Highway Accidents and the Older Driver

FRANCIS X. MCKELVEY, THOMAS L. MALECK, NIKIFOROS STAMATIADIS, AND DANIEL K. HARDY

The research reported in this paper examined the relationship between driver age and highway accidents by using a variation of the induced exposure method. In this method the exposure of drivers to highway accidents is represented by their relative probability of being the driver of the vehicle that was not cited for a contributing hazardous action in an accident, that is, involvement as an "innocent victim" in highway accidents. The measure of induced exposure used in this research is based on the information contained in the computerized accident records prepared by the Michigan Department of State Police and maintained by the Michigan Department of Transportation. These records contain the information reported by the investigating officer at the scene of the accident. The results indicate that the accident involvement of elderly drivers is higher than that of other drivers.

The research project described in this paper had two objectives, namely, determination of the most feasible approach to the study of the relationship between driver age and highway accidents and, by using this approach, identification of those factors or conditions that tend to indicate greater accident involvement for older drivers.

In recent decades, medical advances have greatly increased the average life expectancy. Elderly people are a greater percentage of the total population today than ever before (*1, 2*). Additionally, the automobile has become an integral part of society, particularly in the United States. Therefore a greater percentage of drivers today are elderly people (*3*), and these percentages are expected to continue increasing during the next few decades.

If driver safety is measured by the number of accidents per licensed driver, elderly people appear to have a good safety record. Typically, researchers base accident rates on the number of drivers in the various age groups. A representation of this type for single- and double-vehicle accidents in Michigan over the period 1983–1985 is given in Figure 1. If this approach is taken, the results indicate that driver safety increases with age. However, most elderly drivers do not drive as often or as far as other drivers. Traditionally, a more accurate measure of traffic safety has been the number of accidents per mile driven. If this method is used, it appears that elderly drivers have a below-average safety record (*4*). Given the projected increase in the number of elderly drivers and the corresponding increase in the percentage of total miles driven by elderly drivers, this is cause for concern.

Studies have been conducted by others who sought to determine where and why elderly drivers are a high-risk group. In one study it was found that the young driver, defined as a driver between ages 17 and 19, is more than 3 times as likely to have an accident as the average driver, and that the elderly driver, defined as a driver of age 65 or greater, is slightly less likely to have an accident than the average driver. However, it was noted that the relative accident rates for drivers between 30 and 64 were substantially lower than the average, which indicated a decrease in safety for elderly drivers (*5*). In another study the risks of being in an injury or fatal accident were compared for the 25–64 age group and the over-65 age group. The over-65 age group was found to be 2.5 to 5 times as likely to be involved in a fatal auto accident and 1 to 2 times as likely to be involved in an injury accident (*6*). Finally, it has been reported that older drivers tended to be responsible for accidents more often than younger drivers (*7*). The accident exposure of drivers in various age groups has often been determined through surveys or has been assumed to be proportional to the number of licensed drivers in each age group. An alternative method for analyzing accident frequency is the induced exposure method, which has been used by others (*8–14*).

The variation of the induced exposure method used in this research is based upon the assumption that the accident exposure by any class of driver or vehicle is directly proportional to the number of "innocent victim" involvements in multi-automobile accidents by that class of driver or vehicle (*15*). Innocent victim involvement is defined as involvement in an accident in which the driver (the "innocent victim") was not responsible.

RESEARCH DATA BASE

Data Sources

To examine the relationship between driver age and accidents, use was made of the accident records mentioned previously for 1983–1985, as well as three other highway data files maintained by the Division of Traffic and Safety at the Michigan Department of Transportation. These were the Michigan Dimensional Accident Surveillance (MIDAS) Geometric Segment File, the MIDAS Traffic Volume File, and the Traffic Signal Inventory File.

The geometric file contains information about the geometric characteristics of each unlimited access highway segment on the state trunkline system, such as number of lanes, lane width, roadside development, posted speed limit, curvature, and other elements of the horizontal alignment of the segment. The file also contains information about the existence of an intersection, the type of intersection, and its characteristics.

The traffic volume file contains information about the capacity, average daily traffic, and hourly traffic volume distribution for the counting stations for the state trunkline system.

Department of Civil and Environmental Engineering, Michigan State University, East Lansing, Mich. 48824-1212.

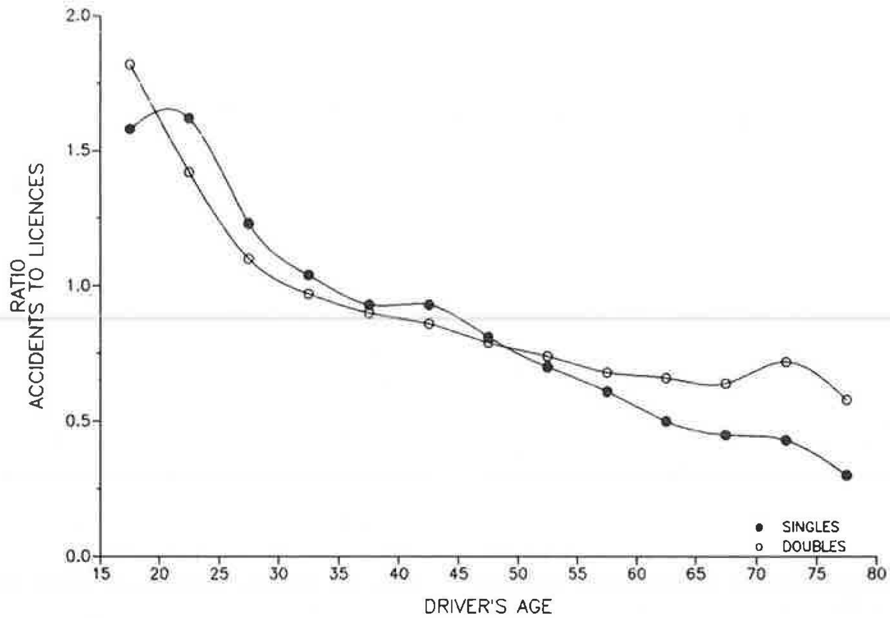

FIGURE 1 Comparison of the percentage of accidents per licensed driver for single- and two-vehicle accidents.

The traffic signal file contains information about the existence of traffic signals or other traffic control devices at intersections. The records contain information about the type of signal, phases, prohibitions of left or right turns, and other characteristics of the signal lantern, such as the manufacturer, material, lens size, and year of installation.

Each of the four data files uses a common system for identifying of highway segments. This factor allowed the research team to merge the accident records with the files describing the characteristics of the locations where the accidents occurred.

Subdivision of the Data for Analysis

After the project data file had been created, 28 separate subsets of data were created for analysis. These subsets were created by subdividing both intersection and nonintersection accidents in the project file into accidents that occurred on the Interstate highway system and accidents that occurred on federal, state, and other highway systems in the state. Those accidents that occurred on the Interstate highway system were then subdivided into accidents that occurred during the day and those that occurred at night. The accidents that occurred on the non-Interstate system were subdivided on the basis of the time of the accident, type of route (i.e., federal, state, or other) on which the accident occurred, and overall surrounding development of the area (i.e., urban or rural area) in which the accident occurred. The partitioning of the project data file is presented in Table 1.

The data were subdivided in this manner because the subdivisions allowed differences in the distribution of the accidents between two given subsets in which all the factors were the same except for one to be explained and attributed to the presence of the noncommon factor. Analyses showed that when the distributions of two subsets were compared and found statistically different, the difference could only be explained by the factor that was not the same in these two subsets. This type of approach thus leads to an identification of the factor that is affecting the accident distributions.

Driver 1–Driver 2 Validation

The basic hypothesis of this research is that a better representation of the driving frequency of drivers of each age group is their exposure to accidents, as represented by their involvement as innocent victims in an accident. Data that show the accident frequency distribution of Driver 2 (the innocent victim) as a function of age are considered in this research to be a measure of accident exposure and therefore also of driving frequency.

The basic interpretation of the meaning of Driver 1 and Driver 2 in the accident data base is fundamental to this hyphothesis. In Michigan, instructions on the accident reporting form indicate that Driver 1 is the driver of the vehicle that is responsible for the accident and Driver 2 is the driver of the vehicle that is not responsible for the accident. Additional data included in the accident record indicate any hazardous actions in which either driver may have been involved that were deemed by the investigating officer to contribute to the accident. In a discussion of a paper by Carr (*9*), in which a similar methodology was used, the impact of bias introduced by a tendency to assign responsibility to certain driver age groups or in situations in which both drivers or neither driver was responsible was addressed. Attempts were therefore made in the current research to minimize these types of bias by classifying a driver as responsible only when that driver was also cited for a hazardous action.

In an earlier study that used these accident records for the relative involvement of vehicles of different characteristics in accidents (*15*), it was found that when the vehicle identification number (VIN) shown on the accident record was used to derive vehicle characteristics from the VNDCTR program, the VINs of up to 42 percent of the vehicles involved in accidents did not

TABLE 1 SUBSETS OF PROJECT DATA FILE

Data Set	Contents
Interstate Accident Data Subsets	
Interchange	
1	Day
2	Night
Noninterchange	
3	Day
4	Night
Non-Interstate Accident Data Subsets	
Intersection	
5	Day, rural, federal
6	Day, urban, federal
7	Night, rural, federal
8	Night, urban, federal
9	Day, rural, state
10	Day, urban, state
11	Night, rural, state
12	Night, urban, state
13	Day, rural, other
14	Day, urban, other
15	Night, rural, other
16	Night, urban, other
Nonintersection	
17	Day, rural, federal
18	Day, urban, federal
19	Night, rural, federal
20	Night, urban, federal
21	Day, rural, state
22	Day, urban, state
23	Night, rural, state
24	Night, urban, state
25	Day, rural, other
26	Day, urban, other
27	Night, rural, other
28	Night, urban, other

decode properly. This problem occurred either because of errors made in recording this information by the investigating officer at the scene of the accident or errors made in transcribing this information from the original accident form to the accident data base.

Errors of this magnitude could dramatically affect the size of the accident samples used in this study and the statistical reliability of the results, particularly for age groups in which smaller samples exist (such as older drivers). Therefore an analysis was undertaken to verify the accuracy of the information recorded on the accident data base for Driver 1 and Driver 2, as indicated in the accident data base. If such errors did exist, it was important to determine if these errors were randomly distributed with respect to the age of the driver. Because the accident records contain both an indication of driver responsibility through the Driver 1 or Driver 2 notation and an indication of any hazardous action performed by each driver, the original data records were examined for a correspondence between the Driver 1 and Driver 2 notations and the indication of which driver committed a hazardous action.

The results for the case of all multivehicle accidents on non-Interstate highways, shown in Figure 2, are typical of the findings from this analysis. In this figure, three curves are plotted. One curve shows the Driver 1 distribution, with all accidents (a total of 193,102) included as indicated in the original data base. The second curve shows the Driver 1 distribution, with only those accidents (154,854) for the original data base in which the indicated Driver 1 was cited as having performed a contributing hazardous action and the indicated Driver 2 was not cited as having performed such an action. This process eliminated 19.8 percent of the accidents from the original data base (plotted in the first curve). The accidents that were eliminated were those in which neither driver was cited for a hazardous action, both drivers were cited for a hazardous action, or the wrong driver was cited for a hazardous action. Finally, the third curve shows the Driver 1 distribution based on the second curve, with the addition of the Driver 1 accidents in which the original data base had the indicated Driver 1 and Driver 2 reversed on the basis of the hazardous action notation. This final curve is based on 190,922 accidents. Therefore this process resulted in the elimination of only 2,180 accidents from the original data base, or roughly a little over 1 percent of the accidents.

A visual examination of this figure indicates that the curves are virtually the same, and statistical analyses verified that the errors were randomly distributed across all age groups. This latter result is significant because it indicates that through the process of examining a hazardous action citation for the drivers involved in an accident, any bias related to age in the designation of the driver responsible on the original accident record can be virtually eliminated. As a result of this analysis, it was apparent that accuracy of the original data base could be enhanced through the comparison and deletion process without the elimination of a significant number of accident records. In the worst case, this process eliminated about 19 percent of the accidents, but it also improved the accuracy of the remaining 81 percent of the accidents in the data base. In this case, it was found that the errors were statistically random at the 95 percent confidence level.

RESEARCH METHODOLOGY

This research is based on the assumption that the probability that a driver in a given age group will be involved as the driver responsible in an accident is represented by the percentage of accidents in which the drivers in that age group were involved and were the driver responsible for the accident. As stated earlier, this driver is defined as Driver 1. Furthermore, the probability that a driver in a given age group will be exposed to an accident in which the driver was not responsible is represented by the percentage of accidents in which the drivers in that age group were involved but were not the driver responsible for the accident. This driver is defined as Driver 2, or the so-called "innocent victim."

This interpretation of Driver 2 is meant to be a measure for accident exposure in this study. This induced exposure measure provides a mechanism by which accident frequency for drivers of different age groups may be studied under a variety of driving conditions, such as on different type of roads, during day and night conditions, under urban and rural conditions, and so on. If it is true that accident involvement as an innocent victim increases in direct proportion to accident exposure, then this surrogate measure should be a reliable indicator of such a phenomenon.

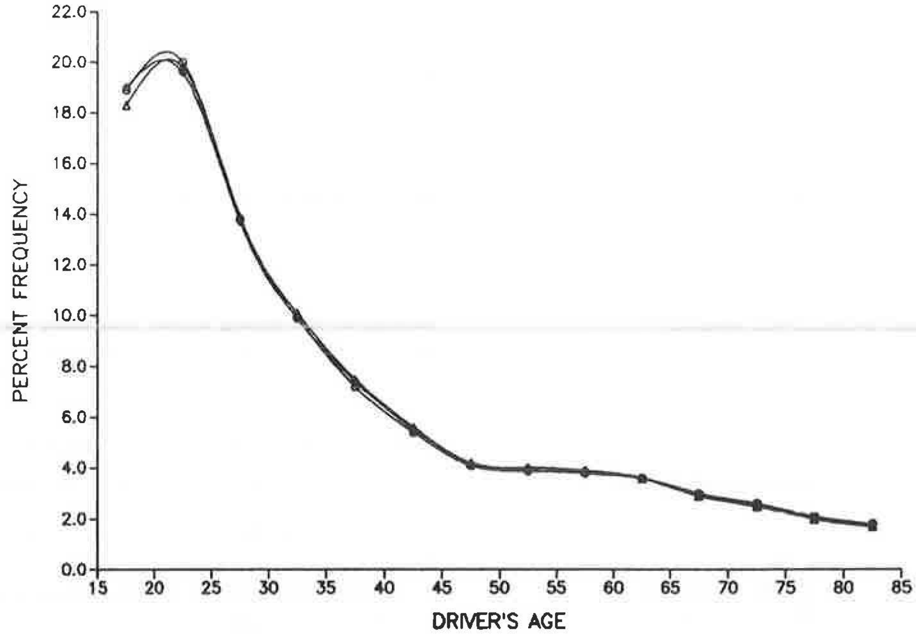

FIGURE 2 Driver 1 distributions for original and modified data sets for all multivehicle accidents on non-Interstate highways.

It should be noted that the interpretations of Driver 1 and Driver 2 in this research are similar to the interpretations made in research performed by others, in which involvement in single-vehicle accidents and involvement in multiple-vehicle accidents were used to derive both driver responsibility and driver exposure. A comparison of various formulations of induced exposure as represented by Thorpe (*8*) and Haight (*10, 11*) with the exposure measure used in this research is given in Figure 3. It can be observed that when the Driver 2 distribution is compared with Thorpe's formulation (*8*), the same exposure trend with driver age occurs, but there are large differences between the two formulations. These differences average about 27 percent across all age groups but are considerably higher for both the younger and the older age groups. Similarly, a comparison with Haight's original formulation (*10*) and his modified formulation (*11*) yields average errors of about 26 percent and 9 percent, respectively. Again, the greatest differences occur with the younger and older age groups.

The assumptions made by Haight and Thorpe in their formulation of induced exposure from the double accident data are considerably relaxed in our formulation of exposure. That is, for each pair of drivers involved in an accident, the designation of the responsible driver and innocent driver is made from the original accident report. The assumption is that the Driver 1

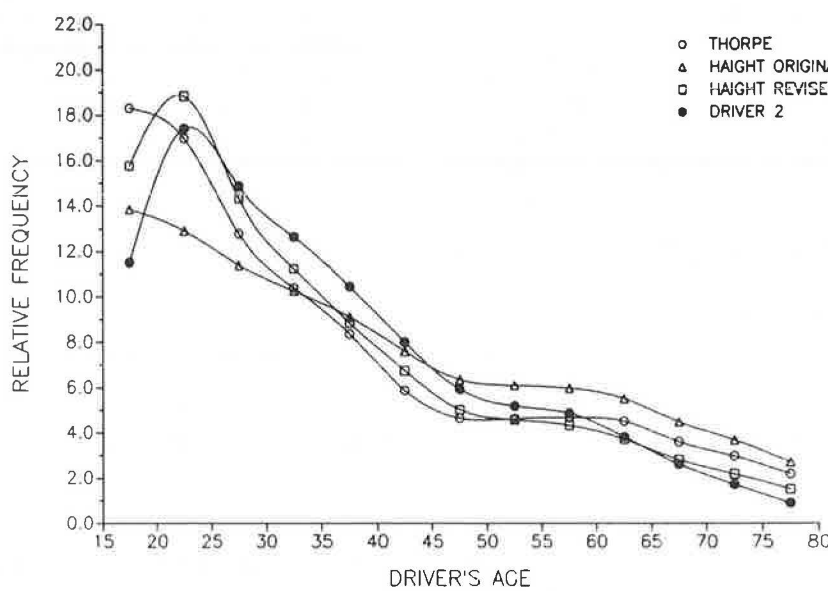

FIGURE 3 Comparisons of various induced exposure means.

distribution in multiple-vehicle accidents is a measure of responsibility and that the Driver 2 distribution in multiple-vehicle accidents is a measure of exposure. For this reason it is expected that the Driver 2 formulation of exposure is considerably more reliable than the formulations of Thorpe and Haight.

Preliminary tests have also been conducted on the accident data base, using the induced responsibility model (*16*) proposed by Wasielewski and Evans. Their formulation seeks to determine the total number of accidents that occurred in which both drivers were responsible on the basis of the distribution of single and double accidents and licensed drivers. These distributions are shown in Figure 4 for all accidents occurring in Michigan during 1983–1985. By applying the induced responsibility model, it was found that 10.3 percent of the accidents were the responsibility of both drivers. The results of comparing the actual double accidents with those derived from the Wasielewski and Evans formulation with a responsibility factor of 10.3 percent are shown in Figure 5. Because only about 10 percent of the accidents involve shared responsibility, the Driver 2 measure of exposure should be reliable.

It should be emphasized at the outset that the measure of exposure that is used here is in fact deduced from accident data and is therefore subject to some degree of error. However, in the absence of a definitive measure of actual exposure that would normally be obtainable only through extensive driver surveys, it may only be possible to deduce the validity of this research methodology by similar comparisons. The results of research undertaken using this measure of induced exposure should therefore be carefully interpreted as indications of likely trends rather than absolute facts about accident involvement.

The probability distributions for both Driver 1 and Driver 2 as a function of age group for all non-interchange multivehicle accidents on Interstate highways in Michigan are shown in Figure 6. If the interpretation of Driver 1 and Driver 2 noted previously is used, the Driver 1 curve on this figure shows the percentage of drivers in different age groups that were the driver responsible in these accidents. The curve indicates that drivers in the 20–25 age group are responsible more often than drivers in any other age group. This curve also indicates a decreasing probability of being involved in an accident and being responsible for that accident with increasing age. This curve is typical of the results of research that bases accident rates on other bases, such as the number of licensed drivers in each age group.

However, it is the interpretation and use of the data plotted in the second curve on Figure 6 that are unique in this research. This curve indicates the percentage of drivers in different age groups that were involved as innocent victims in these accidents. This curve is similar to those plotted by other researchers who used the induced responsibility model (*16*). The curve indicates that drivers in the 20–25 age group have the highest probability of being involved in such accidents as innocent victims and also that the probability of being involved in such accidents as an innocent victim decreases with age. If the results of the Driver 2 curve are an accurate measure of driver exposure to accidents, however, then the accident involvement as a responsible driver is higher than the accident exposure when the Driver 1 curve is above the Driver 2 curve. Conversely, when the Driver 1 curve is below the Driver 2 curve, accident involvement as a responsible driver is less than the accident exposure.

A better indication of the meaning of these statements may be found by examining the results presented in Figure 7. In this figure, the Driver 1 percentage is divided by the Driver 2 percentage. The result, called the relative accident involvement ratio, is plotted for each age group. As can be seen, this ratio is highest for the younger age groups, decreases until about age 40, remains relatively constant from age 45 to about age 60, and then begins to increase again. These results indicate that there is an overinvolvement in such highway accidents by drivers who are less than 30 years old and drivers who are more

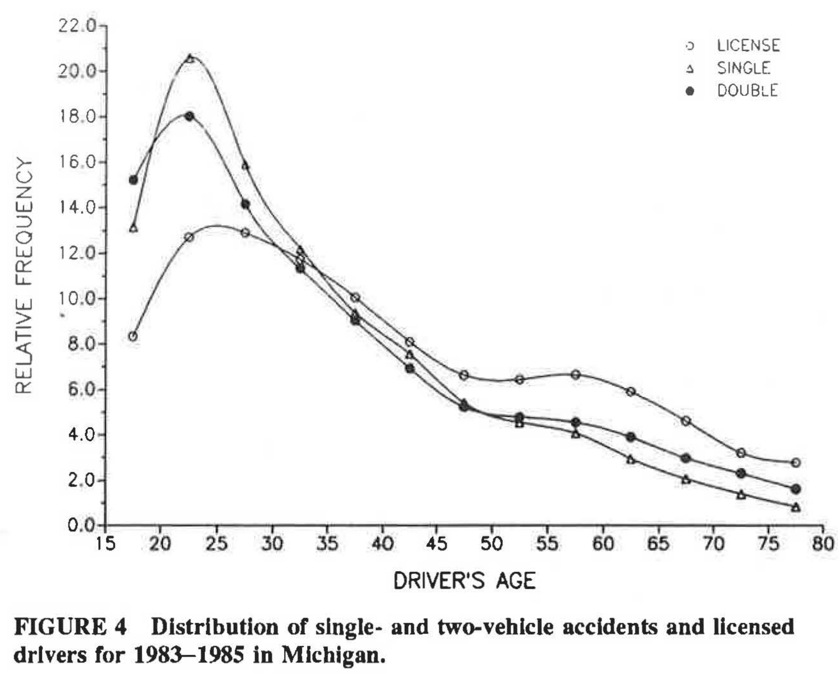

FIGURE 4 Distribution of single- and two-vehicle accidents and licensed drivers for 1983–1985 in Michigan.

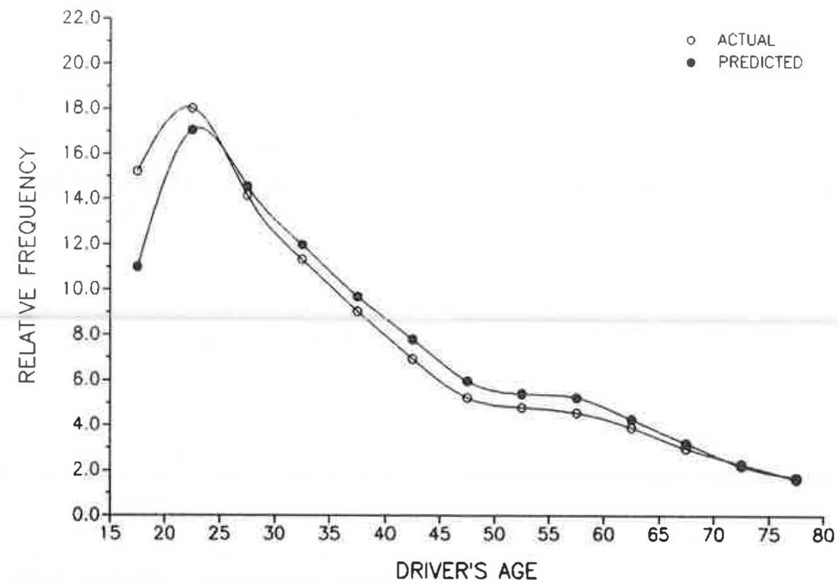

FIGURE 5 Comparison of actual and predicted two-vehicle accidents based on Wasielewski and Evans' formulation with dual responsibility of 10.3 percent.

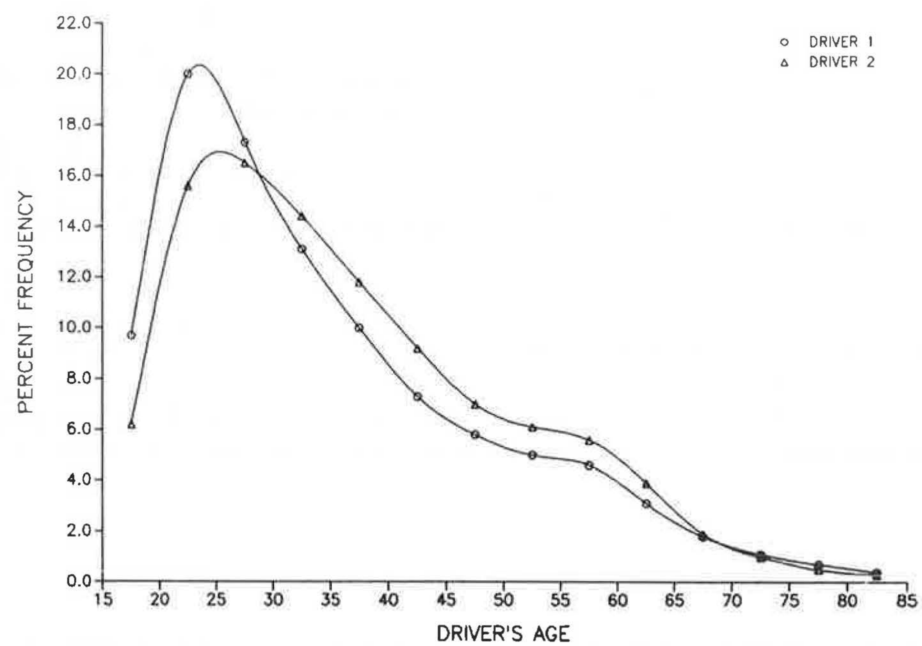

FIGURE 6 Driver distributions for noninterchange multivehicle accidents on Interstate highways.

than 70, because the relative accident involvement ratio is greater than 1.0 for such drivers.

These data give an indication of the relative frequency of accident involvement for drivers in the different age groups and are therefore useful for comparative purposes. When the relative accident involvement ratio is equal to 1.0, the accident involvement for the driver responsible is equal to the accident exposure for drivers in the same age bracket. If this ratio is greater than 1.0, the driver is more likely to be responsible when involved in an accident; that is, the driver is overinvolved in accidents. If the ratio is less than 1.0, the driver is less likely to be responsible when involved in an accident; that is, the driver is underinvolved in accidents.

The results displayed in Figure 7 indicate that young drivers (less than age 30) and older drivers (more than age 70) are more likely to be involved as responsible drivers in a noninterchange, multivehicle accident on an Interstate highway. The results also indicate that accident involvement decreases with increasing age up to about age 40, remains relatively constant from age 40 to age 60, and begins to increase with increasing age thereafter.

RESEARCH RESULTS

Several of the findings in this research study will now be presented for comparative purposes. An examination of the

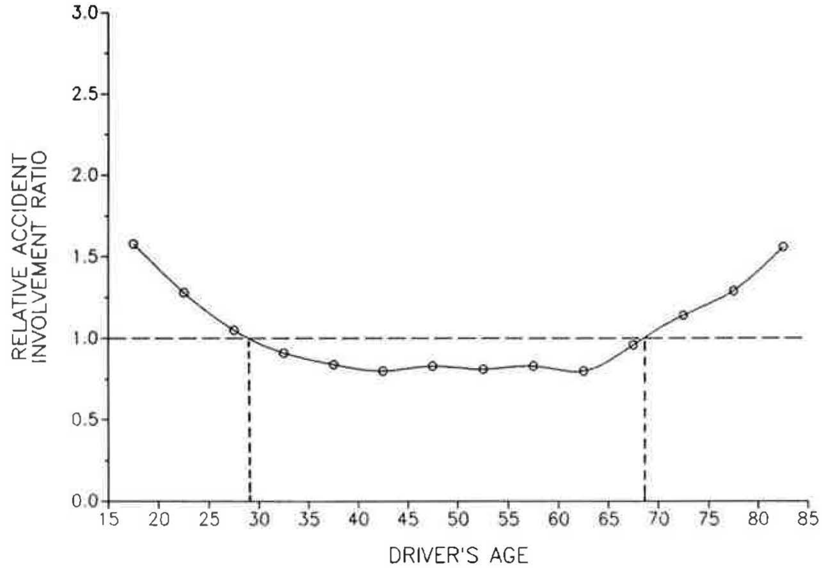

FIGURE 7 Relative accident involvement ratios for noninterchange multivehicle accidents on Interstate highways.

relative accident involvement of both male and female drivers for all multivehicle accidents in calendar years 1983 through 1985 was undertaken. Overall, men are involved in about 2.5 to 3 times as many accidents as women. However, as can be observed in Figure 8, there is a fairly good correspondence between the relative accident involvement of men and women up to about age 50. Beyond age 50, however, the relative accident involvement of female drivers is considerably higher than that of male drivers. These results would seem to suggest that both older men and older women are more likely to be involved in accidents after age 50 than they were in earlier years and that this increase in relative involvement for females is greater for women than for men.

A comparison was made for all multivehicle accidents on Interstate and non-Interstate routes in Michigan. One reason for making such a comparison is to consider the possible impact of the difference in highway design features of the two different classes of highway facilities. As shown in Figure 9, there is a higher accident involvement for older drivers on non-Interstate route than Interstate routes. The reasons for this are not clear at this point, but it is possible that the influence of highway design features is being observed. Additional research is being

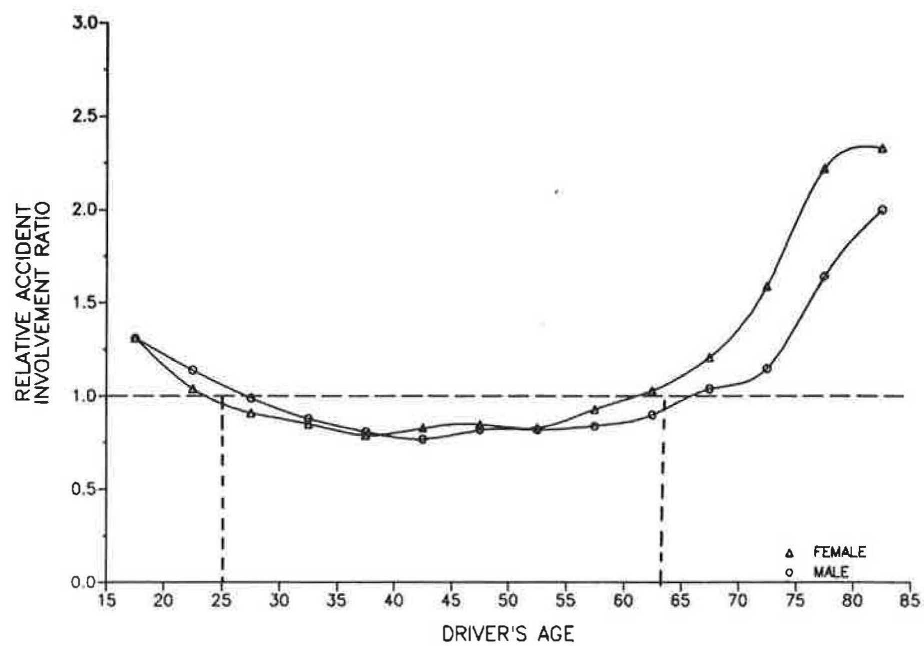

FIGURE 8 Relative accident involvement ratios for male and female drivers for all multivehicle accidents, 1983–1985.

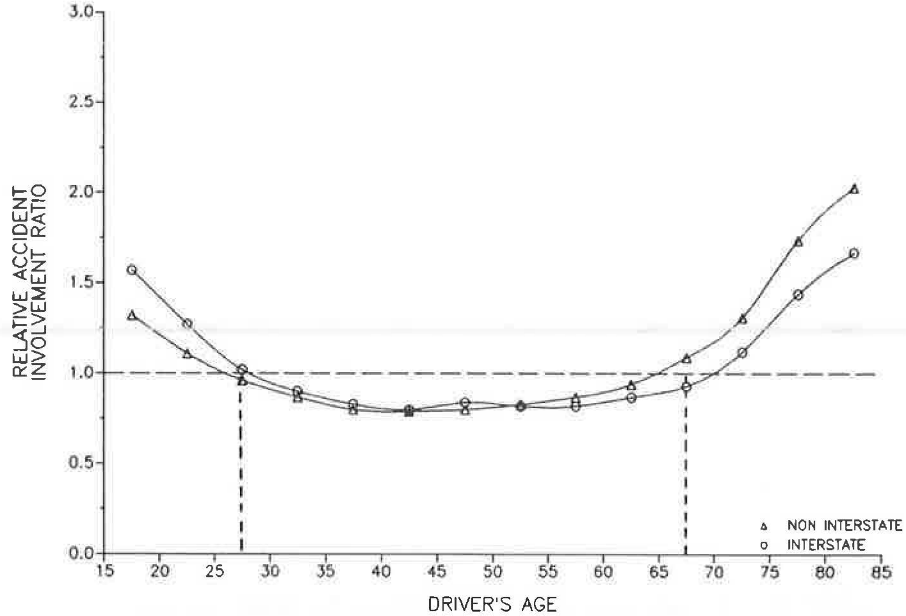

FIGURE 9 Relative accident involvement ratios for multivehicle accidents on Interstate and non-Interstate highways.

performed to identify the apparent increase in accident involvement for older drivers on non-Interstate highways.

Further studies of specific highway design features, such as horizontal curvature, grades, and number of lanes, are being tested in subsequent research. However, at this point it is clear that after age 55 the relative accident involvement of drivers increases on both types of facilities.

An examination of all nonintersection multivehicle accidents on non-Interstate highways in Michigan was also performed. As can be observed in Figure 10, the relative accident involvement on each of these facilities increased dramatically after beyond age 55, and this exposure was significantly higher than that for younger drivers. It may also be seen that the relative accident involvement for older drivers on Michigan state trunkline highways is lower than on U.S. routes and on other highways. The relative accident involvement for older drivers on highways other than Michigan state trunkline and U.S. routes is the highest. These highways include, for example, county roads, which typically have design standards less stringent than either Michigan state trunkline or U.S. routes. This suggests

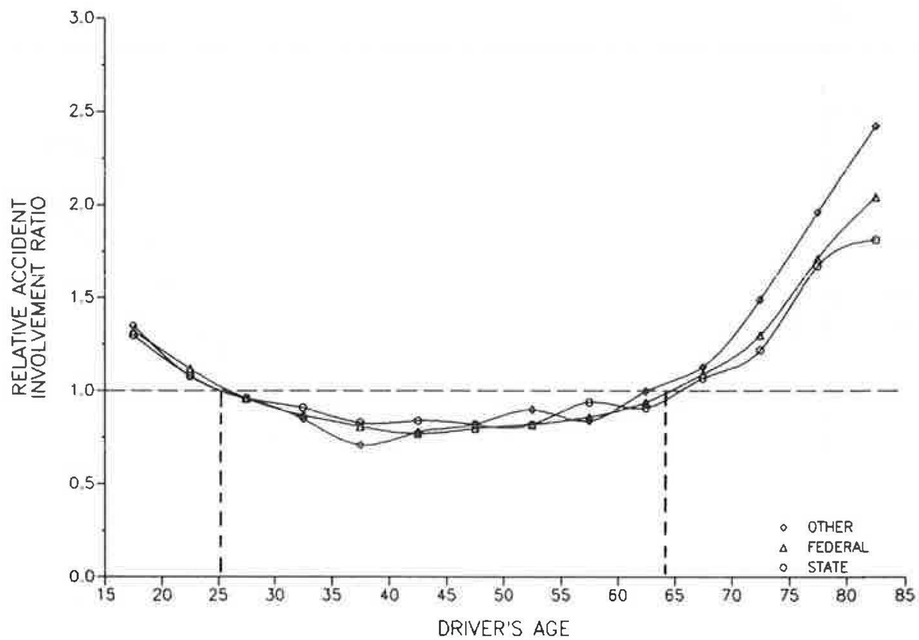

FIGURE 10 Relative accident involvement ratios for multivehicle accidents on non-Interstate highways.

that certain highway design features—perhaps alignment or lane width—may have a more significantly adverse effect on the accident potential for older drivers in comparison to other drivers.

The impact of light conditions, as indicated by whether the accident occurred during day or night, is shown in Figure 11. Although some instability exists toward the higher-age driver range, it appears that the relative accident involvement of older drivers at night is somewhat higher than during the day. The differences between day and night conditions for other drivers is not as significant. This may suggest that the reduced lighting conditions inherent in night driving require better signing or marking of roadways on non-Interstate highways to reduce the accident involvement of older drivers.

The accident involvement of drivers at intersections was also studied and the results are displayed in Figure 12. As can be observed, older drivers tend to be more heavily involved in these types of accidents than other drivers, and this involvement is markedly higher than for young drivers. This could indicate that there may be some diminished physical or mental capability, perhaps reaction time, that affects the abilities of older drivers in such locations. Furthermore, the data on this

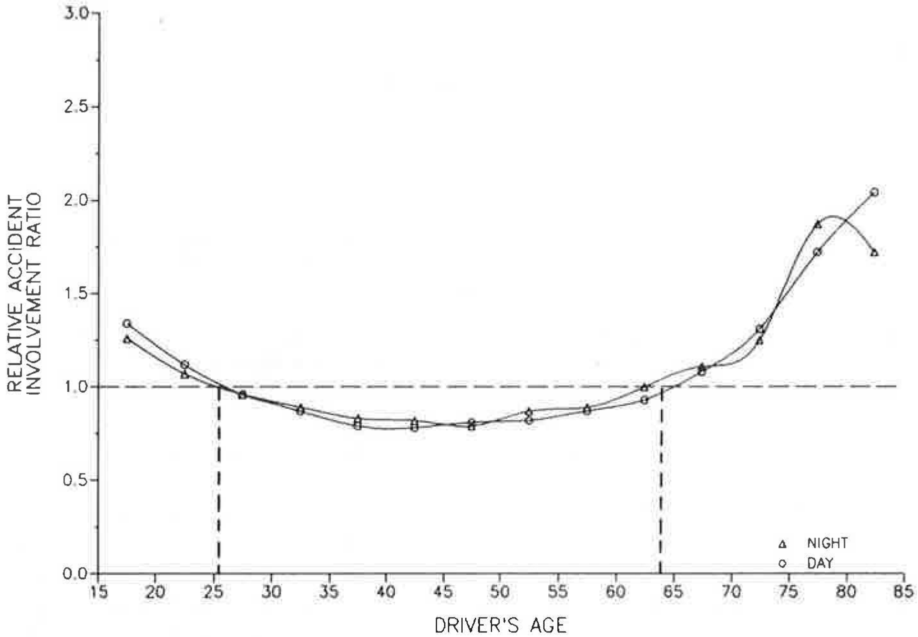

FIGURE 11 Relative accident involvement ratios for multivehicle accidents on non-Interstate routes during day and night.

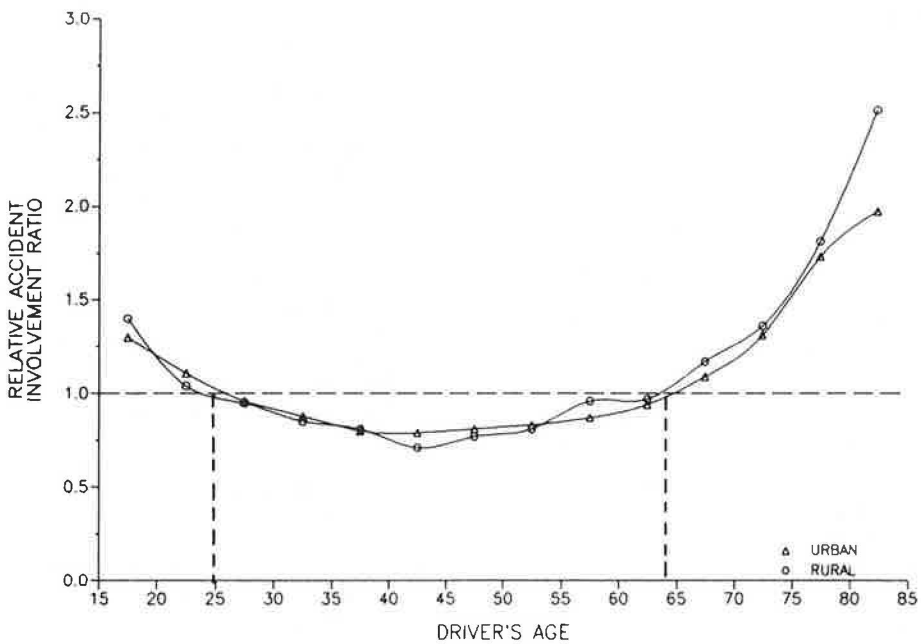

FIGURE 12 Relative accident involvement ratios for multivehicle accidents at intersections on non-Interstate routes in urban and rural areas.

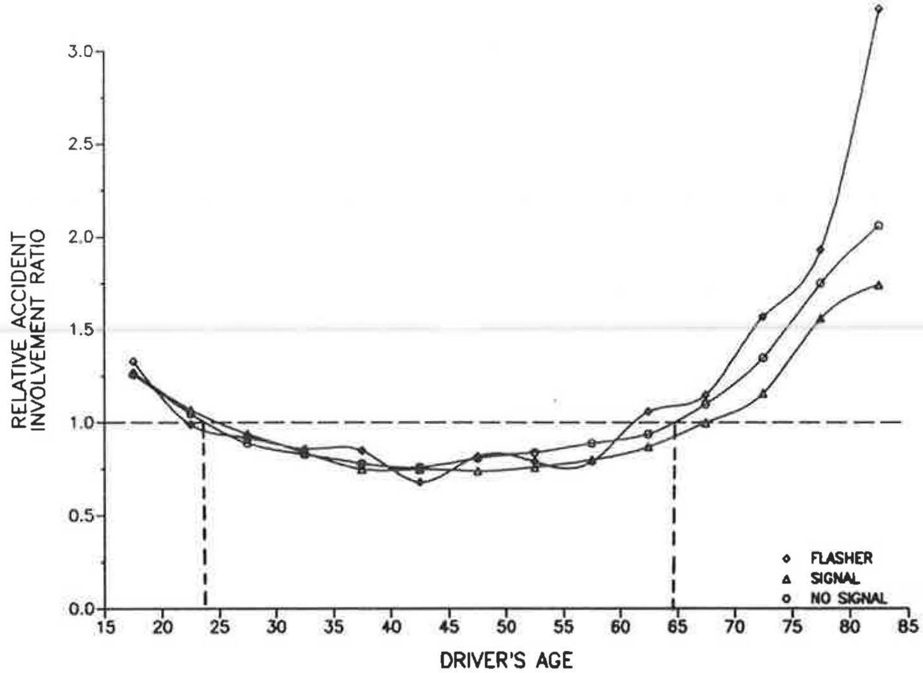

FIGURE 13 Relative accident involvement ratios for multivehicle accidents at signalized and nonsignalized intersections on non-Interstate routes.

figure indicate that older drivers appear to have a greater accident risk at intersections located in rural areas. A more detailed analysis of the accident history of drivers at intersections was also undertaken to examine relative exposure at nonsignalized and signalized intersections. The signalized intersections were classified into two groups, those operating on signal cycles and those operating with a flashing indicator. The results shown in Figure 13 indicate that flashing signals present considerable difficulty for older drivers, whereas signals operating on cycles are the least hazardous for these drivers. These data seem to suggest that there may be a particular problem with older drivers in terms of either the interpretation of or the reaction to flashing signals.

SUMMARY

The research has shown that because of Michigan's unique ability to combine accident records with the physical characteristics of the highway locations where these accidents occurred, indications of the relative involvement of drivers of different ages in accidents may be determined. Furthermore, by configuring the accident data into subsets on the basis of the highway facility characteristics, time of the accident, and measures of roadside development, isolation of the factors that seem to cause the variations in accident involvement by drivers of different ages can be obtained. This research has shown that older drivers have higher accident involvement rates than other drivers and that in many cases their accident involvement rate approaches or exceeds that of young drivers. Subsequent research is planned to identify measures that might be undertaken to improve the observed adverse involvement trends for older drivers.

ACKNOWLEDGMENTS

The research reported in this paper was prepared under a grant issued to Michigan State University by the Office of Highway Safety Planning of the Michigan Department of State Police and National Highway Traffic Safety Administration of the U.S. Department of Transportation. The cooperation of the Division of Traffic and Safety of the Michigan Department of Transportation is gratefully acknowledged.

REFERENCES

1. Y. Kaneto. The Aged in a Society on Wheels: Towards a Traffic Science for the Aged. *IATSS Research,* Vol. 4, 1980.
2. M. Kobayashi. Driver Behavior and Accident Characteristics of Elderly Drivers in Japan. *IATSS Research,* Vol. 8, 1984.
3. *Senior Driver Facts.* Report CAL-DMV-RSS-82-82. California Department of Motor Vehicles, Sacramento, 1982.
4. D. P. Kent and G. B. Novotny. Age and Automotive Accidents. *Geriatrics,* June 1961.
5. R. L. Moore, I. P. Sedgley, and B. E. Sabey. *Ages of Car Drivers Involved in Accidents, With Special References to Junctions.* Report TRRL SR718. Transport and Road Research Laboratory, Crowthorne, England, 1982.
6. *Traffic Safety and Elderly Road Users.* Organization for Economic Cooperation and Development, Paris, 1985.
7. A. J. McKnight and G. A. Simone. *Elderly Driver Retraining.* Final Report, National Public Services Research Institute, NHTSA, U.S. Department of Transportation, Washington, D.C., 1982.
8. J. D. Thorpe. Calculating Relative Involvement Rates in Accidents Without Determining Exposure. *Traffic Safety Research Review,* March 1967.
9. B. R. Carr, A Statistical Analysis of Rural Ontario Traffic Accidents Using Induced Exposure Data. In *Road Research: Proceedings of the Symposium on the Use of Statistical Methods in the*

Analysis of Road Accidents. Organization for Economic Co-operation and Development, London, 1970.

10. F. A. Haight. A Crude Framework for Bypassing Exposure. *Journal of Safety Research,* Vol. 2, 1970.
11. F. A. Haight. Induced Exposure. *Accident Analysis and Prevention,* Vol. 5, 1973.
12. P. F. Waller, D. W. Reinfurt, J. L. Freeman, and P. B. Inrey. Methods for Measuring Exposure to Automobile Accidents. Presented at the 101st Annual Meeting of the American Public Health Association, Washington, D.C., 1973.
13. W. L. Carlson. Induced Exposure Revisited. *HIT Lab Report.* Highway Safety Research Institute, University of Michigan, Ann Arbor, 1970.
14. E. C. Cerrelli. Driver Exposure: The Indirect Approach for Obtaining Relative Measures. *Accident Analysis and Prevention,* Vol. 5, 1973.
15. W. C. Taylor and M. W. DeLong. *Validation of the "Innocent Victim" Concept.* College of Engineering, Michigan State University, East Lansing, 1986.
16. P. Wasielewski and L. Evans. *A Statistical Approach to Estimating Driver Responsibility in Two-Car Crashes.* Research Publication GMR-4545. Transportation Research Department, General Motors Research Laboratories, Warren, Mich., 1983.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Michigan Office of Highway Safety Planning, the National Highway Traffic Safety Administration, U.S. Department of Transportation, or the Michigan Department of Transportation.

Publication of this paper sponsored by Committee on Vehicle User Characteristics.