

# Characteristics of Accidents Involving Elderly Drivers at Intersections

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Statistics indicate that elderly drivers (drivers 65 years and older) are involved in an increasingly high percentage of accidents at intersections. To develop countermeasures to this problem, traffic and geometric characteristics associated with elderly driver accident involvement are identified. The results indicate that the risk of an elderly driver's being in an accident—expressed in terms of an involvement ratio—is higher at intersections outside cities than at those inside cities. It was also found that providing longer amber signal times and protected left-turn phases will help the older driver.

Studies have indicated that significant changes are taking place in the age structure of the U.S. population. This change, which demographers sometimes refer to as the “squaring of the pyramid,” is altering the population structure from one in which many young people are at the base and few old people are at the top of the pyramid to one that resembles a rectangle and has an even distribution of the age groups (1). In 1900, for example, only 4 percent of the population was 65 years old and older; in 1988, this number had increased to 12 percent, and it is expected to grow to 13 percent by the year 2000 (1). In the future, the elderly (defined here as 65 and older) will tend to be more affluent and healthier than the elderly of the past; hence, they are more likely to reside in suburban areas and depend mainly on the automobile for their mobility. This most probably will result in an increase in automobile travel by the elderly.

Unfortunately, statistics indicate that an elderly person has a higher probability of being involved in an automobile accident—particularly a fatal automobile accident—than the average driver or pedestrian. In 1986, there were 5,900 persons 65 and older killed in motor-vehicle crashes; approximately half of them were 75 and older. This is 13 percent of the total traffic fatalities. The elderly represent 12 percent of the population; thus, the proportion of the traffic fatalities for the elderly is approximately equal to their proportion in the population (2). It is, however, well known that the elderly travel much less than members of other age groups; thus, they should have a lower percentage of fatal accidents than their proportion in the population. Hence, it is necessary to identify and correct the features of the highway system that create hazardous situations for the elderly.

Previous studies have indicated that a significant percentage of crashes involving elderly drivers occur at intersections. For example, Hauer's analysis of NHTSA data (3) has shown that approximately 70,000 elderly drivers are injured and 1,000

killed at intersections every year. These represent 60 and 40 percent of all injury accidents of drivers 64 and older. Hence, this paper will concentrate on the problems of elderly drivers at intersections.

The scope is limited to intersection accidents occurring in the rural and urban areas of Virginia. The objective is to identify the characteristics of accidents involving elderly drivers at intersections. The specific objectives are

- To identify the causes of accidents involving elderly drivers at intersections,
- To identify intersection geometric characteristics that are predominant in crashes involving elderly drivers, and
- To identify the intersection traffic-control devices that are predominant in crashes involving elderly drivers.

## LITERATURE REVIEW

The literature search revealed that much research on the safety of elderly drivers has been undertaken. The following paragraphs summarize the relevant information obtained in the literature review.

### Risk of Elderly Drivers in Crash Involvement

Existing data suggest that in general the crash risk for an elderly driver is somewhat higher than it is for the average person, especially the risk of a fatal crash. Evans (4) has shown that when the exposure used for calculating fatality rates is the number of drivers in each age group, the risk starts increasing between ages 65 and 70, but, when the amount of miles traveled is used as the exposure, the risk starts increasing at 50. In the former case, the risk for women is half that of men; in the latter case, there is hardly any difference. This shows that the distribution between age and fatality rate depends on the exposure used to calculate this fatality rate.

### Type of Collision and Driver Action

A recent study by McKelvey et al. has shown that the elderly are involved in a marginally higher percentage of head-on collisions and a significantly higher percentage of angle collisions than young or middle-aged drivers (5). It was also found that elderly drivers are more often charged for failing to yield the right-of-way, turning illegally, and changing lanes improperly than drivers of other age groups.

## Intersection Type and Traffic Control

Most of the studies that have considered the effect of intersection type or traffic control have been for all accidents, and the results have not been broken down for different age groups. It can be assumed, however, that most of the intersection traffic and geometric characteristics that have an adverse effect on the safety of the overall driver population will also have an adverse effect on the elderly driver. The following paragraphs summarize studies on the effect of intersection type and traffic control on accidents.

### *Intersection Type*

There are two common types of intersections: cross and T. Cross intersections are much more complex than T-intersections because of the higher number of conflicting traffic streams. Hence, it is possible that cross intersections are not as safe as T-intersections for the elderly. Unfortunately, very few studies have investigated this problem in detail.

### *Type of Traffic Control*

There are four major options for traffic control: (a) traffic signals, (b) stop signs, (c) yield signs, and (d) no control. A specific type of traffic control is used primarily on the basis of traffic volume and delay, not safety. A few studies have investigated the effect of different types of traffic control on safety, but the results are not consistent (6-8). Because most of the studies did not consider the effect of traffic volumes in their analysis, their results cannot be generalized.

McKelvey et al. calculated involvement ratios for different types of traffic control for accidents that occurred on highway intersections in Michigan (9). They found that there was a large increase in the involvement ratios for drivers over 75 when there were flashing signals. For drivers older than 60, intersections with signals operating on cycles had the lowest involvement ratio. Unsignalized intersections had higher involvement ratios than those with signals operating on cycles, but those with flashing signals had the highest involvement ratios.

## COMPILATION OF ACCIDENT DATA

The Virginia Department of Transportation (VDOT) maintains standardized accident data bases for accidents occurring on Interstates and primary, secondary, and frontage roads. Accident data for 1986, 1987, and 1988 were obtained from VDOT. From this data base, accident data on intersections were extracted for further analysis. In addition to the age of the driver or pedestrian, the following variables were extracted: intersection type, traffic control, weather, lighting, type of collision, vehicle zone of impact, major factor, severity, driver sex, driver action, and vehicle maneuver. Accidents were grouped into intersection and nonintersection accidents on the basis of the zone of impact: accidents that occurred within the intersection proper or within 150 ft of the edge of the intersection on each approach were classified as

intersection accidents. The compiled accident data covered approximately 26,000 accidents involving drivers 50 and older.

It was expected that city intersections would also have a large number of accidents involving the elderly, so accident data were compiled for a sample of cities in Virginia. Unfortunately, the data on accidents occurring in cities are available not in a standard computer form but as police accident report forms, which are maintained by the Virginia Department of Motor Vehicles. Police accident reports for intersection accidents involving drivers 50 and older were therefore obtained for four randomly selected cities: Virginia Beach, Roanoke, Lynchburg, and Fredericksburg. Relevant accident information from these accident records was then coded into a computer file. The coded accident data base consisted of entries on approximately 7,000 intersection accidents involving drivers 50 and older from 1986 to 1988.

## ANALYSIS OF ACCIDENT DATA

### **Risk of Accident Involvement for the Elderly**

The conventional way of expressing risk at intersections, which is based on traffic volume, cannot be used for different age groups because of the lack of adequate data on actual volume distribution by age group. It was therefore necessary to use another definition of risk when comparing age groups.

In this study, risk is expressed in terms of involvement ratio, which is defined as the ratio of the number of accidents attributed to drivers in a given age group to the number of accidents not attributed to drivers in that same age group. Although VDOT does not directly code the responsibility of the driver in an accident, a parameter called driver action is coded. It gives information about whether the driver committed a traffic violation. Hence, in this paper, the involvement ratio for any age group is the ratio of the number of accident involvements by a given age group in which there was a traffic violation to the total number of accident involvements by that age group in which there was no traffic violation.

One assumption is that the police officer who assigns the responsibility for the accident is unbiased with respect to age. McKelvey et al. tested this by analyzing the data for right-angle crashes and comparing the results with those for other crashes. The involvement ratios were found to be quite similar. Because responsibility can be more directly assigned for right-angle crashes, it was concluded that the variation in involvement ratios over age cannot be explained by police officers' biases (10).

### **Accident Characteristics of the Elderly**

Driver ages were divided into 5-year divisions. For accidents that occurred in VDOT-maintained intersections, 14 age groups were considered, starting from the 15-19 age group to the above-79 age group. For accidents that occurred in Virginia cities, only 7 age groups were considered because accident data were compiled only for accidents involving drivers 50 and older. Apart from driver age, the following variables were considered: (a) accident location, (b) driver sex, (c) type of collision, (d) vehicle maneuver, (e) driver action, (f) type of intersection, and (g) traffic control.

The two variables considered for comparison between age groups were percentage of involvements and involvement ratio. The proportionality test was used for comparing the percentage of involvements among age groups for accident location, type of collision, vehicle maneuver, driver action, and traffic control, whereas Student's  $t$ -test was used for comparing the involvement ratios by age groups for all variables considered. A brief description of the theory involved in the proportionality and  $t$ -tests follows.

#### Proportionality Test

As the name indicates, this test is used to compare two proportions. The test statistic is the  $Z$  value, which is given as

$$Z = (p_1 - p_2) / [p(1 - p)(1/n_1 + 1/n_2)]^{1/2}$$

where  $p_1$  and  $p_2$  are the two proportions to be compared, and  $n_1$  and  $n_2$  are the population sample sizes.

$$p_1 = x_1/n_1 \quad p_2 = x_2/n_2$$

where  $x_1$  and  $x_2$  are the number of successes in each sample. The pooled proportion of successes is  $p$ , defined as follows:

$$p = (x_1 + x_2) / (n_1 + n_2)$$

The null hypothesis that was tested was  $H_0: p_1 \leq p_2$ , against the hypothesis that  $H_a: p_1 > p_2$ . The null hypothesis was rejected when the calculated test statistic  $Z$  was greater than  $Z_a$ , where  $Z_a$  is the standard normal variant corresponding to a significance level of  $a$ .

#### Student's $t$ -test

The  $t$ -test was used in this study for the comparison of involvement ratios. The test statistic is the  $t'$  value (14) defined as

$$t' = (X_1 - X_2) / [s_1^2/n_1 + s_2^2/n_2]^{1/2}$$

where

$X_1$  and  $X_2$  = sample means of the two populations,  
 $s_1$  and  $s_2$  = population standard deviations, and  
 $n_1$  and  $n_2$  = population sample sizes.

$t'$  is assumed to follow a  $t$  distribution with the degrees of freedom given by

$$df = f(s, n) / g(s, n)$$

where

$$f(s, n) = [s_1^2/n_1 + s_2^2/n_2]^2, \text{ and}$$

$$g(s, n) = [(s_1^2/n_1)^2/(n_1 - 1) + (s_2^2/n_2)^2/(n_2 - 1)].$$

The null hypothesis that was tested was  $H_0: X_1 \leq X_2$ , against the hypothesis  $H_a: X_1 > X_2$ . The hypothesis is rejected when

$t'$  is greater than  $t_a^*$ , where the  $t_a^*$  is the standard  $t$  value corresponding to a significant level  $a$  and degrees of freedom (df).

## RESULTS OF ANALYSIS

### Percentage of Involvements

#### Accident Location

Figure 1 shows that the percentage of involvements at intersections increases with age. The results of the proportionality test also showed that the percentage of involvements at intersections for the age group 65 and above was higher than that of the 50–64 age group at a significance level of 0.001 percent ( $Z = 10.60$ ). This suggests that the elderly are more likely to be involved in accidents at intersections.

Only the VDOT data were used for this analysis because only data on accidents at intersections were obtained for the cities.

#### Type of Collision

Table 1 shows the percentage distribution of involvements by type of collision for the VDOT data. The results show that not only are angle collisions predominant for all age groups, but this type of collision increases with an increase in age. The proportionality test was again used to determine whether any significant difference existed between the elderly and non-elderly. The results indicate a significant difference at a significance level of 0.001 percent. Table 2 presents the results of the proportionality tests for the VDOT data.

#### Vehicle Maneuver

Tables 3 and 4 show the percentage distribution of crashes by vehicle maneuver for the different age groups for the VDOT and city data. The predominant crash maneuver for all age groups is that in which the vehicle is going straight. This is because this is the predominant driving maneuver. However, the data indicate that for age groups older than 54 (VDOT

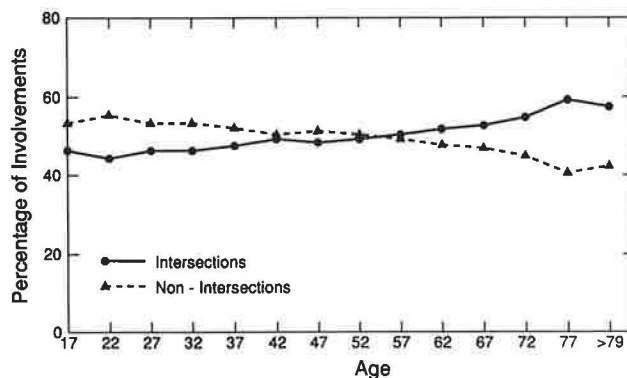


FIGURE 1 Percentage of involvements by location, VDOT data.

TABLE 1 PERCENTAGE OF INVOLVEMENTS BY TYPE OF COLLISION

VDOT Accident Data — 1986 to 1988						
Age Group	Type of Collision					
	1	2	3	4	5	6
15-19	26.0	47.0	1.9	7.4	1.9	15.8
20-24	29.1	46.0	1.7	8.6	1.8	12.8
25-29	30.5	45.2	1.7	8.8	2.0	11.8
30-34	30.3	45.8	1.7	9.5	2.0	10.7
35-39	30.2	47.3	2.0	9.1	1.9	9.5
40-44	30.3	48.3	1.9	8.9	1.9	8.7
45-49	29.9	49.3	1.7	8.8	2.0	8.3
50-54	29.2	49.3	1.7	8.8	2.0	9.0
55-59	26.7	52.5	1.9	9.2	2.1	7.6
60-64	24.7	55.5	1.5	9.2	1.7	7.4
65-69	22.5	57.2	1.7	10.2	1.8	6.6
70-74	19.5	60.4	1.7	9.9	1.5	7.0
75-79	16.5	64.0	1.4	9.2	2.4	6.5
> 79	12.9	67.8	2.3	7.4	1.5	8.1

- 1 - Rear end
- 2 - Angle
- 3 - Head on
- 4 - Sideswipe same direction
- 5 - Sideswipe opposite direction
- 6 - Other (fixed object, noncollision etc.)

TABLE 2 RESULTS OF PROPORTIONALITY TESTS BY TYPE OF COLLISION

VDOT Accident Data — 1986 to 1988			
Type of Collision	Percentage of Involvements		Z
	50-64	65 and above	
Rear End	27.08	19.22	14.52*
Angle	52.14	60.83	13.84*
Head On	1.67	1.72	0.27
Sideswipe Same Direction	9.39	9.56	0.45
Sideswipe Opposite Direction	1.95	1.80	0.85

\* Significant at a 5 percent significance level.

TABLE 3 PERCENTAGE OF INVOLVEMENTS BY VEHICLE MANEUVER, VDOT DATA

VDOT Accident Data — 1986 to 1988						
Age Group	Vehicle Maneuver					
	1	2	3	4	5	6
15-19	49.4	4.0	17.4	7.1	1.8	20.3
20-24	52.5	4.0	15.9	6.1	2.1	19.4
25-29	52.3	3.9	15.4	5.0	1.9	21.5
30-34	51.7	3.9	16.0	4.0	1.9	22.5
35-39	50.5	4.2	16.4	3.3	1.9	23.7
40-44	49.6	4.1	16.8	3.2	1.8	24.5
45-49	50.5	3.9	16.4	2.4	2.1	24.7
50-54	47.2	4.6	19.2	2.4	2.1	24.5
55-59	48.0	4.1	20.4	2.5	2.0	23.0
60-64	45.5	5.0	22.2	2.4	2.1	22.8
65-69	44.4	4.5	24.6	1.9	2.4	22.2
70-74	41.5	4.9	28.1	2.2	2.3	21.0
75-79	38.0	5.4	31.6	1.7	2.2	21.1
> 79	37.2	5.7	35.0	2.0	1.9	18.2

- 1 - Going Straight
- 2 - Right turn
- 3 - Left turn
- 4 - Ran-off-road
- 5 - Changing lanes
- 6 - Other (slowing, stopping, backing, passing)

TABLE 4 PERCENTAGE OF INVOLVEMENTS BY VEHICLE MANEUVER, VIRGINIA CITIES DATA

Virginia Cities Accident Data — 1986 to 1988						
Age Group	Vehicle Maneuver					
	1	2	3	4	5	6
50-54	50.9	5.1	17.1	1.1	1.7	24.1
55-59	51.8	5.2	17.4	1.3	1.7	22.6
60-64	54.7	5.7	17.2	0.5	2.2	19.7
65-69	46.7	8.7	21.1	0.5	3.2	19.8
70-74	47.4	5.6	21.4	0.7	3.2	21.7
75-79	45.6	7.2	28.2	0.7	1.3	17.0
> 79	46.5	8.1	26.2	0.5	3.4	15.3

- 1 - Going Straight
- 2 - Right turn
- 3 - Left turn
- 4 - Ran-off-road
- 5 - Changing lanes
- 6 - Other (slowing, stopping, backing, passing)

data) and 65 (city data), there is a consistent reduction in the percentage of crashes in which the maneuver was going straight, whereas there is a consistent increase in the percentage of crashes in which the left-turn maneuver was involved. This suggests that the potential for left-turn accidents involving the elderly increases with age. The results of the proportionality test also show the proportion of left-turn involvements for the elderly to be significantly higher than that for the 50–64 age group at a significance level of 0.001 percent. Although some increase in the proportion of involvements involving right-turn maneuvers was observed for the elderly as age increases, the proportion of accidents involving right turns for the elderly is not significantly different from that for the 50–64 age group at the 5 percent significance level.

#### Driver Action

Tables 5 and 6 show the percentage distribution of accidents by driver action and age groups for the VDOT and city data. It can be seen that for both sets of data, the predominant violation for the elderly is failure to yield right-of-way. In fact, the percentage of involvements for which the violation is failure to yield right-of-way increases with age not only for those 65 and older but also for those between 50 and 64. This suggests that using traffic control devices that will clearly indicate which traffic stream has the right-of-way will be significant in the reduction of accidents involving the elderly at intersections. Although the predominant violation for all age groups above 50 is failure to yield right-of-way, the results of

TABLE 5 PERCENTAGE OF INVOLVEMENTS BY DRIVER ACTION, VDOT DATA

VDOT Accident Data — 1986 to 1988								
Age Group	Driver Action							
	1	2	3	4	5	6	7	8
15-19	32.9	7.0	21.2	4.5	13.2	2.4	2.5	16.3
20-24	41.8	5.8	15.1	4.5	11.9	2.6	1.9	16.4
25-29	47.3	4.3	14.5	3.9	10.4	2.2	1.7	15.7
30-34	51.5	3.3	14.6	3.8	9.3	2.0	1.3	14.2
35-39	54.1	2.8	15.3	3.4	8.4	1.6	1.4	13.0
40-44	55.3	2.3	16.4	3.1	8.0	1.8	1.2	11.9
45-49	53.4	1.9	15.9	3.1	7.9	1.8	1.3	14.7
50-54	52.9	1.8	18.8	2.8	8.2	1.8	1.6	12.1
55-59	51.6	1.7	20.4	2.7	8.1	2.3	1.4	11.8
60-64	46.9	1.5	24.1	2.6	8.2	2.3	2.4	12.0
65-69	40.3	1.1	29.2	2.8	8.7	2.5	2.4	13.0
70-74	33.7	1.2	35.5	3.1	8.9	2.3	2.6	12.7
75-79	25.2	0.8	43.9	2.5	9.5	3.2	3.0	11.9
> 79	16.6	0.5	48.9	2.7	8.9	3.4	4.0	15.0

- 1 - No violations
- 2 - Exceeding speed limit as well as safe speed
- 3 - Failure to yield right of way
- 4 - Following too close
- 5 - Inattention
- 6 - Disregarded stop-go light
- 7 - Disregarded stop/yield sign
- 8 - Other

TABLE 6 PERCENTAGE OF INVOLVEMENTS BY DRIVER ACTION, VIRGINIA CITIES DATA

Virginia Cities Accident Data — 1986 to 1988								
Age Group	Driver Action							
	1	2	3	4	5	6	7	8
50-54	51.9	0.8	14.3	4.7	5.2	1.6	4.1	17.4
55-59	48.0	1.3	16.6	5.5	4.9	2.8	3.5	17.4
60-64	47.9	0.8	18.4	5.6	4.9	2.6	4.5	15.3
65-69	42.8	0.9	22.0	3.5	5.9	2.4	5.4	17.1
70-74	35.7	1.0	26.3	4.3	6.9	2.9	5.2	17.7
75-79	28.4	1.0	33.9	3.5	7.4	3.7	3.7	18.4
> 79	23.7	0.7	35.2	2.7	7.7	5.9	4.3	19.8

- 1 - No violations
- 2 - Exceeding speed limit as well as safe speed
- 3 - Failure to yield right of way
- 4 - Following too close
- 5 - Inattention
- 6 - Disregarded stop-go light
- 7 - Disregarded stop/yield sign
- 8 - Other

proportionality tests show that there is a difference at the 0.001 percent significance level in the percentage of involvements between that for the elderly and that for the 50-64 age group. The small percentage of violations by the elderly for exceeding the safe speed limit is expected because this group of drivers tends to drive slower than the other age groups. Table 7 provides the results of the proportionality tests for the VDOT data.

*Traffic Control*

Table 8 shows the percentage distribution of accident involvements by traffic control and age for the city data. These indicate that there is an increase in the percentage of involvements for the elderly at intersections controlled by stop signs. In fact, the results of the proportionality tests show that the percentage of involvements at stop-controlled intersections

TABLE 7 RESULTS OF PROPORTIONALITY TESTS BY DRIVER ACTION

VDOT Accident Data — 1986 to 1988			
Driver Action	Percentage of Involvements		Z
	50-64	65 and above	
No violation	50.75	32.37	-29.30*
Did not have right-of-way	20.85	36.46	28.04*
Driver inattention	8.17	8.94	2.20*
Following too-close	2.71	2.81	0.48
Disregarded stop-go light	2.11	2.70	3.11*
Disregarded stop/yield	1.76	2.78	9.90*
Speeding	1.68	0.99	- 4.59*

\* Significant at the 5 percent significance level.

TABLE 8 PERCENTAGE OF INVOLVEMENTS BY TRAFFIC CONTROL

Virginia Cities Accident Data — 1986 to 1988					
Age Group	Traffic Control				
	1	2	3	4	5
50-54	36.3	19.6	20.3	20.0	3.8
55-59	33.2	20.8	21.4	17.9	6.7
60-64	34.1	22.7	20.1	16.9	6.2
65-69	37.1	21.7	20.2	14.8	6.2
70-74	32.3	21.5	22.0	17.3	6.9
75-79	32.9	27.5	19.8	14.2	5.6
> 79	29.6	27.8	21.7	13.9	7.0

- 1 - Traffic signal
- 2 - Stop sign
- 3 - Traffic lanes marked
- 4 - No control
- 5 - Other (slow/warning sign, yield sign, officer, etc.)

for drivers 65 and older is significantly higher than that for drivers 50–64. Table 9 presents the results of the proportionality tests conducted for the VDOT data. Similar results were obtained for the city data.

The increase in percentage of involvements in stop-controlled intersections with age is not surprising considering the fact that there is an increase in failure to yield right-of-way violations with an increase in age.

**Involvement Ratio**

*Accident Location*

Figures 2 and 3 show the distribution of the involvement ratios by age for the VDOT and city data. Figure 2 shows that the involvement ratio for intersection accidents initially decreases from a value of about 1.8 for the youngest age group (15–19) to approximately 0.7 for the 45–50 age group. It then increases to approximately 5 for the oldest age group (above 79). It can also be seen that for drivers above 62, the involvement ratio at intersections is higher than the involvement ratio at all locations combined.

Figure 3 shows an increase in involvement ratio from about 0.7 for the 50–64 age group to a maximum value of about 3 for the oldest age group (above 79). The results of the *t* test show that there is a significant difference in involvement ratio between the 50–64 age group and the elderly for both VDOT and city intersection accidents. These results indicate that the potential for a driving violation increases with age for drivers older than 62. The rate of increase, however, is higher for elderly drivers.

*Driver Sex*

As can be seen from Figure 4, at age 52 and older, the involvement ratio for female drivers is higher than that for male drivers, whereas at 42 and younger, the involvement ratio for male drivers is higher than that for female drivers. The results of *t* tests that were performed show that the involvement ratio for female drivers is significantly higher at a 1 percent significance level than the involvement ratio for male drivers for the 50–64 and the 65-and-older age groups.

Similar results were obtained for the city data. The results of *t* tests also show that the involvement ratio for female drivers is significantly higher than the involvement ratio for male drivers at a significance level of 3.5 percent for drivers 65 and older and 4.5 percent for drivers from 50 to 64.

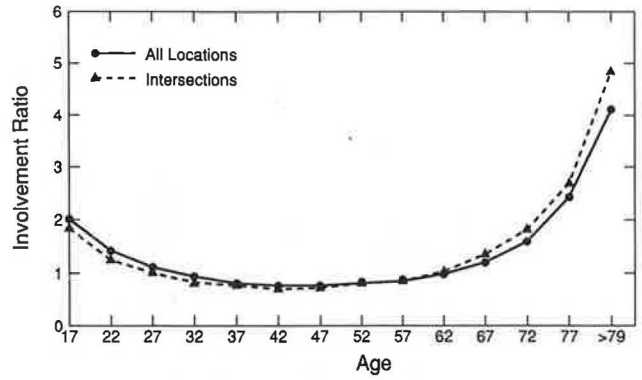


FIGURE 2 Involvement ratio by location, VDOT data.

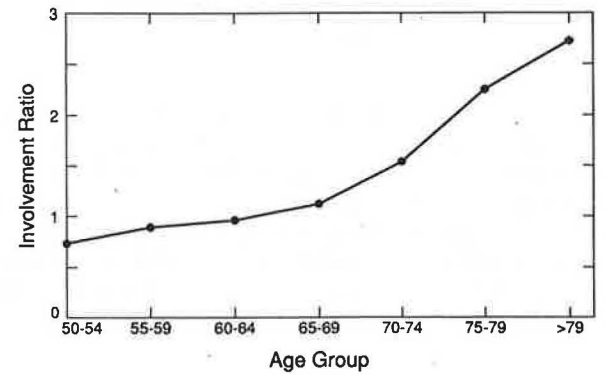


FIGURE 3 Involvement ratio for intersection accidents, Virginia cities data.

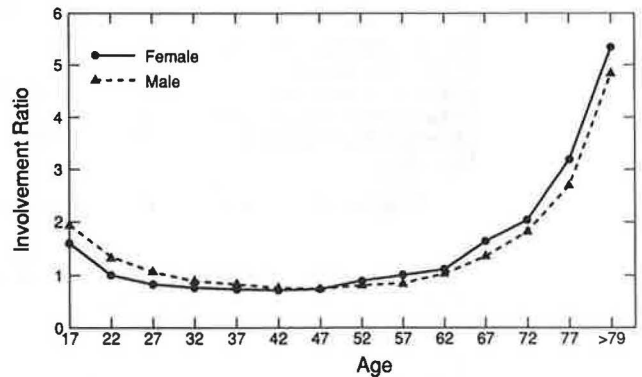


FIGURE 4 Involvement ratio by sex, VDOT data.

TABLE 9 RESULTS OF PROPORTIONALITY TESTS BY TRAFFIC CONTROL

Virginia Cities Accident Data — 1986 to 1988			
Traffic Control	Percentage of Involvements		Z
	50-64	65 and above	
Signal	34.50	33.80	-0.72
Stop	20.94	23.71	2.87*
No control	17.60	15.20	-2.76*

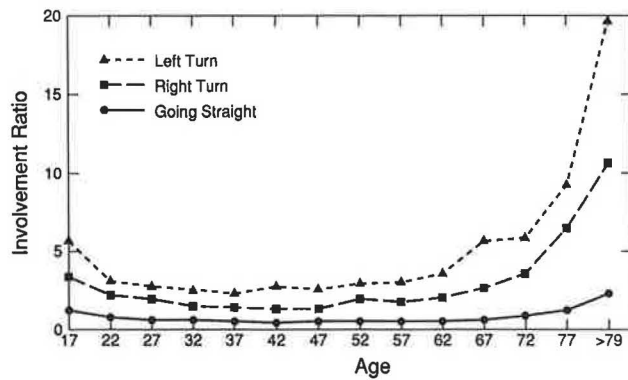
\* Significant at the 5 percent significance level.

*Type of Collision*

Table 10 shows the involvement ratio by type of collision for the VDOT. The results show that for the elderly, there is an increase in the involvement ratio of angle, sideswipe, and head-on collisions with an increase in age. The results of the *t* tests performed on the VDOT data for the 50–64 age group show that the involvement ratios for angle and sideswipe–same-direction collisions are significantly higher than the involvement ratios for rear-end collisions (significance levels are 0.3 percent and 0.2 percent, respectively). For the 65-and-above age group, the *t* tests show that the involvement ratios for angle, head-on, and sideswipe–same-direction collisions are significantly higher than the involvement ratios for rear-end collisions (significance levels were 0.01, 4, and 0.56 percent, respectively). The higher involvement ratios for angle and sideswipe–same-direction collisions support the earlier finding that failure to yield right-of-way is a frequent violation for the elderly. Similar results were obtained when the *t* test was performed on the city data. The involvement ratio for angle collisions was significantly higher than the involvement ratio for rear-end collisions for both the 50–64 age group (significance level = 1 percent) and 65-and-above age group (significance level = 0.03 percent).

*Vehicle Maneuver*

The variations of involvement ratios by vehicle maneuver and age are shown in Figure 5 for the VDOT data. This figure shows that although involvement ratios for accidents involving left-turn maneuvers are the highest for all age groups, significant increases are observed at age 64 and older. Results of the *t* tests performed on the data for the 50–64 and the 65-and-older groups show that the involvement ratios for right- and left-turn maneuvers are significantly higher than those for going straight.



**FIGURE 5** Involvement ratio by vehicle maneuver, Virginia cities data.

*Traffic Control*

Figure 6 shows the involvement ratio for different age groups by traffic control at an intersection. The results of the *t* test performed for the 50–64 age group show that the involvement ratio at intersections with no control is significantly higher than the involvement ratio at intersections with traffic signals (the significance level was 4 percent). When the *t* test was performed on the data for the 65-and-older age group, it was found that the involvement ratio for accidents at intersections with stop control is significantly higher than the involvement ratio for accidents at intersections with no control at a significance level of 2 percent. Also, although the involvement ratio for accidents at intersections with no control is higher than the involvement ratio at intersections with signals, this difference is not significant at the 5 percent significance level.

**CONCLUSIONS**

- Involvement ratios for the elderly (65 years and older) are significantly higher than those for other age groups.

**TABLE 10** INVOLVEMENT RATIO BY TYPE OF COLLISION

VDOT Accident Data — 1986 to 1988					
Age Group	Type of Collision				
	1	2	3	4	5
15-19	1.60	1.64	1.85	1.39	1.57
20-24	1.24	1.02	1.09	1.10	1.14
25-29	0.93	0.86	0.97	0.92	0.90
30-34	0.77	0.77	0.91	0.77	0.86
35-39	0.66	0.74	0.81	0.80	0.56
40-44	0.56	0.77	0.65	0.78	0.53
45-49	0.58	0.81	0.54	0.77	0.53
50-54	0.58	0.95	0.68	0.86	0.78
55-59	0.60	0.99	0.65	1.03	0.46
60-64	0.69	1.21	0.79	1.13	0.61
65-69	0.73	1.71	1.39	1.68	1.42
70-74	0.97	2.28	1.59	2.00	1.50
75-79	1.31	3.61	2.86	2.23	1.88
> 79	1.85	6.34	5.00	6.80	8.00

- 1 - Rear end
- 2 - Angle
- 3 - Head on
- 4 - Sideswipe same direction
- 5 - Sideswipe opposite direction



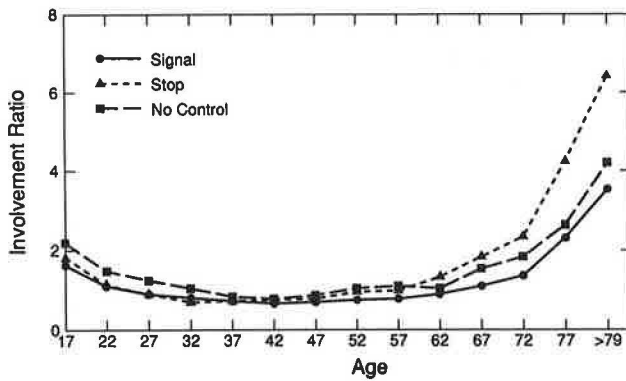


FIGURE 6 Involvement ratio by vehicle maneuver, VDOT data.

- Involvement ratios for the elderly at intersections outside cities are higher than for intersections within cities.
- When the elderly are involved in a crash, it is more likely that they have committed a traffic violation. This likelihood increases with age.
- The probability of the elderly committing a violation at an intersection is much higher than that for other age groups.
- The elderly have a higher potential for committing a traffic violation during a turning maneuver, particularly when making left turns.
- The predominant traffic violation of the elderly is failure to yield right-of-way.
- The elderly are more likely to commit a traffic violation at intersections controlled by stop signs than at any other type of traffic control.
- The provisions of specific countermeasures that will aid the elderly in making turning movements (particularly left turns) will have a significant impact on their crash involvement.

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Publication of this paper sponsored by Task Force on Safety and Mobility of Older Drivers.