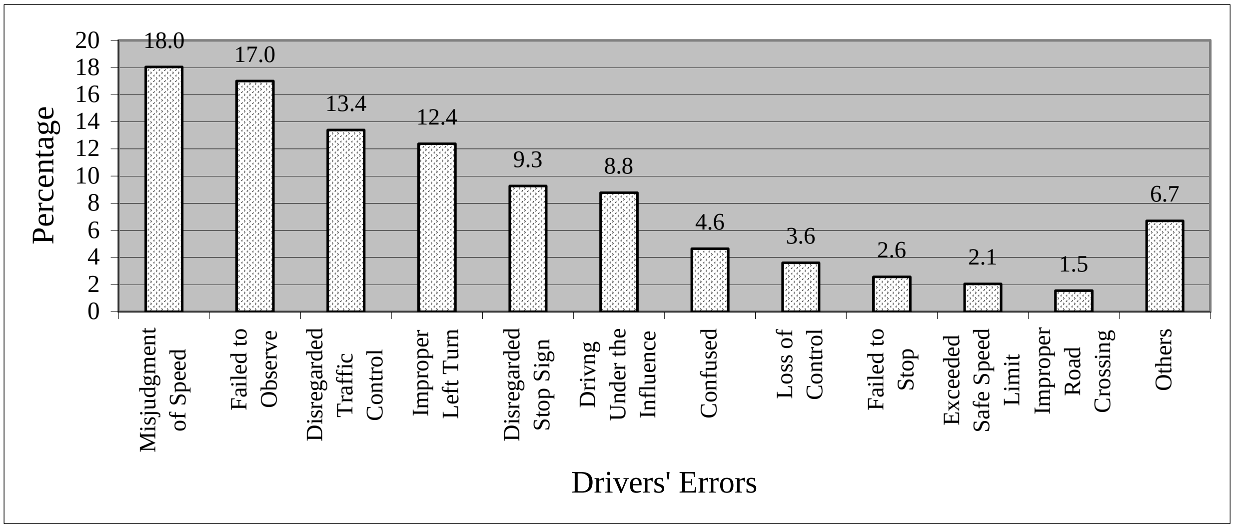

FIGURE 2 Errors of older at-fault drivers in intersection crashes

A total of 98 non-intersection crashes were caused by the older drivers, out of which the cause of one crash was unknown. The results are shown in Figure 3. The figure shows that loss of control contributed to more than one-third of the crashes, while driving under the influence of alcohol contributed to almost one-fifth of such crashes. Exceeding safe speed limits, improper lane change, failure to stop the vehicle to avoid a rear-end collision, driving in the wrong direction, and improper stopping on the roadway were the third to seventh most important contributing factors, respectively, each of which contributed to more than four percent of crashes. The term “others” in this figure include those factors that contributed to less than two percent of the crashes. These included failure to observe other vehicles, improper U-turn, mechanical problems, improper passing, improper left turn, ran off road, lack of visibility, failure to negotiate curves, etc. It is important to note that driving under the influence of alcohol is the second major factor for the older drivers’ non-intersection crashes, although it was not one of the five major causes for intersection crashes.

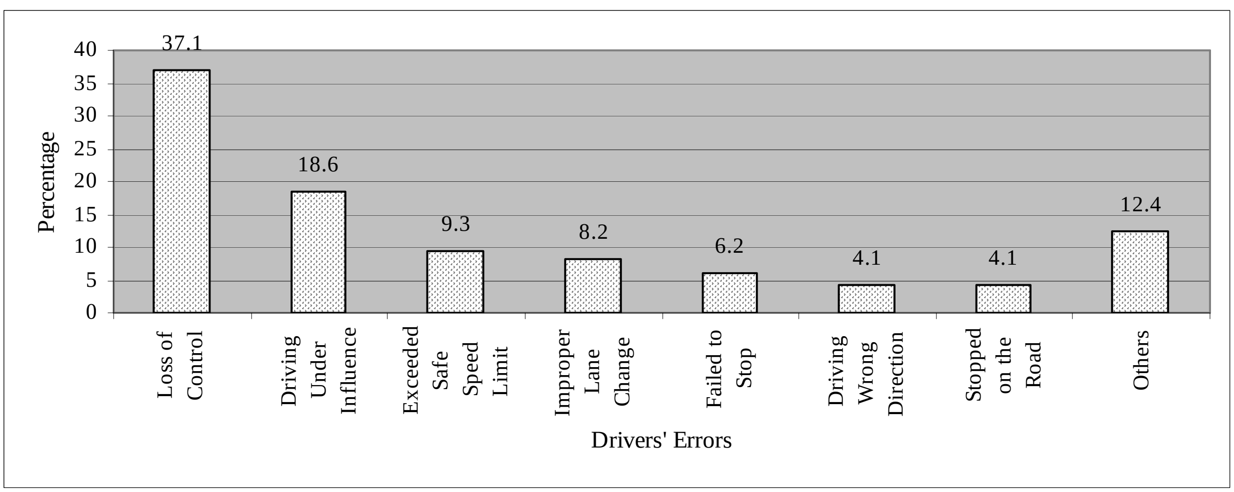

FIGURE 3 Errors of older at-fault drivers in non-intersection crashes

The case review teams found that the investigating officers had a tendency to frequently use the term “failure to yield right of way” for intersection crashes. Driver contributing causes for more than 73% of crashes caused by older drivers were recorded by the investigating officers as “failure to yield right of way” instead of further breaking down the causes. The paper investigated how and why the failure to yield occurred by reconstructing vehicle speeds, watching video logs from the viewpoint of the approaching vehicles, reviewing witness statements, etc. When these crashes were further broken down, as shown in Figure 4, the results show that the overused term "failure to yield right of way" constitutes other more detailed contributing factors, primarily misjudgment of speeds and failure to observe vehicles/all sides before entering the intersection, but also disregarding traffic signals and other less common causes. The first three terms are used as defined previously; the drivers' errors such as disregarding traffic signals, disregarding stop signs and driving under the influence do not need further definition. The term "confused" includes cases in which the older driver appears to have become confused as to what to do, in part because they were provided too much information by a complicated roadway, traffic and/or billboard signs.

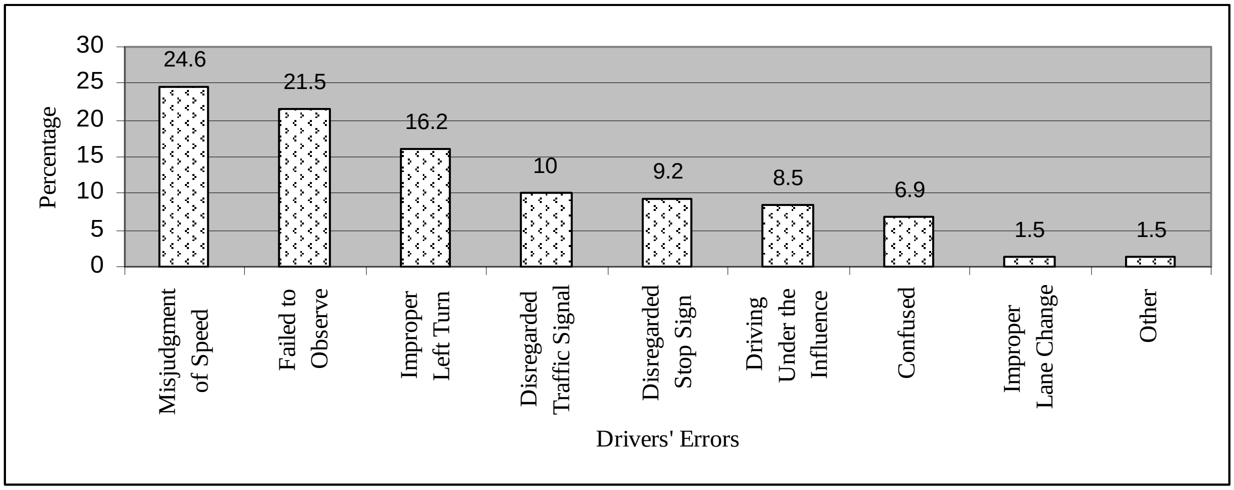

FIGURE 4 Representation of the overused term "failure to yield right of way"

CONCLUSIONS AND RECOMMENDATIONS

This study examined fault in a set of fatal traffic crashes that occurred on state roadways in Florida, primarily in the year 2000. A case-study approach by a team of trained investigators examined data compiled from a variety of sources, including traffic homicide reports and crash scene photographs. Crash types were identified in which older drivers were significantly over- and underrepresented in fault. Finally, for crashes in which older drivers were at fault, various contributing factors were identified, including driver errors.

Examining data on the age distribution of at-fault and not-at-fault drivers in the study showed that younger drivers were more frequently involved in or responsible for fatal traffic crashes in the data set. However, when the data was normalized by population in the state of Florida, both younger drivers and older drivers (75 and above) have higher crash rates than middle aged drivers. Because the main focus of the study was identifying crash types and contributing factors in older driver crashes, no further effort was made to normalize the data against other exposure measures such as driving time or miles, as was done with other studies cited in the literature (*9, 10*). Further, in this study, older drivers were found to be at fault in fatal traffic crashes at much higher rates than all except the youngest drivers. While this result may be skewed by the fact that older drivers are at much greater risk of fatality when involved in a traffic crash (*5, 17, 18*), it does not lessen the need for research that is directed at identifying and ameliorating factors that contribute to fatal crashes involving older drivers.

In the data set described herein, older drivers were at fault in 64% of the fatal crashes in which they were involved, compared with only 47% of the younger drivers. In keeping with other studies (*17, 18, 19, 20*), the data suggests that older drivers are at fault more frequently in intersection crashes than non-intersection crashes. Older drivers were significantly over-represented in fault in left turn crashes versus oncoming traffic and cross traffic; these accounted for over 42% of the crashes in which older drivers were at fault. Misjudgment of speeds of other vehicles, failure to observe other vehicles/all sides before entering the intersection, disregarding traffic signals, and improper left turn were the four major driver errors in intersection crashes, each of which contributed to greater than 10% of the intersection crashes by older drivers. Sudden loss of control contributed to more than one-third of non-intersection crashes, while driving under the influence of alcohol contributed to almost one-fifth of such crashes; these were the most common factors in non-intersection crashes in which older drivers were at fault. These results are in keeping with those of McGwin (*11*), which showed that older drivers had higher fault rates when turns, especially left-turns, were involved, and that failure to yield to the right of way was the leading contributor of crashes caused by older drivers. However, the study described herein separated intersection from non-intersection crashes, allowing the major contributing factors to be categorized for the two different crash types. The data is also based on extensive case studies of fatal traffic crashes, enabling researchers to separate driver errors such as misjudgment of speed, which might be indicative of delayed perception and/or reaction time, from those such as disregarding traffic signals and improper (disallowed) turns, which might be indicative of more serious cognitive issues. Countermeasures to effectively reduce these crash types would be vastly different.

The broad category of age was cited as a primary or secondary contributing factor by the case reviewers in about 15% of the cases. This indicates that the age of a driver affected his or her ability to complete the driving task because of lack of mobility and increased perception-reaction time. Around 10 percent of the crash contributing factors indicated potential confusion on the part of the older driver, including late decisions (e.g. turn from wrong lane), inappropriate action (e.g. stop on interstate, drive around train crossing gates), or illegal maneuvers (e.g., wrong way or left-turn where not permitted). Over two-thirds of the confusion cases were attributed to drivers aged 75 and up. The most common non-human factor was roadway design/geometry, which tended to be applied to wide, non-signalized intersections or those with complicated geometry. Because of the prevalence of intersection crashes among older drivers, the ability to negotiate confusing intersections becomes more of an issue.

The study found that overuse of the term "failure to yield right of way" by the reporting officers makes it difficult for researchers relying only on crash report data to find out the exact reasons for many traffic crashes. Several factors could affect the overuse of the term. It is possible that investigating officers either do not spend enough time or do not have enough information to identify the actual causes behind the fatal crashes. Another potential explanation is that they are unwilling to provide detailed contributing factors because of the ongoing criminal investigation, especially in the case of fatal crashes. Necessary measures should be taken so the investigating officers can investigate in further detail and provide sufficient documentation to supply the actual causes of fatal crashes, so that researchers and policy makers could benefit from the reports.

Finally, while every effort has been made to accurately assess the contributing factors and driver errors associated with each crash, it should be noted that there are limitations to the approach used herein. For instance, a crash that appeared to be caused by increased perception-reaction time (e.g. failure to apply brakes to avoid collision) could actually have been caused by an undetected medical issue). Caution should be used when applying these results. In addition, further research should be conducted to investigate causes and potential countermeasures to crashes in which older drivers are more frequently found to be at fault. Simulator studies can safely investigate issues such as range of motion and age-related vision difficulties (*26*). In areas of high elderly population, ideas to reduce intersection crashes include those recommended by the Florida Elder Road User Program (FERUP), a program being implemented in the state of Florida to make the streets safer and more user-friendly for the increasing large elderly population. The FERUP is instituting safety measures such as larger lettering on street signs, more advanced signage, wider pavement markings and use of reflective pavement markers. Implementing intersection design and signalization that decreases reliance on judgment in making left turns (e.g. protected left turns, roundabouts, etc.) could also be effective in reducing crashes involving older drivers. Prior to implementation of unusual designs such as roundabouts, thorough study should be conducted for the potential to confuse elderly drivers, leading to unsafe and illegal driving maneuvers.

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