Trends Analysis of North Carolina Motor Vehicle Crash Data, 1974-1988

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I. Introduction

Background and Objectives

This report examines motor vehicle crash and injury trends occurring in North Carolina during the period 1974-1988. Trends are examined by age, sex, and race categories, with special focus on five subpopulations: women, older persons, nonwhites, children, and youth. Each of these subpopulations is studied for special reasons. Two of them, women and older persons, are studied because of their marked increases in the U.S. driving population (Malfetti, 1985; Klinger and Kuzmyak, 1986). According to North Carolina data nonwhites have also increased their presence in the licensed driver population. There have been no definitive studies documenting the impact of these increases on motor vehicle crashes and injuries.

The fourth population, children, may likewise be expected to shown changes in exposure to risk of motor vehicle injury. Increases in the number of women driving, coupled with increases in women in the work force, may have contributed to increases in the transportation of young children. To our knowledge, no studies have addressed this issue.

Finally, youth aged 16-19 are included despite the fact that they have been studied extensively (e.g., Williams and Karpf, 1981; Simpson, Mayhew and Warren, 1983). However, it is of interest to examine changes in exposure patterns and crash experiences of this group over an extended period of time during which there have been major changes in the attention given to the problems of young driver crashes. For example, it is of interest to examine trends in alcohol involvement in crashes for this group in light of legislation increasing the minimum age for purchasing and consuming alcoholic beverages.

A major objective of this compendium, then, is to serve as a source book documenting North Carolina motor vehicle crash involvement and injury trends for these various subpopulations defined by age, sex, and race. A second objective is to examine the impact of motor vehicle safety legislation introduced during this time period. This includes the North Carolina child passenger safety laws passed in 1982 and 1985; the Safe Roads Act, which greatly strengthened laws against drinking and driving, passed in 1983; and the North Carolina mandatory seat belt

law which became effective in October 1985. Although an in depth evaluation of the effectiveness of these laws is beyond the scope of this report, their impact on the observed motor vehicle crash and injury trends is examined. Particular attention is paid to differential impact on any of the various subpopulations identified. By examining whether and how different subpopulations respond to legislative interventions, this aspect of the report can have important implications for countermeasure development and the identification of target groups for special interventions.

Data Sources

Data for the report consist of North Carolina motor vehicle crash data (even-numbered years, 1974-1988), along with corresponding population, licensed driver, and mileage data. The crash data are derived from standard statewide accident report forms forwarded to the N.C. Division of Motor Vehicles by local police and State Highway Patrol. North Carolina law requires that a report be filed for any crash resulting in injury and/or property damage exceeding a certain dollar threshold ($500 currently, $200 prior to 1983). The census population data were provided by the North Carolina Office of State Budget and Management, and the driver license data from the North Carolina Department of Transportation, Division of Driver Licensing.

Estimates of annual miles driven for the various subpopulations of interest were derived using the method of induced exposure. This method, first introduced by Thorpe (1964) and later refined by Haight (1970), van der Zwaag, (1971), Koornstra (1973), and others, uses motor vehicle crash data to draw inferences about the population at risk when such exposure information is otherwise unavailable. It assumes that the not-at-fault driver in a two-vehicle crash is representative of what is "on the road" at that point in time. The sample of all such not-at-fault drivers is then used to describe the characteristics of the accident (exposure) population at risk.

For the current study, overall statewide annual mileage estimates were obtained from the Planning and Research Branch of the North Carolina Division of Highways. This overall mileage was distributed across the various age/race/sex/categories according to their representation in the population of not-at-fault drivers. For example, if white females under the age of 25 were the

"innocent victim" in 10 percent of all two-vehicle crashes, and total annual mileage for all drivers in 1986 was 53,000 million miles, then this particular subpopulation would have as its crash "denominator" .10 X 53,000 million, or 5,300 million miles for the 1986 crash year.

Report Format

This is a descriptive document, relying primarily on tables and graphs rather than extensive text to depict motor vehicle crash and injury trends over the 15-year study period. Each section consists of some introductory text, a summary of the major findings, and a discussion of the implications of these findings. Graphs and summary tables appear in the text, with more detailed tables presented in the appendix.

Section II that follows highlights trends in the North Carolina census and driver license populations. Section III then relates these changes to the observed changes in the population of crash-involved drivers. The induced exposure analysis is documented in Section IV, followed by a presentation of injury trends in Section V. Sections VI and VII examine trends with regard to driver culpability in crashes and children as passengers of crash-involved vehicles. Section VIII addresses a number of related topics including trends in the age of crash-involved vehicles, crash severity, belt use, and related injury. A final summary and discussion section concludes the report.

The impact of North Carolina legislation on the observed motor vehicle crash and injury trends is addressed where appropriate throughout the report. For the Safe Roads Act which deals with drunk driving, this is primarily in the sections on motor vehicle crash trends (Section III) and culpability (Section VI). The North Carolina seat belt law, on the other hand, has impacted primarily on injury occurrence, and is discussed in Sections V and VIII. Finally, impact of North Carolina's child restraint laws is addressed in Section VII dealing with young children in crashes.

II. Trends in the North Carolina Census and Licensed Driver Populations

Population Trends

Over the 15 year time period spanned by this study the population of North Carolina increased by 18.7 percent, from 5,464,300 in 1974 to 6,487,438 in 1988. In 1974, at the start of the study period, the breakdown of the population by race and sex was

37.5% white male
38.9% white female
11.3% nonwhite male
12.3% nonwhite female.

By 1988, this distribution had shifted only slightly to accommodate a small increase in the proportion of nonwhite females.

Changes in the age distribution of the North Carolina population during this time period have been more marked. Generally, there has been a large decrease in the proportion of younger persons, balanced by an increase in the proportion of persons 65 and older: North Carolina, like the rest of the United States, is "graying." In 1974, 45.3 percent of the state's population was under age 25, compared with 37.1 percent in 1988. Meanwhile the retirement population, age 65 and older, grew from 9.1 to 12.0 percent.

Appendix **Table A.1** summarizes the population data utilized in this report. The data were available in five-year age increments -- 0-4, 5-9, 10-14, etc. To facilitate comparison with the licensed driver and crash-involved populations, we have restricted the census data to persons 15 years of age and older.

Licensed Driver Trends

Against this backdrop of population dynamics, changes of much greater magnitude have occurred in the North Carolina licensed driver population. Overall the licensed driver population has increased from just over 3,161,000 drivers in 1974 to over 4,337,000 drivers in 1988, a 37 percent increase (see Appendix **Table A.2**). Whereas there had been only a slight shift in the race/sex distribution of the census population, licensed drivers have shown marked increases in the numbers of females and nonwhites. Compared with the overall

growth of 37.2 percent, white females have experienced a 41.0 percent growth and nonwhite females an 82.6 percent growth in the licensed population.

Figure 2.1 graphs the percentage change between 1974 and 1988 in the *proportion of drivers* in each race/sex category (actual numbers and percentages are given in Appendix **Table A.3**). For comparison purposes the shifts in the population distribution are also graphed, where the population has been restricted to those age 15 and older. (Since population data were only available in five-year age categories it was not possible to exactly match the licensed driver population of age 16+.) Presenting the data in this fashion, as changes in the relative proportions of the different subpopulations, highlights changes in the overall composition of the licensed driver population.

As observed above, the population changes are relatively small, the largest shifts being a six percent increase in the proportion of nonwhite females (from 11.6 percent of the population in 1974 age 15 and older to 12.3 percent in 1988). However, shifts in the licensed driver population are substantial. In 1974, white males represented 44.4 percent of all licensed drivers, compared with 41.0 percent in 1988, an eight percent decrease. Nonwhite females, on the other hand, *increased* their representation in the licensed driver population by nearly a third, from 7.0 to 9.2 percent.

A similar graph can be constructed to show changes in the relative proportions of the different age groups (see **Figure 2.2, Table A.4**). Figure 2.2 clearly shows the relative decrease in the proportion of young drivers and increase in the proportions of drivers aged 65-74 and 75+. Note also that the changes in the licensed driver distribution are much more pronounced than in the overall population: whereas, for example, persons age 75 and older have increased their representation in the overall population by 38.4 percent since 1974, their representation in the licensed driver population has grown by 129 percent.

Another approach employed to examine changes in the population and licensed driver distributions was to look at the proportion of the population licensed within the various race/sex or age categories and to see how these proportions have changed over time. This information is presented in **Figures 2.3** and **2.4** (with Appendix **Tables A.5** and **A.6** giving the actual numbers). Overall, 78.0 percent of the North Carolina population 15 years and older was licensed in 1974, compared with 83.8 percent in 1988. This overall increase, however, is due

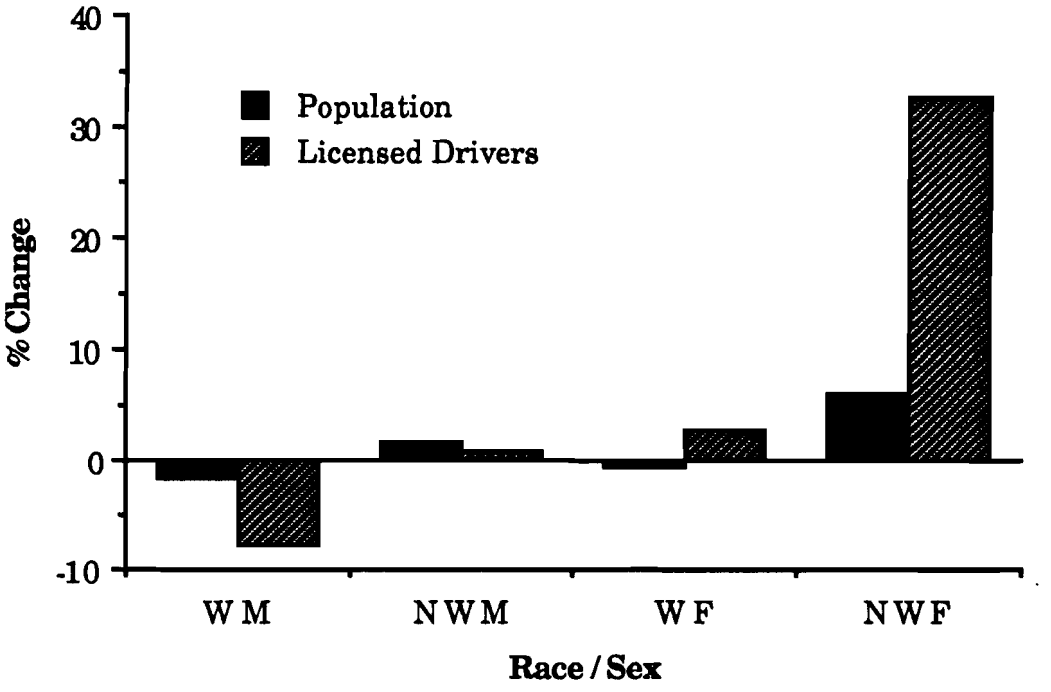

Figure 2.1. Percentage change in proportion of N.C. census population and licensed driver population by race and sex, 1974-1988.

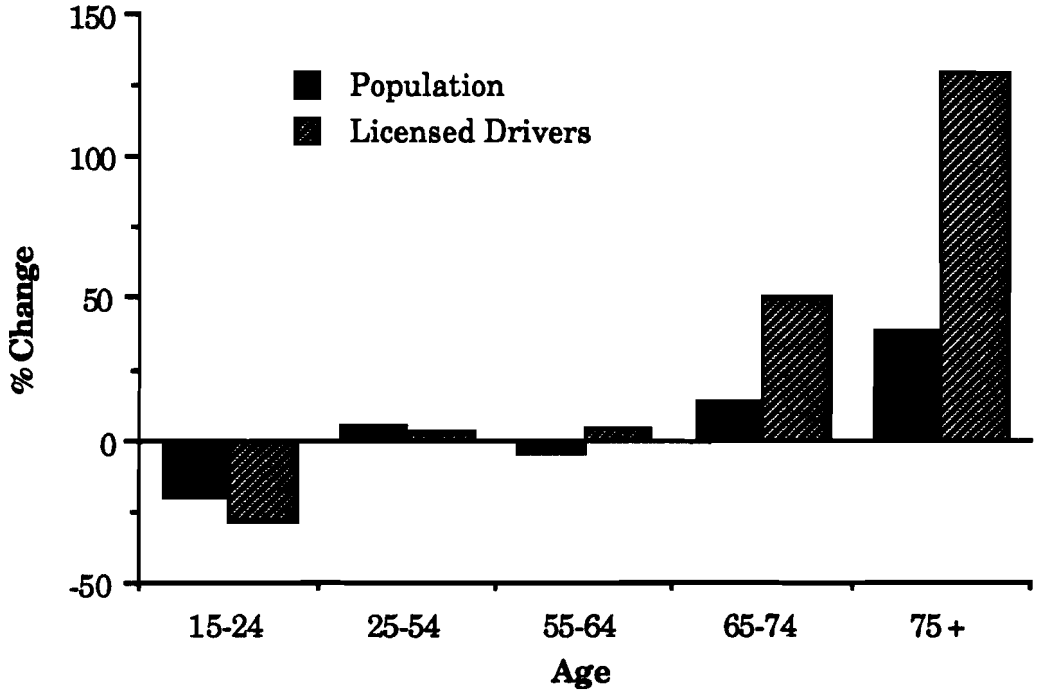

Figure 2.2. Percentage change in proportion of N.C. census population and licensed driver population by age, 1974-1988.

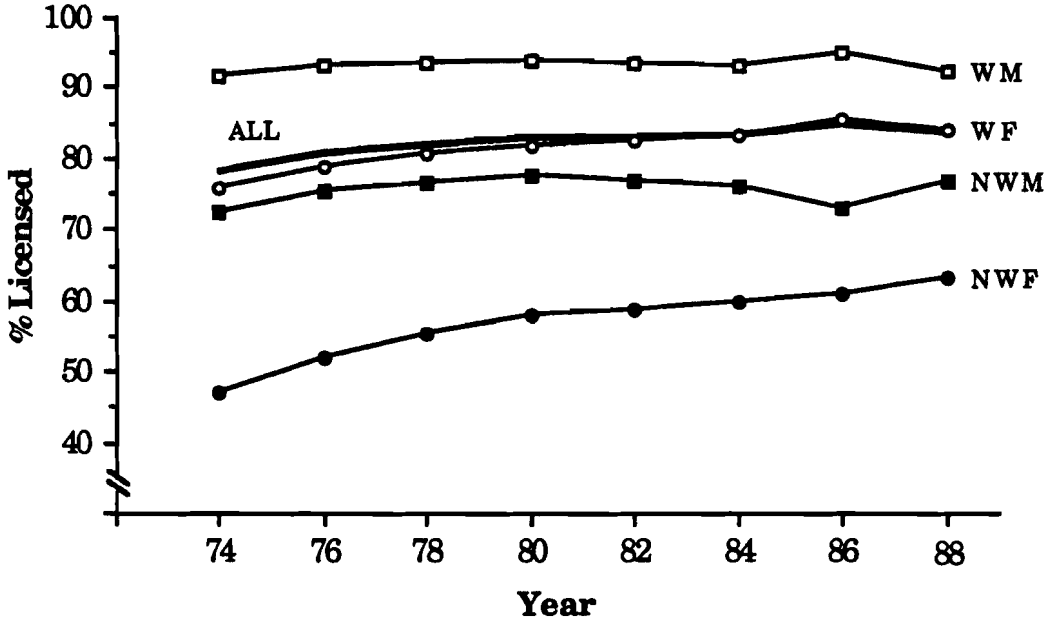

Figure 2.3. Percentage of N.C. census population licensed by race and sex, 1974-1988.

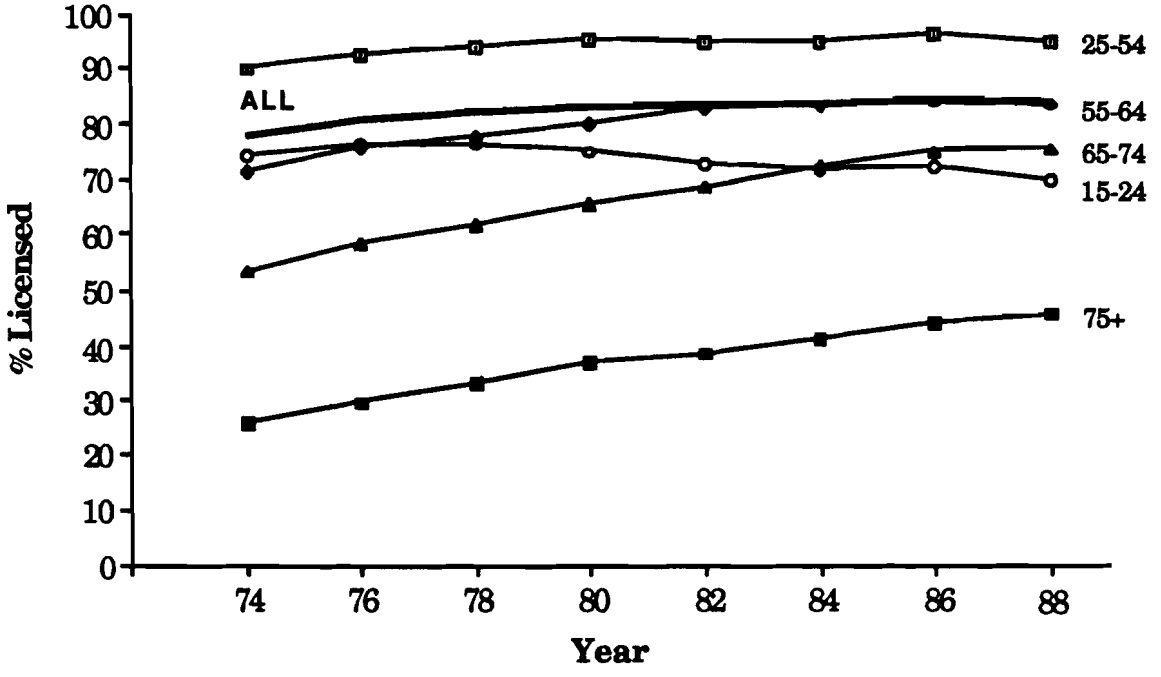

Figure 2.4. Percentage of N.C. census population licensed by age, 1974-1988.

almost entirely to increases in licensure by white and nonwhite females. Figure 2.3 shows that the licensure rate for white males has held fairly constant at 92-93 percent, and the rate for nonwhite males has remained close to 75-77 percent. (These are slight underestimates, since the population denominators include 15-year-olds.) The percentage of white females licensed, however, increased from 72.7 percent in 1974 to 83.9 percent in 1988. And whereas only 46.9 percent of nonwhite females were licensed in 1974, 63.1 percent were licensed in 1988.

Examining trends across age groups (**Figure 2.4**), highest rates are observed, as expected, for the 25-54 year-olds. The licensure rate in this age group ranged from 90.2 percent in 1974 to 95.1 percent in 1988. The licensure rates for the youngest age groups are again underestimates due to the inclusion of 15-year-olds, but show a rather surprising decline from 74-76 percent during the first half of the study period down to 70-72 percent during the second half. Closer examination of the data shows that this drop is due almost entirely to a decrease in the licensure rate of young persons aged 20-24. Older persons, on the other hand, have posted the most dramatic gains in licensure: from 71.7 to 83.9 percent for 55-64 year-olds, 53.5 to 75.6 percent for 65-74 year-olds, and 25.7 to 45.7 percent for those 75 and older.

A final table examines changes in the race/sex and age distributions simultaneously. **Table 2.1** presents the race/sex distribution of North Carolina licensed drivers within age categories. From comparing the 1974 and 1988 percentages for nonwhite females we see that the increased representation of this group has occurred at every age level, whereas the increase for white females has only occurred in the 55 and older age categories. White males, meanwhile, have relinquished much of their dominance in the oldest age categories.

Summary and Discussion

It appears that two effects are present in the data. One is an increase in the percentage of females, particularly nonwhite females, licensed. Over the 15-year period examined, nonwhite females have increased their relative presence in every age category, while white females have shown increases in the 55 and older age categories. For the oldest age categories, the increases have been dramatic. Although part of the increases for the nonwhite females can be attributed to their increased numbers in the population, most of it appears to be due to a genuine

Table 2.1. Race / sex distribution of North Carolina licensed drivers within age categories.

Age	1974				1988			
	WM	NWM	WF	NWF	WM	NWM	WF	NWF
16-17	44.0	10.0	39.4	6.5	43.6	9.7	39.2	7.5
18-20	41.0	12.9	37.2	8.9	40.1	12.2	37.4	10.3
21-24	40.4	12.5	37.2	9.8	39.4	12.4	37.0	11.2
25-54	43.8	8.6	40.5	7.1	40.1	9.8	39.8	10.3
55-64	48.0	8.5	39.0	4.6	43.2	6.8	43.3	6.7
65-74	53.2	8.2	36.1	2.5	44.0	6.7	44.1	5.3
75+	63.7	7.0	28.6	.7	45.7	6.6	44.2	3.4
Overall	44.4	10.9	37.7	6.9	41.0	9.5	40.3	9.2

trend of increased licensure, as best evidenced by the growth in the percentage of the population licensed.

A second effect relates to age, and must be viewed primarily as a cohort effect. That is, most of the increase in licensure for the oldest age groups can be attributed to persons in younger age groups (who are more likely to be licensed) "graduating into" the older age categories. For example, 72 percent of persons in the 55-64 year age category were licensed in 1974 at the onset of our study period. By 1988, 15 years later, all of these persons would have aged into one of the 65+ age categories, causing the overall higher licensure percentages at the end of the study period.

III. Motor Vehicle Crash Trends

Overall North Carolina Crash Trends

Each year some 150,000 crashes involving approximately 250,000 vehicles occur on North Carolina roadways. Information on these crashes is reported to the North Carolina Division of Motor Vehicles, using a standard statewide accident report form. North Carolina law requires that a report be filed by an investigating officer (municipal police or State Highway Patrol officer) for any motor vehicle crash resulting in injury or property damage in access of a certain dollar amount. This amount was set at $200 at the outset of the study period in 1974, but was increased to $500 in October of 1983.

Along with these changes in reporting threshold, some changes have occurred in the report form itself. During the time period of the current study there were two such revisions -- one in 1979 and another in 1983. (A major revision also occurred in October 1973, which is the primary reason for initiating the current study with 1974 crash data.) The 1979 revision incorporated changes in the definition of injury severity levels, reducing the overall reporting incidence of serious (A level) injuries. This change will be most evident in the discussion of injury trends in Section V. Other than this, changes made to the form should not affect the information presented in this report.

Figure 3.1 summarizes North Carolina motor vehicle crash trends since 1973, a year before the onset of the current study period. The plot at the bottom of the graph shows fluctuations in the number of reported motor vehicle crashes in North Carolina during the study period. The low point in the trend line occurs in 1974, coinciding with the Oil Embargo and national "energy crisis." After 1974 the number of crashes increased steadily until 1978, at which point there was another decline extending through 1981-82. This second decline also occurred during a period of economic recession that was reflected by decreased motor vehicle crashes and fatalities throughout the country. Since 1984 there has been a gradual increase in reported motor vehicle crashes occurring in the state.

The top line of Figure 3.1 shows the number of crash units associated with the reported crashes. Here the term "unit" is used to refer to a motor vehicle as well as a pedestrian, bicyclist, motorcyclist, etc. The ratio of number of units to number of crashes is consistently in the neighborhood of 1.8 to 1.

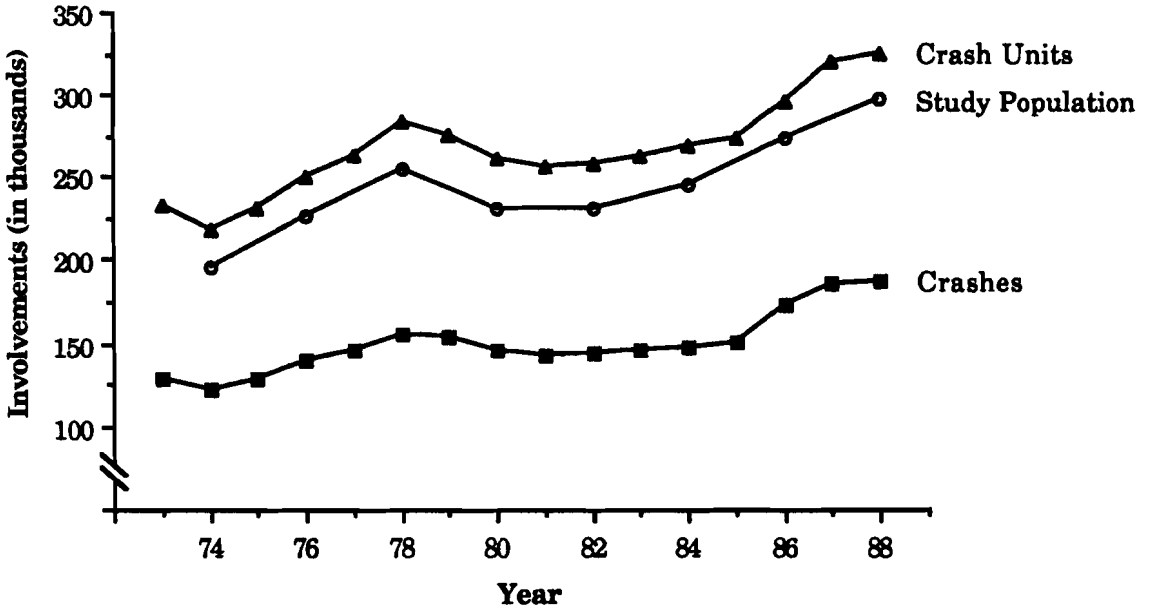

Figure 3.1. North Carolina motor vehicle crash data, 1973-1988.

The middle line in Figure 3.1 depicts the actual database utilized in the current investigation. This database includes all passenger motor vehicles involved in North Carolina crashes and specifically *excludes* pedestrians, bicyclists, motorcyclists, large trucks, and other miscellaneous vehicles. Also excluded from the database are any crash-involved passenger vehicles with missing information in regards to driver age, sex, race, level of injury, or other key study variables. The latter exclusion amounted to approximately 10,000 - 12,000 vehicles each year, or 4-5 percent of the total motor vehicle crash population. The majority of these cases had missing information on all of these key variables and were likely vehicles that were unoccupied at the time of the crash or, less frequently, vehicles that fled the scene of the crash. Overall sample sizes during the 15-year study period ranged from 196,197 crash involved vehicles in 1974 to 297,571 vehicles in 1988. Appendix **Table A.7** presents detailed information on the age/sex/race distribution of the drivers of these crash-involved vehicles.

As might be anticipated from the observed changes in the licensed driver population that were highlighted in Section II, changes have occurred in the crash-involved population as well. **Figures 3.2** and **3.3** present the same bar charts shown earlier, but with a third bar added to show the corresponding percentage changes in the crash-involved population. (Actual data is again presented in Appendix **Tables A.8** and **A.9**.)

Looking at Figure 3.2, we see that the increase in the presence of white females in the licensed driver distribution has been accompanied by an even greater increase in their presence in the crash population. In 1974, white females were involved in 24.1 percent of reported motor vehicle crashes; by 1988, their involvement had increased to 29.4 percent, a 21.7 percent increase. Nonwhite females increased their representation in the crash-involved population to an even greater extent (6.8 to 9.2 percent, a 36.1 percent increase). However, this increase more closely parallels their increase in the driver license population.

The increased representation of females in the motor vehicle crash population has been accompanied by a decrease for males, the decline for nonwhite males being somewhat less than their decline in the licensed driver population, and the decline by white males being greater than their decline in the licensed driver population. On the basis of this graph, one can deduce that crash rates per licensed driver will have increased for white females, nonwhite females, and nonwhite males, but decreased for white males.

Figure 3.3 presents the same information by age. Here, the observed increases in the representation of older persons in the licensed driver population has been matched by increases in the crash involved population. Note, however, that the increases in crash involvement are not as great as the increases in licensed drivers. For example, drivers age 75 and older increased their representation in the licensed driver population by nearly 130 percent, but increased their representation in the crash population by only 75 percent. Drivers in the younger age groups have decreased their relative involvement in crashes. However, this decrease is not as great as their decrease in the licensed driver population: younger drivers in 1988 may be representing a smaller piece of the total crash "pie," but their relative crash involvement has not decreased accordingly.

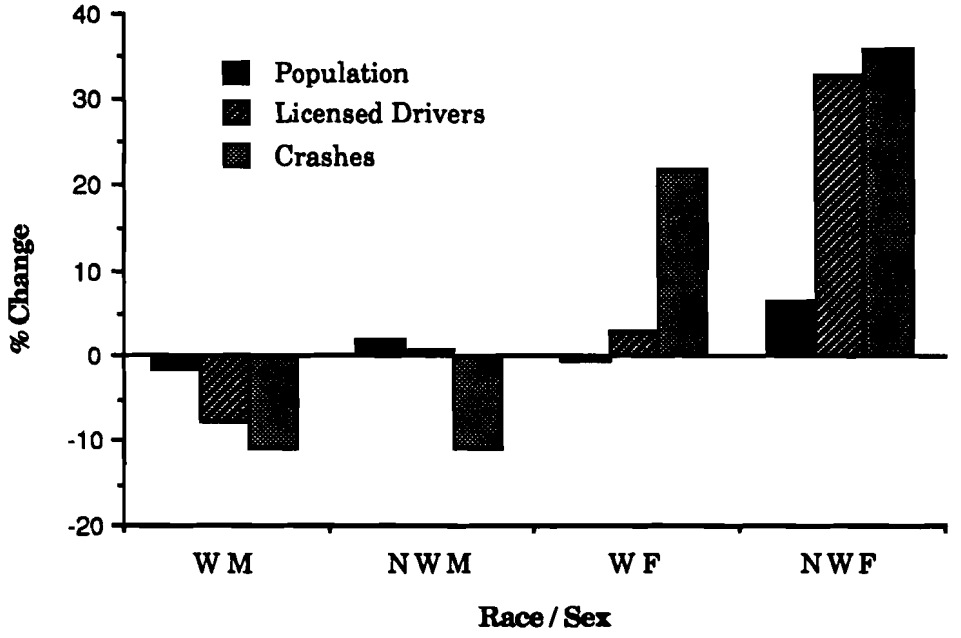

Figure 3.2. Percentage change in proportion of N.C. census population, licensed drivers, and crashes by race and sex, 1974-1988.

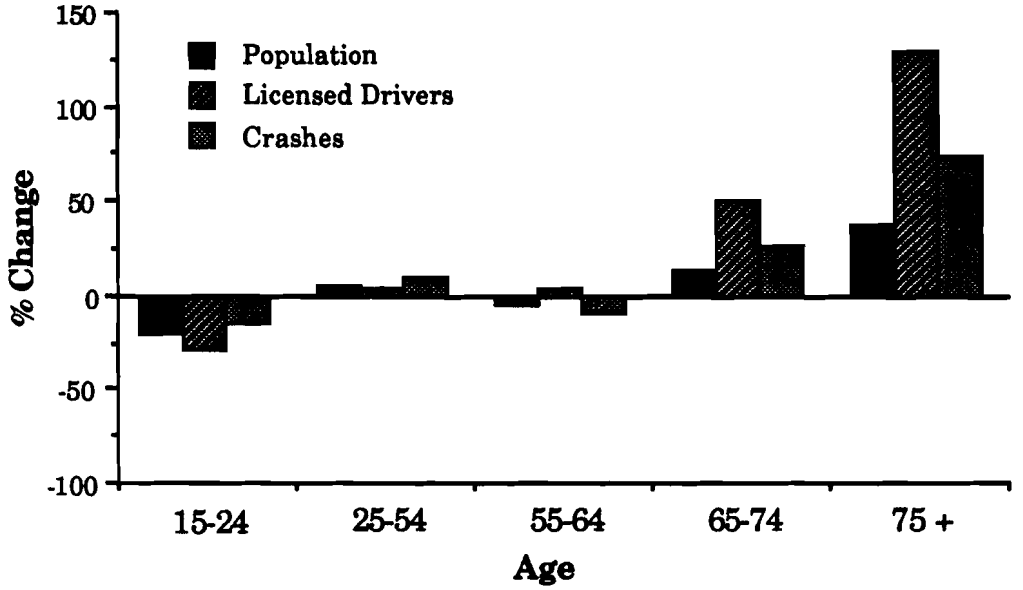

Figure 3.3. Percentage change in proportion of N.C. census population, licensed drivers, and crashes by age, 1974-1988.

Again as in Section II, **Table 3.1** summarizes this information by presenting the race/sex distribution for crash-involved drivers within age categories. Considering only this table and comparing the two years of crash data, one can see the decreases over time in the proportion of males and increases in the proportion of females. (While only two years of data are shown here, the linear trend over all eight accident years is also clearly evident in Appendix Table A.7.)

Table 3.1. Race / sex distribution of North Carolina crash-involved drivers by age category.

Age	1974				1988			
	WM	NWM	WF	NWF	WM	NWM	WF	NWF
16-17	58.0	10.6	27.6	3.8	50.6	9.5	34.7	5.2
18-20	55.2	17.2	22.1	5.5	47.7	15.8	28.1	8.4
21-24	49.3	21.3	21.4	8.0	44.5	17.8	27.7	9.9
25-54	48.9	18.2	25.0	7.9	43.9	16.7	28.9	10.5
55-64	52.1	17.7	24.1	6.1	49.4	13.7	29.7	7.2
65-74	55.5	16.8	24.6	3.1	49.1	13.4	31.2	6.3
75+	65.9	13.4	19.6	1.0	51.5	11.7	32.9	3.9
Overall	51.5	17.6	24.1	6.8	45.7	15.7	29.4	9.2

By comparing the distribution of the crash-involved population in Table 3.1 with the distribution of the licensed driver population in Table 2.1, one can also see *within the various age categories* which subpopulations are "overrepresented" in crashes on the basis of their representation in the licensed driver distribution. That is, if white males in 1988 made up 40.1 percent of the licensed drivers aged 25-54, one would expect them to have experienced 40.1 percent of the crashes. In fact, they experienced 43.9 percent of the crashes, a slight overrepresentation. Nonwhite males, on the other hand, comprised 9.8 percent of the driving

population aged 25-54, but experienced only 16.7 percent of the crashes in this age group, a very clear over-representation.

Figures 3.4 and **3.5** summarize results with respect to crash over- or under-involvement based on representation in the licensed driver population. The data for these tables were derived from Appendix Tables A.2 (licensed driver distribution by age/sex/race) and A.7 (crash distribution by driver age/sex/race). The number plotted is the ratio of the proportion representation in crashes divided by the proportion representation in the population of licensed drivers. For example, in 1988, 16-17 year-old drivers were involved in 8.1 percent of reported crashes, while representing only 2.9 percent of the licensed driver population, producing a crash/licensed driver involvement ratio of 2.8. In contrast, drivers aged 25-54 were involved in 52.1 percent of crashes, while representing 59.3 percent of licensed drivers, an involvement ratio of .88 (i.e., an under-involvement in crashes based on representation in the licensed driver distribution).

Examining these crash involvement ratios with respect to driver sex and race, one sees that nonwhites and males have the highest involvement ratios, with the combination of nonwhite males having by far the highest crash involvement ratio. There is also in Figure 3.4 evidence of trends over time, with a decrease in crash involvement rates for nonwhite males and a slight increase for white females. Generally, the effect over the 15 year study period is a convergence of the various race/sex subpopulations.

This has not been the case with respect to age, however (Figure 3.5). Here, the crash involvement ratios for the various age groups have become more divergent over the course of the study period, the ratio for the younger age groups increasing while that for the older age groups holding steady or showing a slight decline. In 1988, the crash involvement ratio for 16-17 year-olds rose to 2.8 in 1988, compared to a ratio of 0.6 for 65-74 year-olds.

Ratios within age and race/sex groups simultaneously can be derived directly from the appendix tables (A.2 and A.7). The highest overall ratios are obtained by 16-17 year-old white males -- a ratio of 3.3 in 1988. The lowest ratios hold for white females in the 55-64 and 65-74 year age groups -- in 1988, these were approximately 0.4.

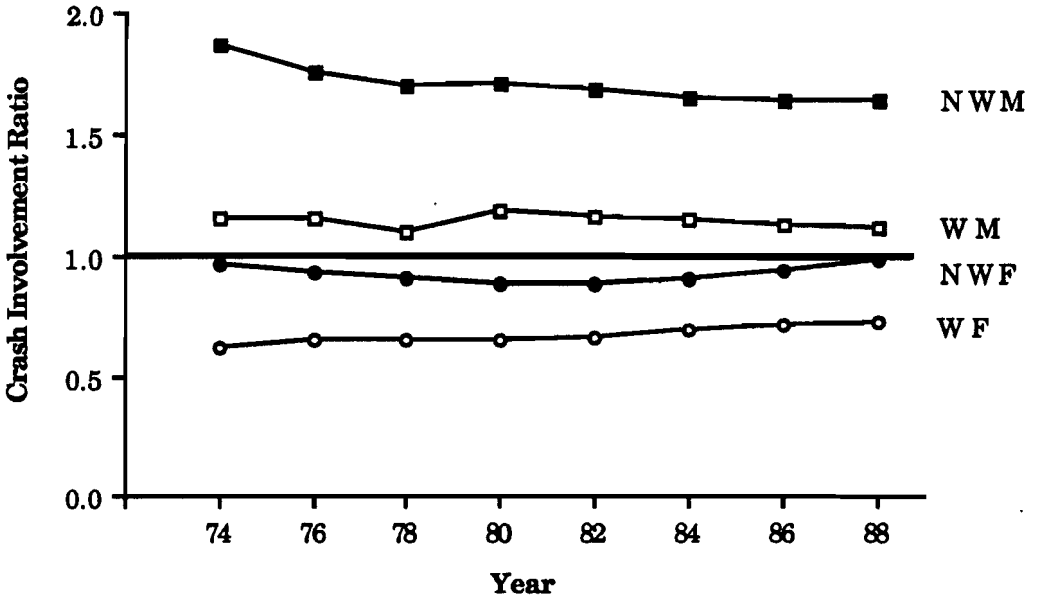

Figure 3.4. Ratio of proportion representation in crash population to proportion representation in licensed driver population by driver race and sex, 1974-1988.

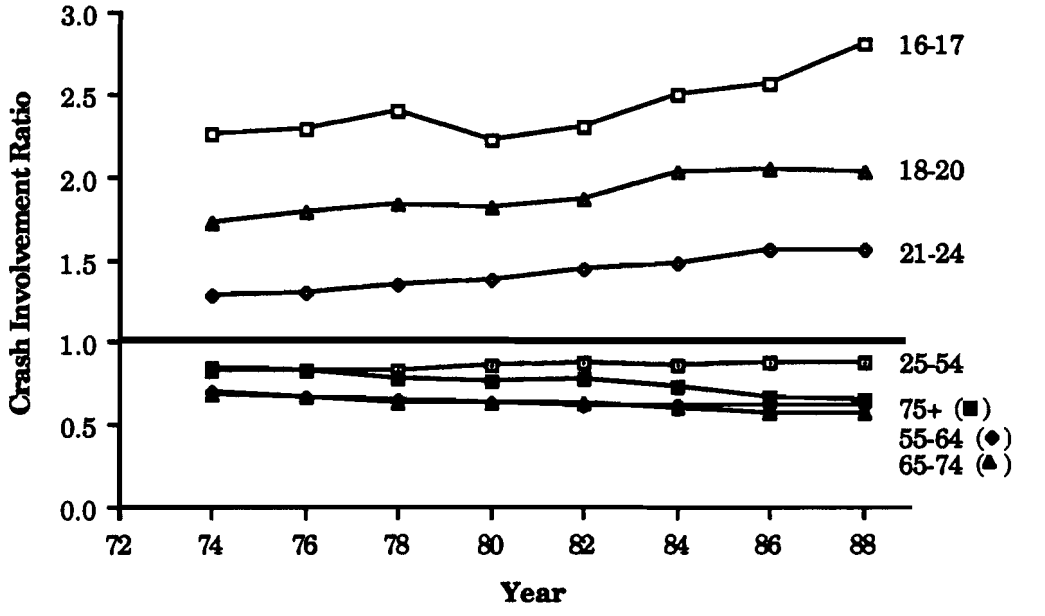

Figure 3.5. Ratio of proportion representation in crash population to proportion representation in licensed driver population by driver age, 1974-1988.

Crashes per Licensed Driver

A more direct approach for comparing licensed driver and crash involvement trends over time is to examine crash rates per licensed driver. Appendix **Table A.10** gives crash involvements per 100 licensed drivers for each subpopulation of interest for each of the eight study years. This information is summarized in **Figures 3.6** and **3.7**, which present crash rates by race/sex and by age, respectively. (Appendix **Table A.11** also presents the numbers for Figure 3.6.) For all of the subpopulations crash rates were lowest in 1974 (during the "energy crisis") and in 1980-82 (during a period of more general economic recession). Since 1982 there has been a slow but consistent increase in crash rates per licensed driver.

Figures 3.6 and 3.7 mirror the results noted above with respect to crash involvement ratios. Again, there are distinct differences across the various subpopulations that hold remarkably consistent throughout the study period. These figures clearly show that, on a licensed driver basis, motor vehicle crash involvement rates are highest for males, nonwhites, and younger drivers. The average crash rate over the eight year study period (found by averaging the "overall" figures at the bottom of Appendix Table A.10) was 6.43 crash involvements per 100 licensed drivers. However, averages for each of the four age/sex groups were as follows:

Nonwhite males	10.79
White males	7.43
Nonwhite females	6.00
White females	4.36

And average rates by age group were:

Age 16-17	15.57
Age 18-20	12.16
Age 21-24	9.10
Age 25-54	5.49
Age 55-64	4.09
Age 65-74	4.01
Age 75+	4.89

The male to female crash rate ratio lies in the range of 1.5-2.0 to 1 for all age levels examined. The higher crash rate for nonwhites also holds at every age level except for 16-17 and 18-20 year-olds.

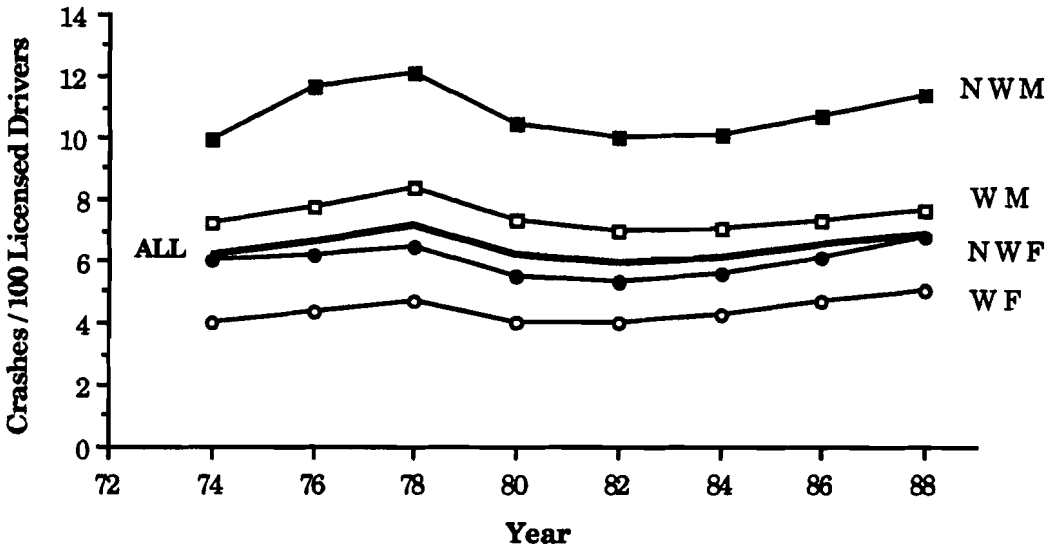

Figure 3.6. North Carolina motor vehicle crashes per 100 licensed drivers by driver race and sex, 1974-1988.

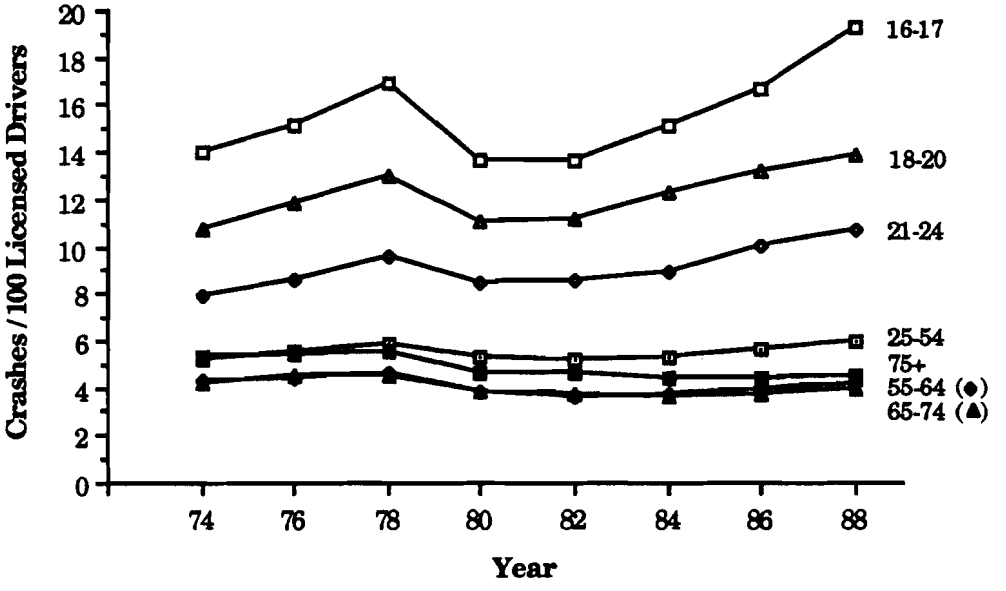

Figure 3.7. North Carolina motor vehicle crashes per 100 licensed drivers by driver age, 1974-1988.

Trends Related to the Safe Roads Act

A final section in this chapter deals with trends with respect to weekend, nighttime, and rural crashes. These crashes are generally associated with more severe injury outcomes, and weekend and nighttime driving, in particular, could be expected to be affected by the 1983 Safe Roads Act. This legislation made sweeping changes to North Carolina's laws regulating drinking and driving, including tougher punishments, reduced discretion in handling cases by the courts, and an increase in the minimum age at which a person may purchase beer or wine from age 18 to age 19. (The minimum age was further raised to age 21 in 1987.) Weekend and nighttime driving, in addition, are likely to be more discretionary, so that crashes at these times might be more heavily impacted by the 1974 energy crises and 1980-81 economic recession.

Figures 3.8 and **3.9** (and Table **A.12**) examine trends with respect to weekend crash involvement. Overall during the 15-year study period there was a decrease in the percentage of crashes occurring on weekends, from 34 percent in 1974 to 28 percent in 1988. The decline was greatest for males and nonwhites, and for young and middle-aged drivers. Although there is evidence of a slight decline in weekend crashes prior to 1983, a sharp drop in the percentage of weekend crashes occurred following enactment of the 1983 Safe Roads Act. This decline is evident for all race/sex groups and for all age groups with the exception of drivers age 75 and older. Thus, the Safe Roads Act appears to have had a clear impact on weekend crash occurrence in North Carolina.

A similar trends holds with respect to nighttime crash involvement (**Figures 3.10** and **3.11**, Table **A.13**). Here the impact due to the Safe Roads Act is most pronounced for drivers in the 18-20 and 21-24 year age groups and among males and nonwhite females. In 1988 there was a further decline in nighttime crash involvement for males, but no such decline for females. The Safe Roads Act appears to have had little impact on the nighttime crash involvement of drivers age 55 and older: these drivers have experienced a steady overall decline in their nighttime crash involvement throughout the 15-year study period. In contrast, prior to 1983, the nighttime crash involvement of younger drivers, and in particular those less than 24 years of age, had been increasing. Since passage of the Safe Roads Act, this trend has been reversed, with the overall percentage of nighttime crashes declining in 1984 and again in 1988.

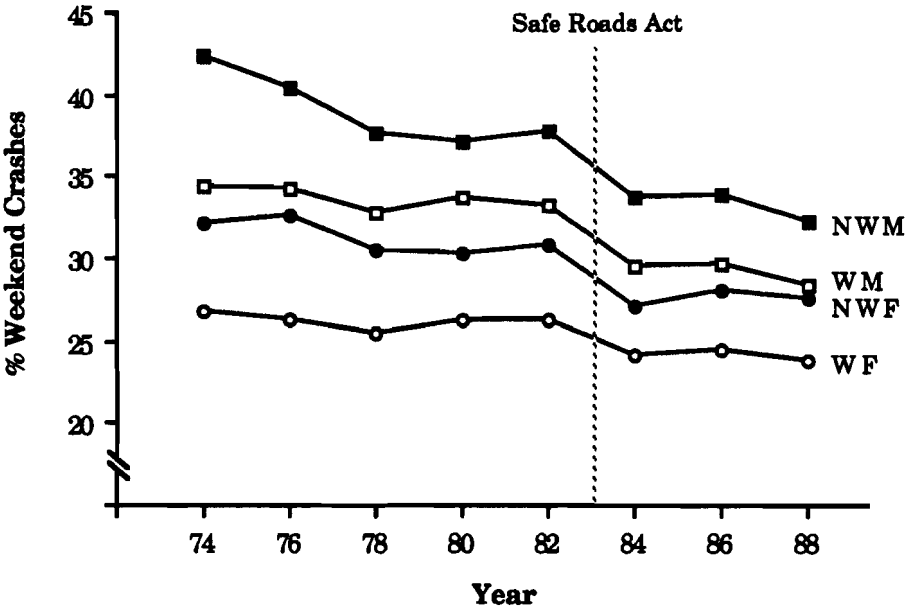

Figure 3.8. Percent of crashes occurring on weekends by driver sex and race, 1974-1988.

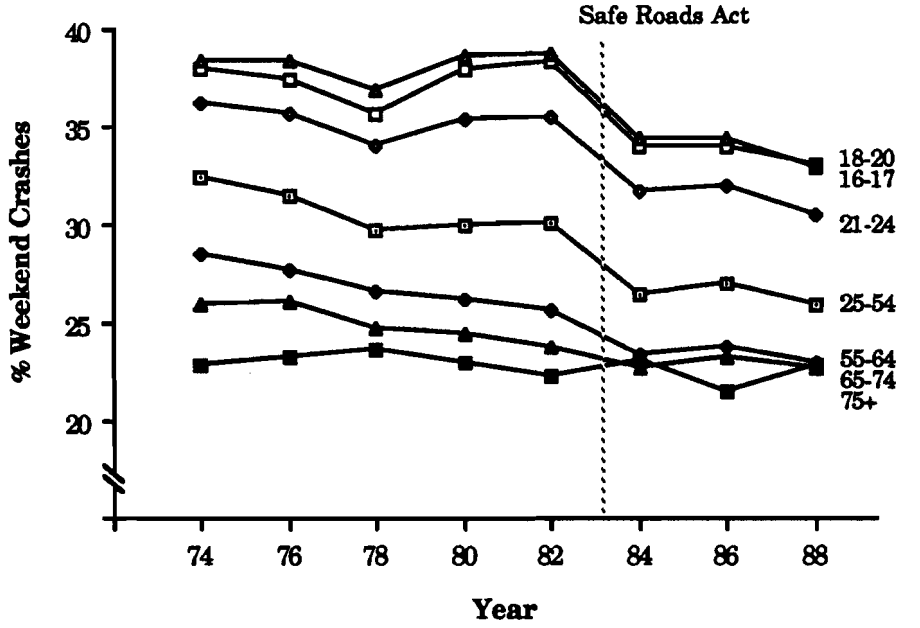

Figure 3.9. Percent of crashes occurring on weekends by driver age, 1974-1988.

Figure 3.10. Percent of crashes occurring during nighttime (6:00 pm - 5:59 am) by driver sex and race, 1974-1988.

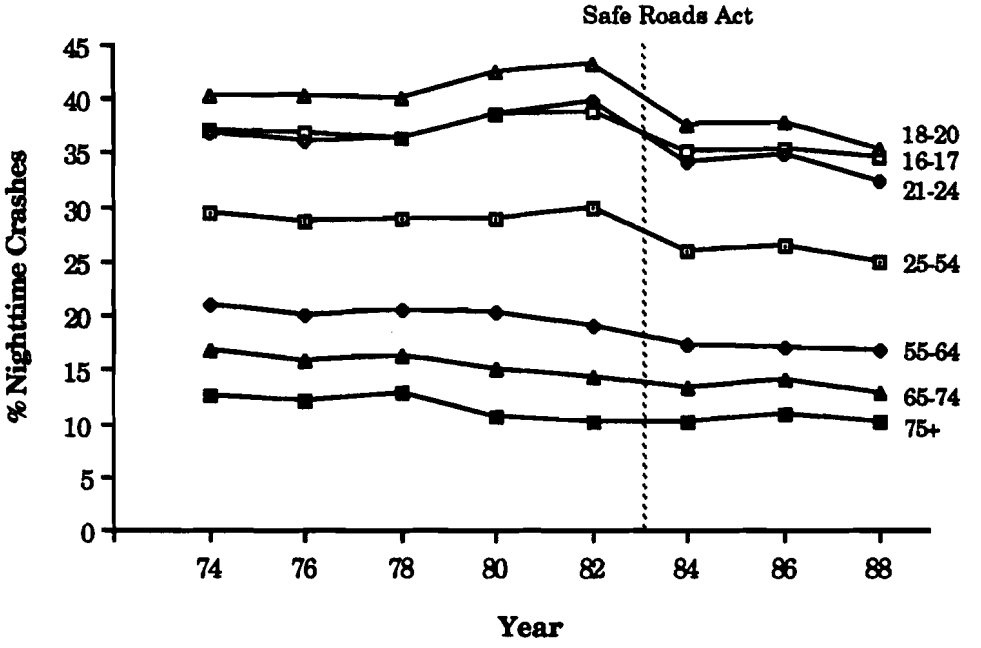

Figure 3.11. Percent of crashes occurring during nighttime (6:00 pm - 5:59 am) by driver age, 1974-1988.

A final set of figures summarizes trends with respect to rural crash involvement (see **Figures 3.12** and **3.13** and **Table A.14**). These figures show a steady decline in rural crash involvement by all sex/race groups and by all but the older (age 75+) drivers. (The latter showed a steep decline in their rural crash involvement between 1974 and 1980, but no further decline.) The decrease in rural crash involvement has been slightly greater for males than for females, and does not appear tied to any specific economic or legislative events in the state. Rather, it is likely reflective of a more general trend of increased urbanization statewide.

Summary and Discussion

Analysis of North Carolina motor vehicle crash data during the 1974-1988 study period shows an increased representation of females, and particularly nonwhite females, in the motor vehicle crash population. For white females, this increase has been far beyond their increase in the licensed driver population, leading to an increase over time in their observed crash rates per 100 licensed drivers. Still, on a licensed driver basis, females (and particularly white females) remain the "safest" drivers, experiencing an overall crash rate about a third lower than that for males.

Results with respect to driver age show the expected higher crash rates for the youngest age groups (two to two-and-a-half times the "average" crash rate), and, perhaps less expected, consistently lower than average crash rates for drivers age 55 and above. Even drivers in the 75+ age group had a lower crash rate on a licensed driver basis than the "typical" 25-54 year-old driver. Undoubtedly exposure is a factor in these results, and will be addressed in the following section.

Finally, analysis of crash occurrence by weekday and time of day variables, factors associated in the literature with alcohol-related crashes, showed sharp declines in both weekend and nighttime crashes with the onset of the 1983 Safe Roads Act. Declines were observed for all age and race/sex groups except for the oldest drivers, presumably because these drivers already limit their driving at such times and are less likely to be involved in alcohol-related crashes. Trends with respect to alcohol-related crashes are further explored in Section VI.

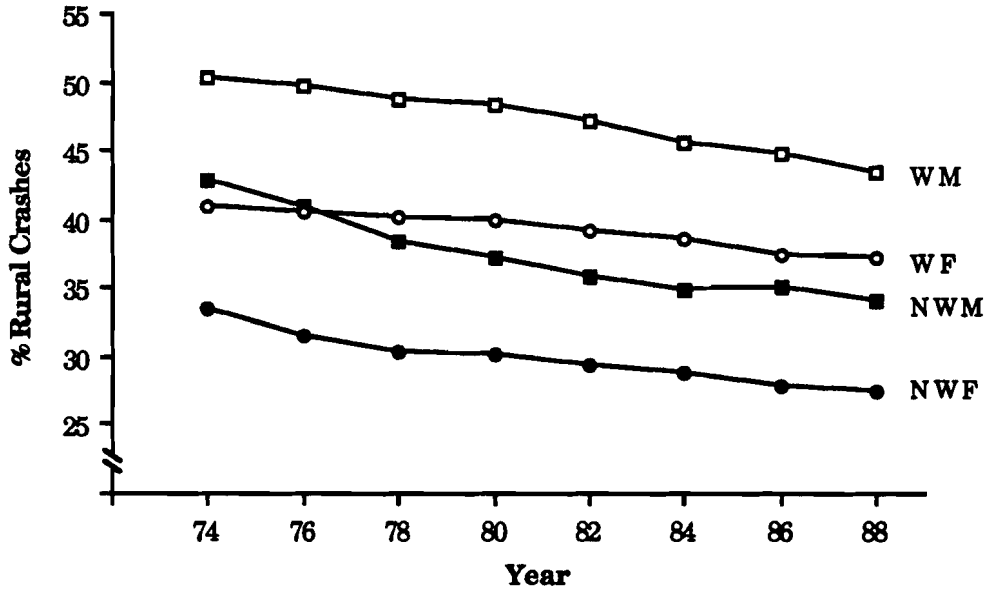

Figure 3.12. Percent of crashes occurring in rural locations by driver sex and race, 1974-1988.

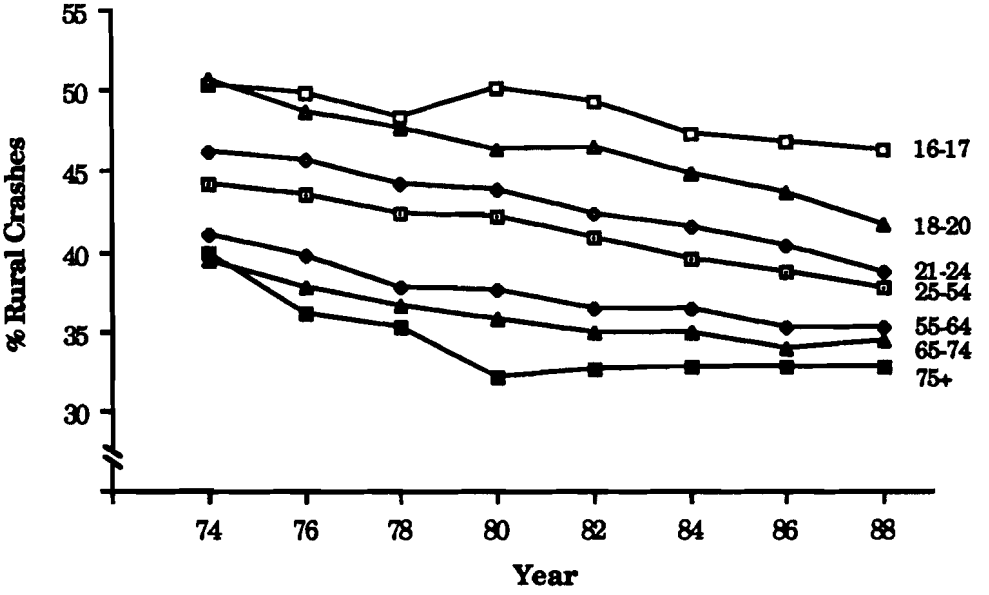

Figure 3.13. Percent of crashes occurring in rural locations by driver age, 1974-1988.

IV. Exposure Trends

Induced Exposure

As noted in the introduction section, the concept of induced exposure has been a part of the highway safety literature for over 25 years. Induced exposure was first introduced in 1964 as "a method that may be used to calculate an approximate relative accident likelihood when this cannot be done by other means" (Thorpe, 1964). The method uses the distribution of "not responsible" drivers in collision accidents as the exposure denominator in calculating relative accident likelihoods. A relative accident likelihood for a given driver population is equal to the proportion of drivers involved in such crashes divided by the proportion of drivers exposed as determined by their representation in the not-at-fault driver distribution.

In accident research, appropriate exposure or "population at risk" data is needed to distinguish between those accidents that occur simply because there are many opportunities for them to occur, and those that occur because *given an opportunity* there is a very high risk of occurrence. For example, a simple tally of nighttime versus daytime accidents would show that the latter are much more numerous. However, when a measure of exposure such as miles of nighttime and daytime driving is taken into consideration, a calculation of nighttime and daytime crash rates per miles travelled shows a two-fold greater risk of crash involvement associated with driving at night.

Although clearly important, good exposure data is often difficult to obtain. Frequently used exposure measures include number of licensed drivers (as illustrated in Section III) or number of registered vehicles. Vehicle (or person) miles of travel is often regarded as an "ideal" exposure measure, but obtaining it can involve costly surveys, and often it is not specific enough to appropriately address the research question at hand. For example, if younger and older drivers accrue the same overall mileage, but younger persons drive primarily during nighttime hours and on weekends while older persons drive primarily during the daytime, then their *opportunity* to crash may differ considerably.

Given these difficulties there are very obvious advantages to the application of induced exposure techniques. Induced exposure measures can be derived entirely from the crash data, requiring no external data collection. Given

adequate sample size they can also be derived for any combination of driver/vehicle/roadway conditions. Van der Zwaag (1971), for example, demonstrated the technique in determining relative crash involvements of passenger cars and trucks. More recently, Maleck and Hummer (1987) used induced exposure methods to determine relative crash involvements by driver age group for various accident types (urban/rural, left-turn, parking/backing, etc.).

It should be stressed that even when applied to the more general situation examining overall crash involvement, induced exposure is *not* synonymous with vehicle miles of travel. It is a measure of "opportunity to crash" that takes into account miles travelled but also traffic conditions, roadway conditions, vehicle speed, length of time on the roadway, and even nighttime driving and driving after drinking.

For the current examination of North Carolina motor vehicle crash and injury trends, measures of induced exposure were derived by first identifying all crashes on the North Carolina motor vehicle crash files involving two motor vehicles in which one vehicle was judged to be "at fault" and the other "not at fault." This determination was based on the investigating officer's reporting of a violation by either of the involved drivers. In 10-16 percent of the crashes, either neither driver was found in violation or both drivers were cited, so that no determination of fault could be made. These cases were excluded from the analysis. The number of cases remaining ranged from 57,000 on the 1974 crash file to 89,000 on the 1988 crash file. Age/sex/race distributions were then calculated for the population of not-at-fault drivers in these crashes, both overall and across selected exposure-related variables -- day of week, time of day, and reporting agency (a proxy for urban/rural location).

Appendix **Table A.15** presents the overall age/sex/race distributions for not-at-fault drivers for each accident year. These proportions became the denominator for determining crash involvement ratios. The numerator was the proportion of overall crash involvement, as presented in Table A.7. Although Thorpe (1964) presented separate formulae for single vehicle versus multivehicle crashes, we chose to focus on overall crash involvement and included both in our numerator. (Since young drivers and males are known to be overrepresented in single vehicle crashes, this would tend to inflate their relative involvement ratios.)

Relative Crash Involvement Trends

Appendix **Table A.16** presents relative crash involvement ratios by driver age, sex, and race for the 1974-1988 crash years. **Figures 4.1** and **4.2** depict the overall age and race/sex trends graphically. The graphs show that, under the assumptions of induced exposure,

- Relative crash involvement ratios are highest for young drivers and drivers over age 75. Drivers age 75+ have the highest involvement ratios (1.6-1.9), followed by 16-17 year-old drivers (1.4-1.5). The 25-54 and 55-64 year age groups both are underrepresented in terms of their crash involvement.

- Males have a higher crash involvement ratio than females. The average involvement ratio for males over the 15 year study period is approximately 1.1; for females, 0.9. Nonwhite males have a slightly higher involvement ratio than white males (1.13 vs. 1.07), but the situation is reversed for females, with white females having the slightly higher relative involvement (.88 vs. .85).

- There has been only a slight trend effect over the 15-year study period. Generally, the relative crash involvement ratio of younger drivers has increased slightly, while that for older drivers has decreased.

Following the same procedure, it was possible to calculate relative crash involvement ratios for weekend, nighttime, and rural crashes as well. The denominator in each case was the age/sex/race proportion of not-at-fault drivers in the designated crash type (weekend, nighttime, or rural). Results for weekend crashes are summarized in **Figures 4.3** and **4.4**. These results are very similar to the overall crash involvement results reported above, i.e., higher involvement ratios for males as well as for the very oldest and youngest drivers. Trend effects are minimal. The absence of any shift, for example, following the enactment of the 1983 Safe Roads Act, likely reflects the situation where the observed decrease in weekend crashes was accompanied by an equally large reduction in exposure to weekend crashes, as measured by representation in the not-at-fault crash population.

Results for nighttime and rural crashes were likewise very similar to the overall and weekend results, and are not presented.

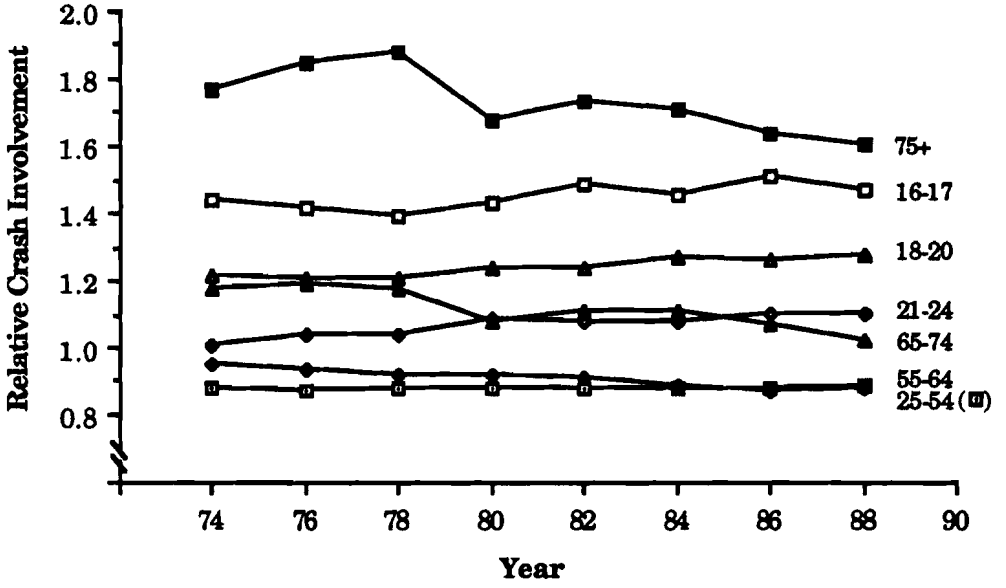

Figure 4.1. Relative crash involvement by driver age, 1974-1988.

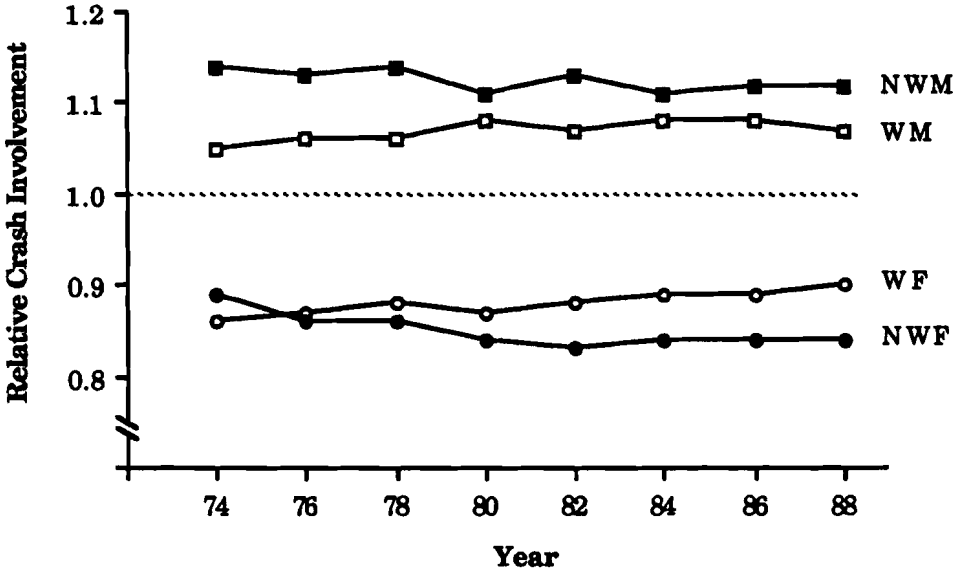

Figure 4.2. Relative crash involvement by driver race and sex, 1974-1988.

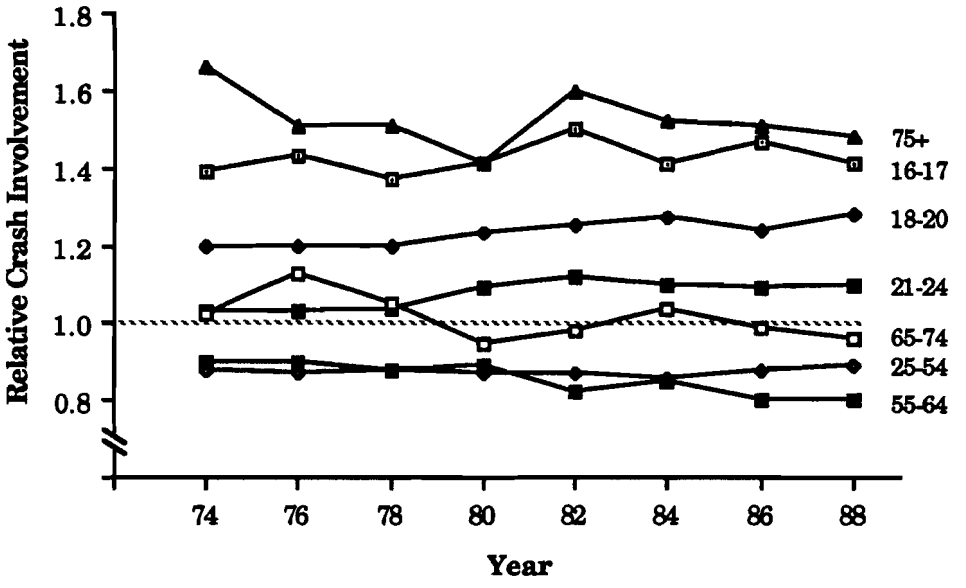

Figure 4.3. Relative crash involvement in weekend crashes by driver age, 1974-1988.

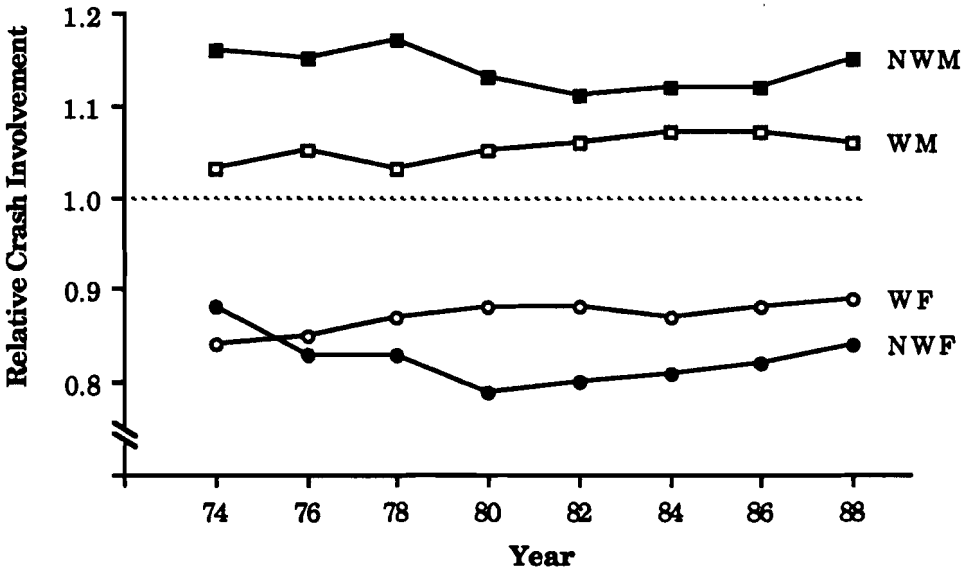

Figure 4.4. Relative crash involvement in weekend crashes by driver sex and race, 1974-1988.

Using Induced Exposure to Estimate Mileages

In an early examination of the induced exposure concept, Waller et al. (1973) compared the age/sex distribution of drivers involved in crashes (overall, two vehicle not-at-fault, two vehicle at fault, and single vehicle crashes) with the age/sex distribution of total fleet mileage generated from a statewide survey of driver license renewal applicants. The authors hypothesized that, if the assumptions underlying induced exposure were correct, then the not-at-fault drivers in two-vehicle crashes would distribute themselves across the various age/sex categories in very much the same manner as the license applicants with regard to proportion of total reported mileage. That is, if 20-24 year-old males represent 20 percent of all not-at-fault drivers in two vehicle crashes, they should account for 20 percent of the total mileage reported. The distributions of at-fault drivers in two vehicle crashes and drivers in single vehicle crashes, on the other hand, should resemble each other but should be different from the distribution of not-at-fault drivers.

Results of the 1973 study generally confirmed these hypotheses, with the distribution of not-at-fault drivers more closely resembling the reported mileage distribution than either the at-fault or single vehicle accident drivers. Differences *did* exist -- middle age groups were somewhat underrepresented by the induced exposure technique while younger and older age groups were overrepresented. However, the authors note that this may be due to the fact that the induced exposure technique measures something qualitatively different than simple miles travelled.

Drawing from this earlier work, the current motor vehicle crash trends analysis applied induced exposure techniques to generate not only relative crash involvement ratios, but crash rates per estimated *induced exposure* miles travelled. The mileage denominators were obtained by multiplying the proportion representation in the not-at-fault driving distribution (presented in Table A.15) by an overall annual statewide mileage estimate obtained from the Planning and Research Branch of the North Carolina Division of Highways. Overall crash involvement and injury rates were then calculated for each age/sex/race subpopulation of interest.

It must be stressed that the resulting crash and injury rates based on induced exposure miles are not the same as the more typical crash rates based on

vehicle or person miles travelled. **Table 4.1**, using 1984 data, clearly illustrates this point. The first column of the table gives the induced exposure distribution based on not-at-fault drivers in two vehicle crashes. This proportion is multiplied by the overall estimated mileage for 1984 to obtain an estimate of total "miles travelled" for each age group. To produce an estimate of average annual miles per licensed driver this total mileage figure was divided by the number of licensed drivers in that age group.

As can be seen, the results are quite different from the estimates of annual miles travelled reported by the 1983-1984 National Personal Transportation Study (FHWA, 1986). The induced exposure approach produces a slightly higher average mileage figure overall, which could be expected due to the inclusion of fleet and truck mileage in our total mileage figure. For drivers age 25 and older the induced exposure and NPTS estimates are quite compatible. However, induced exposure estimates for the ≤24 year age groups are greatly inflated. This would indicate that, *in addition to their overrepresentation in crashes in general, young drivers are also overrepresented in crashes in which they are not at fault.*

Part of this might be explained by the fact that younger aged drivers are more likely to drive at nighttime and on weekends, times associated with higher crash rates. Regardless of the reason why, however, it is clear that, particularly for this group of younger aged drivers, induced exposure miles and actual vehicle miles travelled are not the same. For the purposes of this report, induced exposure based crash rates are used primarily for examining changes in age/sex/race specific crash and injury rates *over time*. In this regard, any differences in "induced" and "actual" exposure miles are not critical. When comparisons are made among the various subpopulations of interest, the inflated "mileages" (and thus reduced crash and injury rates) for the ≤24 year age groups must be considered.

Given these caveats, Appendix **Table A.17** presents crash rates per estimated million induced exposure miles by driver age, sex, and race. This information is summarized graphically in **Figures 4.5** and **4.6**. During the time period of this analysis, the overall crash rate based on induced exposure mileages has declined slightly, from approximately 5.6-6.0 crashes per million induced exposure miles to 5.1-5.2 crashes per million induced exposure miles. The decline has been greatest among the 65-74 and 75+ age groups, and slightly

Table 4.1. Comparison of mileage estimates using induced exposure methods with NPTS mileage estimates, 1984 data.

Induced Exposure Mileages

Age	Induced Exposure Distribution	Estimated Miles (x 10^6)	Licensed Drivers	Annual Miles/ Licensed Driver
16 - 17	5.43	2,609.13	128,791	20,259
18 - 20	10.30	4,949.15	260,777	18,978
21 - 24	14.06	6,755.83	417,184	16,194
25 - 54	56.72	27,253.96	2,342,519	11,634
55 - 64	8.27	3,973.74	484,060	8,209
65 - 74	4.07	1,955.64	303,928	6,435
75+	1.15	552.58	109,505	5,046
Total	100.00	48,050.00	4,046,764	11,874

National Personal Transportation Survey Mileages, 1983-84 *

Age	Estimated Annual Mileage	Age	Estimated Annual Mileage
16 - 19	4,985	50 - 54	10,936
20 - 24	10,339	55 - 59	9,443
25 - 29	11,810	60 - 64	8,568
30 - 34	12,126	65 - 69	6,804
35 - 39	12,662	70+	4,348
40 - 44	13,015		
45 - 49	11,805	Total	10,558

* Source: Klinger and Kuzmyak (1986).

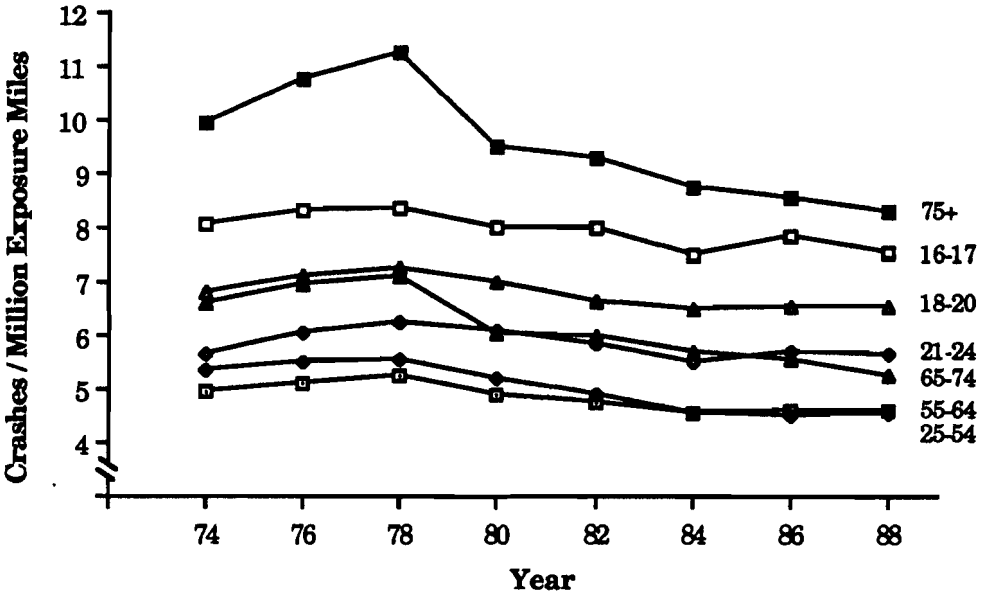

Figure 4.5. Crashes per million induced exposure miles by driver age, 1974-1988.

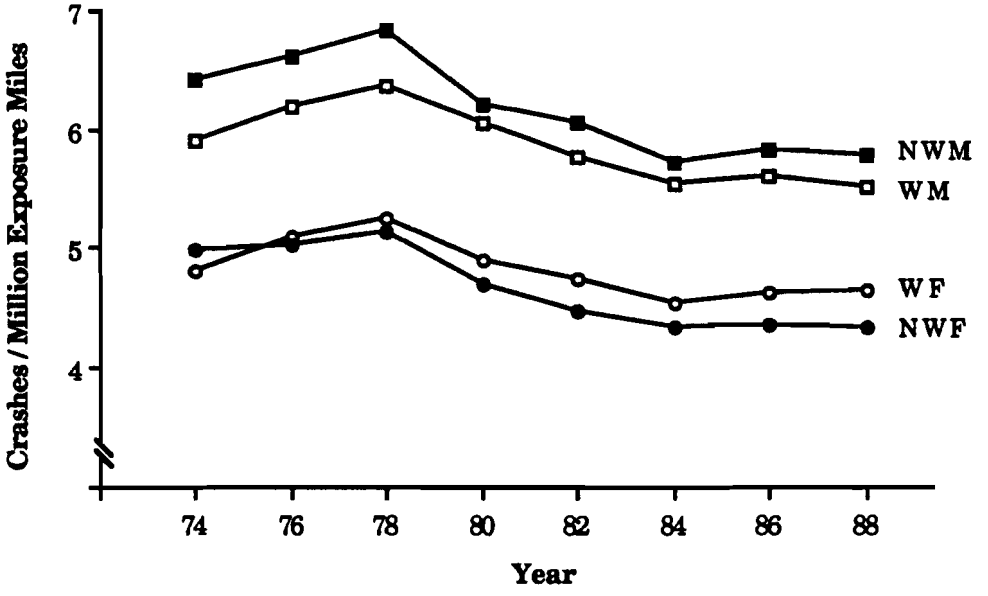

Figure 4.6. Crashes per million induced exposure miles by driver sex and race, 1974-1988.

higher for nonwhites than whites. Males and females have experienced about equal declines, except for the youngest age females whose crash rates have varied little over the 15-year study period.

Note that while Figure 4.5 shows drivers age 75 and older to have the highest crash rate based on induced exposure miles, this may well not be the case if rates were based on actual miles travelled. Again, this is because the technique inflates mileages (and thus underestimate crash rates) for the younger drivers. Following the same reasoning, it may also be that the technique inflates mileages for nonwhites or males as well, thus negating some of the higher crash rates for these groups appearing in Figure 4.6. Additional data are needed to examine these possibilities.

Section V uses the induced exposure mileages to calculate "any" and "serious" driver injuries per estimated million induced exposure miles.

Summary and Discussion

To further examine trends in motor vehicle crash involvement and to make comparisons across subpopulations of interest, information is needed concerning the "population at risk." Number of licensed drivers is one such "exposure" variable that can be used to calculate a crash rate for one population of drivers that can be compared with that of another population of drivers. However, this denominator does not consider differences in miles driven, time of day, etc., for the particular driver subpopulations. An often preferred exposure measure is vehicle (or driver) miles travelled. Though appropriate for the current analysis, such data were not available for each of the eight study years and across each age/sex/race subpopulation.

In the absence of such data, the technique of induced exposure was applied to the study data to identify those subpopulations that are over- or under-represented in crashes with respect to their presence in the "at-risk" driving population, and to estimate crash rates per million "induced exposure" miles. In the process, it was shown that the induced exposure technique generates exposure mileage estimates that are qualitatively different from VMT. In particular, mileage estimates generated using induced exposure greatly inflate mileage figures assigned to the younger drivers (in our analysis, drivers under age 25). If one accepts that the driving actually done by these younger drivers is

indeed "riskier" in the sense that it is more likely to take place at nighttime and on weekends (and perhaps also include the distraction of friends and alcohol), then the induced exposure "mileage" might be viewed as an actual measure of miles travelled *weighted* by some level of risk for that driving, i.e., the mileage of younger drivers is inflated to compensate for the greater risk inherent in their driving.

Within this framework, our results show that on an induced exposure mile basis, drivers age 75+ have the highest crash rates, followed by drivers aged 16-17, 18-20, and 21-24. Lowest crash rates were obtained by 25-54 and 55-64 year-old drivers. The crash rate of males was higher than that for females, with very little differences between the races. Although the oldest age drivers posted the highest crash rates, it was noted that any adjustment to the induced exposure mileages of the younger drivers to more accurately reflect "real world" VMT could increase their crash rates two- or three-fold, placing them at the high end of the continuum. All of these cavets should be borne in mind in the following section focusing on injury trends.

V. Injury Trends

Overall Injury Trends

North Carolina law requires that a standard statewide accident report form be completed for any crash resulting in injury and/or property damage in excess of $500 ($200 prior to 1983). Injury information is recorded for each occupant using the five point KABCO scale. The levels are

K = Killed

A = Serious or incapacitating injury (broken bone, loss of blood, etc.)

B = Moderate or nonincapacitating injury (injury other than K or A evident at the scene)

C = Minor injury

O = No injury

In 1974 at the start of this trends analysis, over 38,000 drivers were injured and of these, 7400 seriously injured in motor vehicle crashes. By 1988 these numbers had increased to 76,800 injuries overall and 12,200 serious injuries.

In addition to the increase in the actual numbers of injured motor vehicle operators, there has been an increase in the percentage of drivers in North Carolina crashes reported as being injured. **Figure 5.1** shows the percent of crash involved drivers with any reported injury (K+A+B+C) and the percent with serious (A+K) injury over the 15-year study period (numbers plotted are found in Appendix **Tables A.18** and **A.19**). During this time period there were two changes in North Carolina's crash reporting procedures that are apparent in the trend lines. First, a 1979 revision of the standard accident report form and accompanying instruction manual included an expanded definition of an "A" level (serious) injury. This change resulted in an increase in the percentage of "A" level injuries reported. Second, in 1983 the minimum dollar threshold for required reporting of a motor vehicle crash was increased from $200 to $500. This reduced the number of "no injury" crashes reported which had the effect of increasing the percentage of injury crashes reported.

Beyond these form-induced changes in injury-reporting practices, it is uncertain whether there has been any true increase in the percentage of crashes involving injury. The percentage of serious (A+K) injury cases appears quite constant (even declining a bit from 1974-78). Any (K+A+B+C) injury cases, on the

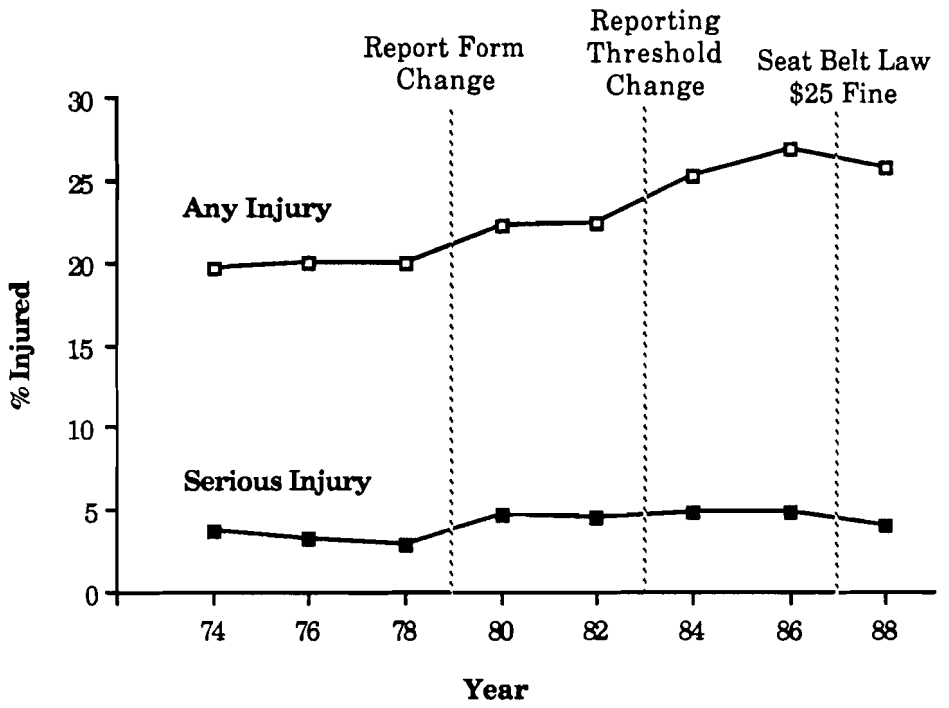

Figure 5.1. Percent of drivers with any (K+A+B+C) or serious (A+K) injuries, 1974-1988.

other hand, may have increased slightly beyond any changes brought about by report form revisions. There was, for example, an increase in reported injuries from 1984-86 that does not coincide with any reporting form change. Even if increases in reported injuries are documented, there remains the problem of deciphering whether these changes represent "real" changes in injury occurrence or simply changes in reporting practices over time. The latter might arise, for example, from a growing tendency by motorists to complain of pain or injury (and thus receive a "C" rather than an "O" injury rating), because of possible insurance consequences.

As a final comment on Figure 5.1, the downward slope of both injury curves from 1986 to 1988 coincides with the beginning of the citation phase of North Carolina's seat belt use law. This law became effective October 1, 1985, and applies to drivers and front seat occupants of all motor vehicles equipped with seat belts. During the period October 1, 1985 - December 31, 1986, violators not wearing a seat belt were issued warnings only. Belt use during this time increased from 20-25 percent just prior to the law's enactment to approximately 40 percent over

the duration of the warning phase. Beginning January 1, 1987, violators became subject to a $25 fine, and use rates jumped to 70 percent initially before falling to about 60 percent over the next two years. In Figure 5.1, the percentage of crash involved drivers experiencing serious injury holds fairly steady from 1980 to 1986, then drops in 1988. Some actual percentage values are 4.9 percent in 1984 and 1986, and 4.1 percent in 1988. Any (K+A+B+C) injury rates also declined slightly, from 26.8 percent in 1986 (during the warning ticket phase of the law) to 25.8 percent in 1988 (after initiation of the $25 fine). While this represents only a modest decline, it should be noted that it follows a period of *increasing* injury rates.

Figures 5.2 - 5.5 show these trends by driver age and race/sex (actual percentage values appear in Tables A.18 and A.19). These results indicate that the very oldest (75+) and the younger (<25) drivers are the most likely to be involved in serious injury crashes. Younger drivers, but not older drivers, are also more likely to be involved in an "any injury" crash. The latter would indicate that, if injured at all in a crash, the older driver is much more likely to be seriously injured. For all age groups, as well as each of the four sex/race groups, there is a sharp drop in serious injuries associated with the onset of the citation phase of the North Carolina seat belt law January 1, 1987.

The graphs also show that, while females are more likely to be reported as injured in a crash (Figure 5.4), males are still more likely to be seriously injured (Figure 5.2). However, the serious injury rate for white males, traditionally the highest of the four race/sex groups, has dropped below the serious injury rate for non-white males since the belt use law became effective. This is despite the fact that observational studies of North Carolina drivers show belt use among nonwhites to have increased to a level higher than that of whites, with nonwhite females having the highest overall use rate (Reinfurt et al., 1988). (It should be noted that these use rates are based on observations made during daylight driving hours and do not include nighttime driving which is associated with generally more serious crash occurrence.)

Injuries per Licensed Driver

As in the crash trends section, it was also possible to examine any (K+A+B+C) and serious (A+K) driver injuries per 100 licensed drivers. These

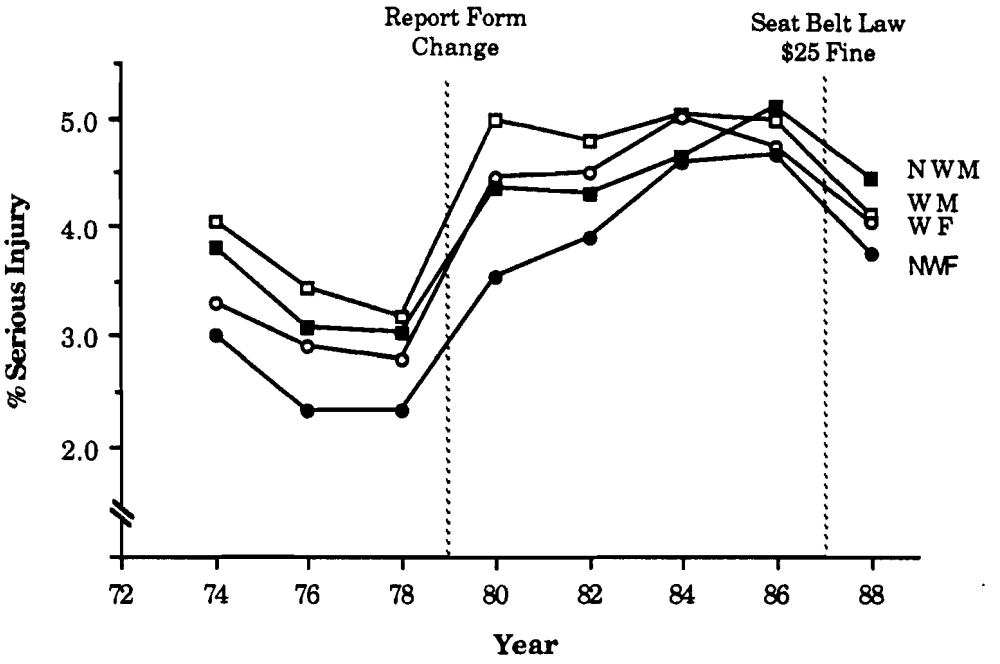

Figure 5.2. Percent of drivers with serious (A+K) injury by sex and race, 1974-1988.

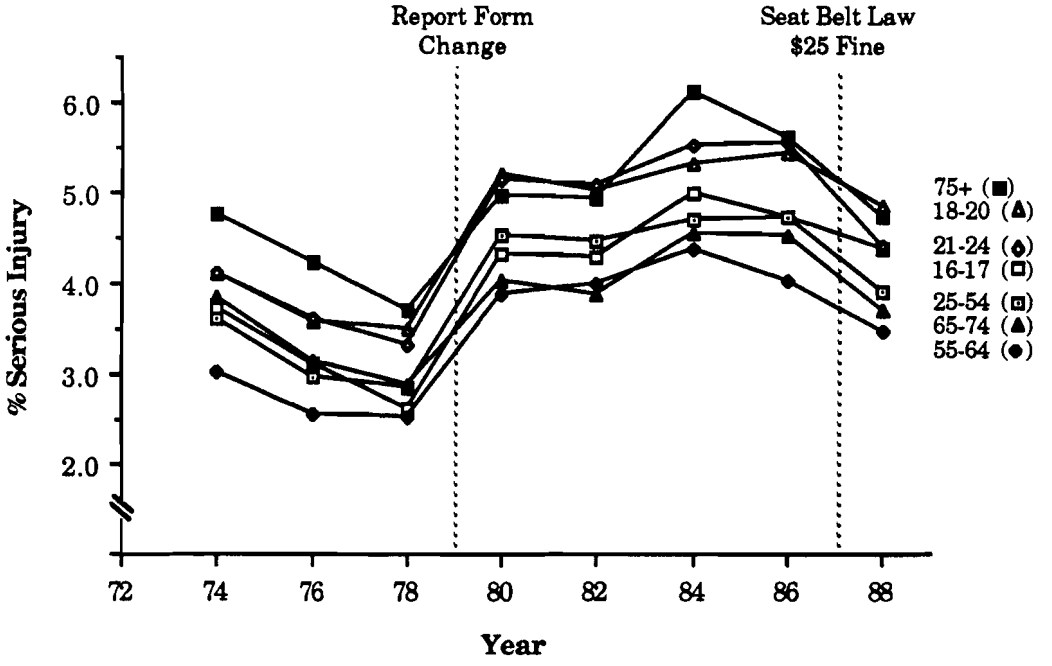

Figure 5.3. Percent of drivers with serious (A+K) injury by age, 1974-1988.

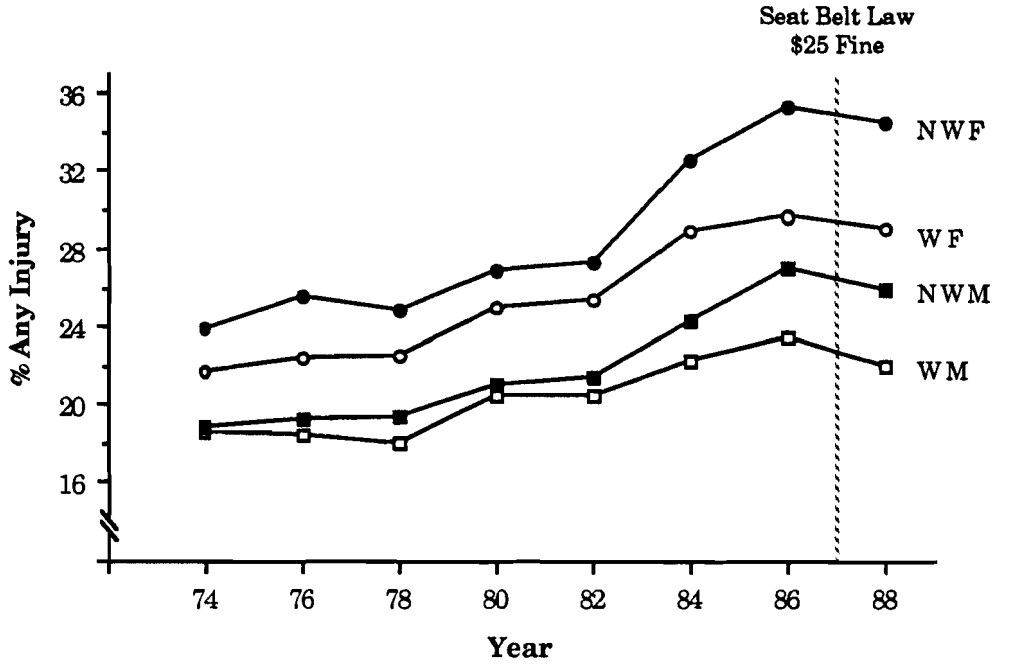

Figure 5.4. Percent of drivers with any (K+A+B+C) injury by sex and race, 1974-1988.

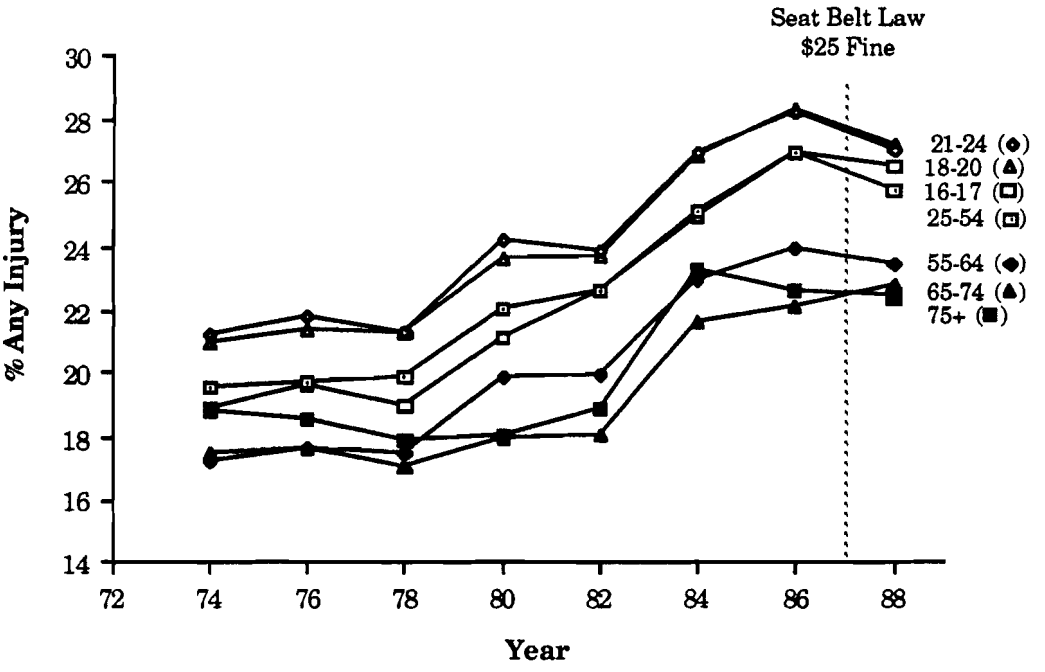

Figure 5.5. Percent of drivers with any (K+A+B+C) injury by age, 1974-1988.

results are displayed in **Figures 5.6 - 5.9** (with accompanying numbers in Appendix **Tables A.20** and **A.21**). Overall there has been an increase in reported injuries per licensed driver, following the pattern of increased crashes per licensed driver shown earlier. The overall any (K+A+B+C) injury rate per 100 licensed drivers was 1.22 in 1974, increasing to 1.77 in 1988. The trend with respect to serious injuries is not as clear, due in part to the 1979 change in reporting of "A" level injuries. Prior to 1979, the serious injury rate was .21 - .23 serious injuries per 100 licensed drivers. With the report form change, this rate jumped to .28 serious injuries, increasing to .32 injuries by 1986. In 1988, following the citation phase of the state seat belt law, the rate declined back to its 1980 level of .28 (see appendix tables).

When the serious injury results are examined by age and race/sex subpopulations (Figures 5.6 and 5.7), drivers age 24 and under show large increases in injury rates from 1980 through 1986, and for the 16-17 year-olds this trend continued even after the belt law took effect. Figure 5.7 also shows an increase in the serious driver injury rate for all race/sex subpopulations *except* white males. All four race/sex groups, however, show the reduction in serious injuries per 100 licensed drivers following the citation phase of the North Carolina seat belt law.

The fact that 16-17 year-olds fail to show a reduction in serious injury rates for the 1988 crash year can be explained at least in part by the large increase in their overall crash involvement rate from 1986 to 1988 (from 16.7 to 19.3 crashes per 100 licensed drivers -- refer to Table A.10 and Figure 3.5). However, it might also be noted that this same age group experienced a *decline* in their serious injury rate from 1974-1978, during a time that their overall crash involvement was also increasing. The increasing serious injury rate per licensed driver for females and nonwhites also likely follows from the increased representation of these groups in the licensed driver and crash involved populations. White males, in contrast, have experienced very little change in their overall crash involvement (Figure 3.4), causing them to be less likely to show an increase in serious injuries over the study period.

The any (K+A+B+C) injury trends (Figures 5.8 and 5.9) follow the crash involvement trends shown in Figures 3.4 and 3.5. The one noticeable exception is that the injury rate per 100 licensed drivers for nonwhite males and, particularly,

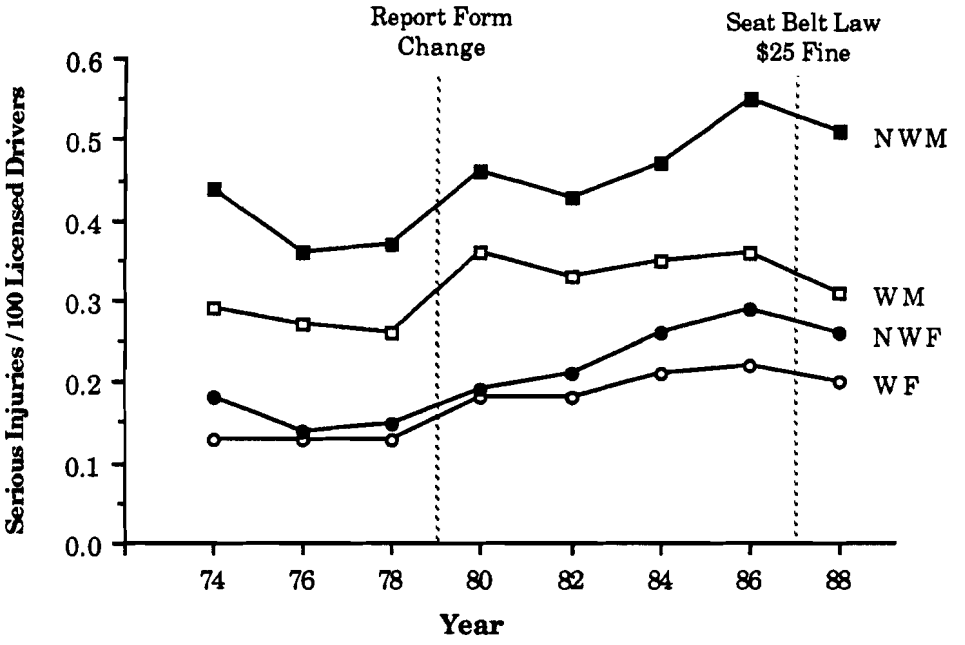

Figure 5.6. Serious injuries per 100 licensed drivers by driver race/sex, 1974-1988.

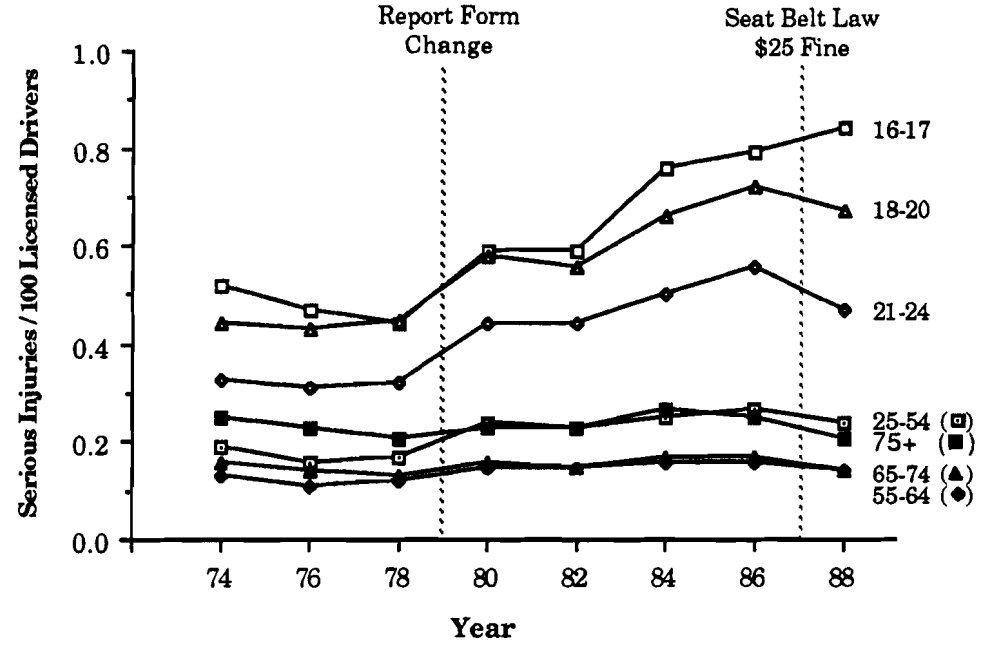

Figure 5.7. Serious injuries per 100 licensed drivers by driver age, 1974-1988.

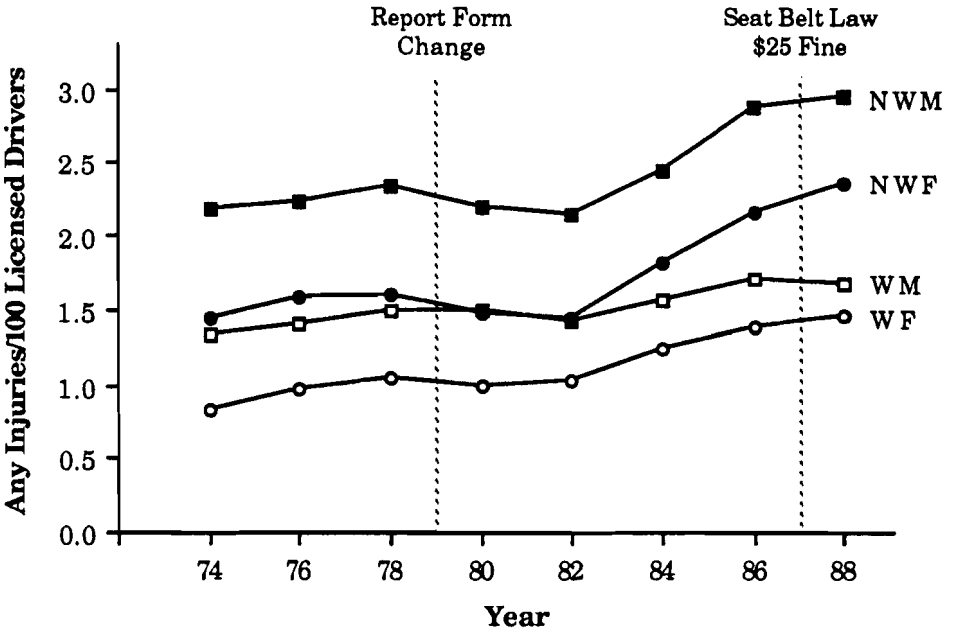

Figure 5.8. Any injuries per 100 licensed drivers by driver race/sex, 1974-1988.

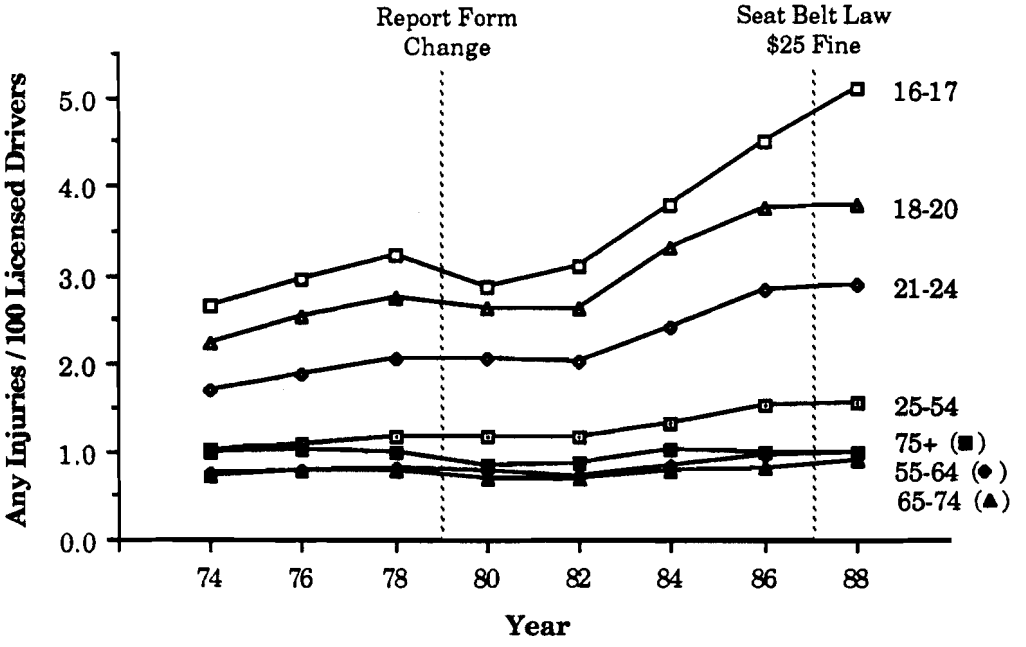

Figure 5.9. Any injuries per 100 licensed drivers by driver age, 1974-1988.

nonwhite females, has increased dramatically since 1982, far exceeding their increase in overall crash involvement. In Figure 3.4, the crash involvement for nonwhite females was found to be consistently lower than that for white males, but the injury rate for the nonwhite females has exceeded that for white males since 1982, with the difference increasing each year. Again, whether this can be attributed to an increased likelihood of reported injuries or to a real difference in injury occurrence is a subject requiring further inquiry.

Crashes per Induced Exposure Miles

In Section IV, estimated crashes per million induced exposure miles were presented. Using the same mileage denominators (and again noting that the induced exposure technique produces "mileage" estimates that, for the younger age groups at least, vary considerably from the typical vehicle miles of travel denominator), serious and any driver injury rates were calculated per estimated million induced exposure miles. These results are summarized in **Figures 5.10 - 5.13** and Appendix **Tables A.22** and **A.23.**

Again for the serious injury results, the effects of the 1979 accident report form revision and the N.C. seat belt law are evident in the trend lines. Apart from these two events, the overall trend line for serious injuries per estimated induced exposure miles is essentially flat. A slightly higher injury rate for the 1974 crash year may reflect a genuine higher reporting of serious injuries for that year or simply lower mileage denominators resulting from the energy crises. The fact that there is no parallel rise in any injuries (Figures 5.12 and 5.13) offers some support at least for the former, although without ready explanation.

The serious injury trends within age and race/sex subpopulations follow the same basic pattern as did the crash trends shown in Figures 4.5 - 4.8. Again, drivers age 75+ have the highest serious injury rate per estimated million induced exposure miles, paralleling their higher crash involvement rate. Drivers ages 16-17 and 18-20 follow, although here it should be emphasized that if actual miles travelled rather than induced exposure miles had been utilized in the denominator, the injury rates for these groups would have been considerably higher. Finally, it is interesting to note that the serious injury rate per estimated exposure miles for drivers in the 65-74 year age group is not significantly elevated above that for the "average" 25-54 year-old driver, and the lowest rate overall

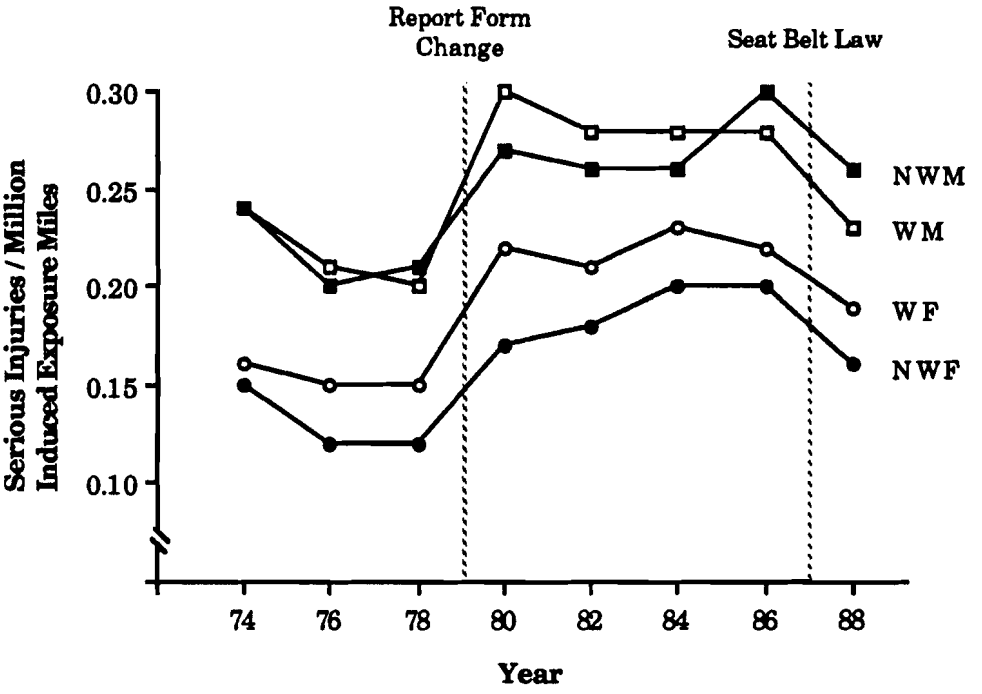

Figure 5.10. Serious injuries per million induced exposure miles by driver race/sex, 1974-1988.

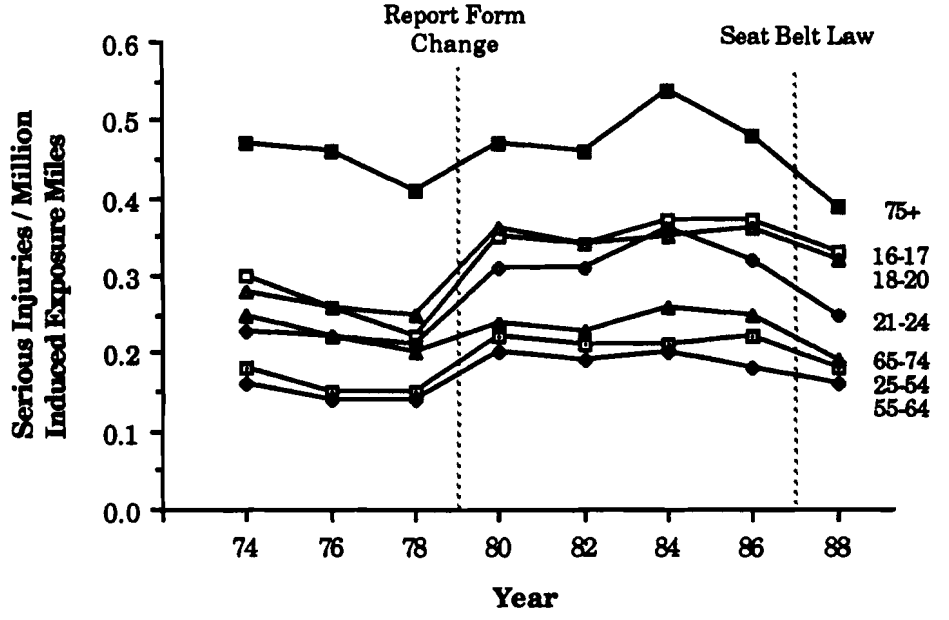

Figure 5.11. Serious injuries per million induced exposure miles by driver age, 1974-1988.

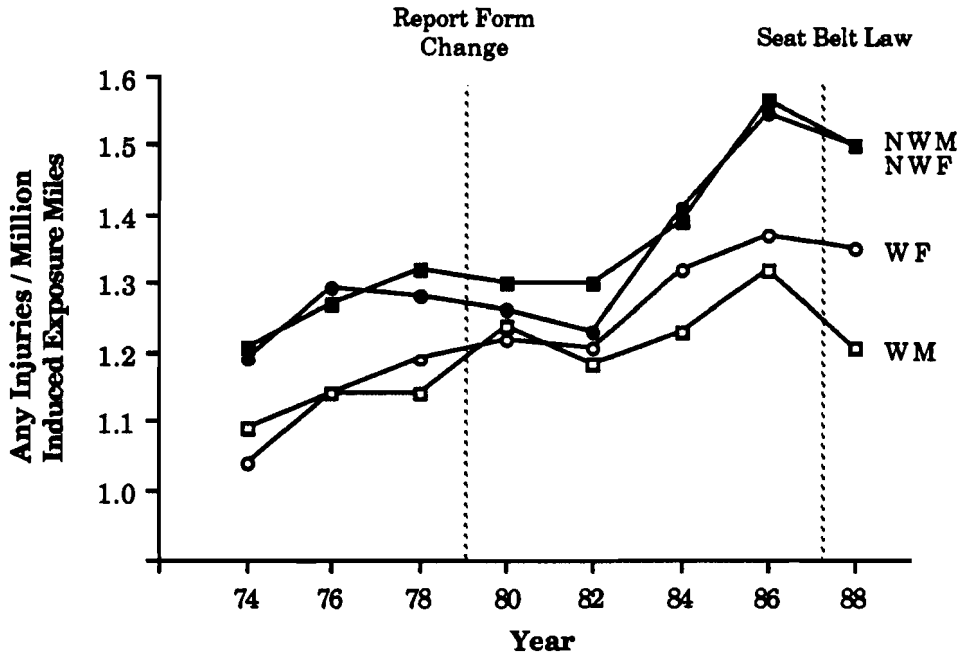

Figure 5.12. Any injuries per million induced induced exposure miles by driver race/sex, 1974-1988.

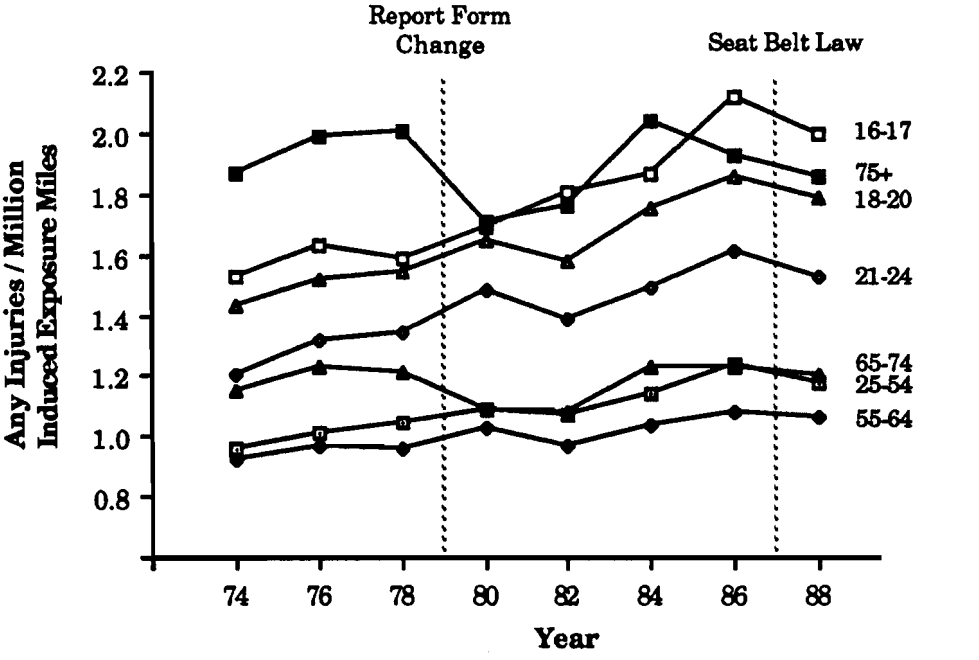

Figure 5.13. Any injuries per million induced induced exposure miles by driver age, 1974-1988.

belongs to 55-64 year-old drivers. All age groups, as well as all race/sex groups, show a reduction in their serious injury rate following onset of the North Carolina seat belt law, even beginning for some age groups with the 1986 crash data.

Somewhat different patterns appear for the any injury trends shown in Figures 5.12 and 5.13. Here there is evidence of an overall increasing trend that stands apart from any report form changes. The trend is especially evident from 1982-1986, and comes despite an overall *decrease* in the crash involvement rate during this time period. Again, there is no ready explanation.

A final difference is that while the overall any injury rate per million induced exposure miles has increased, the rate for drivers age 75+ and 65-74 has held fairly constant. And whereas males had had the highest serious injury rate, nonwhites (both male and female) show consistently higher any injury rates. The patterns for white males and nonwhite females are essentially reversed: nonwhite females having high any injury rates but low serious injury rates, and white males having low any injury rates but high serious injury rates. These results are similar to those seen earlier in Figures 5.2 and 5.4 showing the percentage of crashes resulting in any or serious injuries.

Summary and Conclusions

In interpreting the injury results presented in this section one must bear in mind that they are affected by changes in crash reporting procedures as well as differences with respect to "reported" versus "actual" injury. The former primarily affects comparisons over time, while the latter affects comparisons over time as well as comparisons among subpopulations at any point in time. Thus, part of the observed increase in reported "any" injuries per 100 licensed drivers or per estimated million induced exposure miles may be due, in fact, to changes in reporting tendencies by either the motorist or the investigating police officer. Due to possible legal ramifications, for example, motorists (or police officers) may have become more likely over the 15-year study period to report a "C" rather than an "O" injury. There could also be some differential reporting of injuries for certain segments of the population; for example, females may be more likely to report (or admit) an injury than males, or investigating officers may be more likely to perceive an older person as injured. To the extent that alcohol is involved in a crash, and to the extent alcohol is used differentially by the various age/sex/race

subpopulations, this can also cause some systematic bias in the detection and reporting of injuries.

With these caveats in mind, key findings presented in this section are summarized below:

(1) A decrease in injuries associated with the onset of enforcement of the North Carolina Seat Belt Law. The decrease holds across all age levels and all race/sex groups, and is particularly strong in regards to serious (A+K) level injuries.

(2) An overall trend of increased injuries per 100 licensed drivers that generally parallels the trend of increased crashes per 100 licensed drivers reported in Section III. Young drivers, males, and nonwhites continue to show the highest "any" and "serious" injury rates on a licensed driver basis.

(3) With regard to injuries per million induced exposure miles, a less clear pattern over time, particularly for serious injuries. Again, however, clear differences among the various age/sex/race subpopulations, with highest injury rates among males, nonwhites, young drivers and, in addition, drivers age 75+. Generally, females have higher "any" injury rates, while males have higher "serious" injury rates. Injury rates for drivers aged 55-74 are not significantly higher than for 25-54 year-olds.

VI. Driver Culpability in Crashes

Trends with respect to driver culpability in crashes were examined in two ways: first, by looking at the proportion of two-vehicle crashes in which drivers in each age/sex/race subpopulation were found to be at fault, and second, by examining the proportion of (all) crashes in which the driver was cited for alcohol impairment. The results of these analyses are presented below.

Driver Culpability in Two-Vehicle Crashes

For the first analysis, the data base was restricted to all crashes involving two vehicles where one of the drivers was cited for a violation which would deem them "at fault" in the crash. If either both drivers were cited or neither was cited, the crash was excluded from the analysis file. (This represents essentially the same data base as that used for determining the induced exposure distribution, based on "not-at-fault" drivers in two-vehicle crashes.)

The results of the analysis are documented in Appendix **Table A.24** and summarized graphically in **Figures 6.1** and **6.2**. They show nonwhite males to be slightly overrepresented in at-fault crashes, and nonwhite females slightly underrepresented. For both nonwhite males and females, the trend line has decreased over the study period. In compensation, there has been a very slight increase in crash culpability of white males and females (see actual numbers in Appendix **Table A.25**). All of these changes are quite small, varying only a few percentage points from the mid line 50th percentile.

Much greater differences are found when one examines culpability trends with respect to driver age. Here, the oldest and youngest age drivers are more likely to be the culpable party in a two-vehicle crash. Drivers age 75 and older have the highest "culpability" rate -- in three out of four crashes, they were judged to be at fault. This rate has varied little over the 15-year study period. Younger drivers aged 16-17 and 18-20 are also more likely to be at fault, their rate increasing slightly over the course of the study. Only drivers aged 55-64 and 65-74 show clear decreases in the percentage of crashes in which they have been judged at fault, a decrease of nearly 10 percent over the duration of the study. Finally, as expected, lowest crash culpability rates are posted by middle-aged drivers aged 25-54.

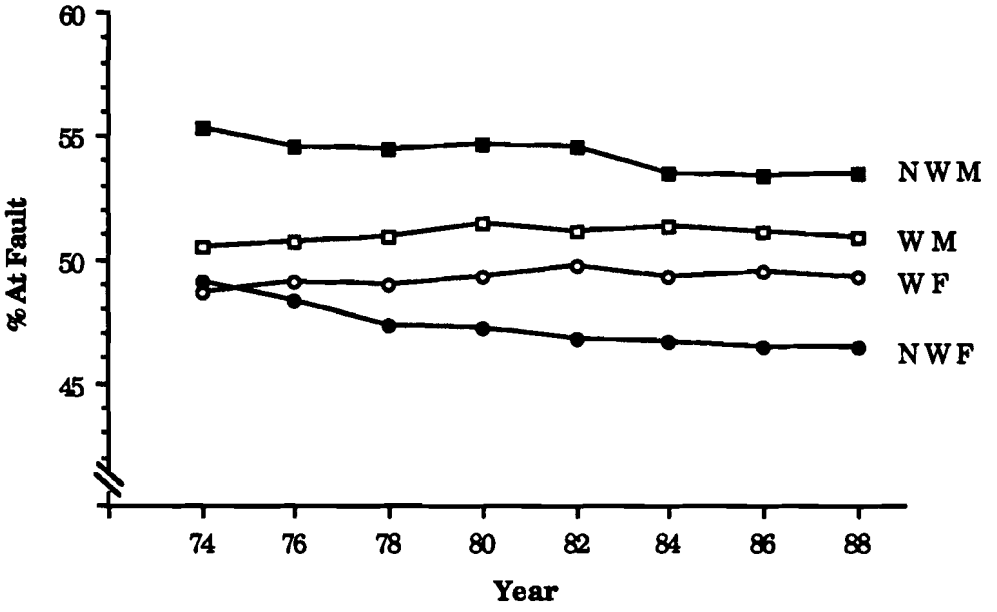

Figure 6.1. Percentage of crashes in which the driver is judged to be at fault, by driver race and sex, 1974-1988.

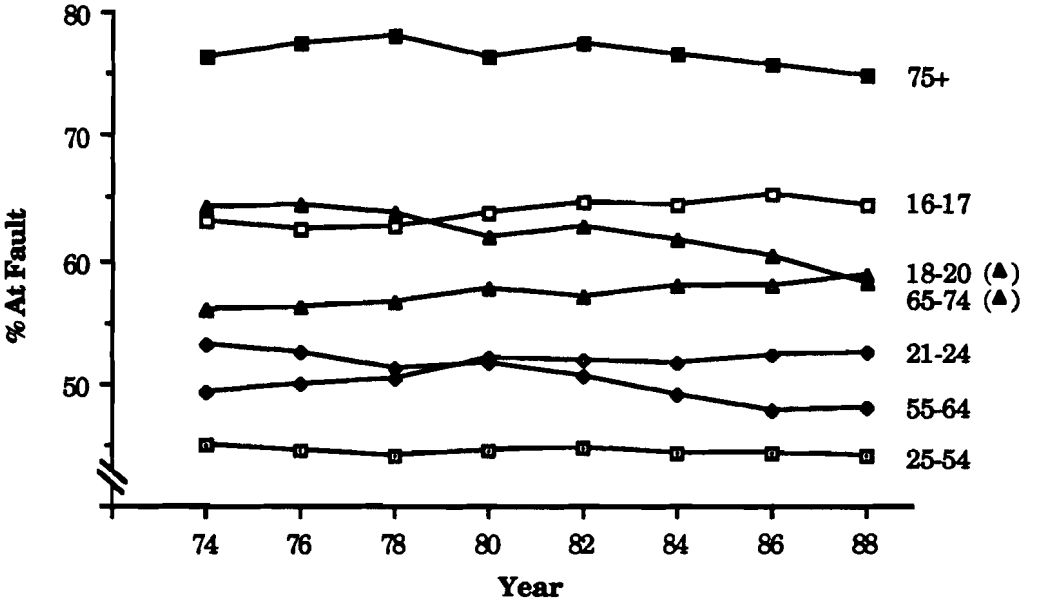

Figure 6.2. Percentage of crashes in which the driver is judged to be at fault, by driver age, 1974-1988.

Driver Alcohol Involvement

For examining trends with respect to alcohol involvement in crashes, the complete data base was utilized, included single as well as multi-vehicle crashes. The determination of alcohol impairment was based on the judgment of the investigating officer at the time of the accident. Specifically, the officer is asked to note whether the driver was

(1) not impaired

(2) drinking, impaired

(3) drinking, impairment unknown.

For the purposes of this study, the categories of "drinking, impaired" and "drinking, impairment unknown" were taken to indicate alcohol involvement on the part of the driver. Independent examination of the North Carolina motor vehicle crash data has shown that crashes involving drivers classified in either of these two categories are similar with respect to many crash-related variables and differ significantly from crashes in which the driver is cited as "not impaired." Furthermore, over 90 percent of these drivers were found to have blood alcohol levels (BAC's) of .05 or greater (Waller, Hansen, Stewart, et al., 1985).

Figures 6.3 and **6.4** are based on the data contained in Appendix **Tables A.26** and **A.27**. The figures show clear race, sex and age effects, and for all sub-populations, a reduction in alcohol-related crashes following implementation of the 1983 Safe Roads legislation. The reduction appears in the 1984 crash data, and again with the 1988 crash data. With the 1983 legislation, the minimum age for the legal purchase of alcoholic beverages was increased from age 18 to age 19. In 1987, this age limit was increased to age 21, contributing to a further drop in alcohol-impaired driving.

Overall, males, nonwhites, and drivers in the 21-24 and 18-20 year age groups show the highest rates of crashes involving alcohol. All of these groups showed significant declines following enactment of the Safe Roads Act. However, there are differences in the *amount* of decline across the various subpopulations. From 1982 to 1988, the overall decline in percentage of alcohol-involved drivers in crashes was 47 percent, dropping from 9.7 to 5.1 percent. Declines for each of the four race/sex groups were:

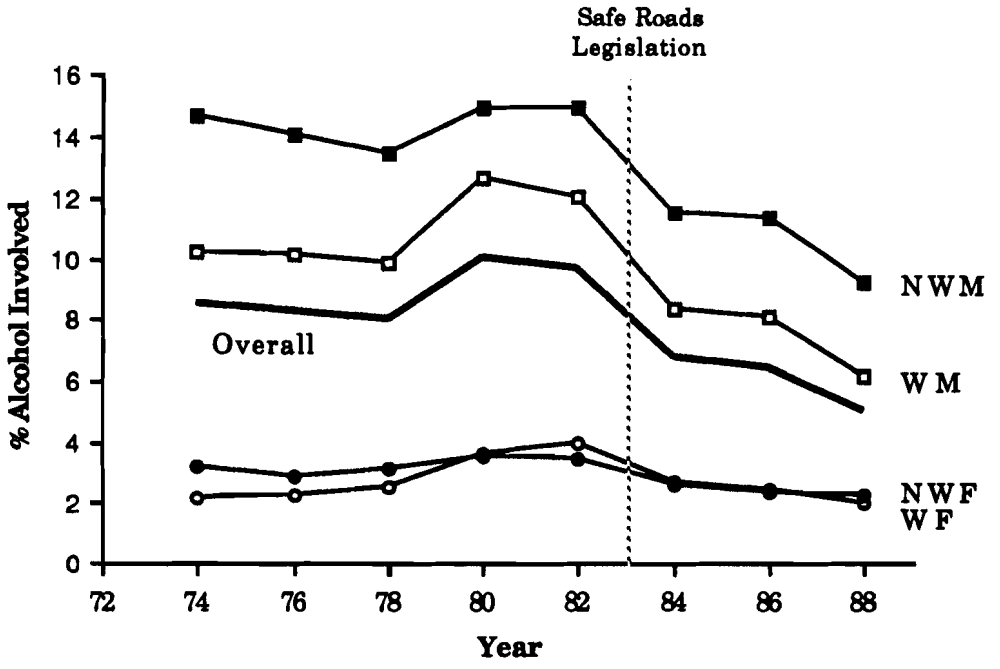

Figure 6.3. Percent of crashes where driver was cited for alcohol impairment, by driver race and sex, 1974-1988.

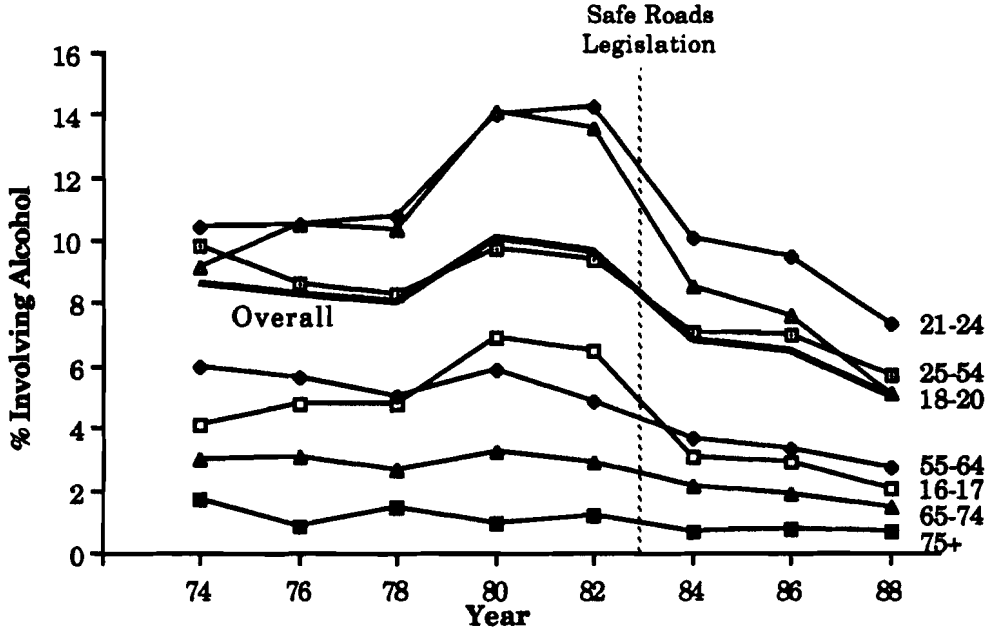

Figure 6.4. Percent of crashes where driver was cited for alcohol impairment, by driver age, 1974-1988.

White males	48.4%
Nonwhite males	37.8%
White females	50.5%
Nonwhite females	30.9%

Thus, the Safe Roads Act has had greater impact on white rather than nonwhite drivers.

Results with respect to driver age show the following:

16-17	68.1%
18-20	62.0%
21-24	48.4%
25-54	38.8%
55-64	44.6%
65-74	44.6%
75+	42.4%

Here, the greater effect for the two under-21 year age groups can be expected, given the increase in the minimum age for purchasing alcoholic beverages. Other than for these younger drivers, the effect of the legislation has been fairly uniform. However, it is of interest to note that the typical "middle-aged" driver (age 25-54) shows the least decline over the seven-year period.

Returning to Figures 6.3 and 6.4, it can be seen that females, both white and nonwhite, are much less likely to be cited for alcohol involvement that males. At the same time, with the overall decline in drinking and driving brought about by the Safe Roads Act, there is less of a distinction between males and females in 1988 than there was in 1974 at the beginning of the study period. In 1974, males were 4 1/2 to 5 times more likely to be cited for alcohol; in 1988, the factor was closer to 3 to 3 1/2 times.

Examining trends with respect to driver age, alcohol is cited for relatively few drivers age 65-74, and for only about one percent of drivers age 75+. Also, whereas alcohol was being cited increasingly often for drivers age 16-17 in crashes prior to the Safe Roads legislation, only about two percent of beginning drivers were cited for alcohol impairment in crashes occurring in 1988.

Summary and Discussion

This brief examination of trends with respect to driver culpability in crashes shows some clear distinctions across the various subpopulations of

interest as well as trends over time. With regard to the percentage of two-vehicle crashes where the driver was judged at fault based on violations cited by the investigating officer, the youngest and very oldest drivers show the most elevated "at fault" risks. Trends over time have been minimal, with the exception of a 10 percent decline by drivers aged 55-64 and 65-74. With regard to crashes of all types where the investigating officer noted that the driver was/was not impaired by alcohol, there are some very definite trends associated with the Safe Roads legislation, particularly for males and for drivers under age 21. Overall, the reduction in drivers cited for impairment has been 47.6% since 1982, with the greatest reductions among whites.

Clearly there are many other ways in which trends in driver culpability could be examined. For example, one could look at specific violation patterns more closely, or examine specific crash types such as single vehicle crashes. The approach followed here was a more global approach that fit within the overall framework set forth for this trends analysis.

Section VII. Children as Passengers in Crash-Involved Vehicles

This section will briefly examine two areas with respect to the involvement of children in motor vehicle crashes. One of these relates to children's exposure in crashes, i.e., are children more or less likely to be involved in crashes today than they were 15 years ago? The other area is that of children's safety in crashes, i.e., once involved in a crash, are children more or less likely to be injured today than in the past? This second question will be examined in light of North Carolina child restraint legislation enacted in 1982 and 1985. For these analyses children in crashes are defined to be passengers under 16 years of age in reported North Carolina motor vehicle crashes.

Children's Exposure in Crashes

Over the 15-year period of this study, the number of children involved in crashes in North Carolina nearly doubled -- from 23,814 in 1974 to 46,142 in 1988. This growth has roughly paralleled that for passengers of all ages in North Carolina crashes (76,040 in 1974, and 144,142 in 1988). Throughout the study period, children under the age of 16 have consistently comprised just under a third of the passengers in motor vehicle crashes.

The question arises as to whether this growth as passengers is reflective of growth in the overall population during the time period under investigation. Looking at North Carolina census data, one finds that children under the age of 15 comprised a larger percentage of the total population in 1974 than they did in 1988. In 1974, 25.9 percent of the North Carolina population was estimated to be under age 15, compared to only 20.2 percent in 1988. **Figure 7.1** compares these two trends. (The exclusion of 15-year-olds was necessary because the population data were only available in five-year age increments, 0-4, 5-9, and 10-14.) The linearity of the census population trend results from procedures followed for estimating yearly counts from the full census data collected only every ten years. Regardless, the two plots clearly diverge.

Based on these results, one would expect that children's representation as passengers will have increased relative to their representation in the overall population distribution. **Figure 7.2** shows these comparisons. The crash involvement ratio plotted is the proportion representation of children in the motor

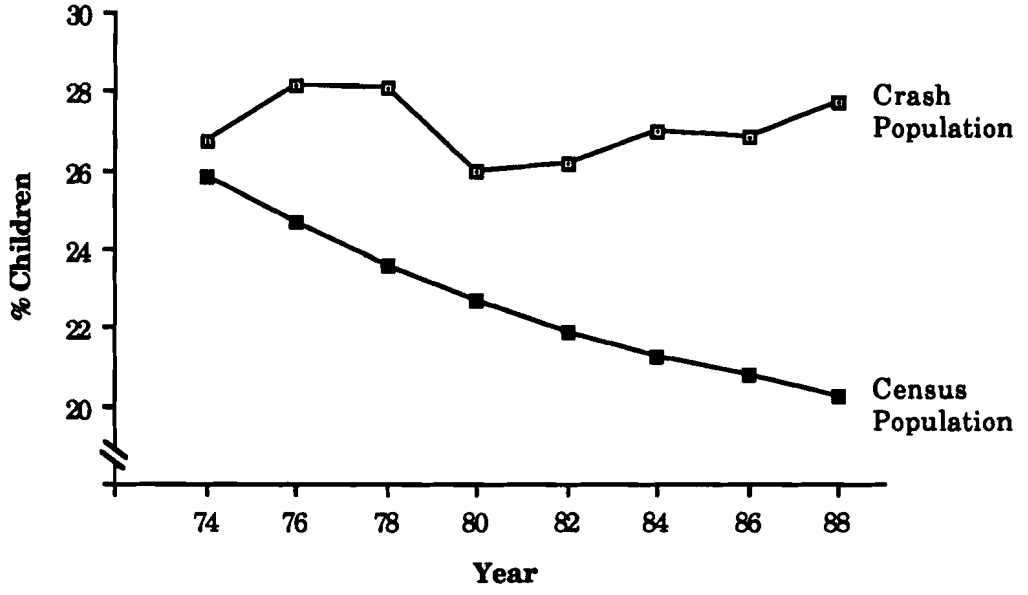

Figure 7.1. Percentage of children under age 15 in North Carolina motor vehicle crash and census populations, 1974-1988.

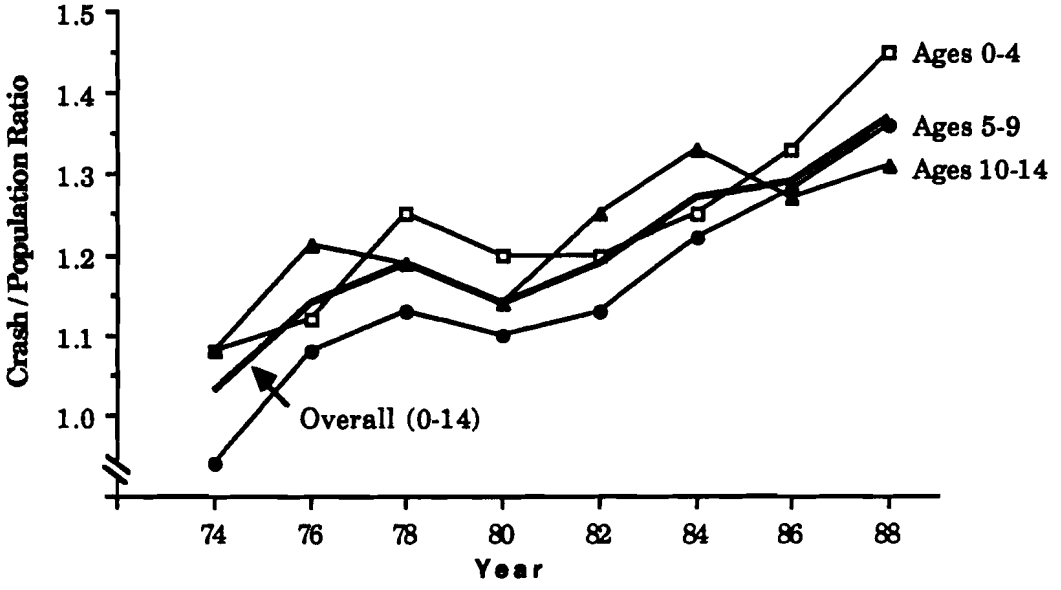

Figure 7.2. Ratio of percent representation as passengers in the N.C. crash population to percent representation in the N.C. census population for children ages 0-14.

vehicle crash population to the proportion representation in the census population. For example, building on the numbers cited above, in 1974 children ages 0-14 represented 26.7 percent of all passengers in crashes, and 25.9 percent of the total population, for a passenger/population ratio of just over 1.0, i.e., about equal representation in both populations. In 1988, however, children ages 0-14 comprised 27.7 percent of all passengers and only 20.2 percent of the census population, for an "overinvolvement" ratio of 1.4. Figure 7.2 shows that these trends hold for all age groups examined, with the youngest passengers (under age 5) showing the greatest overrepresentation in the most recent years of data.

One comment is in order. This discussion has centered on the relative involvement of children as passengers in motor vehicle crashes. If instead, we had examined their relative involvement as occupants of motor vehicles in crashes, the ratios would have been reduced since the denominators for crash involvement would now include drivers as well as passengers. Nevertheless, the same upward trend should hold. Our decision to focus primarily on children as passengers rather than occupants was based upon a limitation in our study data base. Specifically, prior to the 1979 revision in the accident report form, information on age of passengers was computerized as part of a supplemental data processing effort. In 1978, due to a backlog of data entry, only about half of the supplemental forms were computerized. Thus, for this year our data base would have had a reduced proportion of passengers compared to drivers (or children compared to all occupants). Since the supplemental forms were randomly coded, the age distribution of passengers only should not have been affected; thus, this was our denominator of choice for the Figure 7.2 comparison.

Injury Trends for Children in Crashes

In light of this apparent increase in crash involvement, what has been the injury experience of children once in a crash? **Table 7.1** and **Figures 7.3** and **7.4** summarize results pertinent to this question. Figure 7.3 shows an overall increase in the percentage of children seriously injured in crashes beginning with the accident report form revision in 1979 (due, at least in part, to a change in the definition of a serious (A-level) injury), and continuing through 1984. In 1985, however, two events impacted on these trends. One was the North Carolina Seat Belt Law which went into effect October 1985, with active enforcement beginning

Table 7.1. Percentage of children seriously injured (K+A) or injured (K+A+B+C) as passengers in motor vehicle crashesby age group.

Age	1974	1976	1978	1980	1982	1984	1986	1988
	% Serious (K+A) Injury (K+A)							
<2	0.97	1.86	1.81	1.65	1.62	1.47	1.09	0.94
2	1.53	0.94	0.79	1.49	1.90	1.64	1.52	1.38
3-5	1.54	1.32	1.17	1.82	1.84	1.77	1.53	1.50
6-10	1.83	1.55	1.60	1.81	1.95	2.24	2.14	1.84
11-15	2.71	2.69	2.19	2.72	2.70	3.01	3.04	2.71
Overall	**2.07**	**1.95**	**1.73**	**2.13**	**2.20**	**2.37**	**2.26**	**1.98**
	Any Injury (K+A+B+C)							
<2	16.90	16.01	19.98	16.34	14.29	13.84	12.08	11.28
2	17.65	16.85	17.43	15.92	15.80	15.47	13.87	14.34
3-5	17.50	17.59	19.22	16.33	17.01	17.75	16.08	16.61
6-10	18.79	18.59	19.93	17.81	18.97	20.83	20.55	20.61
11-15	19.35	19.74	20.53	19.48	19.94	22.57	23.10	22.79
Overall	**18.57**	**18.63**	**19.89**	**17.94**	**18.43**	**20.15**	**19.59**	**19.35**
Total (N)	**23,814**	**30,457**	**20,096***	**37,642**	**37,731**	**39,000**	**43,130**	**46,142**

* This number lower than actual, since supplemental data (which includes information on passenger age) was not captured for all crashes. Cases with missing information on any of the key study variables were excluded from the final analysis file.

Shaded area corresponds to children covered by N.C. Child Restraint Legislation.

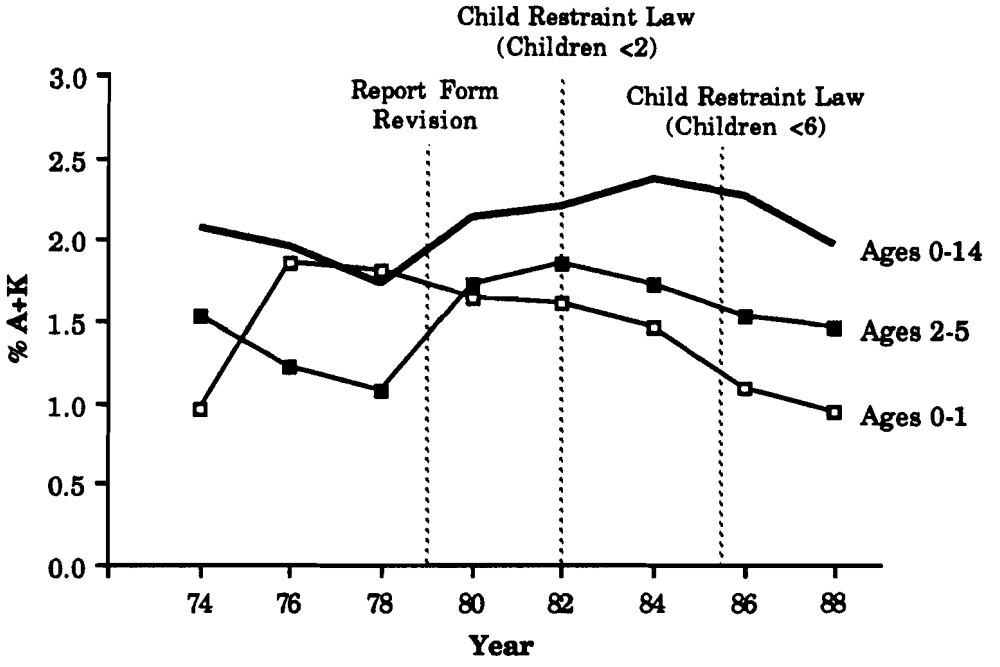

Figure 7.3. Percentage of children with serious (A+K) injury as passengers in motor vehicle crashes, by age of child.

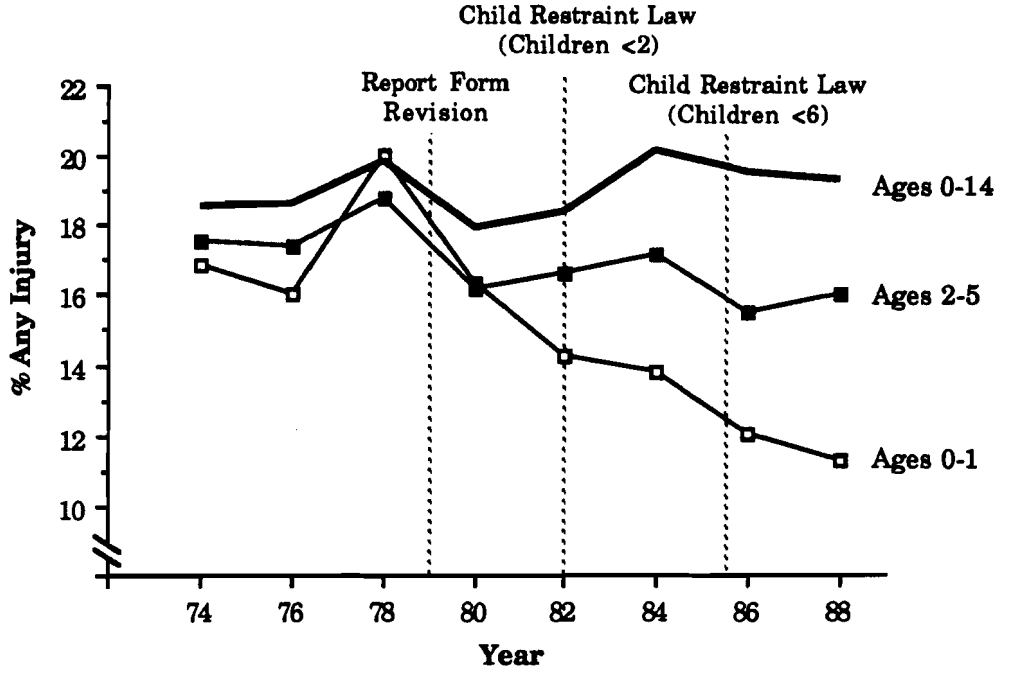

Figure 7.4. Percentage of children with any (K+A+B+C) injury as passengers in motor vehicle crashes, by age of child.

January 1987.

Perhaps more importantly, however, is the child restraint legislation enacted during this period. Effective July 1, 1982, all children under the age of two in North Carolina were required to be restrained while riding with a parent in a family purpose vehicle. For children less than a year old, this restraint had to be an approved safety seat; for one-year-olds, the available seat belt was allowed. The "warning period" for this initial child restraint legislation extended two years until July 1, 1984, after which $10.00 citations were levied. In 1985, additional legislation was passed to strengthen the law, requiring that all children up to age six be restrained, with those under age three in an approved safety seat/booster seat. The law was also expanded to cover all drivers rather than just parents, and all vehicles equipped with safety belts. The fine for non-compliance was set not to exceed $25.00.

Figure 7.3, along with the percentage figures in Table 7.1, shows a reduction in serious level injuries both to children under age two and to those ages 2-5 corresponding with the onset of the initial child restraint legislation. The decrease for 2-5 year-olds occurred despite the fact that they were not directly covered by the law, and in contrast to a continued increase in the percent seriously injured for older children and for all age groups combined. Injury trends for children under two and for 2-5 year-olds continued to decline in 1986 and 1988, following the 1985 child restraint legislation as well as the adult seat belt law (the latter covering all front seat passengers age six and above occupying a front seating position).

Similar trends are seen with respect to any (K+A+B+C) injury (Figure 7.4), although here the downward decline for children under age two has begun prior to 1982 and children ages 2-5 do not show any downward trend until after the 1985 legislation. The overall trend for children under age 16 is again one of an increase up through 1984 and only a slight decline thereafter.

Two effects may be present in these data. One of these is a "spillover" effect, by which children not directly covered by the child restraint legislation nevertheless experience some of the benefits in terms of injury reduction. This is suggested by the decrease in serious injuries among children ages 2-5 in 1984, even though only children under age two were targeted in the 1982 child restraint legislation. Support for this "spillover" effect comes from the observation that belt

use for children ages two and three in crashes, while remaining lower than that for children aged 0-1, increased at about the same rate over the period between the two child restraint laws (Hall, 1989).

There is also likely a "cohort" effect operating in these data. For example, a one-year-old infant in 1982 would be required, by law, to ride restrained. By 1984, this one-year-old would have become a three-year-old, and although he would, at this point be exempt from any restraint legislation, it is likely that he would continue to ride restrained, thus reducing his likelihood of injury in a crash.

Regardless of precisely which legislation is responsible, the net effect of North Carolina's child restraint legislation and seat belt law for front seat occupants is a reduction in serious injuries to children in crashes. The reduction in any injuries, however, extends only to children covered by the child restraint legislation, and not to children ages six and above.

Summary and Discussion

Based on this examination of North Carolina crash data, it appears that children are more likely to be involved in crashes today than they were 15 years ago. However, once in a crash, they are less likely to be seriously injured. Additional information is needed to suggest why children may be more likely involved in crashes. For example, children may be accumulating greater overall exposure in terms of mileage, or they may be making a greater proportion of their trips at more "risky" times during the day (e.g., at nighttime or during peak traffic hours). Examination of these possibilities requires more detailed exposure data than was available to this project. Extending the induced exposure technique to estimate relative mileages for passengers as well as drivers of crash-involved vehicles was one approach explored. However, we felt it too tenuous to provide meaningful results. Data from the National Personal Transportation Surveys could provide useful input here, but reported information on estimated miles travelled is limited to children ages five and above.

Regarding the injury trends, it will be interesting to follow whether the cohort effect continues as children under age six and covered by the 1985 child restraint legislation graduate into the older age group. Presently in North Carolina passengers age six and older riding in the back seat of a car are not required to wear seat belts. These passengers are mostly children, and they

constitute a major "hole" in efforts to reduce injury to all motor vehicle occupants. Whether or not the injury experience of this group of older children will improve in the future depends to a large extent on whether they reap any side benefits from North Carolina's existing child restraint and adult seat belt laws.

Section VIII. Trends in Age of Crash-Involved Vehicles, Crash Severity, Belt Use, and Related Injury

The final section of this compendium of North Carolina motor vehicle crash trends briefly addresses a number of topics related to crash occurrence and/or injury. These include the age of the car in the crash, the severity of the crash, and use of seat belts. Trends with respect to each of these are highlighted below.

Age of Cars in Crashes

Figure 8.1 shows the age of passenger cars involved in North Carolina crashes during the 15-year period from 1974-1988. The lower line shows the percent of crash-involved passenger cars that were current model cars during the crash year indicated. For example, the graph indicates that in 1974 about seven-and-a-half percent of passenger cars in crashes that year were 1974 model vehicles. This trend of current model cars in crashes holds relatively constant over the period involved except for a drop in 1982 that corresponds to the national economic recession.

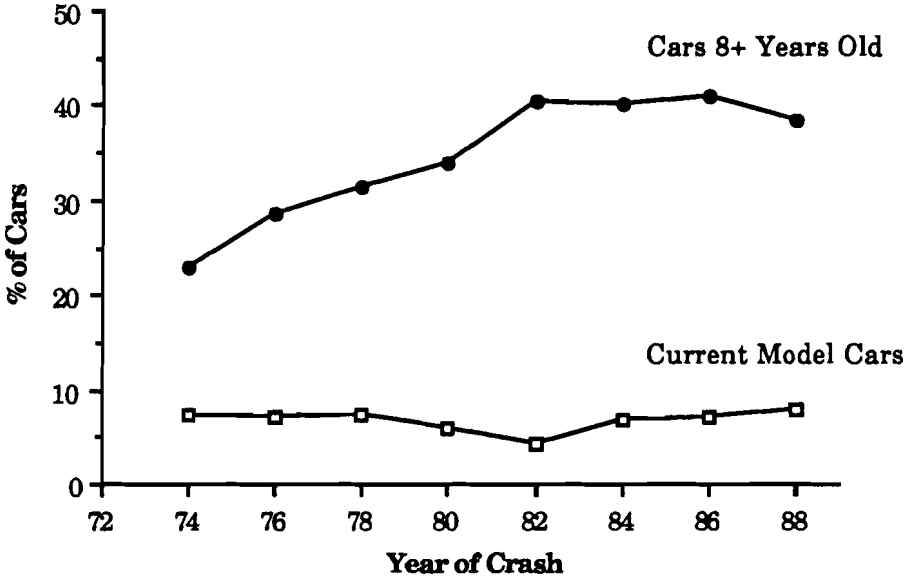

Figure 8.1. Age of crash-involved cars by year of crash.

At the other end of the car age distribution, the upper plot on Figure 8.1 portrays the percent of cars in crashes that were eight or more years old at the time of the crash. Thus, for 1984, this would include all 1967 and earlier model vehicles. Here one can see a more profound change during the 15-year period. General knowledge attests that increases in the pricing of cars is such that many people now retain cars for a longer time than was true 25 years ago. In fact, in 1974 less than 25 percent of the cars in crashes in North Carolina were eight or more years old. By 1982, this figure had reached about 40 percent and held relatively constant, dropping to about 37 percent for 1988, the most recent crash year for which data are available.

One significance of this longer service life is a distinct slowing of the rate at which crash safety features, introduced with new car models, are infused into the vehicle population. Indeed, just at the time when automatic restraints are being introduced, it is seen that the proportion of cars which are eight or more years old is sharply higher than was true a few years ago. This means there will be further delays in achieving fleet-wide presence of automatic seat belts and air bags.

As is expected on the basis of Figure 8.1, the median age of cars in crashes has risen rather steadily over the period involved (see **Figure 8.2**). However, the trend has perhaps changed again in 1988, though further data are required to be certain.

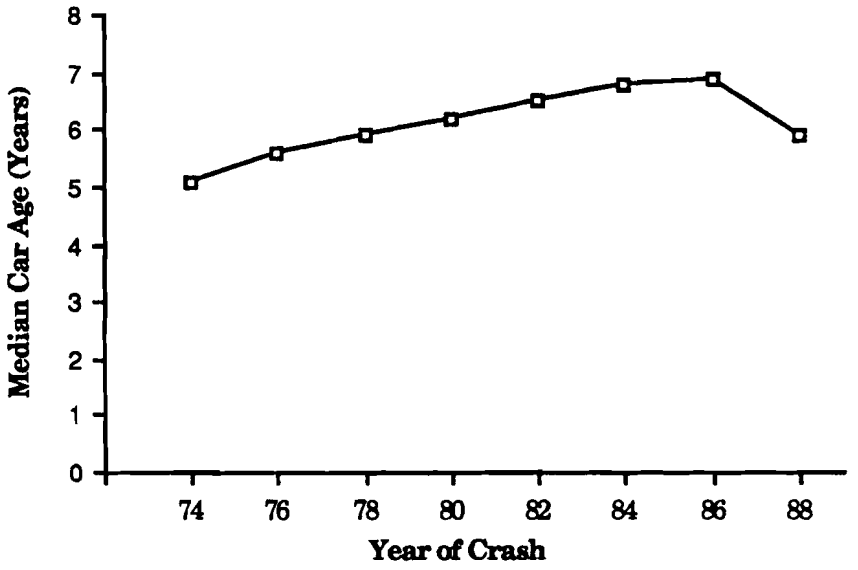

Figure 8.2. Median age of cars in crashes.

Figure 8.3 is a three-dimensional plot showing the percent distribution of the year of the crash and the age of the vehicle. Along the right-hand axis is vehicle age, along the left-hand diagonal is the year of the crash, and along the vertical axis is the percent of cars that fall into each cell. The data are distributed into a non-uniform curvilinear surface. At the left the surface is the lowest, indicating a modest percent of new cars in service, and at the right the surface flares sharply upward indicating that there is a substantial number of cars that are eight or more years old.

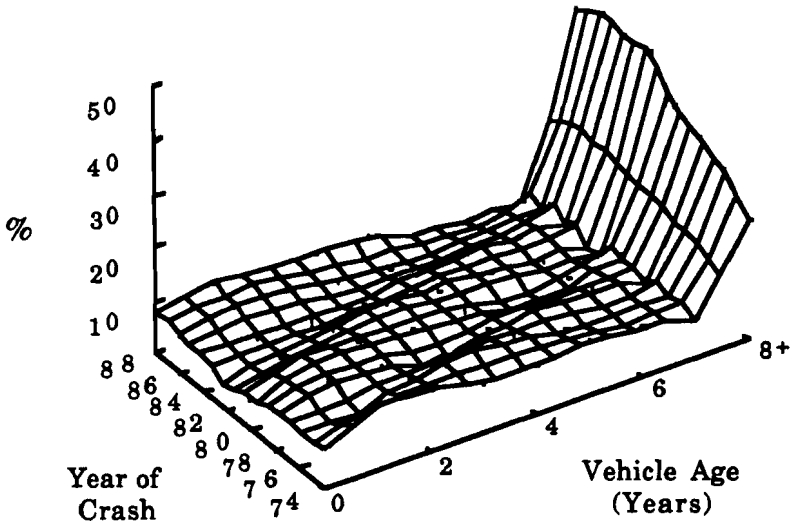

Figure 8.3. Percent distribution of year of crash and vehicle age

If one examines the extreme right of the chart where the surface ends, one can see that, over time, there has been an increase in the number of cars that are eight years old or older. This trends moves from the front to the back side of the surface.

If one looks at this plot as if one were looking down on the earth's surface, one can see two rather distinct "ridge lines" that extend diagonally across the graph. The "back side" of these ridge lines define points at which there was a reduced percentage of cars in crashes in that year. An interesting point is that these ridges have their origins at the time of the two recessions during the study

period. One is the recession of 1973 and 1974 which was accompanied by the gasoline shortage, and the other is the 1981 and 1982 recession mentioned above. New car sales were lower in those years and this deficit continued to be manifested as the cars in question aged.

Crash Severity Trends

North Carolina was the first state to introduce a statewide practice of having officers rate the degree and location of vehicle deformation of crashed cars, using a standard scale of deformation severity. This scale was introduced because it is usually conceded that officers' estimates of impact speed are rather crude. It was believed that vehicle deformation would be a more useful indicator of crash severity, and was a measure that officers could make with a reasonable degree of reliability. Subsequent research has shown that with this standard pictorial scale officers can make deformation ratings with appropriate inter-rater reliability. Also, it has been shown that the vehicle deformation scale accounts for more injury variance than do estimates of speed (Rouse and Gendre, 1969; Vilardo, 1972).

There were, however, logistical problems in introducing the vehicle deformation (TAD) scale on a statewide basis. During the first year, a little more than 50 percent of passenger car vehicles in the crash file did not have a TAD rating accompanying the vehicle record (see **Figure 8.4**). In 1976 and 1978 the reporting of TAD ratings had improved such that slightly fewer than 30 percent of the scores were missing. By 1980 and subsequent years, reporting of the TAD rating was such that about 12 to 15 percent of the cars lacked a rating. By now, reporting of deformation ratings is reasonably satisfactory on a statewide basis, and the availability of deformation ratings is a useful adjunct to various analyses

Figure 8.5 is a three-dimensional plot which characterizes the distribution of deformation rating scores during the period from 1974 crashes to 1988 crashes. The TAD deformation scale is made from a seven point pictorial guide in which the least damaged cars are assigned a rating of "one" and the most damaged cars are assigned a damage of "seven." Not surprisingly, the frequency of more extreme levels of deformation is lower, following the common-sense experience that the more severe the crash, the less frequent its occurrence.

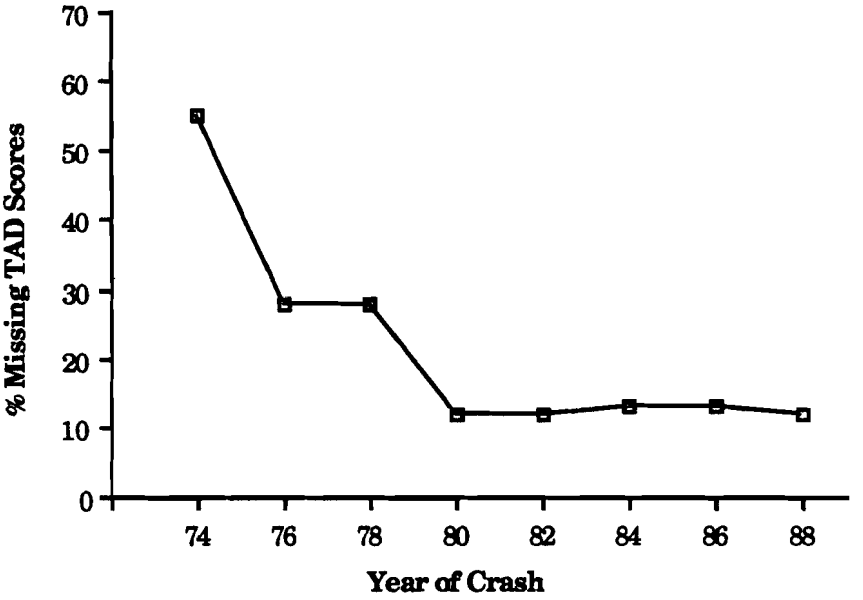

Figure 8.4. Percentage of cars in North Carolina crashes with missing vehicle deformation (TAD) ratings.

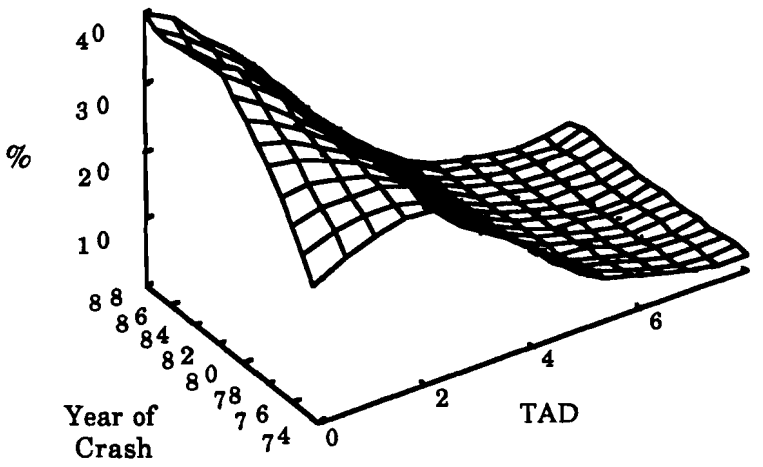

Figure 8.5. TAD distribution from 1974 to 1988.

Note first the edge of the surface "nearest" the reader. One can see that, in 1974, the shape of the TAD scale was such that rating levels "1" occurred somewhat less frequently than rating levels "2" or "3." For vehicle ratings with a higher value there was a curvilinear decline. However, by 1988 the nature of the statewide TAD rating statewide had shifted such that category "1" ratings were the most frequent with a steady decline thereafter.

It is interesting to speculate why there might have been changes during the 15-year period such that the distribution of vehicle deformation would appear to be somewhat less severe than in the earlier years, i.e., category 1 values have increased at the expense of category 2 and 3 values. One possible explanation is that cars today may exhibit less deformation in very mild crashes than was true in earlier years, by virtue of the introduction of so-called crash resistant bumpers. If that is so, then a given (mild) impact on the front end of the car would produce less deformation on today's cars than would have been true 15 years ago. This may account for the change.

Another possibility is the steady increase in urbanization in North Carolina. Every year somewhat fewer crashes occur in rural areas, and because of the prevailing speeds in rural vs urban areas, the crash severity of urban accidents (and resulting vehicle deformation) is, generally, less than those in rural areas.

Seat Belt Use Trends

The North Carolina crash report form provides for reporting seat belt use status of motorists involved in crashes. As can be seen in **Figure 8.6**, during the period from 1974 to 1984, belt use was reported by officers at a level of less than 15 percent. In October of 1985, North Carolina's seat belt law took effect. During the initial phase of the law (October 1, 1985 - December 31, 1986) motorists were only given warnings for non-compliance; beginning January 1, 1986, violators were issued $25 citations. The 1986 and 1988 crash report figures portray (albeit somewhat inaccurately) the resulting growth in seat belt use.

The figures for 1986 indicate belt use of 65 percent in crashes, and the 1988 figures reflect a 90 percent belt use. These figures are exaggerated, however. Sampling of the population at large indicated belt use during that period of time to be 70 percent or less (Reinfurt, et al., 1988). It seems clear that some crash-

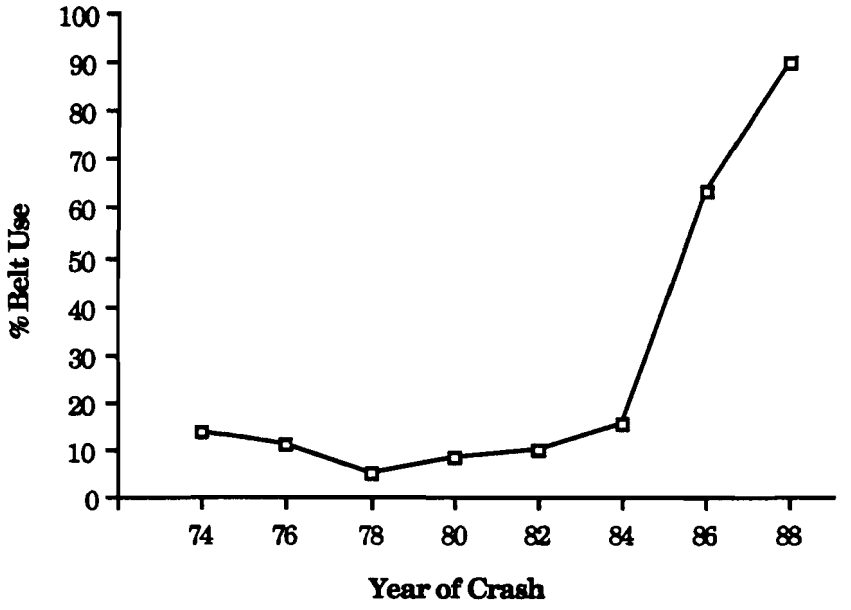

Figure 8.6. Seat belt use among motorists in crashes, 1974-1988.

involved motorists, when questioned by the officer investigating the crash, tend to say they were belted even when they were not. Motorists are perhaps loathe to admit that they were not wearing their seat belt now that the law requires such use.

For that reason, the utility of the belt use category on crash report forms has largely been lost since onset of the seat belt law, a fact that is most unfortunate, because the ability to evaluate benefits of occupant restraint systems (manual or automatic) using this variable is now compromised by this systematic reporting error. (There are, however, other ways to carry out the evaluation.) There is need for a built-in, automatic indicator by which the investigating officer can ascertain whether the restraint system was in use at the time of the crash.

Injuries Associated with Presence and Absence of Belt Use

Figure 8.7 shows three trend lines, each of which reflects the percent of occupants suffering serious or fatal injuries in crashes. The 1974 figures, for example, indicate that approximately two percent of belted drivers suffered serious or fatal injuries. About four and a half percent of unbelted drivers sustained that level of injury, averaging to about four percent overall. In 1974, the

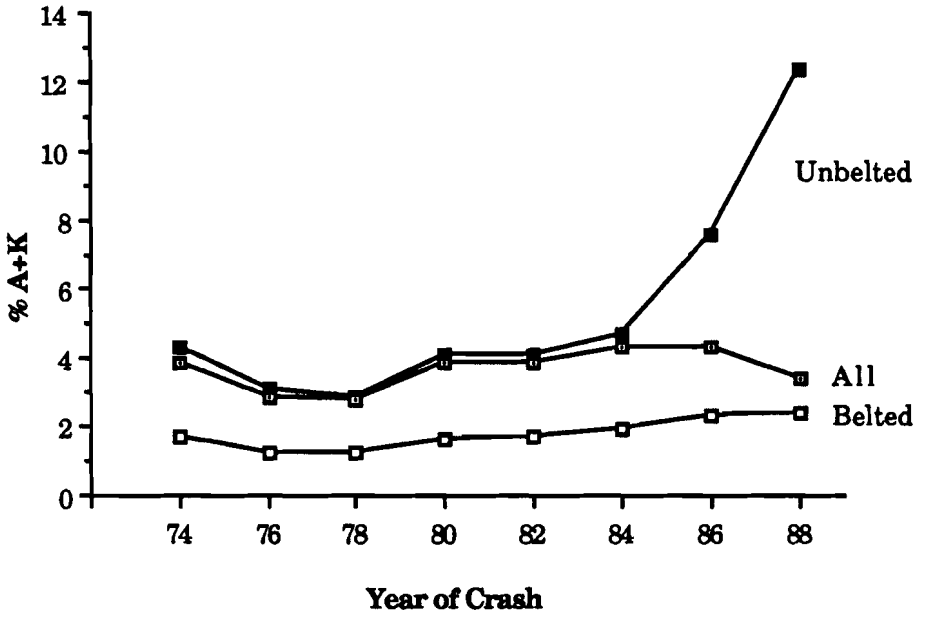

Figure 8.7. Percentage of drivers in crashes seriously (A+K) injured by belt use, 1974-1988.

great majority of people were unbelted, thus the unbelted experience was almost identical to the overall category.

By 1986, however, a rather dramatic shift had occurred. If one compares the 1986 and 1988 overall injury figures, one can see that as the seat belt law took effect in North Carolina, there was a decline in overall injury: in 1986 there was about four percent serious injury overall, and in 1988 the injury had dropped to a little over three percent.

As the proportion of belt users grew dramatically, it is also true that the residual, diminished category of unbelted drivers become more and more deviant in terms of their injury. It is known from other research that those who most resist wearing belts tend to have worse driving records (Hunter, et al., 1988) and are also involved in more severe crashes (Campbell, 1987.) It is therefore perhaps not surprising that the smaller group of "hard core" non-wearers would have crash experience such as to be injured more severely than average. Indeed, 1988 figures indicate that the smaller number of people who are reported as unbelted suffer a relatively high frequency of serious and fatal injuries, compared to those reported as belted. (This could also, to an unknown degree, represent an officer

reporting bias, in that when confronted with a serious injury officers may tend to assume that the occupant was unbelted. Or it could result from the more seriously injured occupants being less able or likely to (erroneously) report that they were wearing their seat belt in the crash.)

One of the numerical anomalies that may be noticed is that the injury for both belted and unbelted drivers went up from 1986 to 1988, but the overall injury (the combination of the two) went *down*. Although this seems counter-intuitive, it is really quite possible. Assume that there is a relationship such that those more likely to wear belts are involved in less severe crashes (such a relationship was demonstrated by Campbell, 1987). When there is a great increase in the number of belt users from one time period to the next (as with onset of a law), it is perhaps not surprising that crash injuries will be more severe among the residual number of people who continue steadfastly to refuse to wear belts in the second time period. That is because the smaller the residual number of non-wearers, the more "hard core" is the remainder, with all that implies for crash frequency, type and severity.

It is also perhaps not surprising that the injuries will go up even among belted occupants from one time period to the next. That is because in the pre-law period, belt wearers consisted of volunteer wearers with all that implies for factors associated with milder crashes (again, see Campbell, 1987). After the law, all of the new wearers were recruited from the previous non-wearer category. Some who are reluctant wearers presumably would retain some of the characteristics manifested when they were non-wearers. Nevertheless, there is improvement in the overall measure because the belts are, indeed, effective.

Injury Severity Related to Crash Year and Car Age

In **Figure 8.8**, there are two trend lines. One (the open boxes) is for crashes that occurred in 1974, the other (solid boxes) indicates crashes that occurred in 1988. Within each category, the plot shows cars of varying age during that crash year. For 1974 crashes, it can be seen that there is a steady climb for older and older cars, thus indicating that serious injuries are somewhat more frequent in a given crash year for occupants of older cars. For the 1974 plot, car ages plotted range from 1974 back to 1967 models.

There are several reasons this could be true. One is that the older cars have

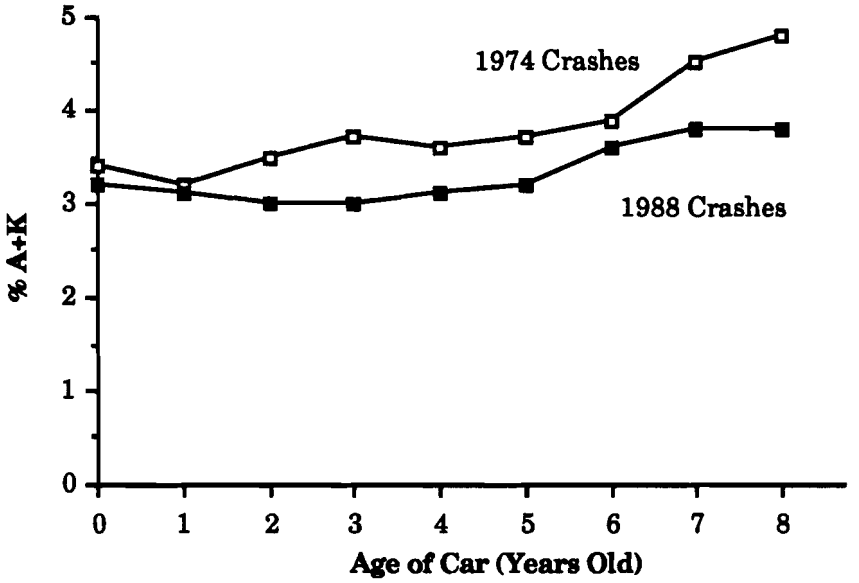

Figure 8.8. 1974 and 1988 serious (A+K) injuries by vehicle age.

fewer safety features in them. Another reason may grow out of changes in ownership. Current model cars tend to be owned by middle-aged relatively affluent persons, whereas cars six, seven or eight years old tend to be owned by younger people and also persons from lower socioeconomic status. It is therefore perhaps not surprising that, in any given calendar year, injuries would be more severe in cars that are older than those that are newer.

The second trend line is for crashes that occurred in 1988, and again there is some indication that the older cars are associated with somewhat more serious injuries. For 1988 crashes, however, the entire trend line is lower, confirming that 1988 crashes were less likely to produce severe injury than 1974 crashes presumably because they involved a newer era of cars with more safety features, and also presumably because increased urbanization is associated with a somewhat lower severity of motor vehicle crashes in North Carolina.

IX. Summary and Conclusions

This compendium of graphs, tables, and accompanying text examines North Carolina motor vehicle crash and injury trends during the period 1974-1988. A specific objective of the analysis was to examine differences with respect to specific subpopulations of interest, namely women, older persons, nonwhites, children, and youth aged 16-19. Another objective was to examine the impact of motor vehicle safety legislation introduced during this period, with a focus on North Carolina's child restraint laws, seat belt law, and legislation aimed at reducing drunk driving. Following are some highlights of the report.

- The percentage of females, and particularly nonwhite females, licensed increased markedly over the 15-year study period. Licensure rates for white males and females, however, remain higher than for nonwhite males and females.

- There was also a large increase in the percentage of older persons licensed, particularly in the 65-74 and 75+ age groups. This was viewed as a cohort effect, with younger (more likely to be licensed) drivers graduating into the older age groups over the course of the study.

- White females increased their representation in the crash population far beyond their increase in the licensed driver population. Nonwhite females also increased their representation in the crash population, but only slightly beyond their expected increase due to increased licensure.

- Still, males, and particularly nonwhite males, have the highest motor vehicle crash rates on a licensed driver basis, with white females continuing to have the lowest crash rate.

- 16-17 year-olds have by far the highest crash rate on a licensed driver basis, followed by 18-20 year-olds and 21-24 year-olds. Drivers age 55 and older have the lowest crash rates per licensed driver.

- The "Safe Roads Act" introduced in North Carolina in 1983 to curb drunk driving brought about a substantial reduction in the percentage of crashes occurring at nighttime and on weekends (crashes more often associated with alcohol) for all race/sex groups and for all but the oldest age groups (ages 65-74 and 75+).

- Use of the "induced exposure" technique to estimate relative exposure to crashes for drivers in each of the various age/race/sex subpopulations showed males to be overrepresented in crashes and females under-represented. Within age groups, drivers 75+ had the highest crash

involvement ratio, followed by drivers 16-17 and 18-20. These results carried over to estimated crashes per miles driven, with the mileage denominator derived from the induced exposure estimates. However, it was noted that the "induced exposure miles" for the younger drivers were much greater than "real" mileage estimates derived from other sources. If these lower mileage estimates were used, then crash rates for the younger age drivers would be considerably higher.

- Young drivers, males, and nonwhites show the highest injury rates on a licensed driver basis. From 1974 to 1986 reported injury rates per licensed driver increased, paralleling an increase in crashes per licensed driver. The trend turned downward in 1988, however, following enactment of the North Carolina seat belt law. This down trend was apparent for all race/sex groups and for all but age 65 and older drivers.

- When injury rates were examined based on estimated miles travelled (using the induced exposure estimates), drivers 75+ joined the younger aged drivers in the most at risk category. The oldest drivers were particularly vulnerable to serious injury.

- The section on driver culpability showed that in two-vehicle crashes where one driver could be deemed at fault, males were more likely to be cited, as were drivers age 75+ and 16-17. Over the 15-year study period, however, drivers aged 55-74 decreased their overall likelihood of being at fault by about 10 percent.

- The percentage of crashes in which the driver was noted for alcohol impairment decreased sharply with implementation of the Safe Roads Act in 1983. This decrease was particularly strong for males and young (under age 25) drivers, and was about equal for whites and nonwhites.

- Children in North Carolina benefited from child restraint legislation targeting those under age 2 in 1982 and extending to those under age six in 1985. This effect has been most noticeable in children under age two and with respect to serious injury. The injury rate for children not covered by the legislation remained consistently higher.

- With the advent of the North Carolina seat belt law in October 1985 (active enforcement beginning January 1987), the overall percentage of drivers experiencing serious injury in crashes dropped dramatically. Meanwhile, the percentage of unbelted drivers experiencing serious injury in 1986 was roughly three times that of belted drivers.

- Finally, the population of cars involved in crashes in North Carolina has aged, which was implications for how rapidly safety features introduced with newer model vehicles can be expected to impact on crash occurrence and/or outcome. Also, there is evidence of an increase in the percentage of very minor crashes, as measured by vehicle deformation, due perhaps to improved vehicle design and/or increased urbanization.

In using this document, it is important to keep in mind the nature and limitations of the data bases employed. The crash data were derived directly from North Carolina motor vehicle crash files maintained by the UNC Highway Safety Research Center. The files contain information on approximately 150,00 crashes involving about 250,00 vehicles and more than 300,000 persons each year. For purposes of this analysis, the data base was restricted to passenger motor vehicles, thereby excluding pedestrians, bicyclists, motorcyclists, large trucks and miscellaneous vehicle types. The data base was also limited to those crashes where there was no missing information on driver age, race, sex, and injury level. These restrictions mean that the numbers appearing in the tables of this report may be lower than those published elsewhere. For a more complete summary of the full range of North Carolina motor vehicle crashes, the interested reader is referred to HSRC's "Redbook" publications, which present single variable tabulations for North Carolina motor vehicle crashes over selected years (most recent: Williams and Hamilton, 1990).

Also at this point it should again be stressed that both the population and mileage data incorporated into portions of this analysis were, at best, rough estimates. All mileage estimates were derived from a single overall statewide mileage figure based on state gasoline sales, and the population estimates were based on an interpolation of available 1970 and 1980 census data. On the positive side, any biases introduced by these limitations in the data should be consistent throughout the study period as well as across the various age/race/sex subpopulations. Thus, in this analysis of *relative* changes, they should have no significant impact.

In regard to one of this project's stated goals, that of examining the impact of North Carolina motor vehicle safety legislation, it should be clearly recognized that much more comprehensive and direct evaluations exist for each of these interventions. Here, the reader is referred to the report by Reinfurt, et al. (1988) for an evaluation of North Carolina's occupant restrain law; a report by Hall (1989) for an evaluation of the state's child passenger safety laws; and reports by Lacey, et al. (1984) and Popkin (1989) for evaluations of alcohol-related legislation. The additional perspective that this document can perhaps provide is increased attention to differential effect among certain segments of the population and a longer term basis for comparison.

The primary usefulness of this document should be as a "springboard" for additional analyses and reports focusing on a specific topic area. Two such reports have already been prepared. One is a report on crash trends with respect to young female drivers (Waller and Popkin, 1988) and the other a report on older driver population and crash involvement trends (Stutts, Waller and Martell, 1989). The database remains available for future analyses, and could be expanded to include additional years of crash data. This "Trends Analysis of North Carolina Motor Vehicle Crash Data" could continue, in fact, for years to come!

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APPENDIX

Table A.1. Percentage distribution of N.C. census population age 15 and above.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
15-24	Male	White	9.99	9.82	9.60	9.40	9.00	8.67	8.19	7.90
		Nonwhite	3.46	3.52	3.56	3.57	3.41	3.29	3.34	2.96
	Female	White	9.26	9.05	8.87	8.72	8.32	7.98	7.54	7.35
		Nonwhite	3.45	3.48	3.50	3.50	3.33	3.19	3.11	2.95
	Total		26.16	25.87	25.53	25.20	24.06	23.12	22.18	21.15
	(N)		(1,059,813)	(1,090,403)	(1,120.435)	(1,145,651)	(1,129,607)	(1,121,940)	(1,111,550)	(1,094,794)
25-54	Male	White	19.42	19.32	19.26	19.23	19.43	19.61	19.65	20.15
		Nonwhite	4.61	4.71	4.79	4.84	5.07	5.26	5.73	5.43
	Female	White	20.06	19.90	19.79	19.72	19.78	19.83	19.78	5.43
		Nonwhite	5.39	5.49	5.57	5.64	5.89	6.10	6.38	20.33
	Total		49.48	42.42	49.41	49.43	50.17	50.80	51.53	52.27
	(N)		(2,004,397)	(2,082,934)	(2,168,705)	(2,247,348)	(2,356,129)	(2,465,102)	(2,582,178)	(2,705,004)
55-64	Male	White	4.50	4.52	4.53	4.56	4.53	4.50	4.39	4.36
		Nonwhite	1.06	1.04	1.03	1.01	.99	.97	.99	.88
	Female	White	5.22	5.22	5.24	5.26	5.23	5.19	5.06	5.04
		Nonwhite	1.30	1.30	1.29	1.29	1.29	1.30	1.30	1.22
	Total		12.08	12.08	12.09	12.12	12.03	11.96	11.72	11.50
	(N)		(489,326)	(509,080)	(530,725)	(550,832)	(565,011)	(580,143)	(587,421)	(595,182)

Table A.1. Percentage distribution of N.C. census population age 15 and above (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
65-74	Male	White	2.66	2.73	2.80	2.85	2.90	2.93	2.98	3.12
		Nonwhite	.68	.70	.70	.71	.71	.70	.74	.68
	Female	White	3.67	3.77	3.87	3.96	4.00	4.02	4.07	4.27
		Nonwhite	.93	.95	.98	1.00	1.00	1.00	1.03	1.01
	Total		7.94	8.15	8.35	8.52	8.60	8.66	8.83	9.08
	(N)		(321,786)	(343,559)	(366,537)	(387,344)	(403,847)	(420,215)	(442,186)	(469,991)
75+	Male	White	1.26	1.27	1.29	1.30	1.42	1.52	1.57	1.64
		Nonwhite	.31	.32	.32	.33	.35	.37	.40	.37
	Female	White	2.27	2.37	2.46	2.54	2.75	2.92	3.06	3.27
		Nonwhite	.49	.52	.55	.57	.61	.65	.70	.71
	Total		4.33	4.48	4.62	4.74	5.14	5.47	5.73	6.00
	(N)		(175,574)	(188,940)	(202,830)	(215,455)	(241,336)	(265,309)	(287,230)	(310,426)
			4,050,896	4,214,916	4,389,232	4,546,630	4,695,930	4,852,709	5,010,565	5,175,397

Table A.2. Percentage distribution of N.C. licensed drivers.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	1.90	1.87	1.82	1.68	1.43	1.38	1.40	1.26
		Nonwhite	.43	.42	.43	.41	.34	.33	.33	.28
	Female	White	1.71	1.68	1.63	1.50	1.26	1.23	1.26	1.13
		Nonwhite	.28	.29	.30	.29	.24	.25	.26	.22
	Total		4.33	4.25	4.17	3.88	3.28	3.18	3.25	2.89
	(N)		(136,750)	(144,771)	(150,060)	(146,505)	(128,089)	(128,791)	(137,749)	(125,177)
18-20	Male	White	3.55	3.39	3.22	3.10	2.87	2.60	2.40	2.39
		Nonwhite	1.12	1.08	1.00	.97	.89	.82	.76	.73
	Female	White	3.23	3.12	2.99	2.85	2.65	2.39	2.22	2.23
		Nonwhite	.77	.78	.76	.75	.68	.64	.61	.61
	Total		8.68	8.38	7.97	7.67	7.09	6.44	5.98	5.97
	(N)		(274,273)	(285,107)	(286,823)	(289,291)	(276,606)	(260,777)	(253,915)	(258,721)
21-24	Male	White	4.80	4.70	4.56	4.42	4.25	4.10	3.85	3.50
		Nonwhite	1.49	1.52	1.50	1.43	1.32	1.28	1.23	1.10
	Female	White	4.42	4.40	4.29	4.14	3.98	3.84	3.58	3.29
		Nonwhite	1.17	1.24	1.27	1.23	1.14	1.10	1.07	.99
	Total		11.88	11.87	11.61	11.21	10.69	10.31	9.73	8.89
	(N)		(375,460)	(403,851)	(417,847)	(423,016)	(417,384)	(417,184)	(412,786)	(385,363)
25-54	Male	White	25.04	24.23	23.71	23.42	23.53	23.49	23.65	23.75
		Nonwhite	4.89	5.07	5.24	5.41	5.60	5.66	5.82	5.83
	Female	White	23.18	22.90	22.81	22.76	22.91	23.09	23.23	23.62
		Nonwhite	4.06	4.47	4.85	5.15	5.41	5.65	5.87	6.10
	Total		57.17	56.66	56.60	56.74	57.46	57.89	58.58	11.29
	(N)		(1,807,274)	(1,928,120)	(2,037,078)	(2,141,378)	(2,242,588)	(2,342,519)	(2,485,557)	(2,571,580)

Table A.2. Percentage distribution of N.C. licensed drivers (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	5.31	5.31	5.26	5.26	5.32	5.26	5.09	4.97
		Nonwhite	.94	.91	.90	.88	.88	.84	.81	.79
	Female	White	4.32	4.54	4.70	4.88	5.05	5.11	5.01	4.99
		Nonwhite	.51	.56	.61	.66	.71	.75	.75	.77
	Total		11.07	11.31	11.47	11.68	11.96	11.96	11.66	11.52
	(N)		(349,967)	(384,861)	(412,883)	(440,843)	(466,771)	(484,060)	(494,748)	(499,489)
65-74	Male	White	2.90	2.99	3.09	3.18	3.29	3.38	3.49	3.60
		Nonwhite	.45	.49	.52	.53	.54	.56	.55	.55
	Female	White	1.97	2.23	2.49	2.74	2.98	3.21	3.40	3.61
		Nonwhite	.14	.18	.23	.27	.32	.37	.40	.43
	Total		5.45	5.89	6.33	6.72	7.14	7.51	7.84	8.19
	(N)		(172,256)	(200,532)	(227,759)	(253,733)	(278,548)	(303,928)	(332,634)	(355,128)
75+	Male	White	.91	.98	1.06	1.13	1.22	1.33	1.40	1.50
		Nonwhite	.10	.12	.14	.15	.17	.18	.20	.22
	Female	White	.41	.51	.64	.78	.94	1.13	1.28	1.45
		Nonwhite	.01	.02	.03	.04	.05	.07	.09	.11
	Total		1.43	1.63	1.85	2.10	2.38	2.71	2.97	3.27
	(N)		(45,166)	(55,574)	(66,693)	(79,278)	(92,895)	(109,505)	(125,952)	(141,937)
Total Licensed Drivers			3,161,146	3,402,816	3,599,143	3,774,044	3,902,881	4,046,764	4,243,341	4,337,395

Table A.3. Comparison of 1974 and 1988 North Carolina census population and licensed driver race/sex distributions.

Race / Sex	Census Population (Age 15 and above)			Licensed Drivers		
	1974	1988	% Change in Distribution	1974	1988	% Change in Distribution
White Male	1,532,850 (37.84)	1,923,649 (37.17)	**25.5 (- 1.8)**	1,404,003 (44.41)	1,776,685 (40.96)	**26.5 (- 7.8)**
Nonwhite Male	410,403 (10.13)	533,763 (10.31)	**30.1 (1.8)**	297,660 (9.42)	411,450 (9.49)	**38.2 (0.7)**
White Female	1,639,627 (40.48)	2,083,225 (40.25)	**27.1 (- 0.6)**	1,239,956 (39.22)	1,748,484 (40.31)	**41.0 (2.8)**
Nonwhite Female	468,016 (11.55)	634,760 (12.27)	**35.6 (6.2)**	219,527 (6.95)	400,776 (9.24)	**82.6 (32.9)**
Total	4,050,896	5,175,397	**27.8**	3,161,146	4,337,395	**37.2**

Table A.4. Comparison of 1974 and 1988 North Carolina census population and licensed driver age distributions.

Age	Census Population			Licensed Drivers		
	1974	1988	% Change in Distribution	1974	1988	% Change in Distribution
15-24	1,059,813 (26.16)	1,094,794 (21.15)	**3.3 (- 19.1)**	786,483 (24.88)	769,261 (17.74)	**-2.9 (- 28.7)**
25-54	2,004,397 (49.48)	2,705,004 (52.27)	**35.0 (5.6)**	1,807,274 (57.17)	2,571,580 (59.29)	**42.3 (3.7)**
55-64	489,326 (12.08)	595,182 (11.50)	**21.6 (- 4.8)**	349,967 (11.07)	499,489 (11.52)	**42.7 (4.0)**
65-74	321,786 (7.94)	469,991 (9.08)	**46.1 (14.3)**	172,256 (5.45)	355,128 (8.19)	**106.2 (50.3)**
75+	175,574 (4.33)	310,426 (6.00)	**76.8 (38.4)**	45,166 (1.43)	141,397 (3.27)	**213.1 (129.0)**
Total	4,050,896	5,175,397	**27.8**	3,161,146	4,337,395	**37.2**

Table A.5. Percentage of North Carolina population licensed by race and sex.

Race / Sex	1974	1976	1978	1980	1982	1984	1986	1988
White Male	91.59	93.19	93.45	93.79	93.45	93.04	95.07	92.36
Nonwhite Male	72.53	75.46	76.59	77.59	76.96	76.06	73.27	77.08
White Female	75.62	78.85	80.58	81.84	82.50	83.51	85.71	83.93
Nonwhite Female	46.91	51.83	55.42	58.05	58.67	60.02	61.19	63.14
Overall	78.04	80.73	82.00	83.01	83.11	83.39	84.69	83.81

Table A.6. Percentage of North Carolina population licensed by age.

Age	1974	1976	1978	1980	1982	1984	1986	1988
15 - 24	74.21	76.46	76.29	74.96	72.78	71.91	72.37	70.27
25 - 54	90.17	92.57	93.93	95.28	95.18	95.03	96.26	95.07
55 - 64	71.52	75.60	77.80	80.03	82.61	83.44	84.22	83.92
65 - 74	53.53	58.37	62.14	65.51	68.97	72.33	75.22	75.56
75+	25.72	29.41	32.88	36.80	38.49	41.27	43.85	45.72
Overall	78.04	80.73	82.00	83.01	83.11	83.39	84.69	83.81

Table A.7. Percentage distribution of reported N.C. motor vehicle crashes by driver age, sex, and race.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	5.67	5.55	5.71	4.97	4.26	4.28	4.31	4.10
		Nonwhite	1.04	.89	.90	.77	.68	.70	.77	.77
	Female	White	2.70	2.88	2.99	2.54	2.35	2.62	2.87	2.82
		Nonwhite	.37	.37	.38	.35	.28	.34	.41	.42
	Total		9.78	9.68	9.99	8.63	7.57	7.93	8.36	8.11
	(N)		(19,192)	(21,857)	(25,480)	(19,984)	(17,560)	(19,555)	(22,981)	(24,119)
18-20	Male	White	8.25	8.16	7.92	7.62	7.17	6.91	6.12	5.78
		Nonwhite	2.56	2.46	2.20	1.99	1.91	1.89	1.92	1.91
	Female	White	3.30	3.52	3.57	3.45	3.44	3.45	3.35	3.41
		Nonwhite	.82	.87	.87	.81	.76	.81	.86	1.02
	Total		14.93	15.00	14.55	13.87	13.28	13.06	12.24	12.11
	(N)		(29,287)	(33,872)	(37,130)	(32,118)	(30,807)	(32,192)	(33,664)	(36,034)
21-24	Male	White	7.50	7.51	7.62	7.70	7.52	7.13	6.92	6.18
		Nonwhite	3.24	3.02	3.03	2.88	2.79	2.74	2.76	2.47
	Female	White	3.26	3.57	3.73	3.64	3.87	3.94	4.06	3.85
		Nonwhite	1.23	1.23	1.33	1.24	1.22	1.31	1.33	1.38
	Total		15.23	15.34	15.71	15.46	15.41	15.12	15.07	13.87
	(N)		(29,888)	(34,618)	(40,087)	(35,808)	(35,736)	(37,259)	(41,439)	(41,280)
25-54	Male	White	23.23	22.43	22.06	23.08	23.21	22.66	22.41	22.86
		Nonwhite	8.66	8.42	8.39	8.90	9.00	8.64	8.70	8.71
	Female	White	11.88	12.33	12.27	12.47	13.25	14.00	14.56	15.07
		Nonwhite	3.74	3.92	4.03	4.38	4.58	4.76	5.09	5.49
	Total		47.51	47.10	46.75	48.83	50.03	50.06	50.76	52.13
	(N)		(93,206)	(106,330)	(119,260)	(113,066)	(116,045)	(123,372)	(139,575)	(155,138)

Table A.7. Percentage distribution of reported N.C. motor vehicle crashes by driver age, sex, and race (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	3.98	3.88	3.87	3.75	3.75	3.63	3.50	3.45
		Nonwhite	1.36	1.28	1.18	1.19	1.10	1.08	.98	.96
	Female	White	1.84	1.94	1.98	2.00	2.02	2.11	2.07	2.07
		Nonwhite	.47	.46	.47	.47	.49	.51	.54	.50
	Total		7.64	7.56	7.50	7.41	7.36	7.32	7.09	6.98
	(N)		(14,992)	(17,062)	(19,132)	(17,167)	(17,063)	(18,048)	(19,496)	(20,776)
65-74	Male	White	2.04	2.08	2.05	2.09	2.18	2.16	2.17	2.29
		Nonwhite	.62	.68	.67	.73	.73	.72	.65	.63
	Female	White	.91	1.04	1.13	1.18	1.33	1.37	1.40	1.45
		Nonwhite	.11	.16	.19	.20	.25	.27	.25	.29
	Total		3.69	3.97	4.05	4.20	4.49	4.53	4.47	4.66
	(N)		(7,233)	(8,957)	(10,324)	(9,727)	(10,417)	(11,154)	(12,290)	(13,873)
75+	Male	White	.81	.84	.88	.89	1.04	1.04	1.03	1.10
		Nonwhite	.16	.17	.19	.23	.25	.25	.25	.25
	Female	White	.24	.32	.35	.43	.52	.63	.65	.70
		Nonwhite	.01	.02	.03	.04	.05	.05	.07	.08
	Total		1.22	1.35	1.45	1.60	1.86	1.97	2.00	2.13
	(N)		(2,399)	(3,046)	(3,703)	(3,697)	(4,307)	(4,861)	(5,510)	(6,351)
Total Crashes			196,197	225,742	255,116	231,567	231,935	246,441	274,955	297,571

Table A.8. Percentage change in race/sex distribution of N.C. crash-involved drivers, 1974-1988.

Race / Sex	Crash Population		
	1974	1988	% Change in Distribution
White Male	101,003 (51.48)	136,131 (45.75)	**34.8 (- 11.1)**
Nonwhite Male	34,615 (17.64)	46,712 (15.70)	**35.0 (-11.0)**
White Female	47,339 (24.13)	87,406 (29.37)	**84.6 (21.7)**
Nonwhite Female	13,240 (6.75)	27,322 (9.18)	**106.4 (36.1)**
Total	196,197	297,571	**51.7**

Table A.9. Percentage change in age distribution of N.C. crash-involved drivers, 1974-1988.

Age	Crash Population		
	1974	1988	% Change in Distribution
16-24	78,367 (39.94)	101,433 (34.09)	**29.4 (- 14.7)**
25-54	93,206 (47.51)	155,138 (52.14)	**66.5 (9.7)**
55-64	14,992 (7.64)	20,776 (6.98)	**38.6 (- 8.6)**
65-74	7,233 (3.69)	13,873 (4.66)	**71.8 (26.4)**
75+	2,399 (1.22)	6,351 (2.13)	**163.2 (74.5)**
Total	196,197	297,571	**51.7**

Table A.10. North Carolina motor vehicle crashes per 100 licensed drivers.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	18.49	19.72	22.29	18.16	17.68	18.94	19.99	22.34
		Nonwhite	14.89	14.01	14.86	11.54	11.74	12.88	14.93	18.97
		Total	**17.82**	**18.67**	**20.87**	**16.86**	**16.53**	**17.77**	**19.02**	**21.73**
	Female	White	9.83	11.38	13.04	10.38	11.04	12.96	14.81	17.06
		Nonwhite	8.08	8.46	9.15	7.35	6.93	8.34	10.22	13.32
		Total	**9.58**	**10.95**	**12.44**	**9.89**	**10.38**	**12.19**	**14.02**	**16.46**
	Total		**14.03**	**15.10**	**16.98**	**13.64**	**13.71**	**15.18**	**16.68**	**19.27**
18-20	Male	White	14.40	15.96	17.44	15.08	14.83	16.21	16.53	16.59
		Nonwhite	14.16	15.07	15.57	12.67	12.82	14.03	16.42	17.95
		Total	**14.34**	**15.74**	**17.00**	**14.51**	**14.36**	**15.69**	**16.50**	**16.91**
	Female	White	6.34	7.48	8.46	7.42	7.72	8.78	9.79	10.46
		Nonwhite	6.60	7.38	8.10	6.63	6.65	7.77	9.09	11.39
		Total	**6.39**	**7.46**	**8.39**	**7.26**	**7.50**	**8.58**	**9.64**	**10.66**
	Total		**10.68**	**11.88**	**12.95**	**11.10**	**11.14**	**12.35**	**13.26**	**13.93**
21-24	Male	White	9.70	10.60	11.84	10.70	10.51	10.59	11.64	12.11
		Nonwhite	13.56	13.19	14.38	12.39	12.53	13.08	14.60	15.37
		Total	**10.61**	**11.23**	**12.47**	**11.11**	**10.99**	**11.18**	**12.36**	**12.89**
	Female	White	4.58	5.38	6.17	5.40	5.78	6.25	7.34	8.02
		Nonwhite	6.51	6.58	7.43	6.23	6.38	7.29	8.07	9.53
		Total	**4.98**	**5.64**	**6.46**	**5.59**	**5.92**	**6.48**	**7.51**	**8.37**
	Total		**7.96**	**8.57**	**9.59**	**8.47**	**8.56**	**8.93**	**10.04**	**10.71**
25-54	Male	White	5.76	6.14	6.59	6.05	5.86	5.88	6.14	6.60
		Nonwhite	10.98	11.01	11.36	10.09	9.54	9.30	9.69	10.26
		Total	**6.61**	**6.98**	**7.46**	**6.81**	**6.57**	**6.54**	**6.84**	**7.33**
	Female	White	3.18	3.57	3.81	3.36	3.44	3.69	4.06	4.38
		Nonwhite	5.71	5.82	5.90	5.22	5.03	5.13	5.62	6.17
		Total	**3.56**	**3.94**	**4.18**	**3.70**	**3.74**	**3.98**	**4.38**	**4.75**
	Total		**5.16**	**5.52**	**5.85**	**5.28**	**5.18**	**5.27**	**5.62**	**6.03**

Table A.10. North Carolina motor vehicle crashes per 100 licensed drivers (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	4.65	4.85	5.21	4.38	4.20	4.20	4.46	4.76
		Nonwhite	8.99	9.34	9.33	8.26	7.43	7.77	7.89	8.36
		Total	**5.30**	**5.50**	**5.81**	**4.94**	**4.65**	**4.70**	**4.93**	**5.25**
	Female	White	2.64	2.84	2.99	2.51	2.37	2.52	2.67	2.86
		Nonwhite	5.68	5.49	5.46	4.40	4.06	4.13	4.62	4.45
		Total	**2.97**	**3.13**	**3.27**	**2.74**	**2.58**	**2.72**	**2.93**	**3.07**
	Total		**4.28**	**4.43**	**4.63**	**3.89**	**3.66**	**3.73**	**5.62**	**4.16**
65-74	Male	White	4.38	4.61	4.70	4.04	3.94	3.89	4.02	4.36
		Nonwhite	8.60	9.21	9.18	8.45	7.99	7.94	7.67	7.84
		Total	**4.95**	**5.26**	**5.35**	**4.66**	**4.51**	**4.46**	**4.52**	**4.82**
	Female	White	2.86	3.10	3.22	2.65	2.65	2.61	2.67	2.77
		Nonwhite	5.18	6.02	6.00	4.46	4.67	4.51	4.15	4.67
		Total	**3.01**	**3.32**	**3.46**	**2.81**	**2.85**	**2.80**	**2.82**	**2.97**
	Total		**4.20**	**4.47**	**4.53**	**3.83**	**3.74**	**3.67**	**3.70**	**3.91**
75+	Male	White	5.50	5.64	5.93	4.83	5.06	4.77	4.79	5.04
		Nonwhite	10.25	9.65	9.80	9.37	8.67	8.20	7.96	7.90
		Total	**5.97**	**6.07**	**6.37**	**5.37**	**5.50**	**5.19**	**5.19**	**5.40**
	Female	White	3.64	4.11	3.94	3.37	3.32	3.43	3.29	3.33
		Nonwhite	7.32	8.81	7.57	7.21	5.45	4.50	5.26	5.10
		Total	**3.73**	**4.26**	**4.08**	**3.54**	**3.43**	**3.49**	**3.42**	**3.46**
	Total		**5.31**	**5.48**	**5.55**	**4.66**	**4.64**	**4.44**	**4.38**	**4.48**
Overall			**6.21**	**6.63**	**7.09**	**6.14**	**5.94**	**6.09**	**6.48**	**6.86**

Table A.11. North Carolina motor vehicle crash involvement per 100 licensed drivers by driver race and sex.

Race / Sex	1974	1976	1978	1980	1982	1984	1986	1988
White Male	7.19	7.70	8.31	7.29	6.97	7.01	7.29	7.66
Nonwhite Male	9.88	11.67	12.09	10.47	10.03	10.09	10.71	11.35
White Female	3.97	4.31	4.67	3.98	4.00	4.28	4.69	5.00
Nonwhite Female	6.03	6.20	6.44	5.48	5.30	5.57	6.13	6.82
Overall	6.21	6.63	7.09	6.14	5.94	6.09	6.48	6.86

Table A.12. Percentage of crashes occurring on weekends.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	40.17	39.29	38.05	40.05	41.08	34.95	35.07	34.12
		Nonwhite	41.80	42.24	38.79	38.29	42.32	37.48	38.22	37.50
		Total	**40.43**	**39.70**	**38.15**	**39.81**	**41.25**	**35.31**	**35.54**	**34.65**
	Female	White	32.59	32.93	30.56	34.38	32.75	31.80	31.66	30.14
		Nonwhite	33.15	34.34	32.48	33.75	35.27	33.13	33.74	35.31
		Total	**32.66**	**33.09**	**30.78**	**34.30**	**33.02**	**31.95**	**31.93**	**30.81**
	Total		**37.99**	**37.48**	**35.66**	**37.97**	**38.39**	**34.06**	**34.12**	**33.12**
18-20	Male	White	40.46	41.18	39.27	41.73	41.85	36.92	36.79	35.10
		Nonwhite	44.00	41.80	42.17	40.88	42.31	37.97	38.19	37.33
		Total	**41.30**	**41.33**	**39.90**	**41.56**	**41.95**	**37.14**	**37.13**	**35.66**
	Female	White	30.36	30.37	29.02	31.86	31.96	29.13	29.00	27.93
		Nonwhite	33.02	35.29	33.56	33.19	32.24	28.54	30.31	29.17
		Total	**30.89**	**31.34**	**29.91**	**32.11**	**32.01**	**29.01**	**29.27**	**28.21**
	Total		**38.42**	**38.41**	**36.86**	**38.66**	**38.80**	**34.49**	**34.43**	**32.94**
21-24	Male	White	36.82	37.54	36.01	37.69	37.57	33.63	33.60	32.48
		Nonwhite	44.15	42.05	39.37	40.11	41.65	36.85	37.52	35.01
		Total	**39.03**	**38.83**	**36.97**	**38.35**	**38.67**	**34.52**	**34.72**	**33.20**
	Female	White	27.82	26.88	26.33	27.95	28.13	26.21	26.53	25.22
		Nonwhite	33.29	34.31	32.51	31.76	32.24	27.69	29.24	28.11
		Total	**29.31**	**28.79**	**27.95**	**28.92**	**29.12**	**26.58**	**27.20**	**25.99**
	Total		**36.17**	**35.69**	**34.07**	**35.37**	**35.51**	**31.76**	**32.03**	**30.48**
25-54	Male	White	32.44	31.70	30.13	30.76	30.61	26.97	27.52	26.36
		Nonwhite	43.18	41.20	37.80	37.16	37.26	32.94	33.12	31.41
		Total	**35.35**	**34.29**	**32.24**	**32.54**	**32.47**	**28.62**	**29.08**	**27.75**
	Female	White	24.66	24.06	23.45	23.67	24.20	21.74	22.33	21.81
		Nonwhite	32.19	32.40	29.87	30.14	30.41	27.07	27.69	26.66
		Total	**26.46**	**26.08**	**25.04**	**25.35**	**25.79**	**23.09**	**23.72**	**23.11**
	Total		**32.43**	**31.46**	**29.73**	**30.06**	**30.09**	**26.55**	**27.01**	**25.92**

Table A.12. Percentage of crashes occurring on weekends (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	27.20	27.73	26.32	26.32	25.49	23.01	24.19	22.46
		Nonwhite	37.01	34.64	31.57	31.29	31.40	29.20	27.70	26.27
		Total	**29.69**	**29.44**	**27.55**	**27.52**	**26.83**	**24.43**	**24.96**	**23.29**
	Female	White	25.84	23.52	24.08	23.25	22.24	21.20	21.24	21.53
		Nonwhite	26.53	26.57	27.03	25.02	29.29	22.05	23.74	26.02
		Total	**25.98**	**24.10**	**24.64**	**23.59**	**23.61**	**21.37**	**21.75**	**22.40**
	Total		**28.57**	**27.75**	**26.60**	**26.21**	**25.73**	**23.33**	**23.78**	**22.96**
65-74	Male	White	25.20	25.46	24.51	24.81	23.64	22.30	23.44	22.71
		Nonwhite	29.77	30.62	27.44	26.88	26.15	26.58	25.11	24.41
		Total	**26.26**	**26.74**	**25.23**	**25.35**	**24.27**	**23.38**	**23.82**	**23.07**
	Female	White	24.94	24.70	23.90	22.58	22.50	21.31	21.93	21.58
		Nonwhite	26.67	22.43	21.88	23.86	24.74	23.77	25.14	25.57
		Total	**25.14**	**24.39**	**23.61**	**22.76**	**22.85**	**21.71**	**22.42**	**22.25**
	Total		**25.95**	**26.02**	**24.70**	**24.50**	**23.77**	**22.77**	**23.30**	**22.76**
75+	Male	White	22.44	23.50	24.22	23.31	21.26	24.10	20.51	22.13
		Nonwhite	31.06	31.54	27.39	25.97	30.18	22.20	26.52	26.55
		Total	**23.90**	**24.88**	**24.78**	**23.86**	**22.96**	**23.74**	**21.69**	**22.95**
	Female	White	18.05	17.94	20.31	20.34	20.71	22.01	21.19	22.24
		Nonwhite	33.33	28.85	24.29	24.49	24.30	19.84	19.61	25.91
		Total	**18.79**	**18.68**	**20.60**	**20.72**	**21.00**	**21.85**	**21.03**	**22.63**
	Total		**22.84**	**23.31**	**23.68**	**22.94**	**22.36**	**23.08**	**21.45**	**22.83**
Overall			**33.79**	**33.13**	**31.52**	**32.12**	**31.96**	**28.50**	**28.76**	**27.57**

Table A.13. Percentage of crashes occurring during nighttime (6 pm - 6 am).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	40.35	40.15	40.15	41.63	42.00	37.36	37.17	36.22
		Nonwhite	40.68	41.50	37.66	40.60	41.62	37.25	41.11	40.16
		Total	**40.40**	**40.33**	**39.81**	**41.50**	**41.95**	**37.34**	**37.77**	**36.85**
	Female	White	29.84	30.16	30.01	32.91	33.05	31.47	31.22	30.64
		Nonwhite	29.40	30.48	27.68	30.27	31.30	29.75	33.13	33.55
		Total	**29.78**	**30.20**	**29.74**	**32.60**	**32.86**	**31.28**	**31.46**	**31.02**
	Total		**37.07**	**36.94**	**36.41**	**38.52**	**38.79**	**35.09**	**35.29**	**34.52**
18-20	Male	White	44.28	44.53	44.20	46.60	47.85	41.24	41.30	38.20
		Nonwhite	46.25	46.16	44.82	45.70	47.04	41.79	43.69	40.91
		Total	**44.74**	**45.00**	**44.34**	**46.41**	**47.68**	**41.36**	**41.87**	**38.87**
	Female	White	29.15	28.91	30.72	34.26	34.18	30.47	29.87	29.23
		Nonwhite	28.56	31.15	30.27	30.24	32.75	27.64	30.69	30.06
		Total	**29.03**	**29.35**	**30.63**	**33.50**	**33.92**	**29.93**	**30.04**	**29.42**
	Total		**40.41**	**40.36**	**40.16**	**42.45**	**43.32**	**37.63**	**37.81**	**35.42**
21-24	Male	White	39.43	39.45	39.92	43.11	43.74	37.14	37.78	34.74
		Nonwhite	45.17	44.05	43.19	44.30	47.80	41.22	42.62	39.62
		Total	**41.16**	**40.77**	**40.85**	**43.43**	**44.84**	**38.27**	**39.16**	**36.13**
	Female	White	24.94	24.21	26.35	27.99	29.20	26.01	26.13	25.32
		Nonwhite	30.22	29.22	27.50	29.16	32.28	28.59	29.27	29.33
		Total	**26.38**	**26.00**	**26.65**	**28.29**	**29.94**	**26.65**	**26.90**	**26.38**
	Total		**36.81**	**35.99**	**36.28**	**38.65**	**39.91**	**34.24**	**34.78**	**32.46**
25-54	Male	White	31.21	30.63	30.68	31.51	32.23	27.77	28.35	26.27
		Nonwhite	38.78	37.62	36.92	36.33	38.01	33.34	34.55	32.11
		Total	**33.27**	**33.00**	**32.40**	**32.85**	**33.85**	**29.31**	**30.09**	**27.88**
	Female	White	20.37	19.78	20.87	20.27	21.60	19.41	19.86	19.39
		Nonwhite	26.49	25.36	25.82	24.51	26.91	22.88	24.17	23.41
		Total	**21.83**	**21.12**	**22.09**	**21.38**	**22.96**	**20.29**	**20.97**	**20.47**
	Total		**29.51**	**28.60**	**28.81**	**28.89**	**29.97**	**25.93**	**26.56**	**24.96**

Table A.13. Percentage of crashes occurring during nighttime (6 pm - 6 am) (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	20.99	20.20	20.95	21.10	19.86	17.73	17.83	17.22
		Nonwhite	27.98	28.10	25.83	25.74	25.68	24.03	24.45	22.80
		Total	**22.76**	**22.16**	**22.09**	**22.21**	**21.18**	**19.17**	**19.28**	**18.43**
	Female	White	16.69	14.69	16.22	15.69	14.27	13.56	12.95	13.70
		Nonwhite	17.90	19.16	21.09	17.72	18.23	14.11	15.13	15.65
		Total	**16.94**	**15.35**	**17.15**	**16.08**	**15.04**	**13.67**	**13.40**	**14.08**
	Total		**21.00**	**20.00**	**20.47**	**20.17**	**19.09**	**17.20**	**17.12**	**16.83**
65-74	Male	White	17.15	15.71	16.59	15.35	14.78	13.16	14.58	13.95
		Nonwhite	22.29	22.24	22.30	18.87	19.64	20.36	19.38	16.61
		Total	**18.34**	**17.32**	**18.00**	**16.26**	**16.00**	**14.97**	**15.68**	**14.52**
	Female	White	12.70	12.37	12.35	12.04	10.96	10.58	10.74	9.77
		Nonwhite	17.33	14.59	14.52	14.32	11.51	11.81	13.07	12.33
		Total	**13.22**	**12.67**	**12.66**	**12.37**	**11.04**	**10.78**	**11.10**	**10.20**
	Total		**16.92**	**15.91**	**16.25**	**14.98**	**14.26**	**13.45**	**13.99**	**12.90**
75+	Male	White	12.39	11.62	13.16	10.59	9.53	10.22	11.42	10.67
		Nonwhite	20.19	20.77	18.05	15.29	18.07	14.47	15.80	14.69
		Total	**13.71**	**13.19**	**14.02**	**11.57**	**11.16**	**11.03**	**12.28**	**11.41**
	Female	White	7.64	8.90	9.66	8.10	7.48	7.74	7.93	7.80
		Nonwhite	16.67	11.54	14.29	15.31	10.28	14.29	11.27	11.34
		Total	**8.08**	**9.08**	**9.99**	**8.75**	**7.70**	**8.23**	**8.27**	**8.17**
	Total		**12.55**	**12.15**	**12.96**	**10.74**	**10.10**	**10.06**	**10.83**	**10.22**
Overall			**31.67**	**30.93**	**31.03**	**31.59**	**32.07**	**27.92**	**28.36**	**26.60**

Table A.14. Percentage of crashes occurring in rural locations.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	54.14	54.07	52.39	54.05	53.72	51.33	51.43	50.29
		Nonwhite	45.33	43.34	40.84	41.16	38.71	35.85	37.08	35.76
		Total	**52.77**	**53.00**	**50.81**	**52.32**	**51.65**	**49.16**	**49.26**	**47.99**
	Female	White	45.76	46.01	45.33	47.41	46.44	46.17	44.78	46.00
		Nonwhite	38.70	33.86	31.56	35.73	35.27	31.20	31.81	31.71
		Total	**44.92**	**45.00**	**43.77**	**46.00**	**45.24**	**44.47**	**43.15**	**44.15**
	Total		**50.31**	**49.92**	**48.43**	**50.21**	**49.42**	**47.41**	**46.86**	**46.45**
18-20	Male	White	54.77	53.55	52.60	51.16	50.79	49.21	49.11	46.79
		Nonwhite	50.67	46.00	42.49	40.52	41.54	37.47	37.44	36.63
		Total	**53.80**	**52.00**	**50.40**	**48.95**	**48.84**	**46.69**	**46.33**	**44.27**
	Female	White	43.71	43.14	43.85	42.79	43.33	43.22	40.75	40.12
		Nonwhite	36.37	33.40	30.99	30.83	32.47	31.42	30.95	27.91
		Total	**42.24**	**41.21**	**41.33**	**40.53**	**41.36**	**40.96**	**38.74**	**37.31**
	Total		**50.61**	**48.71**	**47.64**	**46.37**	**46.47**	**44.82**	**43.72**	**41.73**
21-24	Male	White	51.75	50.99	49.59	49.61	47.61	47.06	45.69	43.75
		Nonwhite	44.96	43.37	40.80	40.04	38.03	37.96	36.98	35.72
		Total	**49.70**	**49.00**	**47.09**	**47.01**	**45.02**	**44.53**	**43.21**	**41.46**
	Female	White	39.52	40.83	40.19	39.70	39.61	38.10	37.86	36.87
		Nonwhite	34.21	32.95	31.89	29.68	29.57	30.04	28.40	27.28
		Total	**38.06**	**39.00**	**38.01**	**37.15**	**37.20**	**36.09**	**35.53**	**34.34**
	Total		**46.28**	**45.68**	**44.17**	**43.89**	**42.43**	**41.60**	**40.46**	**38.78**
25-54	Male	White	49.08	48.93	48.03	48.04	46.65	44.76	44.00	42.68
		Nonwhite	40.91	39.64	37.45	36.41	35.07	34.20	34.69	33.58
		Total	**46.86**	**46.40**	**45.11**	**44.81**	**43.41**	**41.84**	**41.39**	**40.17**
	Female	White	40.77	40.33	39.81	39.94	39.06	38.10	36.74	36.48
		Nonwhite	32.78	31.32	30.39	30.48	29.33	28.57	27.62	27.26
		Total	**38.86**	**38.20**	**37.48**	**37.48**	**36.56**	**35.68**	**34.38**	**34.02**
	Total		**44.23**	**43.55**	**42.45**	**42.28**	**40.97**	**39.53**	**38.68**	**37.74**

Table A.14. Percentage of crashes occurring in rural locations (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	45.48	44.33	42.29	42.00	40.82	40.71	39.81	39.35
		Nonwhite	37.68	37.23	34.03	34.52	30.93	32.44	30.88	31.50
		Total	**43.50**	**43.00**	**40.36**	**40.19**	**38.58**	**38.82**	**37.85**	**37.64**
	Female	White	36.98	35.40	34.04	33.90	33.87	33.90	32.48	32.35
		Nonwhite	29.48	27.15	26.36	25.30	25.75	24.70	24.76	26.76
		Total	**35.46**	**34.00**	**32.57**	**32.26**	**32.29**	**32.12**	**30.89**	**31.26**
	Total		**41.08**	**39.79**	**37.81**	**37.55**	**36.44**	**36.43**	**35.29**	**35.29**
65-74	Male	White	43.59	42.56	42.31	41.65	40.69	40.50	38.50	38.96
		Nonwhite	37.75	34.27	32.57	30.03	29.53	30.51	31.01	29.19
		Total	**42.23**	**40.51**	**39.90**	**38.65**	**37.90**	**37.99**	**36.78**	**36.87**
	Female	White	32.42	32.91	30.79	30.92	30.44	30.94	30.60	31.63
		Nonwhite	30.67	23.51	24.95	24.51	24.23	23.02	22.41	25.23
		Total	**32.22**	**32.00**	**29.94**	**29.99**	**29.45**	**29.63**	**29.35**	**30.55**
	Total		**39.46**	**37.81**	**36.64**	**35.81**	**34.92**	**34.96**	**34.03**	**34.50**
75+	Male	White	44.25	40.27	39.33	37.33	37.80	37.68	38.07	37.24
		Nonwhite	36.96	33.33	31.74	29.10	31.40	28.13	31.01	30.32
		Total	**43.01**	**39.08**	**37.99**	**35.62**	**36.57**	**35.84**	**36.69**	**35.96**
	Female	White	28.24	28.23	28.41	23.68	24.16	27.70	26.76	28.69
		Nonwhite	29.17	19.23	21.43	22.45	20.56	18.25	16.18	17.41
		Total	**28.28**	**27.63**	**27.91**	**23.57**	**23.87**	**26.99**	**25.67**	**27.50**
	Total		**39.97**	**36.18**	**35.05**	**32.08**	**32.67**	**32.77**	**32.72**	**32.85**
Overall			**45.62**	**44.66**	**43.39**	**42.99**	**41.81**	**40.59**	**39.68**	**38.65**

Table A.15. Percentage distribution of total annual mileage by age, sex, and race based on induced exposure.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	3.47	3.46	3.72	3.06	2.54	2.65	2.62	2.51
		Nonwhite	.74	.64	.66	.57	.52	.50	.55	.53
		Total	**4.21**	**4.10**	**4.38**	**3.63**	**3.05**	**3.15**	**3.17**	**3.04**
	Female	White	2.27	2.38	2.46	2.13	1.79	1.96	2.03	2.14
		Nonwhite	.32	.34	.35	.30	.25	.32	.33	.34
		Total	**2.59**	**2.72**	**2.80**	**2.42**	**2.04**	**2.28**	**2.36**	**2.48**
	Total		**6.79**	**6.82**	**7.19**	**6.05**	**5.09**	**5.43**	**5.53**	**5.53**
18-20	Male	White	6.03	5.98	5.84	5.30	5.15	4.77	4.28	4.01
		Nonwhite	2.00	1.87	1.69	1.68	1.51	1.48	1.40	1.39
		Total	**8.03**	**7.85**	**7.53**	**6.98**	**6.66**	**6.25**	**5.69**	**5.40**
	Female	White	3.37	3.56	3.54	3.30	3.27	3.29	3.15	3.10
		Nonwhite	.87	.96	.96	.89	.80	.76	.87	.99
		Total	**4.24**	**4.52**	**4.50**	**4.19**	**4.06**	**4.05**	**4.01**	**4.09**
	Total		**12.27**	**12.37**	**12.04**	**11.17**	**10.72**	**10.30**	**9.70**	**9.49**
21-24	Male	White	6.94	6.64	6.76	6.29	6.09	5.90	5.65	5.09
		Nonwhite	2.80	2.68	2.53	2.42	2.34	2.28	2.31	2.03
		Total	**9.74**	**9.32**	**9.29**	**8.71**	**8.43**	**8.18**	**7.96**	**7.11**
	Female	White	3.94	4.09	4.21	4.10	4.32	4.38	4.25	3.97
		Nonwhite	1.43	1.40	1.57	1.42	1.48	1.50	1.53	1.52
		Total	**5.36**	**5.49**	**5.78**	**5.52**	**5.80**	**5.87**	**5.78**	**5.49**
	Total		**15.10**	**14.81**	**15.07**	**14.22**	**14.22**	**14.06**	**13.75**	**12.61**
25-54	Male	White	25.92	25.03	24.39	25.17	25.31	24.28	23.75	24.31
		Nonwhite	8.07	7.93	7.84	8.46	8.42	8.29	8.37	8.32
		Total	**33.99**	**32.95**	**32.23**	**33.63**	**33.74**	**32.57**	**32.11**	**32.64**
	Female	White	15.57	16.14	16.13	16.43	17.17	18.06	18.76	18.87
		Nonwhite	4.44	4.83	5.01	5.64	5.84	6.09	6.56	7.04
		Total	**20.01**	**20.97**	**21.14**	**22.07**	**23.01**	**24.15**	**25.33**	**25.92**
	Total		**54.00**	**53.92**	**53.37**	**55.70**	**56.75**	**56.72**	**57.44**	**58.55**

Table A.15. Percentage distribution of total annual mileage by age, sex, and race based on induced exposure (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	4.23	4.16	4.29	4.14	4.24	4.10	3.99	3.77
		Nonwhite	1.22	1.17	1.15	1.14	1.03	1.06	.94	.94
		Total	**5.46**	**5.33**	**5.43**	**5.28**	**5.27**	**5.16**	**4.93**	**4.70**
	Female	White	2.13	2.18	2.23	2.24	2.31	2.51	2.67	2.62
		Nonwhite	.45	.50	.48	.50	.53	.59	.58	.63
		Total	**2.57**	**2.68**	**2.71**	**2.75**	**2.85**	**3.11**	**3.26**	**3.24**
	Total		**8.03**	**8.01**	**8.15**	**8.02**	**8.12**	**8.27**	**8.18**	**7.94**
65-74	Male	White	1.81	1.82	1.76	2.00	2.01	2.02	2.08	2.28
		Nonwhite	.49	.53	.57	.63	.63	.60	.56	.56
		Total	**2.30**	**2.36**	**2.32**	**2.63**	**2.64**	**2.62**	**2.64**	**2.84**
	Female	White	.75	.84	.96	1.07	1.17	1.22	1.31	1.43
		Nonwhite	.08	.13	.14	.19	.23	.23	.24	.29
		Total	**.83**	**.97**	**1.10**	**1.26**	**1.40**	**1.45**	**1.56**	**1.72**
	Total		**3.13**	**3.33**	**3.43**	**3.90**	**4.04**	**4.07**	**4.19**	**4.56**
75+	Male	White	.46	.47	.48	.50	.59	.58	.62	.67
		Nonwhite	.09	.11	.10	.17	.15	.18	.17	.20
		Total	**.55**	**.58**	**.58**	**.67**	**.74**	**.76**	**.79**	**.86**
	Female	White	.13	.14	.18	.25	.29	.36	.37	.40
		Nonwhite	.004	.01	.02	.02	.04	.03	.06	.07
		Total	**.13**	**.15**	**.20**	**.28**	**.33**	**.39**	**.43**	**.46**
	Total		**.69**	**.73**	**.77**	**.95**	**1.07**	**1.15**	**1.22**	**1.32**
	Total Mileage (in millions)		**35,000**	**38,600**	**42,500**	**41,234**	**43,100**	**48,050**	**52,881**	**57,784**

Table A.16. Relative crash involvement ratios by driver age, sex, and race, 1974-1988.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	1.63	1.60	1.53	1.62	1.68	1.62	1.65	1.63
		Nonwhite	1.41	1.39	1.36	1.35	1.31	1.40	1.40	1.45
		Total	**1.59**	**1.57**	**1.51**	**1.58**	**1.62**	**1.58**	**1.60**	**1.60**
	Female	White	1.19	1.21	1.22	1.19	1.31	1.34	1.41	1.32
		Nonwhite	1.16	1.09	1.09	1.17	1.12	1.06	1.24	1.24
		Total	**1.18**	**1.19**	**1.20**	**1.19**	**1.29**	**1.29**	**1.39**	**1.31**
	Total		**1.44**	**1.42**	**1.39**	**1.43**	**1.49**	**1.46**	**1.51**	**1.47**
18-20	Male	White	1.37	1.36	1.36	1.44	1.39	1.45	1.43	1.44
		Nonwhite	1.28	1.32	1.30	1.18	1.26	1.28	1.37	1.37
		Total	**1.35**	**1.35**	**1.34**	**1.38**	**1.36**	**1.41**	**1.41**	**1.42**
	Female	White	.98	.99	1.01	1.05	1.05	1.05	1.06	1.10
		Nonwhite	.94	.91	.91	.91	.95	1.07	.99	1.03
		Total	**.97**	**.97**	**.99**	**1.01**	**1.03**	**1.05**	**1.05**	**1.08**
	Total		**1.22**	**1.21**	**1.21**	**1.24**	**1.24**	**1.27**	**1.26**	**1.28**
21-24	Male	White	1.08	1.13	1.13	1.22	1.23	1.21	1.22	1.21
		Nonwhite	1.16	1.13	1.20	1.19	1.19	1.20	1.19	1.22
		Total	**1.10**	**1.13**	**1.15**	**1.21**	**1.22**	**1.21**	**1.22**	**1.22**
	Female	White	.83	.87	.89	.89	.90	.90	.96	.97
		Nonwhite	.86	.88	.85	.87	.82	.87	.87	.91
		Total	**.84**	**.87**	**.88**	**.89**	**.88**	**.89**	**.93**	**.95**
	Total		**1.01**	**1.04**	**1.04**	**1.09**	**1.08**	**1.08**	**1.10**	**1.10**
25-54	Male	White	.90	.90	.90	.92	.92	.93	.94	.94
		Nonwhite	1.07	1.06	1.07	1.05	1.07	1.04	1.04	1.05
		Total	**.94**	**.94**	**.94**	**.95**	**.95**	**.96**	**.97**	**.97**
	Female	White	.76	.76	.76	.76	.77	.78	.78	.80
		Nonwhite	.84	.81	.80	.78	.78	.78	.78	.78
		Total	**.78**	**.77**	**.77**	**.76**	**.77**	**.78**	**.78**	**.79**
	Total		**.88**	**.87**	**.88**	**.88**	**.88**	**.88**	**.88**	**.89**

Table A.16. Relative crash involvement ratios by driver age, sex, and race, 1974-1988 (Cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	.94	.93	.90	.91	.88	.89	.88	.92
		Nonwhite	1.11	1.09	1.03	1.04	1.07	1.02	1.04	1.02
		Total	**.98**	**.97**	**.93**	**.94**	**.92**	**.91**	**.91**	**.94**
	Female	White	.86	.89	.89	.89	.87	.84	.78	.79
		Nonwhite	1.04	.92	.98	.94	.92	.86	.93	.79
		Total	**.90**	**.90**	**.90**	**.90**	**.88**	**.84**	**.80**	**.79**
	Total		**.95**	**.94**	**.92**	**.92**	**.91**	**.89**	**.87**	**.88**
65-74	Male	White	1.11	1.14	1.16	1.05	1.08	1.07	1.04	1.00
		Nonwhite	1.27	1.28	1.18	1.16	1.16	1.20	1.16	1.13
		Total	**1.16**	**1.17**	**1.17**	**1.07**	**1.10**	**1.10**	**1.07**	**1.02**
	Female	White	1.21	1.24	1.18	1.10	1.14	1.12	1.07	1.01
		Nonwhite *	1.38	1.23	1.36	1.05	1.09	1.17	1.04	1.00
		Total	**1.23**	**1.25**	**1.20**	**1.10**	**1.13**	**1.13**	**1.06**	**1.01**
	Total		**1.18**	**1.19**	**1.18**	**1.08**	**1.11**	**1.11**	**1.07**	**1.02**
75+	Male	White	1.76	1.79	1.83	1.78	1.76	1.79	1.66	1.64
		Nonwhite *	1.78	1.55	1.90	1.35	1.67	1.39	1.47	1.25
		Total	**1.76**	**1.74**	**1.84**	**1.69**	**1.74**	**1.70**	**1.62**	**1.57**
	Female	White	1.85	2.29	1.94	1.72	1.79	1.75	1.76	1.75
		Nonwhite *	2.50	2.00	1.50	2.00	1.25	1.67	1.17	1.14
		Total	**1.92**	**2.27**	**1.90**	**1.68**	**1.73**	**1.74**	**1.67**	**1.72**
	Total		**1.77**	**1.85**	**1.88**	**1.68**	**1.74**	**1.71**	**1.64**	**1.61**

* Small sample sizes (< 0.5% of total crash population).

Table A.17. North Carolina motor vehicle crashes per estimated million induced exposure miles by driver age, sex, and race.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	9.16	9.38	9.21	9.13	9.06	8.30	8.56	8.41
		Nonwhite	7.94	8.14	8.18	7.57	7.10	7.10	7.20	7.46
		Total	**8.95**	**9.19**	**9.06**	**8.89**	**8.72**	**8.11**	**8.32**	**8.24**
	Female	White	6.68	7.07	7.31	6.72	7.06	6.86	7.36	6.77
		Nonwhite	6.47	6.28	6.63	6.61	6.08	5.32	6.54	6.31
		Total	**6.65**	**6.97**	**7.22**	**6.70**	**6.94**	**6.64**	**7.24**	**6.71**
	Total		**8.07**	**8.30**	**8.34**	**8.01**	**8.01**	**7.49**	**7.86**	**7.55**
18-20	Male	White	7.66	7.97	8.14	8.07	7.49	7.44	7.43	7.43
		Nonwhite	7.19	7.70	7.81	6.67	6.82	6.52	7.11	7.06
		Total	**7.54**	**7.91**	**8.06**	**7.73**	**7.34**	**7.22**	**7.35**	**7.33**
	Female	White	5.48	5.78	6.04	5.87	5.67	5.37	5.53	5.65
		Nonwhite	5.31	5.29	5.45	5.11	5.16	5.49	5.16	5.28
		Total	**5.45**	**5.67**	**5.91**	**5.71**	**5.57**	**5.39**	**5.45**	**5.56**
	Total		**6.82**	**7.09**	**7.26**	**6.98**	**6.67**	**6.50**	**6.56**	**6.57**
21-24	Male	White	6.06	6.61	6.77	6.88	6.65	6.20	6.37	6.25
		Nonwhite	6.49	6.60	7.20	6.68	6.42	6.15	6.22	6.28
		Total	**6.19**	**6.61**	**6.89**	**6.82**	**6.59**	**6.19**	**6.33**	**6.26**
	Female	White	4.64	5.10	5.32	4.99	4.82	4.62	4.96	4.99
		Nonwhite	4.82	5.15	5.08	4.91	4.47	4.50	4.50	4.67
		Total	**4.69**	**5.11**	**5.25**	**4.97**	**4.73**	**4.59**	**4.84**	**4.90**
	Total		**5.65**	**6.05**	**6.26**	**6.11**	**5.83**	**5.52**	**5.70**	**5.67**
25-54	Male	White	5.02	5.24	5.43	5.15	4.93	4.79	4.91	4.84
		Nonwhite	6.01	6.21	6.43	5.91	5.75	5.35	5.41	5.39
		Total	**5.26**	**5.47**	**5.67**	**5.34**	**5.14**	**4.93**	**5.04**	**4.98**
	Female	White	4.28	4.47	4.57	4.26	4.15	3.98	4.04	4.11
		Nonwhite	4.72	4.74	4.83	4.36	4.22	4.01	4.03	4.01
		Total	**4.38**	**4.53**	**4.63**	**4.29**	**4.17**	**3.98**	**4.04**	**4.09**
	Total		**4.93**	**5.11**	**5.26**	**4.92**	**4.74**	**4.53**	**4.60**	**4.59**

Table A.17. North Carolina motor vehicle crashes per estimated million induced exposure miles by driver age, sex, and race (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	5.27	5.45	5.41	5.10	4.76	4.54	4.57	4.71
		Nonwhite	6.22	6.42	6.19	5.85	5.74	5.22	5.43	5.28
		Total	**5.48**	**5.66**	**5.58**	**5.26**	**4.96**	**4.67**	**4.74**	**4.83**
	Female	White	4.85	5.20	5.34	5.01	4.70	4.31	4.02	4.09
		Nonwhite	5.87	5.39	5.86	5.27	4.91	4.38	4.80	4.13
		Total	**5.03**	**5.24**	**5.43**	**5.06**	**4.74**	**4.33**	**4.16**	**4.09**
	Total		**5.34**	**5.52**	**5.53**	**5.19**	**4.88**	**4.54**	**4.51**	**4.53**
65-74	Male	White	6.34	6.68	7.01	5.88	5.83	5.49	5.43	5.16
		Nonwhite	7.04	7.47	7.10	6.48	6.26	6.15	6.01	5.79
		Total	**6.49**	**6.86**	**7.03**	**6.02**	**5.93**	**5.64**	**5.55**	**5.28**
	Female	White	6.82	7.25	7.09	6.19	6.12	5.77	5.55	5.23
		Nonwhite	8.08	7.25	8.12	5.83	5.93	6.05	5.45	5.27
		Total	**6.94**	**7.25**	**7.23**	**6.13**	**6.09**	**5.82**	**5.53**	**5.23**
	Total		**6.61**	**6.97**	**7.09**	**6.06**	**5.99**	**5.70**	**5.54**	**5.27**
75+	Male	White	9.80	10.36	11.12	10.01	5.93	9.18	8.65	8.49
		Nonwhite	10.01	9.22	11.53	7.86	9.47	7.01	7.72	6.52
		Total	**9.83**	**10.14**	**11.19**	**9.47**	**9.30**	**8.67**	**8.45**	**8.04**
	Female	White	10.29	13.06	11.54	9.51	8.62	9.12	9.06	9.16
		Nonwhite	19.39	14.95	10.46	9.84	9.78	7.61	6.70	6.59
		Total	**10.53**	**13.17**	**11.46**	**9.54**	**9.38**	**8.99**	**8.75**	**8.80**
	Total		**9.97**	**10.77**	**11.26**	**9.49**	**9.32**	**8.77**	**8.56**	**8.31**
Overall			**5.61**	**5.85**	**6.00**	**5.62**	**5.38**	**5.13**	**5.20**	**5.15**

Table A.18. Percent of drivers with serious (A+K) injury.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	4.20	3.50	2.85	4.52	4.28	4.91	4.54	4.28
		Nonwhite	3.18	2.54	2.09	3.26	3.81	4.36	4.55	3.79
		Total	**4.04**	**3.37**	**2.75**	**4.35**	**4.21**	**4.83**	**4.54**	**4.20**
	Female	White	3.15	2.79	2.49	4.50	4.59	5.35	5.12	4.75
		Nonwhite	2.50	1.81	1.12	2.23	2.75	4.84	4.58	3.76
		Total	**3.07**	**2.67**	**2.34**	**4.23**	**4.39**	**5.29**	**5.05**	**4.62**
	Total		**3.74**	**3.13**	**2.61**	**4.31**	**4.28**	**5.00**	**4.74**	**4.37**
18-20	Male	White	4.65	4.08	3.81	5.81	5.69	5.76	5.73	5.23
		Nonwhite	3.48	2.95	3.53	4.55	4.39	4.28	4.95	5.14
		Total	**4.38**	**3.82**	**3.75**	**5.55**	**5.42**	**5.44**	**5.55**	**5.21**
	Female	White	3.65	3.36	3.12	4.63	4.52	5.16	5.26	4.46
		Nonwhite	2.85	1.94	2.30	3.49	2.88	4.68	5.12	3.34
		Total	**3.49**	**3.08**	**2.96**	**4.41**	**4.23**	**5.07**	**5.23**	**4.20**
	Total		**4.13**	**3.60**	**3.51**	**5.20**	**5.04**	**5.32**	**5.44**	**4.84**
21-24	Male	White	4.77	4.23	3.80	5.91	5.58	5.90	5.95	4.68
		Nonwhite	3.99	3.36	3.23	4.49	4.91	5.50	5.79	4.33
		Total	**4.53**	**3.98**	**3.64**	**5.52**	**5.40**	**5.79**	**5.91**	**4.58**
	Female	White	3.24	2.87	2.75	4.65	4.57	5.05	5.07	4.12
		Nonwhite	2.99	2.62	2.39	3.51	4.22	5.17	4.65	4.20
		Total	**3.17**	**2.80**	**2.66**	**4.36**	**4.48**	**5.08**	**4.96**	**4.14**
	Total		**4.13**	**3.61**	**3.32**	**5.16**	**5.10**	**5.54**	**5.57**	**4.42**
25-54	Male	White	3.79	3.14	2.97	4.81	4.63	4.78	4.78	3.87
		Nonwhite	4.04	3.17	3.09	4.67	4.40	4.63	5.21	4.61
		Total	**3.85**	**3.15**	**3.00**	**4.77**	**4.57**	**4.74**	**4.90**	**4.07**
	Female	White	3.15	2.70	2.65	4.20	4.41	4.78	4.40	3.70
		Nonwhite	3.05	2.32	2.46	3.65	4.06	4.38	4.70	3.68
		Total	**3.13**	**2.61**	**2.60**	**4.06**	**4.32**	**4.68**	**4.48**	**3.69**
	Total		**3.62**	**2.96**	**2.86**	**4.52**	**4.48**	**4.72**	**4.74**	**3.92**

Table A.18. Percent of drivers with serious (A+K) injury (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	2.94	2.31	2.41	3.74	3.78	4.17	3.75	2.96
		Nonwhite	2.78	2.87	2.26	3.09	3.57	4.11	3.96	3.86
		Total	**2.90**	**2.45**	**2.38**	**3.58**	**3.73**	**4.16**	**3.79**	**3.16**
	Female	White	3.60	3.06	3.06	4.65	4.66	4.72	4.43	4.03
		Nonwhite	2.29	1.84	2.01	3.65	3.72	4.89	4.48	3.81
		Total	**3.34**	**2.82**	**2.86**	**4.46**	**4.48**	**4.76**	**4.44**	**3.99**
	Total		**3.03**	**2.57**	**2.54**	**3.87**	**3.99**	**4.37**	**4.03**	**3.47**
65-74	Male	White	3.41	2.94	2.85	3.80	3.77	4.19	4.34	3.36
		Nonwhite	4.11	2.15	1.98	3.09	2.43	3.81	3.93	2.96
		Total	**3.58**	**2.74**	**2.64**	**3.61**	**3.44**	**4.10**	**4.25**	**3.28**
	Female	White	4.33	4.17	3.49	5.27	4.93	5.56	5.22	4.55
		Nonwhite	6.22	3.51	2.45	2.82	3.44	4.63	3.59	3.65
		Total	**4.54**	**4.08**	**3.34**	**4.92**	**4.69**	**5.40**	**4.97**	**4.40**
	Total		**3.84**	**3.15**	**2.87**	**4.04**	**3.88**	**4.57**	**4.52**	**3.70**
75+	Male	White	4.99	4.51	3.33	5.17	5.14	5.93	5.60	4.37
		Nonwhite	4.04	4.10	4.36	3.50	3.33	4.28	4.78	3.64
		Total	**4.83**	**4.44**	**3.51**	**4.83**	**4.74**	**5.61**	**5.44**	**4.24**
	Female	White	3.61	3.20	4.22	5.16	5.01	7.29	6.07	5.60
		Nonwhite	20.83	9.62	4.29	7.14	8.41	4.76	4.90	5.67
		Total	**4.44**	**3.63**	**4.22**	**5.34**	**5.29**	**7.10**	**5.95**	**5.60**
	Total		**4.75**	**4.24**	**3.70**	**4.98**	**4.95**	**6.13**	**5.63**	**4.74**
Overall			**3.76**	**3.17**	**2.99**	**4.64**	**4.58**	**4.94**	**4.91**	**4.11**
(N)			**(7,379)**	**(7,157)**	**(7,633)**	**(10,736)**	**(10,619)**	**(12,170)**	**(13,495)**	**(12,244)**

Table A.19. Percent of drivers with any (K+A+B+C) injury.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	19.12	18.81	17.65	19.83	20.76	22.77	24.50	23.17
		Nonwhite	15.71	16.76	17.33	18.30	21.38	22.84	27.26	28.35
		Total	**18.59**	**18.53**	**17.61**	**19.63**	**20.84**	**22.78**	**24.92**	**23.99**
	Female	White	19.53	21.81	22.09	24.27	25.92	29.04	30.05	30.08
		Nonwhite	19.83	20.48	19.41	22.46	25.95	26.36	30.84	32.03
		Total	**19.57**	**21.66**	**21.78**	**24.05**	**25.92**	**28.73**	**29.82**	**30.33**
	Total		**18.90**	**19.58**	**19.02**	**21.11**	**22.61**	**25.00**	**26.97**	**26.52**
18-20	Male	White	20.53	21.00	20.13	22.73	22.64	24.82	25.97	23.97
		Nonwhite	20.18	20.00	20.20	22.83	22.21	25.73	28.11	28.67
		Total	**20.45**	**20.77**	**20.14**	**22.75**	**22.55**	**25.02**	**26.48**	**25.14**
	Female	White	22.50	22.48	23.67	25.40	26.44	30.59	31.42	30.17
		Nonwhite	22.24	24.31	24.59	26.27	24.72	32.32	33.74	33.13
		Total	**22.18**	**22.84**	**23.85**	**25.57**	**26.13**	**30.92**	**31.89**	**30.79**
	Total		**21.00**	**21.38**	**21.27**	**23.62**	**23.68**	**26.94**	**28.34**	**27.22**
21-24	Male	White	20.70	20.60	19.69	23.18	22.26	24.05	25.11	23.64
		Nonwhite	20.85	21.02	21.34	23.65	24.08	27.75	29.45	28.07
		Total	**20.75**	**20.72**	**20.16**	**23.31**	**22.75**	**25.08**	**26.35**	**24.91**
	Female	White	22.10	23.59	23.31	25.83	25.49	29.67	29.84	28.83
		Nonwhite	22.82	26.70	25.26	27.04	27.91	33.35	37.10	35.53
		Total	**22.29**	**24.39**	**23.82**	**26.14**	**26.07**	**30.59**	**31.63**	**30.60**
	Total		**21.20**	**21.87**	**21.34**	**24.20**	**23.85**	**26.99**	**28.24**	**27.05**
25-54	Male	White	17.58	17.24	17.43	19.88	19.98	21.54	23.04	21.42
		Nonwhite	19.12	19.43	19.77	21.15	21.66	24.39	27.32	25.61
		Total	**18.00**	**17.84**	**18.07**	**20.23**	**20.45**	**22.33**	**24.23**	**22.57**
	Female	White	21.74	22.33	22.47	24.94	25.72	28.84	29.77	29.11
		Nonwhite	25.02	25.99	25.75	27.81	28.28	33.01	36.09	35.04
		Total	**22.52**	**23.21**	**23.28**	**25.69**	**26.38**	**29.90**	**31.41**	**30.69**
	Total		**19.49**	**19.69**	**19.89**	**22.11**	**22.56**	**25.16**	**27.01**	**25.78**

Table A.19. Percent of drivers with any (K+A+B+C) injury (Cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	15.75	15.47	15.39	17.13	17.87	19.61	20.38	19.11
		Nonwhite	12.97	14.67	15.27	17.24	16.97	18.67	21.30	21.71
		Total	**15.04**	**15.27**	**15.36**	**17.15**	**17.67**	**19.40**	**20.58**	**19.38**
	Female	White	21.62	22.33	21.14	24.89	24.00	28.21	28.52	28.93
		Nonwhite	23.91	24.44	23.60	26.67	25.93	33.52	35.07	34.25
		Total	**22.09**	**22.73**	**21.61**	**25.23**	**24.37**	**29.24**	**29.87**	**29.96**
	Total		**17.17**	**17.64**	**17.41**	**19.85**	**19.95**	**22.92**	**23.99**	**23.47**
65-74	Male	White	15.48	15.39	15.75	16.30	16.70	18.94	19.29	19.36
		Nonwhite	15.38	15.47	13.08	14.24	13.20	17.61	19.38	20.22
		Total	**15.46**	**15.41**	**15.09**	**15.77**	**15.82**	**18.60**	**19.31**	**19.54**
	Female	White	22.36	21.81	21.13	23.12	22.33	26.30	26.89	27.73
		Nonwhite	24.00	27.57	20.04	19.31	21.48	30.19	28.16	30.02
		Total	**22.54**	**22.59**	**20.98**	**22.57**	**22.20**	**26.94**	**27.08**	**28.11**
	Total		**17.42**	**17.60**	**17.02**	**18.00**	**18.07**	**21.63**	**22.19**	**22.76**
75+	Male	White	16.94	17.93	16.27	16.88	18.07	20.63	20.83	20.27
		Nonwhite	20.50	17.95	15.15	13.81	15.96	20.72	22.32	19.95
		Total	**17.54**	**17.93**	**16.07**	**16.24**	**17.67**	**20.65**	**21.12**	**20.21**
	Female	White	23.14	19.47	23.09	22.37	21.36	28.34	25.07	25.11
		Nonwhite	33.33	30.77	21.43	21.43	25.23	26.98	25.98	34.82
		Total	**23.64**	**20.23**	**22.97**	**22.28**	**21.68**	**28.24**	**25.16**	**26.13**
	Total		**18.80**	**18.52**	**17.88**	**18.01**	**18.90**	**23.29**	**22.58**	**22.39**
	Overall (N)		**19.66 (38,563)**	**20.01 (45,182)**	**19.90 (50,770)**	**22.15 (51,297)**	**22.45 (52,071)**	**25.30 (62,345)**	**26.84 (73,789)**	**25.81 (76,816)**

Table A.20. Serious injuries (A+K) per 100 licensed drivers.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	.78	.69	.64	.82	.76	.93	.91	.96
		Nonwhite	.47	.36	.31	.38	.45	.56	.68	.72
		Total	**.72**	**.63**	**.57**	**.73**	**.70**	**.86**	**.86**	**.91**
	Female	White	.31	.32	.33	.47	.51	.69	.76	.81
		Nonwhite	.20	.15	.10	.16	.19	.40	.47	.50
		Total	**.29**	**.29**	**.29**	**.42**	**.46**	**.65**	**.71**	**.76**
	Total		**.52**	**.47**	**.44**	**.59**	**.59**	**.76**	**.79**	**.84**
18-20	Male	White	.67	.65	.67	.88	.84	.93	.95	.87
		Nonwhite	.49	.45	.55	.58	.56	.60	.81	.92
		Total	**.63**	**.60**	**.64**	**.81**	**.78**	**.85**	**.92**	**.88**
	Female	White	.23	.25	.26	.34	.35	.45	.52	.47
		Nonwhite	.19	.14	.19	.23	.19	.36	.47	.38
		Total	**.22**	**.23**	**.25**	**.32**	**.32**	**.43**	**.50**	**.45**
	Total		**.44**	**.43**	**.45**	**.58**	**.56**	**.66**	**.72**	**.67**
21-24	Male	White	.46	.45	.45	.63	.59	.63	.69	.57
		Nonwhite	.54	.44	.46	.56	.62	.72	.85	.67
		Total	**.48**	**.45**	**.45**	**.61**	**.59**	**.65**	**.73**	**.59**
	Female	White	.15	.15	.17	.25	.26	.32	.37	.33
		Nonwhite	.20	.17	.18	.22	.27	.38	.38	.40
		Total	**.16**	**.16**	**.17**	**.24**	**.27**	**.33**	**.37**	**.35**
	Total		**.33**	**.31**	**.32**	**.44**	**.44**	**.50**	**.56**	**.47**
25-54	Male	White	.22	.19	.20	.29	.27	.28	.29	.26
		Nonwhite	.44	.35	.35	.47	.42	.43	.51	.47
		Total	**.26**	**.22**	**.22**	**.33**	**.30**	**.31**	**.34**	**.30**
	Female	White	.10	.10	.10	.14	.15	.18	.18	.16
		Nonwhite	.17	.14	.15	.19	.20	.23	.26	.23
		Total	**.11**	**.10**	**.11**	**.15**	**.16**	**.19**	**.20**	**.18**
	Total		**.19**	**.16**	**.17**	**.24**	**.23**	**.25**	**.27**	**.24**

Table A.20. Serious injuries (A+K) per 100 licensed drivers (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	.14	.11	.13	.16	.16	.18	.17	.14
		Nonwhite	.25	.27	.21	.26	.27	.32	.31	.32
		Total	**.15**	**.14**	**.14**	**.18**	**.17**	**.20**	**.19**	**.17**
	Female	White	.10	.09	.09	.12	.11	.12	.12	.12
		Nonwhite	.13	.10	.11	.16	.15	.20	.21	.17
		Total	**.10**	**.09**	**.09**	**.12**	**.12**	**.13**	**.13**	**.12**
	Total		**.13**	**.11**	**.12**	**.15**	**.15**	**.16**	**.16**	**.14**
65-74	Male	White	.15	.14	.13	.15	.15	.16	.18	.15
		Nonwhite	.35	.20	.18	.26	.19	.30	.30	.23
		Total	**.18**	**.14**	**.14**	**.17**	**.16**	**.18**	**.19**	**.16**
	Female	White	.12	.13	.11	.14	.13	.15	.14	.13
		Nonwhite	.32	.21	.15	.13	.16	.21	.15	.17
		Total	**.14**	**.14**	**.12**	**.14**	**.13**	**.15**	**.14**	**.13**
	Total		**.16**	**.14**	**.13**	**.16**	**.15**	**.17**	**.17**	**.14**
75+	Male	White	.28	.25	.20	.25	.26	.28	.27	.22
		Nonwhite	.41	.40	.43	.33	.29	.35	.38	.29
		Total	**.29**	**.27**	**.22**	**.26**	**.26**	**.29**	**.28**	**.23**
	Female	White	.13	.13	.17	.17	.17	.25	.20	.19
		Nonwhite	1.52	.85	.32	.52	.46	.21	.26	.29
		Total	**.17**	**.16**	**.17**	**.19**	**.18**	**.25**	**.20**	**.19**
	Total		**.25**	**.23**	**.21**	**.23**	**.23**	**.27**	**.25**	**.21**
Overall			**.23**	**.21**	**.21**	**.28**	**.27**	**.30**	**.32**	**.28**

Table A.21. Any injuries (C+B+A+K) per 100 licensed drivers.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	3.54	3.71	3.94	3.60	3.67	4.31	4.90	5.18
		Nonwhite	2.34	2.35	2.58	2.11	2.51	2.94	4.07	5.38
		Total	**3.31**	**3.46**	**3.68**	**3.31**	**3.45**	**4.05**	**4.74**	**5.21**
	Female	White	1.92	2.48	2.88	2.52	2.86	3.76	4.45	5.13
		Nonwhite	1.60	1.73	1.78	1.65	1.80	2.20	3.15	4.27
		Total	**1.88**	**2.37**	**2.71**	**2.38**	**2.69**	**3.50**	**4.23**	**4.99**
	Total		**2.65**	**2.96**	**3.23**	**2.88**	**3.10**	**3.80**	**4.50**	**5.11**
18-20	Male	White	2.96	3.35	3.51	3.43	3.36	4.03	4.29	3.98
		Nonwhite	2.86	3.01	3.15	2.89	2.85	3.61	4.61	5.15
		Total	**2.93**	**3.27**	**3.42**	**3.30**	**3.24**	**3.93**	**4.37**	**4.25**
	Female	White	1.43	1.68	2.00	1.88	2.04	2.69	3.08	3.16
		Nonwhite	1.47	1.79	1.99	1.74	1.64	2.51	3.07	3.77
		Total	**1.44**	**1.70**	**2.00**	**1.86**	**1.96**	**2.65**	**3.07**	**3.29**
	Total		**2.24**	**2.54**	**2.75**	**2.62**	**2.64**	**3.33**	**3.76**	**3.79**
21-24	Male	White	2.01	2.18	2.33	2.48	2.34	2.55	2.92	2.86
		Nonwhite	2.83	2.77	3.07	2.93	3.02	3.63	4.30	4.32
		Total	**2.20**	**2.33**	**2.51**	**2.59**	**2.50**	**2.80**	**3.26**	**3.21**
	Female	White	1.01	1.27	1.44	1.39	1.47	1.85	2.19	2.31
		Nonwhite	1.49	1.76	1.88	1.68	1.78	2.43	3.00	3.39
		Total	**1.11**	**1.38**	**1.54**	**1.46**	**1.54**	**1.98**	**2.37**	**2.56**
	Total		**1.69**	**1.88**	**2.05**	**2.05**	**2.04**	**2.41**	**2.84**	**2.90**
25-54	Male	White	1.01	1.06	1.15	1.20	1.17	1.27	1.41	1.41
		Nonwhite	2.10	2.14	2.25	2.13	2.07	2.27	2.65	2.63
		Total	**1.19**	**1.25**	**1.35**	**1.38**	**1.34**	**1.46**	**1.66**	**1.65**
	Female	White	.69	.80	.86	.84	.88	1.07	1.21	1.28
		Nonwhite	1.43	1.51	1.52	1.45	1.42	1.70	2.03	2.16
		Total	**.80**	**.92**	**.97**	**.95**	**.99**	**1.19**	**1.37**	**1.46**
	Total		**1.01**	**1.09**	**1.16**	**1.17**	**1.17**	**1.33**	**1.52**	**1.56**

Table A.21. Any injuries (C+B+A+K) per 100 licensed drivers (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	.73	.75	.80	.75	.75	.82	.91	.91
		Nonwhite	1.17	1.37	1.42	1.42	1.26	1.45	1.68	1.82
		Total	**.89**	**.84**	**.89**	**.85**	**.82**	**.91**	**1.02**	**1.03**
	Female	White	.57	.63	.63	.63	.57	.71	.76	.83
		Nonwhite	1.36	1.34	1.29	1.17	1.05	1.39	1.62	1.52
		Total	**.66**	**.71**	**.71**	**.69**	**.63**	**.80**	**.87**	**.92**
	Total		**.74**	**.78**	**.81**	**.77**	**.73**	**.85**	**.95**	**.98**
65-74	Male	White	.68	.71	.74	.66	.66	.74	.78	.84
		Nonwhite	1.32	1.43	1.20	1.20	1.05	1.40	1.49	1.58
		Total	**.76**	**.81**	**.81**	**.74**	**.71**	**.83**	**.87**	**.94**
	Female	White	.64	.68	.68	.61	.59	.69	.72	.77
		Nonwhite	1.24	1.66	1.20	.86	1.00	1.36	1.17	1.40
		Total	**.68**	**.75**	**.73**	**.63**	**.63**	**.76**	**.76**	**.84**
	Total		**.73**	**.79**	**.77**	**.69**	**.68**	**.79**	**.82**	**.89**
75+	Male	White	.93	1.01	.96	.82	.91	.99	1.00	1.02
		Nonwhite	2.10	1.73	1.48	1.29	1.38	1.70	1.78	1.58
		Total	**1.05**	**1.09**	**1.02**	**.87**	**.97**	**1.07**	**1.10**	**1.09**
	Female	White	.84	.80	.91	.75	.71	.97	.82	.84
		Nonwhite	2.44	2.71	1.62	1.55	1.38	1.21	1.37	1.78
		Total	**.88**	**.86**	**.94**	**.79**	**.74**	**.99**	**.86**	**.90**
	Total		**1.00**	**1.02**	**.99**	**.84**	**.88**	**1.03**	**.99**	**1.00**
Overall			**1.22**	**1.33**	**1.41**	**1.36**	**1.33**	**1.54**	**1.74**	**1.77**

Table A.22. Serious (A+K) driver injuries per estimated million induced exposure miles.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	.38	.33	.26	.41	.39	.41	.39	.36
		Nonwhite	.25	.21	.17	.25	.27	.31	.33	.28
		Total	**.36**	**.31**	**.25**	**.39**	**.37**	**.39**	**.38**	**.35**
	Female	White	.21	.20	.18	.30	.32	.37	.38	.32
		Nonwhite	.16	.11	.07	.15	.17	.26	.30	.24
		Total	**.20**	**.19**	**.17**	**.28**	**.31**	**.35**	**.37**	**.31**
	Total		**.30**	**.26**	**.22**	**.35**	**.34**	**.37**	**.37**	**.33**
18-20	Male	White	.36	.33	.31	.47	.43	.43	.43	.39
		Nonwhite	.25	.23	.28	.30	.30	.28	.35	.36
		Total	**.33**	**.30**	**.30**	**.43**	**.40**	**.39**	**.41**	**.38**
	Female	White	.20	.19	.19	.27	.26	.28	.29	.25
		Nonwhite	.15	.10	.13	.18	.15	.26	.26	.18
		Total	**.19**	**.17**	**.18**	**.25**	**.24**	**.27**	**.29**	**.24**
	Total		**.28**	**.26**	**.25**	**.36**	**.34**	**.35**	**.36**	**.32**
21-24	Male	White	.29	.28	.26	.41	.37	.37	.38	.29
		Nonwhite	.26	.22	.23	.30	.32	.34	.36	.27
		Total	**.28**	**.26**	**.25**	**.38**	**.36**	**.36**	**.37**	**.29**
	Female	White	.15	.15	.15	.23	.22.	.23	.25	.21
		Nonwhite	.14	.13	.12	.17	.19	.23	.21	.20
		Total	**.15**	**.14**	**.14**	**.27**	**.21**	**.23**	**.24**	**.20**
	Total		**.23**	**.22**	**.21**	**.31**	**.31**	**.36**	**.32**	**.25**
25-54	Male	White	.19	.16	.16	.25	.23	.23	.23	.19
		Nonwhite	.24	.20	.20	.28	.25	.25	.28	.25
		Total	**.20**	**.17**	**.17**	**.25**	**.23**	**.23**	**.25**	**.20**
	Female	White	.13	.12	.12	.18	.18	.19	.18	.15
		Nonwhite	.14	.11	.12	.16	.17	.18	.19	.15
		Total	**.14**	**.12**	**.12**	**.17**	**.18**	**.19**	**.18**	**.15**
	Total		**.18**	**.15**	**.15**	**.22**	**.21**	**.21**	**.22**	**.18**

Table A.22. Serious (A+K) driver injuries per estimated million induced exposure miles (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	.16	.13	.13	.19	.18	.19	.17	.14
		Nonwhite	.17	.18	.14	.18	.20	.21	.22	.20
		Total	**.16**	**.14**	**.13**	**.19**	**.18**	**.19**	**.18**	**.15**
	Female	White	.17	.16	.16	.23	.22	.20	.18	.16
		Nonwhite	.13	.10	.12	.19	.18	.21	.21	.16
		Total	**.17**	**.15**	**.16**	**.23**	**.21**	**.21**	**.18**	**.16**
	Total		**.16**	**.14**	**.14**	**.20**	**.19**	**.20**	**.18**	**.16**
65-74	Male	White	.22	.20	.20	.22	.22	.23	.24	.17
		Nonwhite	.29	.16	.14	.20	.15	.23	.24	.17
		Total	**.23**	**.19**	**.19**	**.22**	**.20**	**.23**	**.24**	**.17**
	Female	White	.29	.30	.25	.33	.30	.32	.29	.24
		Nonwhite	.50	.25	.20	.16	.20	.28	.20	.19
		Total	**.31**	**.30**	**.24**	**.30**	**.29**	**.31**	**.27**	**.23**
	Total		**.25**	**.22**	**.20**	**.24**	**.23**	**.26**	**.25**	**.19**
75+	Male	White	.49	.47	.37	.52	.49	.54	.49	.37
		Nonwhite	.40	.38	.50	.28	.29	.30	.37	.24
		Total	**.48**	**.45**	**.39**	**.46**	**.45**	**.49**	**.46**	**.34**
	Female	White	.37	.42	.49	.49	.49	.67	.55	.51
		Nonwhite	4.04	1.44	.45	.70	.54	.36	.33	.37
		Total	**.47**	**.48**	**.48**	**.51**	**.50**	**.64**	**.52**	**.49**
	Total		**.47**	**.46**	**.41**	**.47**	**.46**	**.54**	**.48**	**.39**
Overall			**.21**	**.20**	**.18**	**.26**	**.25**	**.25**	**.25**	**.21**

Table A.23. Any (C+B+A+K) driver injuries per estimated million induced exposure miles.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	1.75	1.76	1.63	1.81	1.88	1.89	2.10	1.95
		Nonwhite	1.25	1.36	1.42	1.39	1.52	1.62	1.96	2.12
		Total	**1.66**	**1.70**	**1.59**	**1.74**	**1.82**	**1.84**	**2.07**	**1.98**
	Female	White	1.30	1.54	1.61	1.63	1.83	1.99	2.21	2.04
		Nonwhite	1.28	1.29	1.29	1.48	1.58	1.40	2.02	2.02
		Total	**1.30**	**1.51**	**1.57**	**1.61**	**1.80**	**1.91**	**2.18**	**2.03**
	Total		**1.53**	**1.63**	**1.59**	**1.69**	**1.81**	**1.87**	**2.12**	**2.00**
18-20	Male	White	1.57	1.67	1.64	1.84	1.70	1.85	1.93	1.78
		Nonwhite	1.45	1.54	1.58	1.52	1.52	1.68	2.00	2.02
		Total	**1.54**	**1.64**	**1.62**	**1.76**	**1.66**	**1.81**	**1.95**	**1.84**
	Female	White	1.23	1.30	1.43	1.49	1.50	1.64	1.74	1.71
		Nonwhite	1.18	1.29	1.34	1.34	1.28	1.77	1.74	1.75
		Total	**1.22**	**1.30**	**1.41**	**1.46**	**1.46**	**1.67**	**1.74**	**1.72**
	Total		**1.43**	**1.52**	**1.54**	**1.65**	**1.58**	**1.75**	**1.86**	**1.79**
21-24	Male	White	1.26	1.36	1.33	1.59	1.48	1.49	1.60	1.48
		Nonwhite	1.35	1.39	1.54	1.58	1.55	1.71	1.83	1.76
		Total	**1.28**	**1.37**	**1.39**	**1.59**	**1.50**	**1.55**	**1.67**	**1.56**
	Female	White	1.03	1.20	1.24	1.29	1.23	1.37	1.48	1.44
		Nonwhite	1.10	1.38	1.28	1.33	1.25	1.50	1.67	1.66
		Total	**1.05**	**1.25**	**1.25**	**1.30**	**1.23**	**1.40**	**1.53**	**1.50**
	Total		**1.20**	**1.32**	**1.34**	**1.48**	**1.39**	**1.49**	**1.61**	**1.53**
25-54	Male	White	.88	.90	.95	1.02	.99	1.03	1.13	1.04
		Nonwhite	1.15	1.21	1.27	1.25	1.25	1.30	1.48	1.38
		Total	**.95**	**.98**	**1.03**	**1.08**	**1.05**	**1.10**	**1.22**	**1.12**
	Female	White	.93	1.00	1.03	1.06	1.07	1.15	1.20	1.20
		Nonwhite	1.18	1.23	1.24	1.21	1.19	1.32	1.46	1.41
		Total	**.99**	**1.05**	**1.08**	**1.10**	**1.10**	**1.19**	**1.27**	**1.25**
	Total		**.96**	**1.01**	**1.05**	**1.09**	**1.07**	**1.14**	**1.24**	**1.18**

Table A.23. Any (C+B+A+K) driver injuries per estimated million induced exposure miles (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	.83	.84	.83	.87	.85	.89	.93	.90
		Nonwhite	.81	.94	.95	1.01	.98	.97	1.16	1.15
		Total	**.82**	**.86**	**.86**	**.90**	**.88**	**.91**	**.97**	**.95**
	Female	White	1.05	1.16	1.13	1.25	1.13	1.22	1.15	1.18
		Nonwhite	1.40	1.32	1.38	1.40	1.27	1.47	1.68	1.41
		Total	**1.11**	**1.19**	**1.17**	**1.28**	**1.15**	**1.26**	**1.24**	**1.23**
	Total		**.92**	**.97**	**.96**	**1.03**	**.97**	**1.04**	**1.08**	**1.06**
65-74	Male	White	.98	1.03	1.10	.96	.97	1.04	1.05	1.00
		Nonwhite	1.08	1.16	.93	.92	.83	1.08	1.17	1.17
		Total	**1.00**	**1.06**	**1.06**	**.95**	**.94**	**1.05**	**1.07**	**1.03**
	Female	White	1.52	1.58	1.50	1.43	1.37	1.52	1.49	1.45
		Nonwhite	1.94	2.00	1.63	1.13	1.27	1.83	1.54	1.58
		Total	**1.56**	**1.64**	**1.52**	**1.38**	**1.35**	**1.57**	**1.50**	**1.47**
	Total		**1.15**	**1.23**	**1.21**	**1.09**	**1.08**	**1.23**	**1.23**	**1.20**
75+	Male	White	1.66	1.86	1.81	1.69	1.71	1.89	1.80	1.72
		Nonwhite	2.05	1.65	1.75	1.09	1.38	1.45	1.72	1.30
		Total	**1.72**	**1.82**	**1.80**	**1.54**	**1.64**	**1.79**	**1.79**	**1.63**
	Female	White	2.38	2.54	2.67	2.13	2.09	2.58	2.27	2.30
		Nonwhite	6.46	4.60	2.24	2.11	1.62	2.05	1.74	2.29
		Total	**2.49**	**2.66**	**2.63**	**2.13**	**2.03**	**2.54**	**2.20**	**2.30**
	Total		**1.87**	**1.99**	**2.01**	**1.71**	**1.76**	**2.04**	**1.93**	**1.86**
Overall			**1.10**	**1.17**	**1.19**	**1.24**	**1.21**	**1.30**	**1.40**	**1.33**

Table A.24. Percentage of crashes at fault by driver age, sex, and race.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	65.18	64.52	64.47	66.05	66.69	65.72	65.98	66.13
		Nonwhite	62.15	61.01	60.03	59.22	60.18	61.88	60.90	63.19
		Total	**64.69**	**64.01**	**63.87**	**65.13**	**65.74**	**65.16**	**65.19**	**65.65**
	Female	White	60.65	60.39	60.82	61.45	63.41	64.10	65.81	63.08
		Nonwhite	58.72	57.70	59.17	60.56	58.52	56.16	62.83	62.27
		Total	**60.42**	**60.07**	**60.62**	**61.34**	**62.87**	**63.15**	**65.43**	**62.97**
	Total		**63.18**	**62.53**	**62.67**	**63.71**	**64.65**	**64.34**	**65.29**	**64.49**
18-20	Male	White	57.89	57.97	58.77	60.49	59.04	60.55	60.22	60.94
		Nonwhite	57.55	58.57	58.41	56.15	56.83	57.09	59.44	60.30
		Total	**57.81**	**58.11**	**58.69**	**59.53**	**58.56**	**59.78**	**60.03**	**60.78**
	Female	White	52.43	52.97	53.61	54.99	55.36	54.65	55.04	56.43
		Nonwhite	51.72	51.22	50.24	52.70	51.46	56.59	53.79	54.77
		Total	**52.29**	**52.61**	**52.93**	**54.53**	**54.65**	**55.03**	**54.78**	**56.04**
	Total		**56.05**	**56.26**	**56.71**	**57.79**	**57.16**	**58.04**	**58.02**	**58.87**
21-24	Male	White	48.87	50.75	50.77	53.75	53.97	53.64	54.12	54.14
		Nonwhite	54.23	52.66	55.00	55.78	55.40	54.32	54.68	55.46
		Total	**50.54**	**51.31**	**52.00**	**54.33**	**54.38**	**53.83**	**54.28**	**54.52**
	Female	White	46.40	47.25	48.07	48.05	48.41	48.99	50.75	50.65
		Nonwhite	48.30	48.45	45.49	49.03	46.69	46.63	46.20	48.01
		Total	**46.92**	**47.56**	**47.40**	**48.30**	**47.98**	**48.41**	**49.62**	**49.94**
	Total		**49.31**	**49.99**	**50.34**	**52.17**	**51.97**	**51.71**	**52.43**	**52.63**
25-54	Male	White	43.03	42.91	42.75	43.30	43.46	43.86	43.94	43.68
		Nonwhite	52.53	51.40	51.34	52.00	51.56	50.64	49.77	49.69
		Total	**45.61**	**45.21**	**45.11**	**45.77**	**45.72**	**45.76**	**45.59**	**45.34**
	Female	White	43.27	42.71	41.96	42.50	43.00	42.29	42.47	42.69
		Nonwhite	45.91	45.08	44.01	43.03	43.40	42.36	42.14	42.12
		Total	**43.88**	**43.27**	**42.46**	**42.64**	**43.10**	**42.31**	**42.38**	**42.54**
	Total		**44.98**	**44.47**	**44.09**	**44.57**	**44.69**	**44.34**	**44.22**	**44.14**

Table A.24. Percentage of crashes at fault by driver age, sex, and race (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	51.02	50.42	48.70	48.50	47.80	47.03	45.47	46.85
		Nonwhite	59.02	57.02	54.53	55.76	56.53	52.33	54.07	53.63
		Total	**53.07**	**52.03**	**50.05**	**50.26**	**49.77**	**48.21**	**47.35**	**48.35**
	Female	White	52.04	53.41	52.70	53.64	51.77	50.54	47.15	47.32
		Nonwhite	58.07	53.71	55.47	55.05	54.38	50.75	52.79	47.96
		Total	**53.20**	**53.47**	**53.21**	**53.90**	**52.28**	**50.58**	**48.26**	**47.44**
	Total		**53.11**	**52.52**	**51.15**	**51.57**	**50.68**	**49.13**	**47.71**	**47.99**
65-74	Male	White	62.96	61.94	62.62	59.98	60.33	58.77	57.91	56.48
		Nonwhite	65.17	66.57	63.24	64.33	63.99	62.82	61.07	59.46
		Total	**63.46**	**63.10**	**62.77**	**61.12**	**61.26**	**59.78**	**58.62**	**57.10**
	Female	White	66.08	67.23	65.19	63.87	65.28	64.04	62.78	59.77
		Nonwhite	70.20	66.41	68.61	59.55	63.74	65.85	62.04	59.97
		Total	**66.52**	**67.12**	**65.67**	**63.27**	**65.04**	**64.34**	**62.67**	**59.80**
	Total		**64.32**	**64.37**	**63.76**	**61.84**	**62.66**	**61.53**	**60.22**	**58.16**
75+	Male	White	75.92	76.27	77.55	77.26	77.57	77.09	75.34	74.81
		Nonwhite	75.47	73.06	76.99	71.83	73.92	69.75	71.07	67.16
		Total	**75.85**	**75.72**	**77.46**	**76.11**	**76.91**	**75.69**	**74.54**	**73.40**
	Female	White	77.78	82.18	79.62	77.25	79.36	78.25	78.33	78.12
		Nonwhite	75.00	80.65	76.92	72.41	62.86	75.73	67.81	70.10
		Total	**77.71**	**82.09**	**79.43**	**76.89**	**78.22**	**78.05**	**77.33**	**77.26**
	Total		**76.24**	**77.39**	**78.00**	**76.34**	**77.32**	**76.55**	**75.60**	**74.88**
(N)	(Total No. Drivers in Two Vehicle Crashes)		**114,862**	**134,966**	**154,362**	**135,250**	**136,761**	**147,033**	**164,933**	**180,127**

Table A.25. Percent of crashes at fault by driver race and sex.

Race / Sex	1974	1976	1978	1980	1982	1984	1986	1988
White Male	50.54	50.69	50.88	51.43	51.14	51.30	51.10	50.94
Nonwhite Male	55.38	54.55	54.50	54.71	54.56	53.55	53.41	53.51
White Female	48.69	49.03	48.93	49.29	49.69	49.32	49.52	49.35
Nonwhite Female	49.05	48.29	47.39	47.26	46.83	46.71	46.46	46.50

Table A.27. Percent of crashes involving alcohol by driver race and sex.

Race / Sex	1974	1976	1978	1980	1982	1984	1986	1988
White Male	10.25	10.18	9.91	12.66	12.05	8.40	8.14	6.22
Nonwhite Male	14.66	14.10	13.50	14.93	14.92	11.53	11.34	9.28
White Female	2.20	2.28	2.54	3.70	4.00	2.68	2.42	1.98
Nonwhite Female	3.25	2.92	3.11	3.58	3.46	2.59	2.39	2.24
Overall	8.61	8.31	8.08	10.06	9.71	6.82	6.51	5.09

Table A.26. Percentage of crashes involving alcohol by driver age, sex, and race.

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
16-17	Male	White	5.91	6.63	6.87	9.60	8.83	4.40	3.94	3.11
		Nonwhite	3.13	4.99	3.74	5.73	4.76	2.38	3.27	1.70
		Total	**5.48**	**6.40**	**6.45**	**9.08**	**8.27**	**4.11**	**3.84**	**2.88**
	Female	White	1.10	1.62	1.80	3.03	3.33	1.55	1.48	.91
		Nonwhite	.56	.84	.61	.74	1.22	.48	.71	.48
		Total	**1.03**	**1.53**	**1.66**	**2.75**	**3.10**	**1.43**	**1.39**	**.85**
	Total		**4.09**	**4.77**	**4.83**	**6.96**	**6.48**	**3.11**	**2.88**	**2.07**
18-20	Male	White	12.42	14.36	13.85	19.02	18.11	11.63	10.85	7.34
		Nonwhite	10.09	11.05	11.79	12.88	12.91	8.71	8.21	6.15
		Total	**11.87**	**13.60**	**13.40**	**17.75**	**17.01**	**11.01**	**10.22**	**7.05**
	Female	White	2.20	3.42	3.97	6.49	6.88	3.89	2.95	2.23
		Nonwhite	1.18	1.58	1.62	2.90	2.94	1.89	1.65	.73
		Total	**1.99**	**3.06**	**3.51**	**5.81**	**6.17**	**3.50**	**2.68**	**1.89**
	Total		**9.14**	**10.51**	**10.39**	**14.09**	**13.58**	**8.56**	**7.63**	**5.16**
21-24	Male	White	13.43	14.24	14.19	18.51	19.12	13.19	12.75	9.99
		Nonwhite	15.06	14.42	14.85	17.15	17.41	13.68	12.64	10.69
		Total	**13.92**	**14.29**	**14.38**	**18.14**	**18.66**	**13.32**	**12.72**	**10.19**
	Female	White	2.08	2.56	3.31	5.70	6.18	4.37	4.33	3.05
		Nonwhite	2.24	1.72	2.48	3.12	3.41	3.13	2.08	1.93
		Total	**2.13**	**2.34**	**3.09**	**5.05**	**5.52**	**4.06**	**3.78**	**2.75**
	Total		**10.45**	**10.55**	**10.75**	**14.00**	**14.31**	**10.11**	**9.53**	**7.39**
25-54	Male	White	11.03	9.84	9.50	11.51	10.89	8.34	8.40	6.69
		Nonwhite	18.61	17.10	15.80	16.88	16.77	13.32	13.44	11.13
		Total	**13.09**	**11.82**	**11.24**	**13.00**	**12.53**	**9.72**	**9.81**	**7.92**
	Female	White	2.73	2.36	2.51	3.25	3.63	2.67	2.47	2.25
		Nonwhite	4.54	3.91	4.01	4.16	3.99	2.92	2.90	2.90
		Total	**3.17**	**2.73**	**2.88**	**3.48**	**3.72**	**2.73**	**2.58**	**2.43**
	Total		**9.83**	**8.68**	**8.32**	**9.72**	**9.39**	**7.10**	**7.01**	**5.75**

Table A.26. Percentage of crashes involving alcohol by driver age, sex, and race (cont.).

Age	Sex	Race	1974	1976	1978	1980	1982	1984	1986	1988
55-64	Male	White	6.66	6.16	5.66	6.65	5.23	3.94	3.63	2.89
		Nonwhite	11.28	11.80	10.46	11.72	11.60	8.56	8.32	6.84
		Total	**7.83**	**7.56**	**6.78**	**7.87**	**6.67**	**4.99**	**4.66**	**3.75**
	Female	White	1.66	1.39	1.44	1.40	1.33	1.17	.88	.86
		Nonwhite	1.86	2.42	2.09	4.02	2.21	1.68	1.63	1.41
		Total	**1.70**	**1.59**	**1.57**	**1.91**	**1.50**	**1.27**	**1.03**	**.97**
	Total		**5.98**	**5.66**	**5.08**	**5.88**	**4.91**	**3.66**	**3.33**	**2.72**
65-74	Male	White	3.39	3.41	3.19	3.75	3.34	1.97	2.03	1.65
		Nonwhite	5.76	6.11	5.25	6.65	6.45	5.89	4.61	3.60
		Total	**3.94**	**4.07**	**3.70**	**4.50**	**4.12**	**2.96**	**2.62**	**2.07**
	Female	White	.56	.81	.38	.81	.75	.59	.47	.35
		Nonwhite	1.33	1.35	1.02	.87	1.03	1.05	1.29	1.26
		Total	**.65**	**.88**	**.47**	**.81**	**.79**	**.67**	**.59**	**.50**
	Total		**3.03**	**3.10**	**2.64**	**3.29**	**2.95**	**2.13**	**1.87**	**1.48**
75+	Male	White	1.77	.90	1.47	.87	1.24	.78	1.02	.76
		Nonwhite	3.73	1.54	3.73	3.13	2.98	1.81	1.88	1.89
		Total	**2.10**	**1.01**	**1.87**	**1.34**	**1.58**	**.98**	**1.19**	**.97**
	Female	White	.00	.14	.44	.00	.25	.06	.06	.19
		Nonwhite	.00	3.85	.00	1.02	.94	.00	.00	.00
		Total	**.00**	**.39**	**.41**	**.09**	**.30**	**.06**	**.05**	**.17**
	Total		**1.67**	**.85**	**1.49**	**.97**	**1.18**	**.66**	**.78**	**.68**
	Overall		**8.61**	**8.31**	**8.08**	**10.06**	**9.71**	**6.82**	**6.51**	**5.09**
	(N)		**(16,899)**	**(18,757)**	**(20,621)**	**(23,284)**	**(22,526)**	**(16,817)**	**(17,855)**	**(15,146)**