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DEMOGRAPHIC FACTORS AND TRAFFIC CRASHES: PART I – DESCRIPTIVE STATISTICS AND MODELS

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16. Abstract

This research analyzes the Department of Highway Safety and Motor Vehicle's (DHSMV) 1993 to 1995 crash data. There are four demographic variables investigated throughout the research, which are age, gender, race, and residency. To show general trends, descriptive statistics of crash rates was first introduced using exposure data. To identify high risk groups in certain Florida counties, the concept of relative risk was applied. The method of conditional probability was used to investigate the drivers' demographic differences in crash involvement. Log-linear models were used to determine the association between the different demographic factors and type, severity, and involvement in crashes. Major findings in this research were: (1) driver age between 19-24 tend to have higher crash involvement with head-on collision, on two-lane rural undivided highways, on curves, not wearing seat-belt, while cited for violation, and while speeding; (2) drivers aged between 25-64 tend to have higher crash involvement with rear-end and sideswipe collisions, on freeways, and associated with DUI; (3) elderly drivers tend to have higher crash involvement with angle and turning collisions, at intersections, while cited for violation, disregarding traffic sign or control; (4) male drivers tend to speed, not wear seat-belts, be more involved in severe or fatal injury crashes; (5) female drivers tend to, have high crash involvement at intersections and parking lots, angle and turning collisions, and disregarding stop and yield signs; (6) White drivers tend to speed, be involved in DUI related crashes; (7) Black and Hispanic drivers tend not to wear seat-belts; (8) local drivers tend to be involved in crashes related to speeding and not wearing seat-belts; (9) state and out-state drivers have higher involvement with DUI and severe and fatal injuries; (10) foreign drivers have more problems at intersections with turning maneuvers.

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DISCLAIMER

"The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Department of Transportation or the U.S. Department of Transportation. This report is prepared in cooperation with the State of Florida Department of Transportation and the U.S. Department of Transportation."

EXECUTIVE SUMMARY

This research analyzes the Department of Highway Safety and Motor Vehicle's (DHSMV) 1993 to 1995 crash data. This relational database consists of seven files. The study concentrates on the effect of demographic and roadway factors on traffic crash involvement. Four out of the seven files, which are event, vehicle, driver, and DOT site location files, were used in the study. There are four demographic variables investigated throughout the research, which are age, gender, race, and residency. The demographic variables of race and residency are considered unique since they were rarely addressed in the past. However, these two demographic variables are used as a surrogate measure for other variables, such as education, income, or driving behavior, which are not available in any crash database. Furthermore, environmental, roadway, and driver-related factors were analyzed and associated with these demographic variables.

This research illustrates a full range of methodological approaches used to analyze the data. To show general trends, descriptive statistics of crash rates was first introduced using exposure data (e.g. population or number of licensed drivers). To identify high risk groups in certain Florida counties, the concept of relative risk was applied. The method of conditional probability was used to investigate the drivers' demographic differences in crash involvement. Finally, a powerful way of analyzing categorical data, using log-linear modeling, was able to determine the association between the different demographic factors and type, severity, and involvement in crashes.

This research reached important findings and thus recommended fields of application or improvement to reduce the crash occurrence for certain demographic groups. Major findings in this research were: (1) driver age between 19-24 tend to have higher crash involvement with head-on collision, on two-lane rural undivided highways, on curves, not wearing seat-belt, while cited for violation, and while speeding; (2) drivers aged between 25-64 tend to have higher crash involvement with rear-end and sideswipe collisions, on freeways, and associated with DUI; (3) elderly drivers tend to have higher crash involvement with angle and turning collisions, at intersections, while cited for violation, disregarding traffic sign or control; (4) male drivers tend to speed, not wear seat-belts, be more involved in severe or fatal injury crashes; (5) female drivers tend to, have high crash involvement at intersections and parking lots, angle and turning collisions, and disregarding stop and yield signs; (6) White drivers tend to speed, be involved in DUI related crashes; (7) Black and Hispanic drivers tend not to wear seat-belts; (8) local drivers tend to be involved in crashes related to speeding and not wearing seat-belts; (9) state and out-state drivers have higher involvement with DUI and severe and fatal injuries; (10) foreign drivers have more problems at intersections with turning maneuvers.

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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

In 1992, Florida had the third largest number of fatal traffic crashes in the nation (2,170 fatal crashes) ranked after California and Texas. If the number of licensed drivers is to be considered, then Florida had one of the highest rates of fatality in the nation. About 29.4 percent of the fatal crashes occurred on Florida Freeways and Expressways. Moreover, in 1995, 15.3 percent of the fatal crashes resulted in the death of people 65 years and older. This result might indicate a particular problem for this age group because they make up a significant part of the driving population. Looking at specific cities, the crash related fatality rates per 100,000 of the population in Jacksonville, Miami, Tampa, and Orlando, were 12.18, 13.11, 19.28, and 10.93, respectively (1990 Census of the population). These statistics demonstrate that there are enormous loss of life and resources with direct social impacts on society (Abdel-Aty, 1996).

1.2. PROBLEM STATEMENT

Two major factors usually play an important role in the occurrence of a traffic crash. The first is related to the driver, and the second is related to the roadway design. Many of the important road-user factors in traffic safety depend strongly on the age and gender of the driver. U.S. male crash related fatalities outnumber female fatalities by well over a factor of two (Evans, 1991). According to Census Bureau figures, person's 65 years and older represent the fastest growing segment of the population in the United States. Between 1960 and 1980 the number of people in this age group increased by 54 percent. It is estimated that 50 million people representing about 17 percent of the population in the U.S. will be over the age of 65 years by the year 2020 (Abdel-Aty, 1996).

During the past decades the proportion of elderly drivers has increased, making their group a significant part of the driving population. Between 1965 and 1985 the driving population in the U.S. increased by 59.3 percent. During the same period, drivers between ages 60 and 69 increased 93.8 percent and drivers aged over 70 increased by 187.4 percent (Stamatiadis et al., 1991). Elderly female drivers experienced the highest growth during recent years. Between 1965 and 1985 female driving population of the 60-69 age group increased by 173.5 percent and the over-70 group increased by 446.5 percent, while the total growth for female drivers was only 87.3 percent. Male drivers showed an increase of 52.7 percent for the 60-69 age group and 105.7 percent for the over-70 group, which is almost three times larger than the increase of the total male driving population. This trend will continue to increase for at least the next few decades according to forecasts from the Bureau of census. It is very important to keep these statistics in mind when studying the effect of age and gender on traffic safety in Florida since Florida has one of the highest levels of elderly drivers in the nation due to the many retirees that reside in the state. It is important to note that not only the older drivers have a high risk of traffic crashes, several research works have found that younger drivers (16-24 years old) also have high crash risks. The inexperience and the willingness to take risks are the major factors contributing to their increased crash involvement (Abdel-Aty, 1996).

It is widely believed that age affects several driving characteristics that lead to crash occurrence. Driving inexperience or alcohol could be a factor in the increased crash risk for young drivers. Drivers' perception, reaction time, and perceptual judgment are affected by age. Older drivers need more perception and reaction times and sometimes have problems in judging the distance and speed on the roadway. This would lead to higher risk of crashes in locations such as left turns, where drivers need to judge the distance and speed of the coming vehicles. Other locations would be on- and off-ramps, stopping at the amber light at signalized intersections, and pedestrian locations (Abdel-Aty, 1996).

The traditional focus in safety research using the variables of age and gender is to be expected. Nearly all the available crash databases include only these two demographic variables. There is also a need to determine the effect of other demographic variables on the crash occurrence. Among these variables are the drivers' income level, race, and residency (which is a function of residential location, education, lifestyle and other characteristics). Income is addressed elsewhere (Part 2). In this report, race and residency are addressed along with age and gender.

As for the roadway design, which is the second major factor that affects crash occurrence, there are several elements of design that are found to influence traffic crashes. Among these design factors are both horizontal and vertical alignments, as well as the roadway grade (NCHRP report 374). Other design criteria are whether the roadway is divided or undivided, the number of lanes, and also the functional classification of the roadway that directly affect the access control and design speeds. Certain locations have high crash risks, such as highway interchanges, intersections, and railroad grade crossing.

1.3. RESEARCH OBJECTIVES

It is clear from the initial literature search that very few studies have attempted to associate both the demographic factors and the roadway design components or features with traffic crashes. Therefore, the basic objective of this research is to investigate relationships between different demographic groups and crash-related factors of traffic crash involvement in Florida. More specifically, the goals are:

1. to illustrate the full range of methodological approaches, such as crash rates, relative risk, conditional probability, or log-linear modeling to analyze the crash data;
2. to introduce demographic factors, other than age and gender, that affect the crash involvement;
3. to determine general crash rates for different demographic groups;
4. to identify high risk groups in certain Florida counties;
5. to address the difficulty of certain population groups (e.g., elderly drivers) in dealing with the roadway elements;
6. to investigate any association between the different demographic factors, the type severity, and involvement of crashes;

7. to identify and recommend field applications or improvements to reduce the crash occurrence for certain demographic groups on particular roadway locations.

1.4. DATA SOURCES

The Florida traffic crash database is the primary source for data. This electronic crash data is located in the Office of Management and Planning Service (OMPS). It is a relational database consisting of seven files. These files areV events, vehicle, driver, pedestrian, violations, passenger, and DOT site location files. The data used in this research are the 1993's to 1995's events, vehicle, drivers, and DOT site location files.

The Florida Visitor Study (1995), published by the Florida Department of Commerce's Office of Tourism Research, offers a wealth of data regarding the current status and historical nature of Florida's tourism industry. This resource was required to analyze non-residents' crash rates. (see Chapter 2)

Florida Traffic Crash Facts and Driver Licenses Data were obtained directly from the Florida Department of Highway Safety and Motor Vehicles. These were categorized and used as the exposure measures for the analysis of resident crash rates and relative risks.(see Chapters 2 and 3).

Florida Consensus estimating conference, State of Florida Population and Demographic Forecast, volume 10, Spring 1994, was utilized for the analysis of total crashes', including residents and non-residents, relative risk (see Chapter 3). Florida Census Data (1990) of General Population Characteristics for Age and Sex for Race by Hispanic Origin was used for the analysis of race residents' traffic crashes' relative risk (see Chapter 3).

CHAPTER 2

DESCRIPTIVE STATISTICS: CRASH RATES

2.1 METHODOLOGY

Three years of crash data, 1993 through 1995, were obtained from the Florida Department of Highway Safety and Motor Vehicles (DHSMV). The DHSMV data is a relational database that includes seven files for each year. These files include an event, drivers, and vehicles' file, which can be linked using the report number. Screening the data showed that the crash involvement patterns and rates are very close across the three years (1993-95). Most of the analysis presented here was from the year 1995.

The Vehicle Miles Traveled (VMT) and the number of licensed drivers was initially attempted to be used as exposure measures. However, the VMT sometimes provided inconsistent results since each source of VMT data in Florida provided different estimates. As generally known, there are several methods of estimating the VMT. They all involve many assumptions, and mostly include population projections. When using VMT for different age groups, the VMT is estimated as a function of the drivers licensed per capita [14]. When considering age, the basis for calculating the VMT is the number of licensed drivers in each age group. Thus, a more reliable exposure measure when addressing age should not use any projections but rather use the number of active drivers licenses for each age group in the year of the analysis. Therefore, the active number of licensed drivers was extracted from the state Department of Motor Vehicle's Drivers' data-base, and used as an exposure measure for the analyses presented in this research.

As indicated above, there is a need to evaluate the crash involvement of not resident drivers in Florida. The problem here becomes the exposure measure. Several approaches were considered to determine the crash rates by age. If the total crashes (involving residents and non-residents) are considered, the number of licensed drivers can not be used as an exposure measure since the available data are for residents only. However, a possibility is to use the population of each age group. Although the crash rates per capita can be determined, this is an inaccurate assumption since the population statistics do not include the non-residents of the state. Therefore, in the statistics presented in the following section, the crash rates for Florida residents and non-residents are separated. The numbers of active drivers' licenses is used as exposure for the residents, and the number of visitors per year are used for calculating the crash rates of the non-residents.

2.2 RESULTS

In 1995, the number of total crashes in Florida was 228,589. Crashes that involved at least one severe (non-incapacitating or incapacitating evident) injury for driver or passenger were 76,089 (33.3%), and crashes that involved at least one fatality were 2,586 (1.1%). Drivers involved in crashes were 385,923, of them 18291 (4.7%) were non-residents. Table 3.1 presents the crash involvement in 1995 by severity and residency. Injury crash is defined as the severity to be possible injury, non-incapacitating or incapacitating injury. The table depicts that the percent of injury crash involvement was higher for the residents compared to the non-residents, while the percent of fatal crash involvement was slightly higher for non-residents.

Table 2.1 Crash Involvement by Injury Severity and Residency

Injury Severity Residency	No Injury	Injury	Fatal	Total
Residents	221970 (60.4%)	144075 (39.2%)	1587 (0.4%)	367632 (100%)
Non-Residents	12354 (67.5%)	5834 (31.9%)	103 (0.6%)	18291 (100%)
Total	234324 (60.7%)	149909 (38.8%)	1690 (0.4%)	385923 (100%)

In the following section, the relationship between crash involvement and the drivers' age from different angles has been investigated. The relationships were analyzed separately for both residents and non-residents of Florida, as indicated above. The exposure used to determine the crash involvement rates for the residents is the number of licensed drivers for each age group, while the number of visitors from each age group is used for the non residents. Although there are 11 age categories used for the residents crash involvement, the age categories for the non residents is limited to only 6 groups due to the availability of statistics for only these groups (Florida Visitor Study, 1995).

2.2.1. Age and Crash Involvement

Figure 2-1 shows the number of Florida residents' total crash involvement by ages per 100 licensed drivers for the years, 1993-1995 (the number of active drivers licenses for each year is used as exposure for the relevant crash year). All three curves are similar in trend with teenage drivers having the highest average rate of 6.76 (i.e., 1993's rate is 6.4, 1994's rate is 6.63, and 1995's rate is 7.24). The rate then declines with each age group, reaching a low average rate of 1.38 for drivers in the 70-74 age group. Then, the rate starts to rise and reach an average rate of 1.80 (i.e. 1.53, 1.63, and 2.26 for the years 1993, 1994, and 1995, respectively) for drivers 85 and over. According to Figure 2.1, the total crash involvement seems to gradually increase from 1993 to 1995. However, this might be misleading, because of several factors related to reporting crashes might change from one year to another.

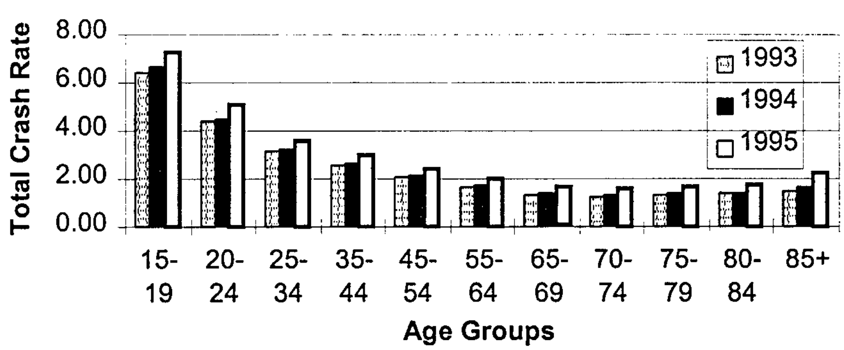


Figure 2-1 Residents' Total Crash Involvement by Age per 100 Licensed Drivers/year

Figure 2-2 shows the number of non-Florida-residents' total crash involvement by ages per 10,000 visitors/year. Non-Florida-residents are either out-of-state or foreign visitors. This figure is not comparable to Figure 2-1 since they do no have the same type of exposure. However, a similar relationship can be seen in Figures 2-1 and 2-2. They both show the classic U-shape curve for the relationship between crash involvement and age. The younger non-resident drivers are always the high risk groups with average crash rate of 6.73 involvement per 10,000 visitors (i.e. 6.68, 6.87, and 6.64, for 1993, 94 and 95, respectively). The rate then declines as age increase until 65 years old. The average rate at age group of 56-65 is 3.54. At the age group of 66+, the rate starts to go up again and reach an average of 3.62 . It is likely that the crash involvement rates could have continued to decrease till the age group 70-74 and then started to rise again as the case in Figure 2-1, but defining the elderly as being 66 years of age or older did not capture the exact trend.

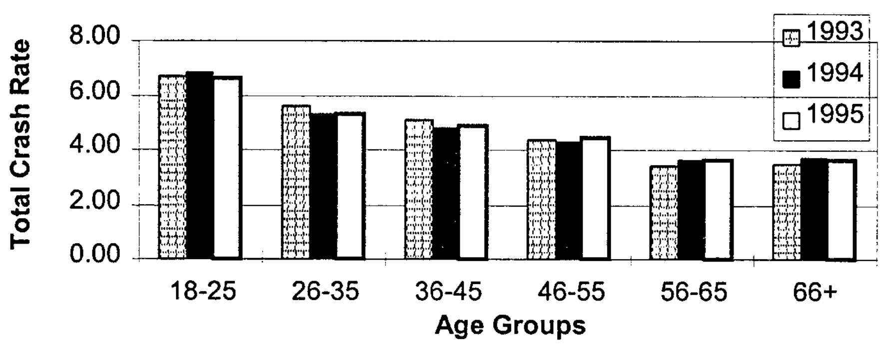


Figure 2-2 Non-Residents' Total Crash Involvement by Age per 10,000 visitors/year

Figure 2-3 shows the number of Florida residents' total crash involvement by drivers of fault and ages per 100 licensed drivers/year for 1995. The definition of a driver of fault is the vehicle driver who was cited for a moving violation that lead to the crash. The purpose of this analysis is to determine if the fault or violation of drivers might show different trend than that presented in Figure 2-1. Nevertheless, the curve depicts some similarities with Figure 2-1 (U-shape) except that the lowest crash involvement is now at age group of 65-69 with the rate of 0.54 crash involvement per 100 licensed drivers. Moreover, the upturn in the involvement rate for elderly drivers is steeper than the case of total crash involvement (Figure 2-1). The explanation might be that as drivers get older, they tend to be more involved in inappropriate driving maneuvers, probably due to the reduction in their driving capabilities. It seems that the same trend also occurs in the youngest age group. Perhaps due to their lack of driving experiences, the downturn of crash involvement rate for younger drivers who were cited for a moving violation is steeper as well. The crash involvement rates decrease from the age groups of 15-19 to 20-24 by 42 percent for the fault related involvement (Figure 2-3), while it only decrease by 29 percent if we consider all the crash involvement (Figure 2-1).

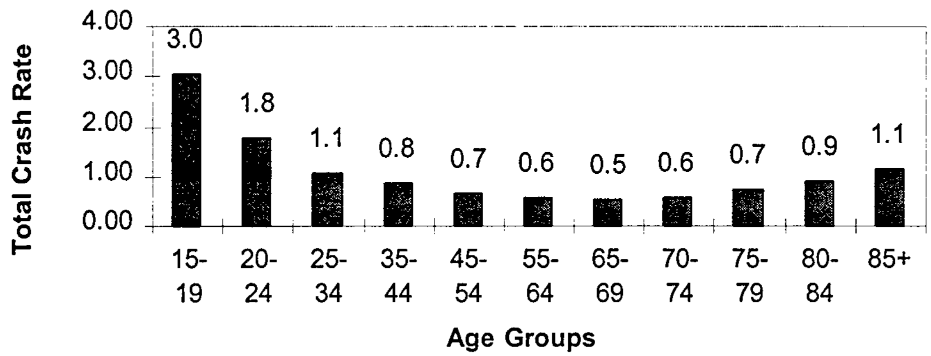


Figure 2-3 Residents' Total Crash Involvement (fault) by Age per 100 Licensed Drivers/year

Figure 2-4 shows the number of non-Florida residents' total crash involvement by drivers at fault and ages per 10,000 visitors/year for 1995. The curve is similar to Figure 2-3 with upturn rate for elderly drivers and downturn rate from the young drivers are steeper than total crash involvement (with both faulty and no-fault drivers). In Figure 2-2, the percentage of crash involvement rate reduction from age groups of 18-25 to 26-35 is 18%. The percentage of crash involvement rate increased from age groups of 56-65 to 66+ is 4%. In Figure 2-4, the percentage of crash involvement rate reduction from age groups of 18-25 to 26-35 is 30%. The percentage of crash involvement rate increased from age groups of 56-65 to 66+ is 39%. Again, this result proved our assumption that young and elderly drivers have higher tendency to be cited for moving violations when crashes occur.

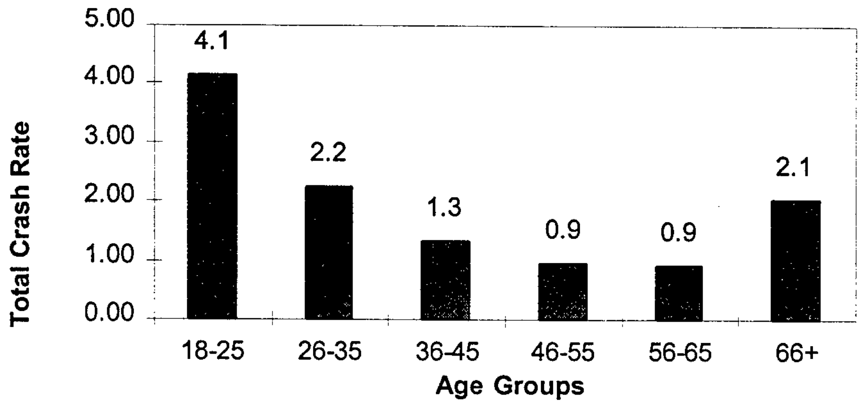


Figure 2-4 Non-Residents' Total Crash Involvement (fault) by age per10,000 visitor/year

Figure 2-5 shows the number of Florida residents' severe (non-incapacitating or incapacitating evident) injury crash involvement by age per 1,000 licensed drivers/year. The curve is similar to Figure 2-1 with lowest involvement rate of 2.76 at age group of 65-69. The teenage drivers are still the riskier group with the rate of 14.51. The involvement rate declines with each age group and rises after age of 69.

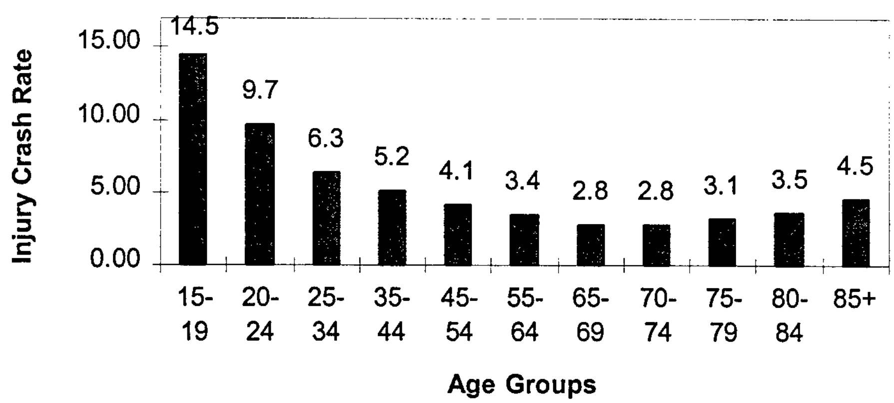


Figure 2-5 Residents' Severe Injury Crash Involvement by Age per 1000 Licensed Drivers/year

Figure 2-6 shows the number of non-Florida residents' severe injury crash involvement by ages per 10,000 visitors/year for 1995. The curve is similar to Figure 2.2 with lowest involvement rate of 0.38 at age group of 56-65. The teenage drivers are still the highest risk group with the rate of 1.90. The involvement rate declines with each age group and rises after age of 65.

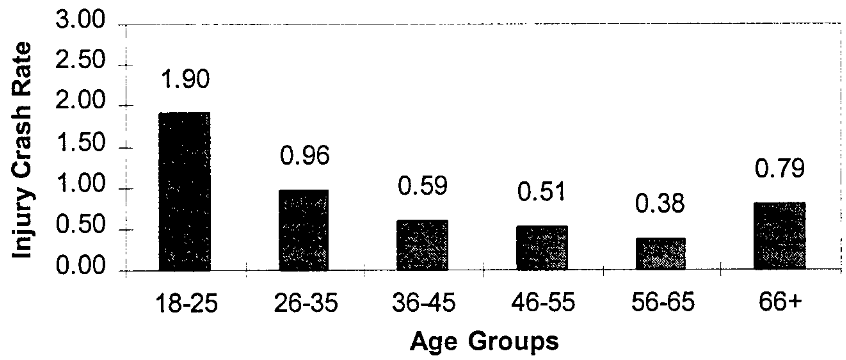


Figure 2-6 Non-Residents' Injury Crash Involvement by Age per 10,00 visitors/year

Figure 2-7 shows the number of Florida residents' fatal crash involvement by ages per 10,000 licensed drivers/year for 1995. The curve shows that the elderly drivers at ages 80 and above have the highest risk in terms of fatal crash with the rate of approximately 2.9. The rates of fatal crash start to go up dramatically after the age of 64. The teenage group is still having a high crash rate of 2.33 but rate goes down as drivers get older until the age group of 55-64.

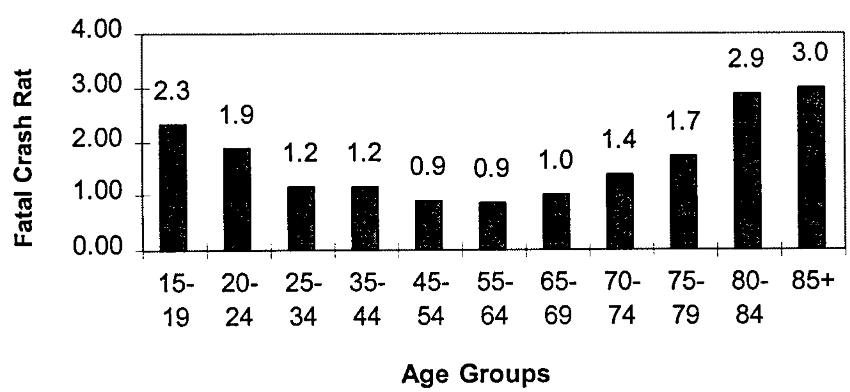


Figure 2-7 Residents' Fatal Crash Involvement by Age per 10,000 Licensed Drivers/year

Figure 2-8 shows the number of non-Florida residents' fatal crash involvement by ages per 1,000,000 visitors/year for 1995. The curve shows that the young drivers at age of 18-25 are still the highest risk people in terms of fatal crash with the rate of 6.66. The lowest rate of fatal crash is now at the ages of 36-45 with the rate of 0.79. After this age group, the fatal crash rate goes up again. At the age of 66 and above, the rate is also very high but not as high as the young driver's group. The explanation might be that group of 66+ is aggregate, and should be divided into smaller age groups to show the difference. The high fatality rates of older drivers could be explained by their physical weakness. The high fatality rates of the young drivers might be explained partially by the severity of the crash, which might be attributed to the young drivers' inexperience and tendency to speeding.

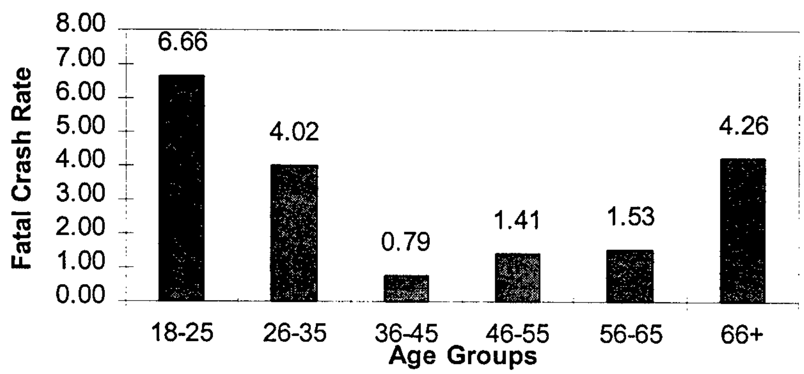


Figure 2-8 Non-Residents' Fatal Crash Involvement by Age per 1,000,000 Visitors/year

Figure 2-9 shows that number of Florida residents' total crash involvement by ages and genders per 100-licensed drivers/year for 1995. Both curves are similar in trend but different in rates. According to this figure, male drivers have about 1.5 times higher involvement rate than female drivers. However, whether male or female, the teenage drivers are still the riskier drivers with males' rate of 8.35 and females' rate of 6.06. The group with lowest involvement rate is between the ages of 70 and 74. After this age group, the rate starts to go up again.

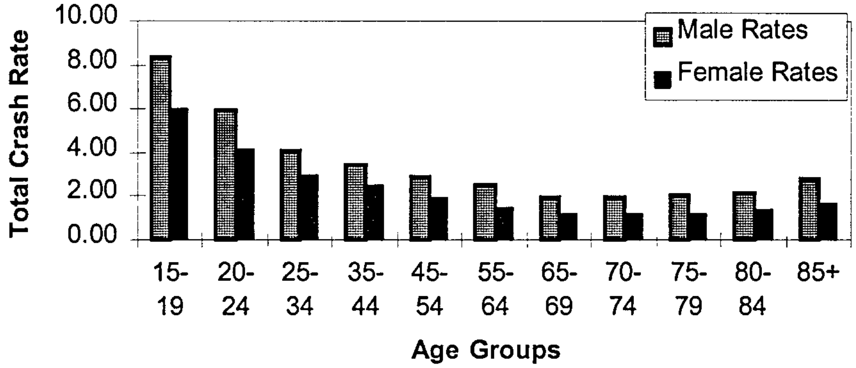


Figure 2-9 Residents' Total Crash Involvement by Age and Gender per 100 Licensed Drivers/year

Figure 2-10 shows that number of non-Florida residents' total crash involvement by ages and genders per 1000 visitors/year for 1995. Both curves are similar in trend but different in rates. According to this figure, male drivers have about 3 times higher involvement rate than female drivers. However, whether male or female, the teenage drivers are still the highest risk drivers with male's rate of 1.53 and females' rate of 0.57. The group with lowest involvement rate is between the age of 56 and 65. The rate then goes up after this age group.

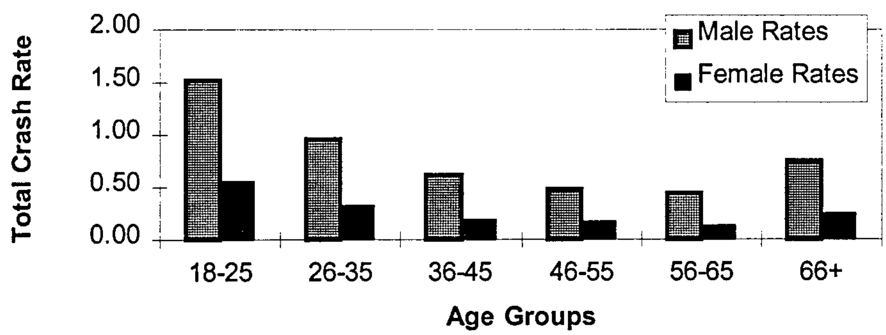


Figure 2-10 Non-Residents' Total Crash Involvement by Age and Gender per 1,000 visitors/year

2.2.2. Race and Crash Involvement

In this section we investigate the relationship between crash involvement and the drivers race, age or gender from different aspects. The relationships were analyzed with Florida residents only due to there being no exposure data for non-residents with race variable. The exposure used to determine the crash involvement rates is the general population characteristic of age and sex for race by Hispanic origin in the 1990 census data. We used eight age categories for the race groups' crash involvement since that is how census data categorized the groups. Table 3.2 presents the crash involvement and populations by Race in Florida.

Table 2.2 Crash Involvement and Populations by Race in Florida

Race Groups	Number of Crash Involvement	Florida Race Populations
White	244354	7933235
Black	59240	1200852
Hispanic	28205	1248573
Other	4099	143197
Total	335898	10525857

Figure 2-11 shows the rate of residents' total crash involvement by race per 100 race population / year for 1995. The chart shows that *Black* drivers have the highest risk of crash involvement with rate of 4.82 involvement per 100 *Black* people. *Hispanic* drivers, however, have the lowest risk of crash involvement with 2.22 involvement per 100 *Hispanic* people.

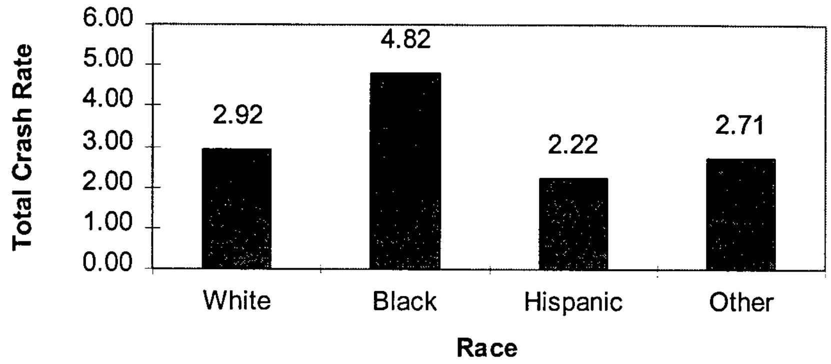


Figure 2-11 Residents' Total Crash Involvement by Race per 100 race population/year

Figure 2-12 shows the rate of residents' total crash involvement by race and gender per 100 race population / year for 1995. The chart shows that both *Black* male and female drivers have highest risk of crash involvement with rates of 6.11 involvement per 100 *Black* males and 3.70 involvement per 100 *Black* females. Overall, regardless of which race group analyzed, female drivers have relatively lower crash involvement rate than their same race male drives. In other word, female drivers have lower risk than male drivers.

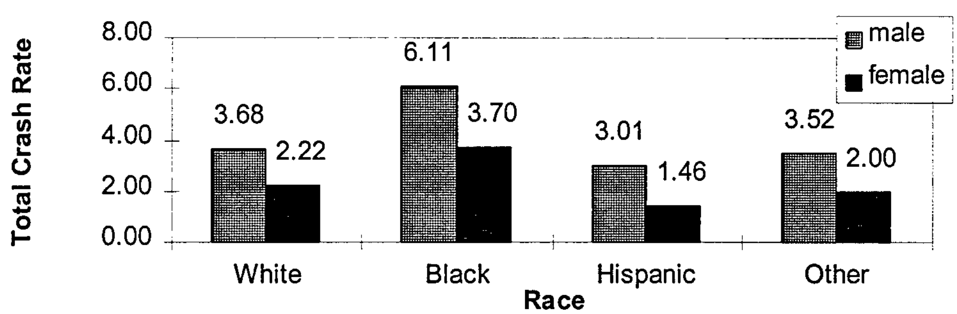


Figure 2-12 Residents' Total Crash involvement by Race and Gender per 100 race population/year

Figure 2-13 shows the rate of residents' total alcohol/drug involvement crash by race per 1000 race population / year for 1995. *Black* drivers overall have highest rate than other three race groups with rate of 3.93 involvement per 1000 race population. *White* drivers also have higher rate with 3.53 involvement per 1000 race population in term of alcohol/drug involved. *Hispanic* drivers, however, have the lowest crash involvement rate with 2.14 involvement per 1000 race population.

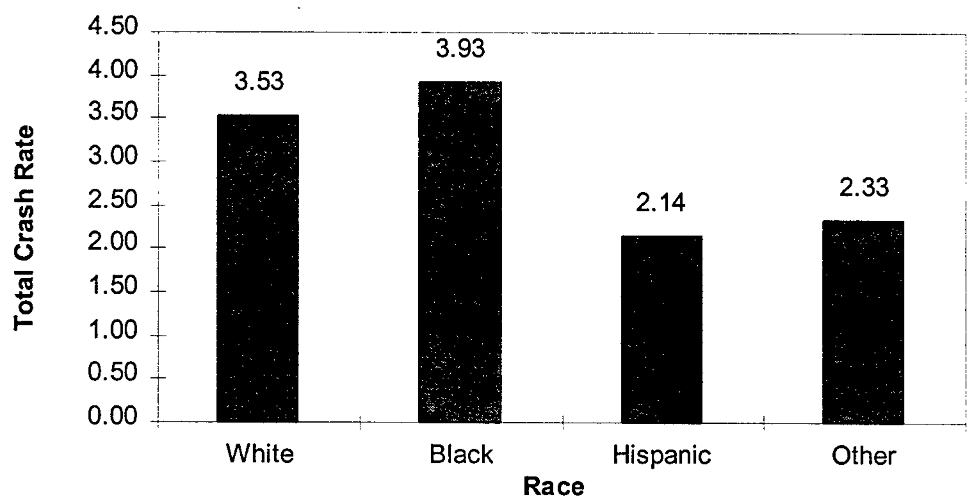


Figure 2-13 Residents' Total Alcohol/Drug Involvement Crashes by Race per 1000 race population/year

Figure 2-14 shows the race of residents' total "No Seat-Belt Use" crash involvement by race per 1000 race population / year of 1995. The figure shows that *Black* drivers have double the involvement rate with 7.74 involvement per 1000 race population than any other three groups. This might due to their lack of traffic safety education.

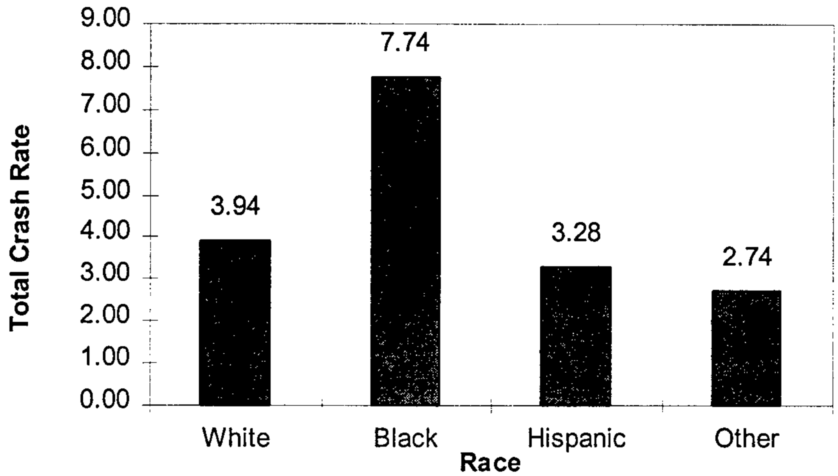


Figure 2-14 Residents' Total "No Seat-Belt Use" Crash Involvement by Race per 1000 race population/year

Figure 2-15 shows the rate of residents' total crash involvement by race and age per 100 race population / year for 1995. The curve shows that *Black* middle age drivers from age of 35 to 44 have highest risk of crash involvement with rate of 5.64 involvement per 100 *Black* people in this age group. As for elderly drivers of age 85 and above, *Other* race drivers have the highest risk of crash involvement with rate of 3.20 involvement per 100 *Other* race people. The curve follows the classical U-shape curve for *White* drivers with higher crash rates on both ends. However, *Black* drivers' curve has different shape with higher risk in the middle age group. The reason might be due to economic situation (income level).

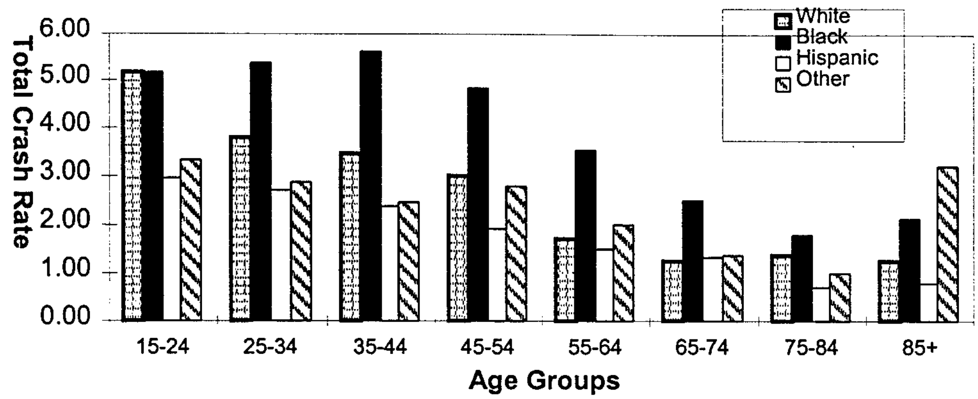


Figure 2-15 Residents' Total Crash Involvement by Race and Age per 100 race population/year

Figure 2-16 shows the rate of residents' total crash involvement by race and age drives at fault per 100 race population / year for 1995. The results with four different race groups form a U-shape curve. This indicate that regardless at what race groups, young and elderly drivers are more likely to be the drivers at fault, who were cited for a moving violation that lead to crashes. Nevertheless, when we look closely at *Hispanic* group the curve shows that there is no upturn rate for elderly drivers at fault.

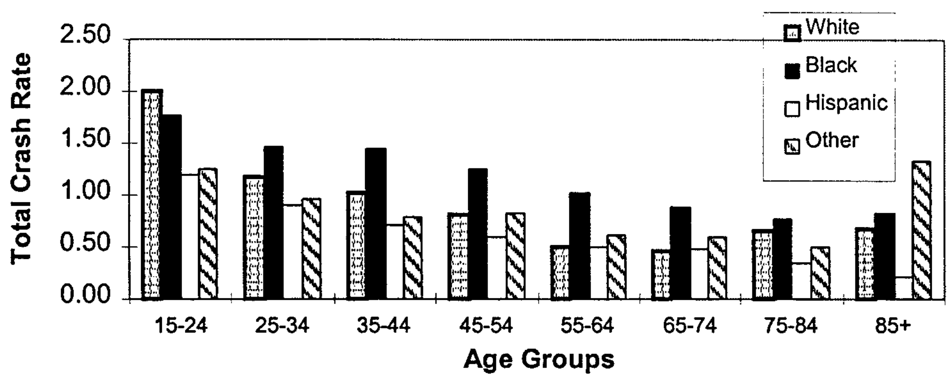


Figure 2-16 Residents' Total Crash Involvement (Fault) by Race and Age per 100 race population/year

Figure 2-17 shows the rate of residents' total sever crash involvement by race and age per 100 race population / year for 1995. This figure is similar to figure 3-5 except the rate is different. However, *Other* race group of 85+ shows extremely high crash involvement with severe injuries. This result is hard to interpret.

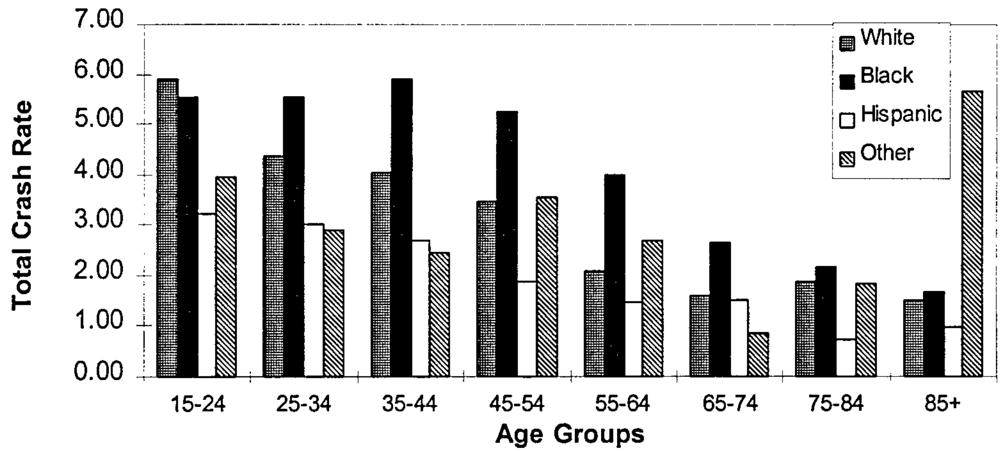


Figure 2-17 Residents' Total Sever Crash Involvement by Race and Age per 1000 race population/year

Figure 2-18 shows the rate of residents' total fatal crash involvement by race and age per 1000 race population / year for 1995. This figure is not quite similar as figure 2-17, because *Other* race group drivers at age of 15 to 24 and 75-84 are now have highest risk fatal crash involvement with the rate of 5.69 and 9.20 involvement per1000 *Other* race population. Moreover, *Black* at the age of 85+ has high crash involvement rate with 6.43 per 10000 race population.

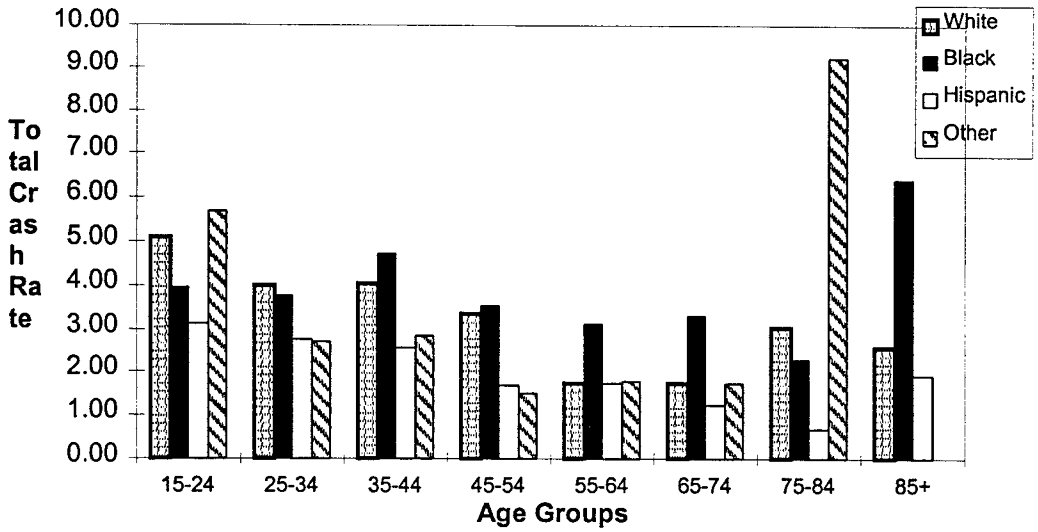


Figure 2-18 Residents' Total Fatal Crash Involvement by Race and Age per 10000 race population/year

Figure 2-19 shows the rate of total alcohol/drug involvement crashes by age and race per 1000 race population / year for 1995. This figure is similar to figure 3-5. The curve shows that the drivers of age 25 to 34, especially *White* young drivers, have the highest risk of being involved in crashes that related to alcohol/drug involvement with the rate of 5.68 involvement per 1000 *White* people. However, as the age increase and after age of 44, compare with other race groups, *Black* drivers now have higher risk of being involved in crashes that related to alcohol/drug with rate of 5.33 per 1000 race population. Nonetheless, at the age of 85 and above, the *Other* race group has higher risk with a rate of 1.88 involvement per 1000 *Other* race population.

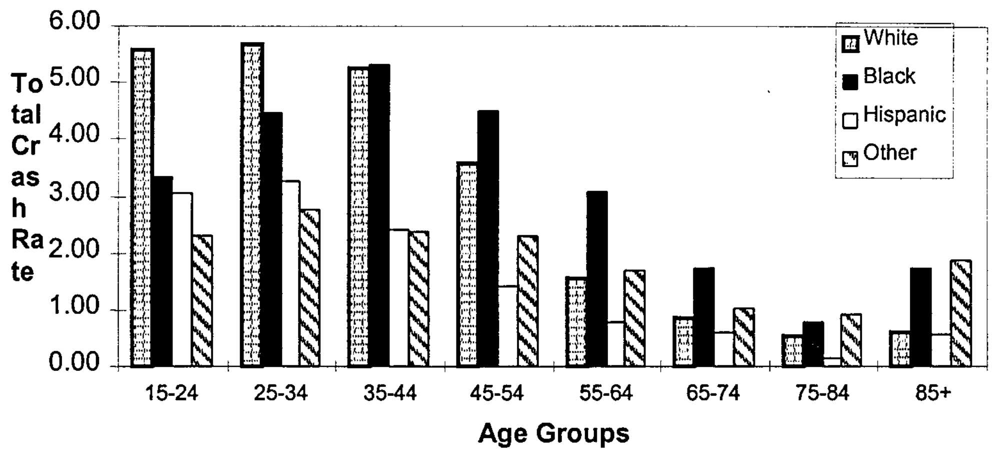


Figure 2-19 Residents' Total Alcohol/Drug Involvement Crashes by Age and Race per 1000 race population/year

Figure 2-20 shows the rate of residents' total "no seat-belt use" crash involvement by age and race per 1000 race population / year for 1995. This figure is similar to figure 6 except that it shows the *Black* young drivers at age of 15-24 have the highest "NO SEAT-BELT USE" crash involvement than any other groups with rate of 10.46 involvement per 1000 *Black* young people. The elderly *Other* race group drivers at age of 85 and above have higher risk of "NO SEAT-BELT USE" crash involvement with rate of 5.65 involvement per 1000 *Other* race people in this age group.

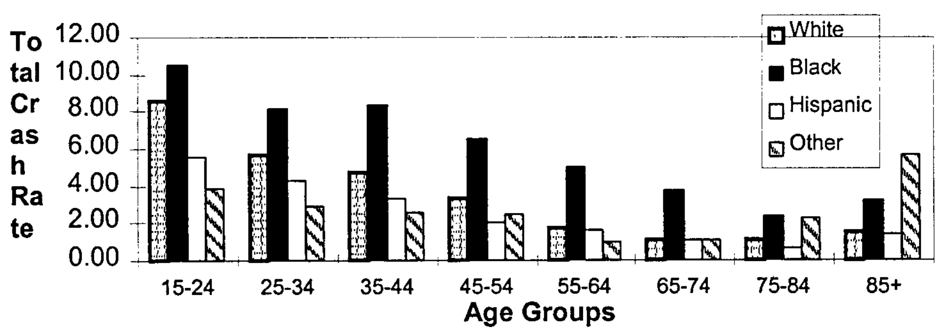


Figure 2-20 Residents' Total " No Seat-Belt Use" Crash Involvement by Age and Race per 1000 race population/year

2.3. CONCLUSIONS

The results showed that the relationship between age and crash involvement follows the traditional U-shape, with very high rates in particular for age bellow 25. Severe injury crash involvement rates generally follows the same trend, but fatal crash involvement rates are very high for drivers of the age 80 and above. Considering the drivers at fault in a crash showed that the U-shape is maintained, however, it becomes lower in the middle and higher on the edges particularly for the younger ages. This means more crash involvement for the younger and older ages where they were cited or committed inappropriate maneuver. Considering gender and age showed that both males and females have almost the same crash involvement trends, but males' rates were roughly 50 percent higher.

As for the relationships between race and crash involvement, the result shows that, in general, *Black* residents have the highest total crash involvement per 100 race population / year. Without taking age into account, *Black* female drivers have the highest crash involvement rate considering alcohol/drug and without seat-belt used variables. *Black* drivers have the highest rate per 1000 race population /year. When including age, the curve shifts and becomes higher for alcohol/drug involvement for young *White* drivers and middle age *Black* drivers. The no seat-belt used curve, however, is the traditional U-shape curve.

The result of race residents' total crash involvement while considering age depicts that *White* , *Hispanic*, and *Other* drivers' crash rates follow a traditional U-shape curve. However, *Black* drivers' crash rate seems like a wave shape where the highest crash rates are not at the two ends but rather on the center (middle age group, 35-44 year-old). This might indicate that perhaps income might be a factor since less young Black own and drive cars. As for the drivers at fault in a crash, four race groups have the traditional U-shape curve. The original assumption is that it means more crash involvement for the young and older drivers where they were cited or committed inappropriate maneuver.

As for severe and fatal injuries, *White* drivers have a higher rate than the other races in young age (15-24), *Black* drivers have a higher rate in middle age (35-44), and *Other* drivers have higher severe crash rate ate 85+ and a higher fatal crash rate at 75-84. *Hispanic* drivers, however, do not have very high crash rates compared with the other race groups, but their crash rate follows the U-shape curve with the higher rates at both ends, which means that young and elderly drivers have a higher risk.

CHAPTER 3

RELATIVE RISK

3.1. METHODOLOGY

The method applied in this chapter is called the relative risk. The procedure for determining the relative risk is as follows:

p_1 = crash frequency for an age group in a particular county /population (or licensed drivers) in this age group in this county

p_2 = total crash frequency in a particular county /total population (or licensed drivers) in this county

Relative risk = p_1 / p_2

Another way of viewing relative risk is to divide the percentage of crash involvement of each age group in each county by the percentage of an exposure measure (No. of licensed drivers or population in the same year) of the relevant age group in the same county. If the relative risk is greater than one, this means that this age group is over-represented in their involvement in crashes (i.e., their percent of crash involvement in the county is larger than their percentage in the exposure in the county), which is an indication of risk in this age group. If the relative risk is less than or equal to one, then there is no risk for this age group. As for the analysis of relative risk with different race groups, the same approach was applied but using only the population as the exposure measure since license data do not contain race.

The first part in this section is analyzing the relative risk for 1995's total (residents and non-residents) and residents-only crashes for age vs. counties. For total crashes, the exposure used here is the population of each county. To determine the relative risk for 1995's residents-only crashes for age vs. counties, instead of using the population as an exposure measurement, the number of licensed drivers is used to calculate the risk. The second part of this section contains the relative risks of race groups in different counties for 1995 total crashes. Since the license data did not contain race information, the only available exposure measure for the time been is the population data.

3.2. RESULTS

3.2.1. AGE AND COUNTY

The approach explained above was performed on the 1995's crash data for all the age groups, including both residents and non-residents for every county in the state of Florida. The exposure used here is the population of each county that does not include the non-resident population. Then, the relative risks were divided into categories to show the different levels of crash involvement risk. The categories are: 1.01-1.5, 1.51-2, 2.01-2.5, 2.51-3, and >3.

In Appendix A, Tables A-1 and A-2 provides the percentage of population and the percentage of crash involvement by age and county for the 1995's total crash involvement. Table A-3 shows the relative risk by age and county for the 1995's total crash involvement. As for the residents-only crashes, Table A-4 and A-5 provides the percentage of licensed drivers and the percentage of crash involvement by age and county for the 1995's data. Table A-6 shows the relative risk by age and county for the 1995's residents-only crashes. The results of this analysis indicate that the high relative risk groups are the age groups of 15-19, 20-24, and 25-34 and somewhat the age group of 35-44 in most counties. Nevertheless, drivers' ages between 15-19 and 20-24 have higher relative risks than other age groups. For example, the highest relative risk for total crashes of drivers' age 15-19 is at Union County with the ratio of 3.27 and for the residents-only crashes, the highest relative risk for teenage is at Taylor with ratio of 3.75. The highest relative risk for total crashes of drivers' age 20-24 is at Lake County and for the residents-only crashes, the highest relative risk for teenage is at Suwannee County with ratio of 2.15.

Elderly groups from age of 65 and above do not seem to have a problem. The relative risk for residents-only crashes illustrates a similar manner as the total crashes, except that elderly group of 85+ indicates some problem in certain counties such as Jefferson County with ratio of 2.47. Figures 3.1 and 3.2 illustrates the relative risks for the teenage and the elderly (>85) drivers, respectively. The figures are based on Table A.6, and illustrate the counties in which these two age groups are over-involved in crashes.

3.2.2. RACE AND COUNTY

To find the relative risk of race by county, Tables A-7 and A-8 provide the percentage of population and the percentage of crash involvement by race and county for the 1995's total crash involvement. Table A-9 shows the relative risk by race and county for the 1995's total crash involvement. The results of the race vs. county depict that the relative risk for total crashes indicates that the Black drivers have higher relative risk in most counties. The highest relative risk for Black drivers was in the Collier County with ratio of 2.22.

White drivers have relative risk slightly higher than unity that means the percentages of White driver crashes in certain counties are slightly higher than the percentages of White population in those counties. The highest relative risk county for White drivers is the Dade county with ratio of 1.63.

There are few counties that have high relative risk for Hispanic drivers. However, the counties that indicate problems for Hispanic drivers have very high ratio. For example, county Gadsden and Liberty both have relative risks greater than three. This means that the percentages of Hispanic crashes in these counties are three times greater than their percentages of Hispanic population in these counties.

As for the Other race group, only 12 counties indicate greater than one relative risk. The highest relative risk county is the Dixie County with ratio of three. Figure 3.3 shows the race that had the highest crash relative risk for each county. The figure is based on TableA.9.

3.3. CONCLUSIONS

The results of relative risk analysis does not indicate total (both residents and non-residents) elderly drivers to be the highest risk group; however, in certain counties, the relative risk analysis shows that resident elderly drivers might have safety problems. As for the younger drivers, age below 24 years old, are the highest risk group. Perhaps, this is the reason that auto insurance tends to be higher for drivers younger than 25 years old. As for the race groups, it seems that Black drivers have higher relative risks in most of the counties. The White drivers have more close to unity relative risks. The Hispanic drivers do not have many counties with ratios greater than one, but the counties with ratio greater than one have relatively high risk. As for the Other race drivers, there are only 12 counties that show risks and only two counties (Dixie and Gulf) with very high ratio.

An important recommendation to the state law enforcement and DOT officials is to target these specific counties with educational and awareness programs.

Figure 3.1. Relative Risk of the (15-19) Age Group (Residents)

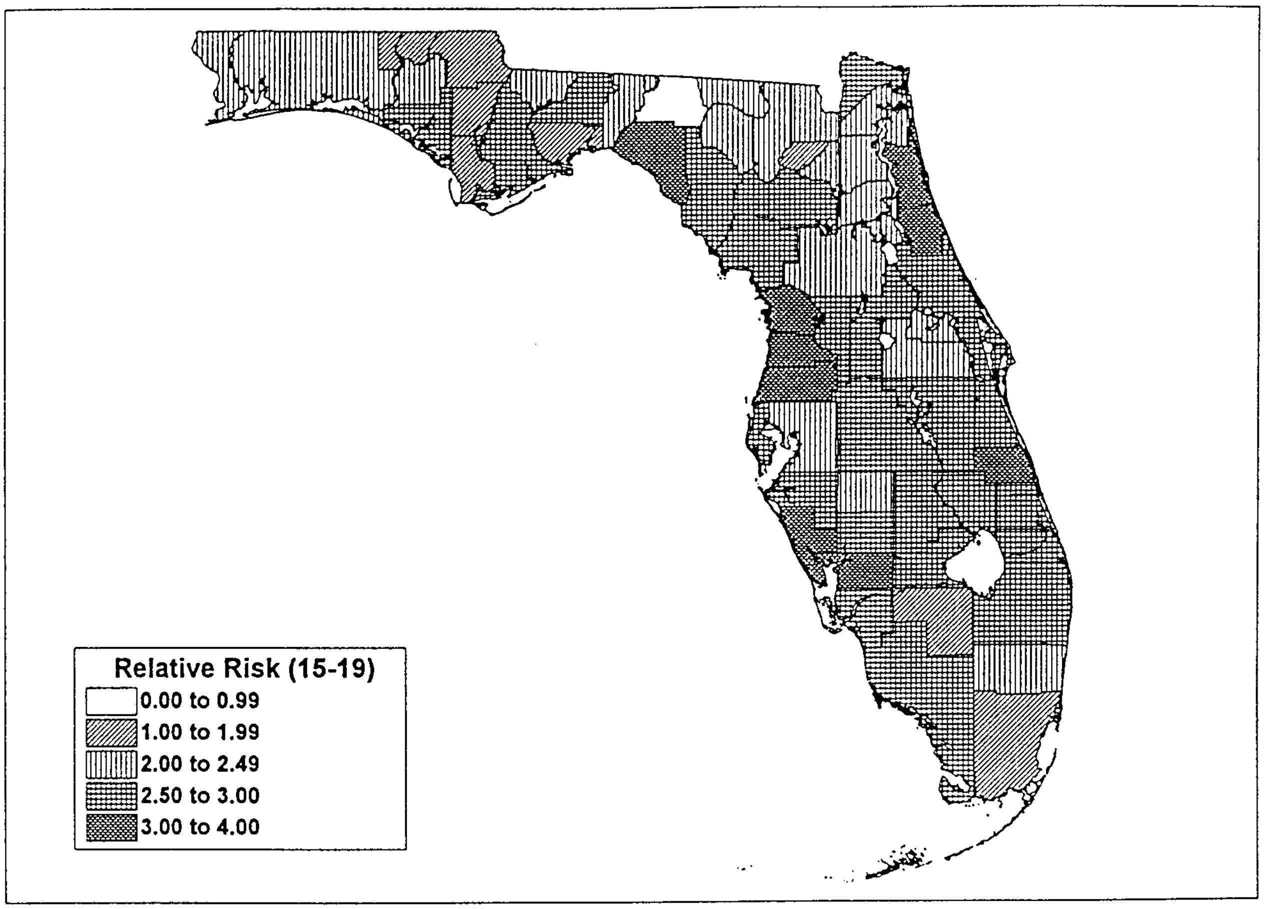


Figure 3.2. Relative Risk of the (85+) Age Group (Residents)

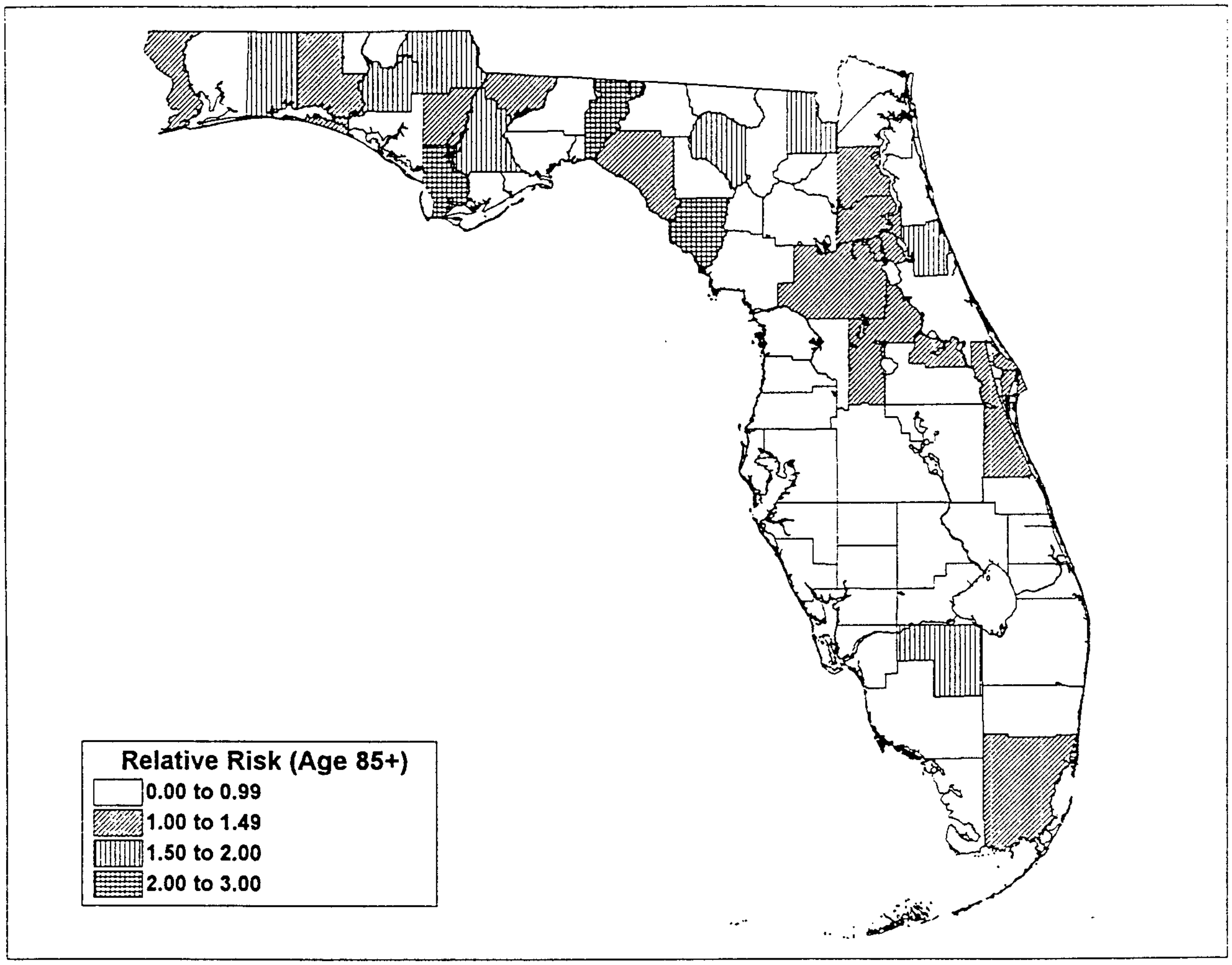
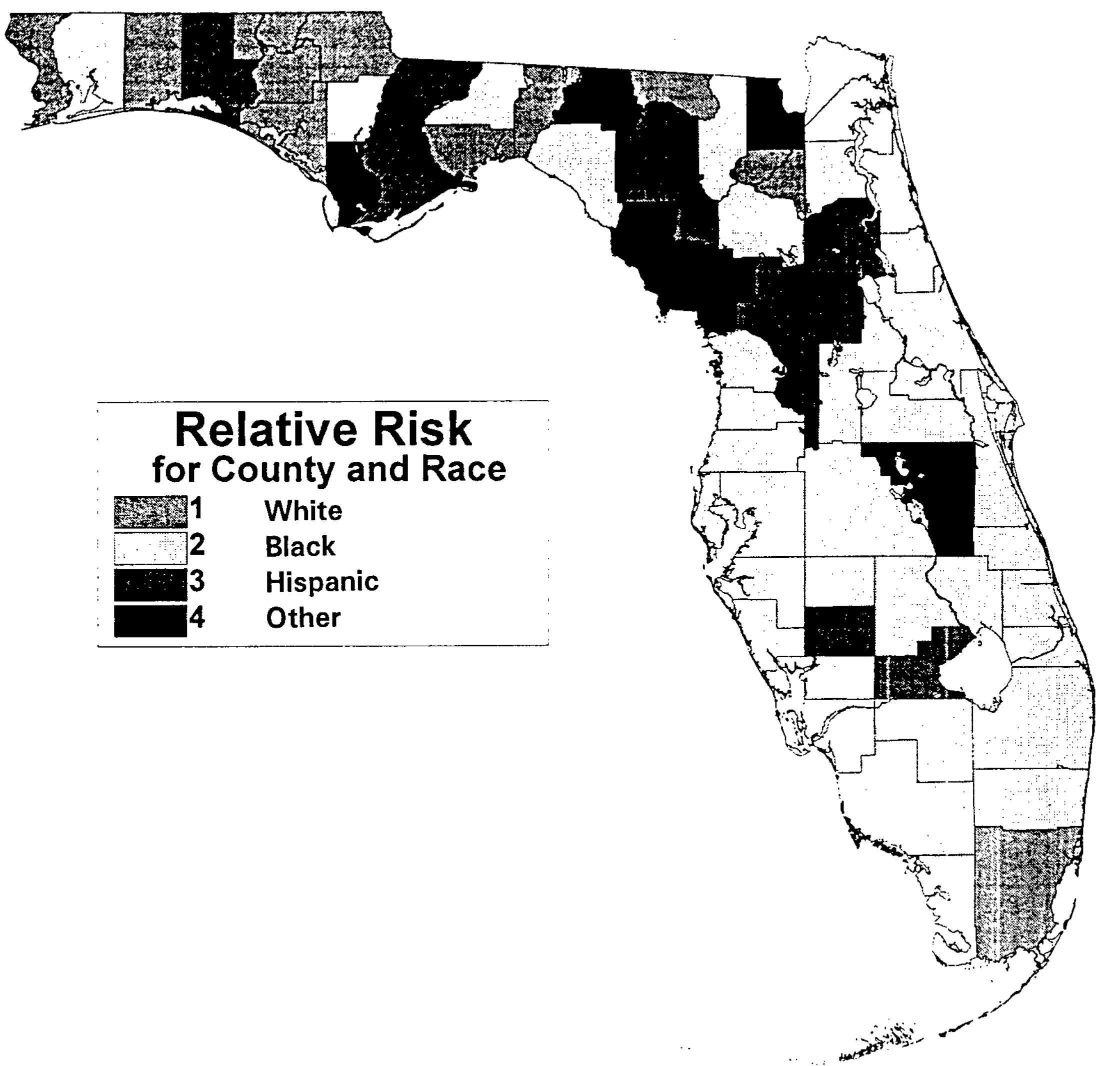


Figure 3.3. Relative Risk by county and race



CHAPTER 4

USING CONDITIONAL PROBABILITY TO INVESTIGATE THE DRIVERS' DEMOGRPHIC DIFFERENCES I N CRASH INVOLVEMENT

4.1. METHODOLOGY

Categorical data, such as most crash variables, consist of frequency counts of observations occurring in the response categories. Let X and Y denote two categorical variables, X having I levels and Y having J levels. The IJ possible combinations of outcomes could be displayed in a rectangular table having I rows for the categories of X and J columns for the categories of Y. The cells of the table represent the IJ possible outcomes. A table of this form in which the cells contain frequency counts of outcomes is called a "contingency table".

Let $p_{ij} = P(X = i, Y = j)$ denote the probability that (X, Y) falls in the cell in row i and column j. The probabilities $\{p_{ij}\}$ form the joint distribution of X and Y. These are the cell proportions. They satisfy $\Sigma_{i,j} p_{ij} = 1$.

The marginal distributions are the row and column of the joint probabilities. These are denoted by $\{p_{i+}\}$ for the row variable and $\{p_{+j}\}$ for the column variable, where the subscript "+" denotes the sum over the index it replaces. For instance, for 2 X 2 tables, $p_{1+} = p_{11} + p_{12}$ and $p_{+1} = p_{11} + p_{21}$. The cell counts are denoted by $\{n_{ij}\}$, with $n = \Sigma_{i,j} n_{ij}$ denoting the total sample size. The cell proportions and cell counts are related by $p_{ij} = n_{ij}/n$. The marginal frequencies are the row totals $\{n_{i+}\}$ and the column totals $\{n_{+j}\}$. For a detailed discussion of this methodology, the reader is referred to Agresti, 1996.

To illustrate, one variable is the age categories (say, the row variable, X) and the other is a variable of interest (the column variable, Y). It is informative to construct a separate probability distribution for X at each level of Y. Such a distribution consists of *conditional probabilities* for X, given the level of Y, and is called conditional distribution.

Consider the simple example in Table 4.1. This 2 X 2 contingency table, cross classifies $n = 1091$ crash involvement by age and the location. Table 4.1 illustrates the cell count notation for these data. For instance, $n_{11} = 435$, and the corresponding joint proportion is $p_{11} = 435/1091 = 0.399$.

For old drivers, the proportion of intersection related crash involvement is 435/582 = 0.747. The proportion for young drivers is 375/509 = 0.737. This indicates that the proportion of intersection related crashes for older drivers are larger than that of young drivers, showing a possible problem for older driver at intersections.

From a traffic safety perspective, it is argued that the location in the previous example is an implicit measure of exposure. Thus the ratio of age to location is indicative of relative over- or under-representation. In this example the proportion of old age's intersection crash involvement is greater than that of the young age, then this age group is over-represented in crashes relative to their exposure. This approach is discussed elsewhere in the context of quasi-induced exposure (Lyles et. al. 1991, Staplin and Lyles, 1992).

Table 4.1 Example for conditional probabilities

	Crash location		
Age	Intersection	non-intersection	Total
Old	$n_{11} = 435$	$n_{12} = 147$	$n_{1+} = 582$
Young	$n_{21} = 375$	$n_{22} = 134$	$n_{2+} = 509$
Total	$n_{+1} = 810$	$n_{+2} = 281$	$n = 1091$

4.2. RESULTS

This section presents the results of conditional probability analysis for 1995's crash data. The analysis was performed for each of the four demographic variables which are age, gender, race, and residency. For simplicity and ease of the interpretation of the results, the age is divided into five groups: 15-19 representing teenage drivers, 20-24 for young, 25-64 for middle, 65-79 for old, and 80+ and very old. Race is categorized into White, Black, Hispanic, and Other drivers. Residency is then defined as the local drivers (in the same county as crash location), state drivers (live in Florida), out-state (from different state), and foreign drivers (from other country). Each demographic variable is cross tabulated with certain factor. To have a clear view, these crash-related factors are listed in Figure 4-1.

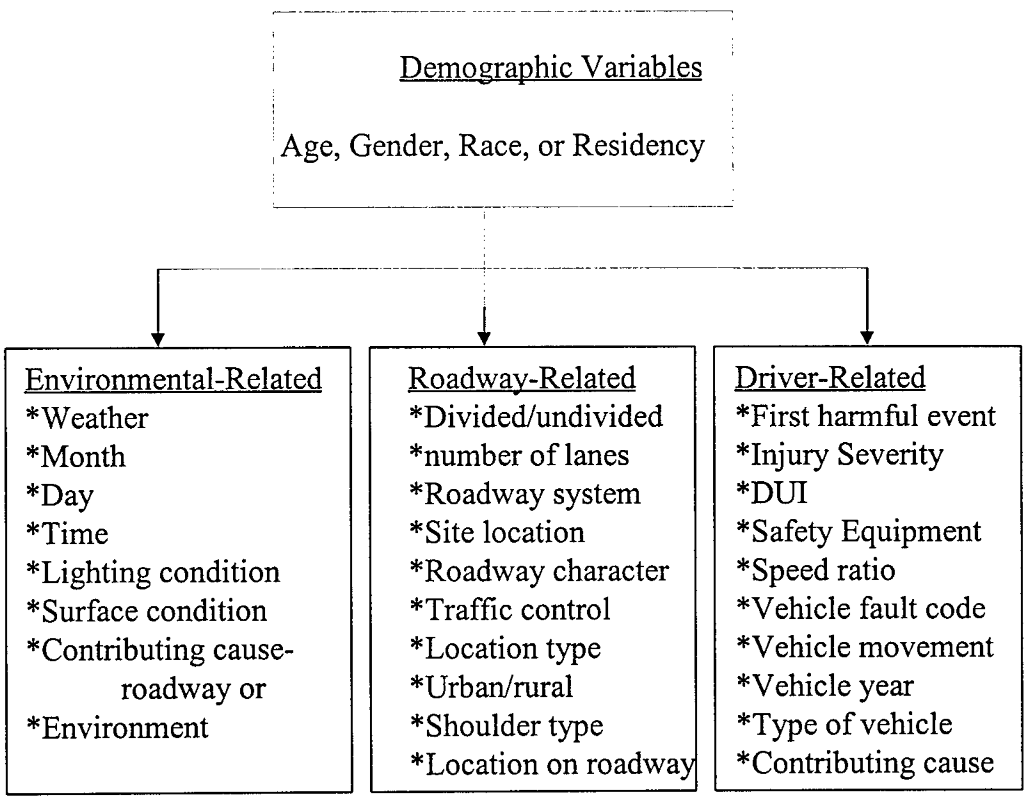


Figure 4-1 Demographic variables and crash related factors

4.2.1. AGE AND CRASH-RELATED FACTORS

In this section, the associations between age and environment, roadway, and driver-related factors were investigated. The age is divided into five groups: 15-19 representing teenage drivers, 20-24 for young, 25-64 for middle, 65-79 for old, and 80+ for very old.

4.2.1.1. Age and Environmental-Related Factors

In this section, the factors that are related to the environment of a crash are investigated. Some of these factors were: weather, month, day of the week, time, lighting condition, surface condition, and contributing causes of roadway or environment.

Addressing the relationship between *age and weather* showed that the 15-19 age group has higher crash proportions at cloudy and rain conditions (rates=19.88 and 13.10, means=19.59 and 12.28). Most elderly drivers of ages 65-79 and 80 and older have higher crash proportions in clear weather (rates=71.03 and 71.86, mean=67.48). Both young and middle age groups have larger crash probability under foggy conditions. It seems that the elderly drivers try to avoid adverse weather conditions. Whereas young and middle age groups generally are obliged to work or go to school, which is sometimes during bad weather. Very young drivers (15-19), as indicated before, tend to speed and lack experience, and therefore they might be over-involved in crashes in rainy conditions. The following Table 4.2 gives the rates and means of the age and weather relationship. The parenthesis values represent the proportions of crashes. It is a ratio of the crash frequency of an age group in a particular condition divided by the total crash frequency of this age group. For example,; 7271 crashes in cloudy weather out of 36579 crashes in all weather for age of 15-19 has the crash proportion of 19.88. The mean value of 19.59 represents that 65810 crashes in cloudy weather out of 335898 crashes in all weather for all ages. If the rate is higher than the mean, it represents higher proportions of crash involvement of certain age group in certain condition. Some of the bold parenthesis values represent the rates that are higher than the mean value.

Table 4.2 Age and Weather

Weather Age	Clear	cloudy	Rain	fog	other	Total
15-19	24241 (66.27%)	7271 **(19.88%)**	4793 **(13.10%)**	176 (0.48%)	98 (0.27%)	36579 (100%)
20-24	30633 (66.73%)	9076 (19.77%)	5868 (12.78%)	226 **(0.49%)**	104 (0.23%)	45907 (100%)
25-64	147407 (67.26%)	43124 (19.68%)	27219 (12.42%)	934 (0.43%)	486 (0.22)	219170 (100%)
65-79	19194 **(71.03%)**	4928 (18.24%)	2784 (10.30%)	59 (0.22%)	57 (0.21%)	27022 (100%)
80+	5188 **(71.86%)**	1411 (19.54%)	593 (8.21%)	13 (0.18%)	15 (0.21%)	7220 (100%)
Total **Mean**	226663 (67.48%)	65810 (19.59%)	41257 (12.28%)	1408 (0.42%)	760 (0.23%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	16	377.762	0.001

A relationship which is unique in Florida, particularly for elderly drivers, is that between *age and month*. The results show that the elderly drivers, ages 65-79, have higher crash proportions between January to April (especially on January with rate of 8.36, mean of 7.06). As for 80 and older, they have higher crash proportions in November and December (especially on December with rate of 14.07 and mean of 11.82). This might be because many elderly people move to Florida from northern states during the winter season. Therefore, there are more elderly drivers in Florida during the winter months, which results in higher possibility of crash involvement. On the contrary, it was realized that young drivers, age 20-24, are more involved in crashes during the summer months and in the month of March (rate=7.79, mean=7.68). This might be attributed to more driving during the summer vacation and Spring break.

The analysis shows the relationship between *age and day of week*; the young age group has a higher crash proportion on weekends, Saturday rate of 14.97 and average of 13.99, and

Sunday rate of 12.02 and average of 10.33. This might be associated with several factors including alcohol involvement as well as night driving which will be investigated next.

Investigating if there is a relationship between *age and time of day*; the result of the contingency Table 4.3 illustrated that the teenage age group tends to have higher crash proportions during night time between 6-12 PM (rate=29.33, mean=24.20). The young drivers have higher crash involvement rates after midnight to six o'clock in the morning (rate=11.63, mean=7.01). The middle age group has higher crash involvement rates during morning 6-12 AM (rate=25.48, mean =24.45). The elderly groups, 65-79 and 80+, have higher crash rates during 6-12 AM and after (rate=5.8 vs. young drivers' rate of 2.5). It appears that the young drivers might be driving more during the night, thus, their crash proportion is higher between 6-12 PM. The middle age group commutes during rush hours; thus, the crash proportion is higher during the peak hours. The elderly usually avoid driving at night and rush hours, hence, the crash proportion is higher after 6 AM.

Table 4.3 Age and Time of Day

Time Age	00:00-06:00	06:01-12:00	12:01-18:00	18:01-24:00	Total
15-19	3136 (8.57%)	6454 (17.64%)	16262 (44.46%)	10727 **(29.33%)**	36579 (100%)
20-24	5337 **(11.63%)**	9311 (20.28%)	18902 (41.17%)	12357 (26.92%)	45907 (100%)
25-64	14471 (6.60%)	55846 **(25.48%)**	96062 (43.83%)	52791 (24.09%)	219170 (100%)
65-79	476 (1.76%)	8150 **(30.16%)**	13919 (51.51%)	4477 (16.57%)	27022 (100%)
80+	139 (1.93%)	2357 **(32.65%)**	3773 (52.26%)	951 (13.17%)	7220 (100%)
Total **Mean**	23559 (7.01%)	82118 (24.45%)	148918 (44.33%)	81303 (24.20%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	12	6657.927	0.001

Directly related to the above discussion is the relationship between *age and lighting condition*. The teenage group has a higher crash proportion at dusk (rate=3.15, mean=2.84). The young age group has a higher crash proportion at dark (rate=32.17 and mean=25.24). The middle age group has a higher crash proportion at dawn (rate=1.23, mean=1.14). The elderly groups, 65-79 and 80+, have higher proportions during daylight (rates=83.45 and 86.54, mean=70.78).

As for the association between *age and roadway surface condition*, teenage and young groups seem to have higher crash proportions on wet and slippery surface. Elderly drivers tend to have higher crash proportions on dry roadway surface. The middle age group has an even crash proportion on all surface types. The results are similar to the discussion on age and weather for very young and young drivers. They tend to speed and lack experience, and therefore they might be over-involved in crashes on wet or slippery surface (rain). Whereas elderly drivers try to avoid adverse weather conditions, thus only driving on dry road surface.

For the relationship between *age and roadway contributing cause*, teenage drivers tend to have higher crash proportions on loose roadway surfaces, odd shoulders, and unsafe paved edge. Young drivers seem to have higher crash proportions with roadway obstructions. Very old drivers tend to have higher crash proportions were there are no roadway defects or in construction zones. As for the association between *age and environmental contributing cause*, teenage drivers tend to have higher crash proportions during inclement weather conditions. Young drivers seem to have higher crash proportions of hitting the parked or stopped vehicles. Middle age drivers tend to have higher crash proportions of hitting building or fixed objects. Drivers between the ages of 65-79 seem to have higher crash proportions when glare conditions exist. As for elderly drivers, they have higher crash proportions when not visional obstructions exist due to the environment surroundings.

4.2.1.2. Age and Roadway-Related Factors

In this section, the factors that are related to the roadway elements of a crash are investigated. Some of these factors are: number of lanes, divided/undivided, roadway system, site location, roadway character, traffic control, and location type, urban/rural, shoulder type, and location on roadway.

As Table 4.4 depicts, the relationship between *age and divided/undivided highways* showed that the 15-19 age group has a higher total crash proportion with undivided highways (rate=57.96, mean=51.53). A reason for that might be due to young drivers' riskier driving behavior, they tend to be impatient and try to pass the vehicle in front of them. Thus, they are more likely to be involved in crashes on undivided highways. It is also believed that teenage drivers will also have higher crash involvement on two-lane highway.

Table 4.4 Age and Divided/Undivided Highway

Divided/Undivided Age	Divided	undivided	Total
15-19	15379 (42.04%)	21200 **(57.96%)**	36579 (100%)
20-24	21756 (47.39%)	24151 **(52.61%)**	45907 (100%)
25-64	108474 (49.49%)	110696 (50.51%)	219170 (100%)
65-79	13529 (50.07%)	13493 (49.93%)	27022 (100%)
80+	3682 (51.00%)	3538 (49.00%)	7220 (100%)
Total Mean	162820 (48.47%)	173078 (51.53%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	4	764.164	0.001

The analysis of the relationship between *age and number of lanes* confirms the assumption above because ages between 15-29 have higher crash proportion on two-lane highway with rate of 42.27 and mean of 33.98. On the other hand, middle age drivers have higher crash proportion on more than eight-lane highway with rate of 3.2 and mean of 2.91. The old drivers between the age of 65 and 79 have higher crash proportion on three or four-lane highway (rate=39.67, mean=37.43). The elderly drivers, however, seem to have a problem in parking lot (rate=2.74, mean=1.82) and five to seven-lane highway (rate=24.7, mean=22.33). Since the elderly drivers tend to have longer perception and reaction times, they are more likely to ignore signs or not being aware of other vehicle movement in parking lots; thus, they have higher crash proportions in parking lots.

Analyzing the association between *age and roadway system identifier* shows that the 15-19 age group has higher total crash proportion at county roads (rate=22.74, mean=18.64). Ages 25-34 have higher total crash proportion at interstate highways (rate=6.25, mean=5.52). Ages 65-69 shows higher total crash proportion at U.S. highways (rate=9.22, mean=7.14).

Table 4.5 depicts the relationship between *age and site location*. The results show that the age groups of teenage and young drivers have higher crash proportions at non-intersections (rates=38.34 and 39.25, mean=37.62). A non-intersection includes straight roadway segments. This might indicate that the young drivers are more likely to be involved in crashes related to speeding. This issue is addressed in terms of collision and speed ratio in the following sections. The 80+ age group has higher crash proportions at intersections (rate=63.56, mean=54.03) and parking lots (rate=2.74, mean=1.82). Based on this result, perhaps the elderly drivers have problems related to turning maneuvers and angle collisions, which are common at intersections. Parking collisions are related to backing movement and sometimes require the need for quick reactions. The 25-64 age group has higher crash proportions at railroad crossing (rate=0.23, mean=0.2) and on ramps/off ramps (rate=1.37, mean=1.25).

Table 4.5. Age and site location

Location Age	non-intersection	intersection	drive-way	parking lot	railroad crossing	on/off ramps	Total
15-19	14023 **(38.34%)**	19527 (53.38%)	1938 (5.3%)	723 (1.98%)	46 (0.13%)	322 (0.88%)	36579 (100%)
20-24	18020 **(39.25%)**	24004 (52.59%)	2305 (5.0%)	872 (1.90%)	79 (0.17%)	627 (1.37%)	45907 (100%)
25-64	84115 (38.38%)	117109 (53.43%)	10701 (4.9%)	3734 (1.70%)	499 **(0.23%)**	3012 **(1.37%)**	219170 (100%)
65-79	8285 (30.66%)	16253 **(60.15%)**	1648 (6.1%)	582 (2.15%)	37 (0.14%)	217 (0.80%)	27022 (100%)

80+	1921 (26.61%)	4589 **(63.56%)**	470 (6.5%)	198 **(2.74%)**	5 (0.07%)	37 (0.51%)	7220 (100%)
Total	126364 (37.62%)	181482 (54.03%)	17062 (5.1%)	6109 (1.82%)	666 (0.2%)	4215 (1.25%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	20	1359.391	0.001

The association between *age and roadway character* was examined in Table 4.6. The results indicate that the 15-19 age group tend to have higher crash proportion at "curve-level". Five percent of the total involvement of this age group takes place on a curve. This percentage is 2.9 percent for drivers above the age of 85. The percentage of involvement on a "curve-grade" section is the highest for ages 20-24, accounting for 1.68 percent of the total involvement of this age group. Also the same age group has the highest percentage of crash involvement on "straight grades" (rate=7.67, mean=7.27). Ages 80 and above have high crash proportions at roadway character of "straight-level" (rate=90.3, mean=87.73). These results again point to the higher driving speed, and riskier driving behavior for the younger age groups, as opposed to the slower more careful elderly driving that compensate for their decline in driving capabilities.

Table 4.6 Age and Roadway Character

Rd character Age	**straight level**	**Straight Grade**	**curve level**	**curve grade**	**Total**
15-19	31406 (85.86%)	2756 (7.53%)	1847 (5.05%)	570 (1.56%)	36579 (100%)
20-24	39691 (86.46%)	3519 (7.67%)	1926 (4.20%)	771 (1.68%)	45907 (100%)
25-64	192833 (87.67%)	15925 (7.27%)	7463 (3.41%)	2949 (1.35%)	219170 (100%)
65-79	24231 (89.67%)	1782 (6.59%)	758 (2.81%)	251 (0.93%)	27022 (100%)
80+	6520 (90.30%)	431 (5.97%)	209 (2.89%)	60 (0.83%)	7220 (100%)
Total Mean	294681 (87.73%)	24413 (7.27%)	12203 (3.63%)	4601 (1.37%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	12	520.202	0.001

The comparison between *age and traffic control* shows that the age groups of teenage and young drivers tend to have higher crash proportions in the area with "no traffic control" and "special speed zone". The age group of 25-64 has higher crash proportions in the areas with yield signs and railroad crossing. Age group of 65-79 has higher crash proportions at no U-turn area. Age group of 80+ has higher crash proportion at stop signs and signalized intersection.

Location type is defined as the crash location at either the business, residential, or open country area. As for Table 4.7, the relationship between *age and location type*, the results show that teenage drivers have higher crash proportion at residential area (rate=34.84, mean=27.32). Middle age driver, ages of 25-64, have higher crash proportion at open country area (rate 10.50, mean=10.19). Elderly driver, ages of 65 to 79, have higher crash proportions at business areas; this finding might be related to access points, at which turning collision are common.

Table 4.7 Age and Location Type

Location type **Age**	**Business**	**Residential**	**Open Country**	**Total**
15-19	20109 (54.97%)	12745 **(34.84%)**	3725 (10.18%)	36579 (100%)
20-24	28203 (61.44%)	12895 **(29.09%)**	4809 (10.48%)	45907 (100%)
25-64	139148 **(63.49%)**	57012 (26.01%)	23010 **(10.50%)**	219170 (100%)
65-79	17708 **(65.53%)**	7080 (26.20%)	2234 (8.27%)	27022 (100%)
80+	4719 **(65.36%)**	2039 (28.24%)	462 (6.40%)	7220 (100%)
Total **Mean**	209887 (62.49%)	91771 (27.32%)	34240 (10.19%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	8	1566.603	0.001

As for the relationship between *age and urban/rural*, teenage drivers tend to have higher crash proportions at rural area (rate=44.69, mean=41.65). For the ages of 65-79 and 80+, they tend to have higher crash proportions at urban area (rates=59.55 and 63.86, mean=58.35).

The relationship between age and shoulder type shows that teenage drivers tend to have higher crash proportions at unpaved shoulders. Young and middle age drivers seem to have higher crash proportions at paved shoulders. Ages of 65-79 and 80+ tend to have higher crash proportions as curbs.

As for the association between *age and location on roadway*, teenage drivers tend to have higher crash proportions not on the road but on the shoulder. Young drivers tend to have higher crash proportions on medians. Drivers' Age of 65-79 are more likely to have higher crash proportions on the road. Whereas elderly drivers of 80+, they tend to have higher crash proportions on turning lanes. This result confirms the assumption that very old drivers have problems with turning maneuvers.

4.2.1.3. Age and Driver-Related Factors

In this section, the factors that are related to the drivers involved in crashes are analyzed. Some of these factors are: first harmful event (manner of collision, injury severity, alcohol/drug involvement (driving under influences), safety equipment, speed ratio, vehicle fault code, vehicle movement, vehicle year, type of vehicle, residency, and contributing cause of driver.

Table 4.8 illustrates the relationship between the drivers' *age and the first harmful event (manner of collision)*. The table shows that as age increase the involvement in turning (right or left) and angle collisions increase. The largest proportions of 22.45 percent (mean = 14.79%) for turning collisions and 33.75 percent (mean = 25.83%) for angle collisions are for the ages of 80 and above. Looking carefully at more desegregated age and harmful event groups (not shown in Table 4.8) it can be said that the age group 15-19 tends to have higher crash proportions on "head on " (rate=2.04, mean=1.91) and "hit fixed object" (rate=3.2, mean=2.0). The 35-44 age group has a higher crash proportion on "rear-end" (rate=32.02, mean=29.44). The 45-54 age group has a higher crash proportion on "sideswipe" (rate=4.12, mean=3.9) types of crashes. The 80-84 age group has a higher crash proportion on "angle" (rate=41.9, mean=34.87), "left turn" (rate=24.71, mean=19.21), and "right turn" (rate=2.45, mean=1.82) collisions. The 85+ age group has a higher crash proportion on "backed into" collision (rate=0.61, mean=0.49). As mentioned before, the older drivers are more involved in crashes at intersections and were more likely to be involved in turning and angle collisions. The might be because of their difficulty to perceive and judge the speed and gaps between vehicles which is required to perform a left or a right-turn. In this section we look at all the crashes (not only at intersections) and the manner of the collision. The results illustrated in Table 4.8 show that the age group of 15-19 tend to have higher crash proportions on "head on " (rate=2.20, mean=2.14), "overturn" (rate=1.77, mean=1.04), and "off road" (rate=2.22, mean=1.79) collisions. Young drivers, age of 20-24, have higher crash proportion on rear-end, ran-off, and overturn. Age group of 25-64 has higher crash proportions on "rear-end" (rate=38.58, mean=36.66) and higher crash proportion on sideswipe (rate=5.78, mean=5.57). Age group of 65-79 has higher crash proportions on "angle" (rate=31.42, mean=25.83), "turn" (rate=18.06, mean=14.79) collisions. The above results points out to the young drivers' tendency to speeding. As a result, "overturn" or "off road" are more easily to happen. Their safety problems on curves require reduction in speed. A similar result, investigating the relationship between age and the number of vehicles involved in a crash, showed that teenage drivers have higher crash proportions in single vehicle's crashes (rate=14.24, mean=9.54). It is possible that "head on" collisions happen on two lane, undivided highways when young drivers try to pass other vehicles. As for the middle age people, most of them commute. They have higher crash proportions during the morning peak hours, at which vehicles have fewer gaps between each vehicle and often change lanes. Hence, the "rear-end" and "sideswipe" are more likely to happen. Elderly drivers have a problem with turning maneuvers because of the decline in perception abilities that result in a difficulty to judge the speed of the on-coming vehicles and the gaps between them.

Table 4.8 Age and First Harmful Event

Event Age	rear-end	head-on	angle	turn	sideswipe	ran-off	overturn	all others	Total
15-19	12116 (33.12%)	806 **(2.20%)**	9207 (25.17%)	5435 (14.86%)	1700 (4.65%)	813 **(2.22%)**	647 **(1.77%)**	5855 **(16.01%)**	36579 (100%)
20-24	15961 (34.77%)	953 (2.08%)	11534 (25.12%)	6695 (14.58%)	2599 **(5.66%)**	823 **(1.79%)**	691 **(1.51%)**	6651 (14.49%)	45907 (100%)
25-64	84560 **(38.58%)**	4711 (2.15%)	55097 (25.14%)	31057 (14.17%)	12659 **(5.78%)**	2655 (1.21%)	2047 (0.93%)	26384 (12.04%)	219170 (100%)
65-79	8690 (32.16%)	565 (2.09%)	8491 **(31.42%)**	4881 **(18.06%)**	1425 (5.27%)	183 (0.68%)	83 (0.31%)	2704 (10.01%)	27022 (100%)
80+	1824 (25.26%)	141 (1.95%)	2437 **(33.75%)**	1621 **(22.45%)**	321 (4.45%)	48 (0.66%)	26 (0.36%)	802 (11.11%)	7220 (100%)
Total **mean**	123151 (36.66%)	7176 (2.14%)	86766 (25.83%)	49689 (14.79%)	18704 (5.57%)	4522 (1.35%)	3494 (1.04%)	42396 (12.62%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	15	2896.35	0.001

As for the relationship between *age and injury severity*, Table 4.9 shows that teenage drivers tend to have higher crash proportions with no or minor injury. Elderly drivers, age of 65-79 and 80+, tend to have higher crash proportions with severe or fatal injury.

Table 4.9 Age and Injury Severity

Severity Age	no injury	Minor	severe	fatal	Total
15-19	9689 **(26.49%)**	22355 **(61.11%)**	4199 (11.48%)	336 (0.92%)	36579 (100%)
20-24	12896 (28.09%)	27388 (59.66%)	5137 (11.19%)	486 (1.06%)	45907 (100%)
45-64	58149 (26.53%)	133803 (61.05%)	24921 (11.37%)	2297 (1.05%)	219170 (100%)
65-79	6182 (22.88%)	17078 (63.20%)	3366 **(12.46%)**	396 **(1.47%)**	27022 (100%)
80+	1650 (22.85%)	4462 (61.80%)	941 **(13.03%)**	167 **(2.31%)**	7220 (100%)
Total mean	88566 (26.37%)	205086 (61.06%)	38564 (11.48%)	3682 (1.10%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	21	1262.073	0.001

Table 4.10 shows that the young to middle age groups have higher proportions of traffic crashes while *driving under the influence* of alcohol (rates=10.72 and 10.70, mean=9.59). It is worth mentioning that 37488 drivers in 1995 were involved in crashes while "under the influence" in Florida, accounting for about 11 percent of the total involvement. Middle age drivers tend to have higher crash proportions while driving under influence of drugs and both alcohol and drugs (rates=0.2 and 0.82, means=0.17 and 0.71). Elderly drivers, however, do not show high crash proportions for driving under the influences.

Table 4.10 Age and Driving Under Influences

DUI Age	no DUI	alcohol	drugs	alcohol & drugs	un-determined	Total
15-19	33935 (92.77%)	2255 (6.16%)	56 (0.15%)	137 (0.37%)	196 (0.54%)	36579 (100%)
20-24	40260 (87.70%)	4921 **(10.72%)**	57 (0.12%)	315 (0.69%)	354 (0.77%)	45907 (100%)
25-64	191850 (87.53%)	23450 **(10.70%)**	438 **(0.20%)**	1799 **(0.82%)**	1633 (0.75%)	219170 (100%)
65-79	25445 **(94.16%)**	1340 (4.96%)	30 (0.11%)	106 (0.39%)	101 (0.37%)	27022 (100%)
80+	6920 **(95.84%)**	251 (3.48%)	6 (0.08%)	18 (0.25%)	25 (0.35%)	7220 (100%)
Total Mean	298410 (88.84%)	32217 (9.59%)	587 (0.17%0	2375 (0.71%)	2309 (0.69%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	16	2174.491	0.001

Table 4.11 depicts the relationship between crash involvement by _age and safety equipment_.; it shows that teenage and young drivers tend to have higher crash proportions of not wear seat belt or not use any type of safety equipment while driving (rates=19.04 and 17.31, mean=14.40).

Table 4.11 Age and Safety Equipment

Safety equip. Age	not in use	seat belt	air bag	safety helmet	eye protection	all other	Total
15-19	6767 **(19.04%)**	28180 (79.27%)	190 (0.53%)	354 (1.00%)	7 (0.02%)	51 (0.14%)	35549 (100%)
20-24	7675 **(17.31%)**	35632 (80.35%)	263 (0.59%)	718 (1.62%)	7 (0.02%)	52 (0.12%)	44347 (100%)
25-64	29223 (13.79%)	178912 **(84.45%)**	998 (0.47%)	2411 (1.14%)	50 (0.02%)	267 (0.13%)	211861 (100%)
65-79	2328 (9.02%)	23218 **(89.99%)**	137 (0.53%)	79 (0.31%)	3 (0.01%)	36 (0.14%)	25801 (100%)
80+	743 (10.79%)	6081 **(88.27%)**	43 **(0.62%)**	10 (0.15%)	2 (0.03%)	10 (0.15%)	6889 (100%)
Total mean	46736 (14.40%)	272023 (83.84%)	1631 (0.50%)	3572 (1.10%)	69 (0.02%)	416 (0.13%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	20	2057.907	0.001

Alcohol and seat belt use are two areas where a well designed educational and awareness campaigns targeting specific age groups could make a large difference in improving the traffic safety.

Vehicle fault code is defined as vehicle driver cited/not cited for moving violation (excludes properly parked vehicles, bicycles, and certain government vehicles). The relationship between *age and vehicle fault code* shows that middle age driver, ages between 25-64, have higher proportion for "no cited for violation" (rate=69.60, mean=66.07). However, teenage and elderly driver, ages 80 and above, have very high proportion for "cited for violation" (rates=43.77 and 53.2, mean=33.93). The results might indicate teenage and elderly drivers need more traffic safety education.

Table 4.12 presents the relationship between *age and speed ratio* (the ratio of the estimated speed at the time of the crash to the posted speed limit). The results show that the age group of 80+ shows higher crash proportions with estimated speed 30% below the posted speed (rate=70.27, mean=57.96). Age group of 15-19 shows higher crash proportions with percentage of estimated/posted speed above 30% (rate=5.99, mean=3.26). This indicates that younger drivers tend to drive above the speed limit and therefore are more likely to be involved in collisions that are related to speeding.

Table 4.12. Age and Speed Ratio

Speed ratio **Age**	**<0.7**	**0.701-0.9**	**0.901-1.1**	**1.101-1.3**	**>1.301**	**Total**
15-19	18015 (50.68%)	5377 (15.13%)	8199 (23.06%)	1827 (5.14%)	2131 (5.99%)	35549 (100%)
20-24	22727 (51.25%)	6789 (15.31%)	10514 (23.17%)	2105 (4.75%)	2212 (4.99%)	44347 (100%)
25-64	125243 (59.12%)	32221 (15.21%)	42595 (20.11%)	6032 (2.85%)	5770 (2.72%)	211861 (100%)
65-79	17211 (66.71%)	3778 (14.64%)	4065 (15.76%)	390 (1.51%)	357 (1.38%)	25801 (100%)
80+	4841 (70.27%)	962 (13.96%)	876 (12.72%)	118 (1.71%)	92 (1.34%)	6889 (100%)
Total	188037 (57.96%)	49127 (15.14%)	66249 (20.42%)	10472 (3.23%)	10562 (3.26%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	16	4960.735	0.001

For the relationship between *age and vehicle movement*, teenage and young drivers tend to have higher crash proportions while driving vehicles that are going straight and passing. Elderly drivers, age of 65-79 and 80+, tend to have higher crash proportions with left/right turns, backing, and in/out parking. The results confirm the findings with first harmful event and number of lanes. Teenage and young drivers tend to speed and be impatient on two-lane highways and try to pass other vehicles. Thus, they are more likely to have head-on, run off, and overturned collisions. As for elderly drivers, they have more problems in parking lots and turning lanes. They tend to have higher turning and angle type of collisions.

As for *age and vehicle year*, teenage drivers tend to have higher crash proportion with vehicle years 81-85 and 86-90 (rates=19.77, 37.66, means=17.24, 33.77). Young driver, age 20-24, have higher crash proportion with vehicle years 91-95 (rate=41.76, mean=39.94). Middle age drivers, perhaps more financially secure, have a slightly higher crash proportion with newer vehicle of years after 95 (rate=0.54, mean=0.5). Elderly drivers seem to have a higher crash proportion with older vehicles of years before 1980 (rate=8.87, mean=7.52).

An interesting relationship between *age and type of vehicle* is that middle age drivers tend to have a higher crash proportion with van and truck (rates=8.36, 19.31, means=6.8, 17.04). As for older drivers, ages between 65 to 79, have a higher crash proportion with RV (rate=0.31, mean=0.08); possibly, this result is more likely to occur in Florida since there are more retired elderly that live in RV.

To conclude this section, the association between *age and contributing-cause by driver* was discussed. For young drivers, they are more likely to drive carelessly, following too closely, exceeding safety speed limit, driving left of center, improper passing, and driving the wrong way. For the middle age drivers, their contributing causes are more likely to relate with driving under influences. As for the elderly drivers, their causes are more likely to be failing to yield, improper backing, improper turning, disregarding traffic sign or control, and obstructing traffic.

4.2.2. GENDER

In this section, the associations between gender and environment, roadway, and driver-related factors were investigated. The gender is male and female drivers of age 15 year-old and older.

4.2.2.1 Gender and Environmental Related Factors

In this section, the factors that are related to the environment of a crash are analyzed. The factors are the same as the previous sections and followed the order as Figure 4.1; however, they are cross tabulated with different demographic variable, gender.

The relationship between *gender and weather* was first analyzed. It found that male drivers seem to have slightly higher crash proportions on foggy weather (rate=0.47, mean=0.42). As for the relationship between *gender and the month* , according to the proportions (row percentage), there is no significant differences between male and female drivers with month when crashes occurred. As Table 4.13 presents the relationship between *gender and day of the week*, male drivers tend to have higher crash proportions on weekend (especially on Sundays with rate=11.10, mean=10.33) and female drivers on weekdays (especially on Wednesday with rate=15.52, mean=14.78). They have similar results as gender and time, since there are more alcohol/drug involved crashes on weekends for male drivers.

Table 4.13 Gender and Day of the Week

Day Gender	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
Male	28739 (13.99)	29069 (14.15)	29399 (14.31)	28781 (14.01)	36373 (17.71)	30255 **(14.73)**	22796 **(11.10)**	205412 (100%)
Female	18899 **(14.48)**	19752 **(15.14)**	20249 **(15.52)**	19333 **(14.82)**	23609 **(18.09)**	16753 (12.84)	11891 (9.11)	130486 (100%)

Total	47638 (14.18)	48821 (14.53)	49648 (14.78)	48114 (14.32)	59982 (17.86)	47008 (13.99)	34687 (10.33)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	6	696.341	0.001

As Table 4.14 shows, for *gender and time*, males have a higher crash proportion at 0:00-6:00 AM and 18:00-24:00 PM (especially 0:00-6:00 AM with rate=8.51, mean=7.01). Females have higher crash proportion at 6:01-12:00 AM and 12:01-18:00 PM (especially 12:01-18:00 PM with rate=47.36, mean=44.33). This might indicate that the male drivers tend to drive at night and might be related to alcohol/drugs involvement. Female drivers have higher crash proportions during the afternoon, it might indicate that they drive more during this time for shopping, picking up kids, or getting off from school or work. For self-security, most of female drivers tend to avoid nighttime driving.

Table 4.14 Gender and Time of the Day

Time Gender	00:00-06:00 AM	06:01-12:00 AM	12:01-18:00 PM	18:01-24:00 PM	Total
Male	17480 **(8.51%)**	48047 (23.39%)	87120 (42.41%)	52765 **(25.69%)**	205412 (100%)
Female	6079 (4.66%)	34071 **(26.11%)**	61798 **(47.36%)**	28538 (21.87%)	130486 (100%)
Total mean	23559 (7.01%)	82118 (24.45%)	148918 (44.33%)	81303 (24.20%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	2849.637	0.001

Table 4.15 depicts the relationship between *gender and lighting condition*. The results indicate that males have higher crash proportions during dawn, and dark (especially dark with rate=28.26 and mean=25.24). Female drivers have higher crash proportions during daylight (rate=75.70, mean=70.78), because of self-security, they try to avoid nighttime driving.

Table 4.15. Gender and lighting condition

Lighting condition Gender	Daylight	dusk	dawn	dark	Total
Male	138970 (67.65%)	5767 (2.81%)	2617 **(1.27%)**	58058 **(28.26%)**	205412 (100%)
Female	98774 **(75.70%)**	3764 **(2.88%)**	1299 (0.94%)	26719 (20.48%)	130486 (100%)
Total **mean**	237744 (70.78%)	9531 (2.84%)	3846 (1.14%)	84777 (25.24%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	2725.281	0.001

Slippery and icy *surface conditions* result in higher crash proportions. However, male and female do not show any difference in proportions on different types of surface conditions. The relationship between *gender and first contributing cause-road* shows that male drivers seem to have slightly higher crash proportions on road under repair/construction (rate=1.32, mean=1.26). Perhaps, there are more males working in construction sites or simply driving carelessly; thus, more male drivers have higher crash proportions on road under repair/construction. As for the relationship *between gender and contributing cause of environment*, male drivers tend to have higher crash proportions on foggy weather and female drivers on glare condition.

4.2.2.2. Gender and Roadway-Related Factors

The roadway-related factors in this section are the same as shown in Figure 4-1. As Table 4.16 depicts the relationship between *gender and number of lanes*, males have higher crash proportion at 1, 2, 8-11, and 12-16 number of lanes (especially at 12-16 lanes highway with rate=0.20, mean=0.18). Females have higher crash proportion at parking lots, 3-4, and 5-7 lanes (especially at parking lots with rate=1.87, mean=1.82). Female drivers' higher crash proportion at parking lots might be related to shopping trips, picking up kids, or getting off from school or work. They might be in a rush doing those activities; hence, they tend to ignore the stop sign or ignore checking the surroundings to make sure that no other car is parking or backing.

Table 4.16 Gender and Number of Lane

# of lanes Gender	parking lot	1	2	3-4	5-7	8-11	12-16	Total
Male	3671 (1.79%)	2885 (1.40%)	70017 **(34.09%)**	76460 (37.22%)	45605 (22.20%)	6366 **(3.10%)**	408 **(0.20%)**	205412 (100%)
Female	2438 **(1.87%)**	1698 (1.30%)	44120 (33.81%)	49254 (37.75%)	29391 (22.52%)	3400 (2.61%)	185 (0.14%)	130486 (100%)
Total mean	6109 (1.82%)	4583 (1.36%)	114137 (33.98%)	125714 (37.43%)	74996 (22.33%)	9766 (2.91%)	593 (0.18%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	6	101.906	0.001

According to the proportions (row percentage), there is no significant relationship between *gender and the highway being divided/undivided*. As Table 4.17 presents, the relationship between *gender and roadway systems* shown that male drivers tend to have higher crash proportions at interstate, U.S., and turnpike/toll (especially interstate with rate=6.26, mean=5.70). Female drivers tend to have higher crash proportions at local streets (rate=31.03, mean=30.06). Male drivers tend to have more long distance driving; female drivers are more likely not to drive too far from home.

Table 4.17. Gender and Roadway System

rd system Gender	interstate	U.S.	State	county	local	turnpike/ toll	forest road	Total
Male	12866 **(6.26%)**	15899 (7.74%)	75415 (36.71%)	39768 (19.36%)	60467 (29.44%)	906 (0.44%)	91 (0.04%)	205412 (100%)
Female	6271 (4.81%)	9382 (7.19%)	47838 (36.66%)	25953 (19.89%)	40493 **(31.03%)**	514 (0.39%)	35 (0.03%)	130486 (100%)
Total mean	19137 (5.70%)	25281 (7.53%)	123253 (36.69%)	65721 (19.57%)	100960 (30.06%)	1420 (0.42%)	126 (0.04%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	6	419.426	0.001

As Table 4.18 depicts, the relationship between *gender and site location*, male drivers tend to have higher crash proportions not at intersections (rate=39.30, mean=37.62) and female drivers at intersections (rate=56.54, mean=54.03). Table 4.17 shows the relationship between gender and roadway systems indicates that male drivers tend to have higher crash proportions at interstate which mostly are on highways (not intersection) and female drivers at local streets (more intersections). The result could be related to first harmful event and traffic control.

Table 4.18 Gender and Site Location

Site Gender	not intersection	intersection	driveway	railroad crossing	on/off ramp	parking lot	Total
Male	80737 **(39.30%)**	107705 (52.43%)	10182 (4.96%)	447 **(0.22%)**	2670 **(1.30%)**	3671 (1.79%)	205412 (100%)
Female	45627 (34.97%)	73777 **(56.54%)**	6880 **(5.27%)**	219 (0.17%)	1545 (1.18%)	2438 **(1.87%)**	130486 (100%)
Total mean	126364 (37.62%)	181482 (54.03%)	17062 (5.08%)	666 (0.20%)	4215 (1.25%)	6109 (1.82%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	5	685.262	0.001

As for the relationship between _gender and roadway character_, Table 4.19 shows that male drivers tend to have higher crash proportions at curve-level (rate=3.9, mean=3.63) and females at straight-level (rate=88.40, mean=87.73). Male driver tend to have higher crash proportions at curve-level, this might indicate that male driver are more involved in crashes related to alcohol/drug involvement or speeding. Alcohol/drug will mix up driver's judgment and concentration. Fast speeds will make it hard to control the wheels.

Table 4.19. Gender and Roadway Character

Curvature Gender	straight- level	straight- grade	curve- level	curve- grade	Total
Male	179329 (87.30%)	15065 **(7.33%)**	8021 **(3.90%)**	2997 **(1.46%)**	205412 (100%)
Female	115352 **(88.40%)**	9348 (7.16%)	4182 (3.20%)	1604 (1.23%)	130486 (100%)
Total	294681 (87.73%)	24413 (7.27%)	12203 (3.63%)	4601 (1.37%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	152.524	0.001

Table 4.20 shows that in the relationship between *gender and traffic control*, male drivers tend to have higher crash proportions at no control, special speed zone, and railroad (especially special speed zone with rate=12.73, mean=12.20). Female drivers tend to have higher crash proportions at traffic signal, stop, yield and officer/guard/flagman (especially at stop sign with rate=15.88, mean=14.61). Male drivers tend to have higher crash proportions at special speed zone, this might indicate that they are more involved in crashes related to speeding. Female drivers have higher crash proportions at stop signs. This result might explain their higher crash proportions in parking lots since they might forget to stop at stop signs.

Table 4.20. Gender and Traffic Control

Control Gender	no control	special zone	signal	Stop	yield	railroad	Guard	no u-turn	Total
Male	90478 **(44.05)**	26154 (12.73)	56355 (27.44)	28353 (13.80)	2500 (1.22)	300 (0.15)	1181 (0.57)	91 (0.04)	205412 (100%)
Female	53730 (41.18)	14837 (11.37)	38510 **(29.51)**	20716 **(15.88)**	1665 (1.28)	181 (0.14)	793 (0.61)	54 (0.04)	130486 (100%)
Total Mean	144208 (42.93)	40991 (12.20)	94865 (28.24)	49069 (14.61)	4165 (1.24)	481 (0.14)	1974 (0.59)	145 (0.04)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	7	635.262	0.001

As for the relationship between *gender and location type*, male drivers tend to have higher crash proportions on open country areas (rate=11.22, mean=10.19). Female drivers tend to have higher crash proportions at both business and residential areas (especially residential area with rate=28.12, mean=27.32). Table 4.21 shows, for the relationship between *gender and rural/urban*, male drivers tend to have higher crash proportions on rural area (rate=42.63, mean=41.65) and female drivers on urban (rate=59.88, mean=58.35).

Table 4.21 Gender and Rural/Urban

Rural/Urban Gender	Rural	Urban	Total
Male	87564 **(42.63%)**	117848 (57.37%)	205412 (100%)
Female	52348 (40.12%)	78138 **(59.88%)**	130486 (100%)
Total mean	139912 (41.65%)	195986 (58.35%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	1	206.980	0.001

As Table 4.22 depicts, for the relationship between *gender and type of shoulder*, male drivers tend to have higher crash proportions at paved shoulder (rate=31.56, mean=30.89) and females at curb (rate=29.81, mean=28.47).

Table 4.22. Gender and Shoulder Type

Shoulder Type Gender	Paved	unpaved	curb	Total
Male	64820 **(31.56%)**	83846 (40.82%)	56746 (27.63%)	205412 (100%)
Female	38943 (29.84%)	52650 (40.35%)	38893 **(29.81%)**	130486 (100%)
Total mean	103763 (30.89%)	136496 (40.64%)	95639 (28.47%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	2	213.279	0.001

As for the relationship between *gender and location on roadway*, Table 4.23 shows that male drivers tend to have higher crash proportions on shoulder (rate=2.64, mean=2.25) and female drivers on the road (rate=94.03, mean=92.91).

Table 4.23 Gender and location on the roadway

Location Gender	on road	not on road	shoulder	median	turning lane	Total
Male	182734 (92.20%)	7024 **(3.54%)**	5234 **(2.64%)**	998 **(0.50%)**	2210 (1.12%)	198200 (100%)
Female	118709 **(94.03%)**	3309 (2.62%)	2062 (1.63%)	491 (0.39%)	1676 **(1.33%)**	126247 (100%)
Total mean	301443 (92.91%)	10333 (3.18%)	7296 (2.25%)	1489 (0.46%)	3886 (1.20%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	4	633.352	0.001

4.2.2.3. Gender and Driver-Related Factor

Referring to Figure 4-1 for the list of driver-related factors, the relationship between gender and first harmful event, Table 4.24 presents that male drivers tend to have higher crash proportions on head-on, sideswipe, ran-off, and overturned (especially overturn with rate=1.27, mean=1.04). Female drivers tend to have higher crash proportions on rear-end, angle, and turn. (especially angle with rate=27.18, mean=25.83). Male drivers may have higher overturned crash proportions be due to speeding. Female drivers have higher crash proportions on "turning" and "angle" maneuver might be due to slower perception/reaction time compared with male drivers or ignoring the traffic sign (because of complicated situation at intersection). This result is related to traffic control and site location.

Table 4.24. Gender and first harmful event

Event Gender	rear-end	head-on	Angle	turn	sideswipe	all other	ran-off	over-turn	Total
Male	73777 (35.92)	4646 **(2.26)**	51299 (24.97)	29090 (14.16)	12174 (5.93)	28709 (13.98)	3109 **(1.51)**	2608 **(1.27)**	205412 (100%)
Female	49374 (37.84)	2530 (1.94)	35467 **(27.18)**	20599 **(15.79)**	6530 (5.0)	13687 (10.49)	1413 (1.08)	886 (0.68)	130486 (100%)
Total mean	123151 (36.66)	7176 (2.14)	86766 (25.83)	49689 (14.79)	18704 (5.57)	42396 (12.62)	4522 (1.35)	3494 (1.04)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	7	1680.361	0.001

For the relationship between gender and injury severity, Table 4.25 depicts that male drivers tend to have higher crash proportions with no injury, severe, and fatal injuries (especially fatal injury with rate=1.32, mean=1.10) and female drivers with minor injury (rate=64.09, mean=61.09). Most of high speed driving or alcohol/drug involved crashes result in fatalities.

At the parking lots or local streets, driving speeds are not as high as highways; hence, female drivers tend to have high crash proportions on minor injury.

Table 4.25. Gender and injury severity

Severity Gender	no injury	minor injury	severe injury	fatal	Total
Male	57058 **(27.78%)**	121454 (59.13%)	24186 (11.77%)	2714 **(1.32%)**	205412 (100%)
Female	31508 (24.15%)	83632 **(64.09%)**	14378 (11.02%)	968 (0.74%)	130486 (100%)
Total mean	88566 (26.37%)	205086 (61.06%)	38564 (11.48%)	3682 (1.10%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	1005.26	0.001

Table 4.26 shows that the relationship *between gender and alcohol/drugs involvement (DUI)*, male drivers tend to have higher crash proportions with driving under influence (especially alcohol with rate=11.65, mean=9.59) and female with no DUI (rate=92.52, mean=88.84). This contingency table confirms the above assumption of male drivers being more involved in crashes that related to alcohol/drug. Female drivers, crash involvement are less likely to be alcohol/drug involved.

Table 4.26. Gender and alcohol/drug involvement

DUI Gender	no DUI	Alcohol	drugs	alcohol & drugs	un-determined	Total
Male	177678 (86.50%)	23922 **(11.65%)**	394 **(0.19%)**	1709 **(0.83%)**	1709 **(0.83%)**	205412 (100%)
Female	120732 **(92.52%)**	8295 (6.36%)	193 (0.15%)	666 (0.51%)	600 (0.46%)	130486 (100%)
Total mean	120732 (88.84%)	32217 (9.59%)	587 (0.17%)	2375 (0.71%)	2309 (0.69%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	4	2939.689	0.001

As for the relationship between *gender and first safety equipment*, Table 4.27 illustrates that male drivers tend to have higher crash proportions with no seat-belt use (rate=16.82, mean=14.40) and female drivers with seat-belt use (rate=88.54, mean=83.84). Male drivers are riskier and careless; hence, they tend to have higher crash proportions of not wearing seat-belts.

Table 4.27. Age and first safety equipment

Safety Equip. Gender	no in use	seat belt	air bag	safety helmet	eye protection	other	Total
Male	33331 (16.82%)	160243 (80.85%)	947 (0.48%)	3344 (1.69%)	61 (0.03%)	274 (0.14%)	198200 (100%)
Female	13405 (10.62%)	111780 (88.54%)	684 (0.54%)	228 (0.18%)	8 (0.01%)	142 (0.11%)	126247 (100%)
Total mean	46736 (14.40%)	272023 (83.84%)	1631 (0.50%)	3572 (1.10%)	69 (0.02%)	416 (0.13%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	5	4223.383	0.001

As Table 4.28 depicts, for *gender and vehicle fault code*, male drivers tend to have slightly higher crash proportions with cited violation (rate=34.98, mean=33.93). Male drivers' riskier and careless behavior, such as speeding, alcohol involvement, or not wearing seat-belt, are all violations of traffic safety.

Table 4.28 Gender and Vehicle Fault Code

Fault Code Gender	fault	no fault	Total
Male	69324 **(34.98%)**	128876 (65.02%)	198200 (100%)
Female	40748 (32.28%)	85499 **(67.72%)**	126247 (100%)
Total mean	110072 (33.93%)	214375 (66.07%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	1	250.881	0.001

As for the relationship between *gender and speed ratio*, Table 4.29 shows that male drivers tend to have higher crash proportions with speed ratio >0.701 (especially with speed ratio >1.301, rate=3.98 and mean=3.26) and female drivers with speed ratio <0.7 (rate=62.01, mean=57.98). All above analyses show that male drivers are more involved in crashes related to speeding, this table supports the results.

Table 4.29. Age and speed ratio

Speed Ratio Gender	<0.7	0.701-0.9	0.901-1.1	1.101-1.3	>1.301	Total
Male	109755 (55.38%)	30481 (15.38%)	42724 (21.56%)	7358 (3.71%)	7882 (3.98%)	198200 (100%)
Female	78282 (62.01%)	18646 (14.77%)	23525 (18.63%)	3114 (2.47%)	2680 (2.12%)	126247 (100%)
Total mean	188037 (57.96%)	49127 (15.14%)	66249 (20.42%)	10472 (3.23%)	10562 (3.26%)	324447 (!00%)

Statistic	DF	Value	Prob.
Chi-square	4	2111.667	0.001

For *gender and vehicle movement*, the relationship shows that male drivers tend to have higher crash proportions when backing, lane changing, parking, U-turn, and passing (especially passing with rate=0.68, mean=0.56). Female drivers tend to have higher crash proportions when slowing/stopped/stalled and left turn (especially left-turn with rate=12.92, mean=11.63).

The relationship between *gender and vehicle year* depicts that male drivers tend to have higher crash proportions with vehicle years of <80, 81-85, and >95 (especially with <80, rate=9.37 and mean=7.52) and female drivers with vehicle years 86-90 and 91-95 (especially 91-95, rate=43.75 and mean=39.94).

For the relationship between *gender and type of vehicle*, Table 4.30 shows that male drivers tend to have higher crash proportions with motorcycles (rate=2.03, mean=1.34) and female drivers with auto (rate=86.31, mean=73.05). The male driver's higher crash proportions with motorcycles might be an indication of their riskier behavior while driving.

Table 4.30 Age and Type of Vehicle

Types Gender	auto	van	truck	RV	bus	bike	motor-cycle	terrain	other	Total
Male	128027 (64.59)	14637 **(7.38)**	47187 **(23.81)**	239 (0.12)	1120 (0.57)	2737 **(1.38)**	4030 **(2.03)**	121 (0.06)	102 (0.05)	198200 (100%)
Female	108969 **(86.31)**	7410 (5.87)	8113 (6.43)	22 (0.02)	709 (0.56)	612 (0.48)	326 (0.26)	48 (0.04)	38 (0.03)	126247 (100%)
Total mean	236996 (73.05)	22047 (6.80)	55300 (17.04)	261 (0.08)	1829 (0.56)	3349 (1.03)	4356 (1.34)	169 (0.05)	140 (0.04)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	8	21439.395	0.001

As for *the gender and first contributing cause-driver* , male drivers tend to have higher crash proportions with careless driving, alcohol involved, exceeded safe speed limit, driving wrong way, and fleeing police (especially with alcohol involved, rate=1.22 and mean=0.93). Female drivers tend to have higher crash proportions with failed to yield, improper turn, and disregarded traffic sign (especially with failed to yield, rate=13.41 and mean=11.77). This contingency table also confirms the assumption that male drivers tend to have higher crash involvement due to careless driving, alcohol/drug involved, and speeding. Female drivers are more likely to ignore the traffic signs due to being in a hurry.

4.2.3. RACE AND CRASH-RELATED FACTORS

In this section, the associations between race and environment, roadway, and driver-related factors were investigated. The demographic variable, race, is categorized as White, Black, Hispanic, and Other. The intention of investigating race is to use it as a surrogate for other variables like education, income, or culture, which are not available in any crash database; however, the race has not been treated as the color of the drivers in this research.

4.2.3.1.Race and Environmental-Related Factors

As mentions in Figure 4-1, the environmental-related factors of a crash are weather, month, day of the week, time of the day, lighting and surface conditions, and contributing cause of roadway or environment.

The relationship between *race and weather* indicates that White drivers tend to have slightly higher crash proportions on foggy weather (rate=0.44, mean=0.42). Black, Hispanic, and Other drivers tend to have higher crash proportions on raining day (especially Other drivers, rate=13.66, mean=12.28).

The relationship between *race and month* shows that the Other race group has higher crash proportion in May (rate=7.59, mean=6.84). Hispanic drivers have higher crash proportion in July and December (especially in July, rate=8.14, mean=7.82). As Table 4.31 depicts, the association between *race and day of the week*, White drivers tend to have higher crash proportions on Friday (rate=18.13, mean=17.86), Black drivers on Saturday (rate=14.71, mean=13.99), and Hispanic drivers on Sunday (rate=12.07, mean=10.33). Other drivers tend to have higher crash proportions on Monday to Wednesday (rates=14.64, 14.78, and 15.15, means=14.18, 14.53, and 14.32).

Table 4.31 Race and Day of the Week

Day \ Race	White	Black	Hispanic	Other	Total
Monday	34550 (14.14%)	8424 (14.22%)	4064 (14.41%)	600 (14.64%)	47638 (14.18%)
Tuesday	35584 (14.56%)	8582 (14.49%)	4049 (14.36%)	606 (14.78%)	48821 (14.53%)
Wednesday	36613 (14.98%)	8456 (14.27%)	3958 (14.03%)	621 (15.15%)	49648 (14.78%)
Thursday	35320 (14.45%)	8238 (13.91%)	4000 (14.18%)	556 (13.56%)	48114 (14.32%)
Friday	44298 (18.13%)	10265 (17.33%)	4693 (16.64%)	726 (17.71%)	59982 (17.86%)
Saturday	33719 (13.80%)	8712 (14.71%)	4037 (14.31%)	540 (13.17%)	47008 (13.99%)
Sunday	24270 (9.93%)	6563 (11.08%)	3404 (12.07%)	450 (10.98%)	34687 (10.33%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	18	272.137	0.001

As for the association between *race and time*, White drivers have higher crash proportions at 12:01-18:00 PM (rate=44.92, mean=44.33). Black drivers have higher crash proportions at 0:00-6:00 AM (rate=7.40, mean=7.01). Hispanic drivers have higher crash proportions at 6:01-12:00 AM (rate=24.95, mean=24.45). Other drivers tend to have higher crash proportions at 18:01-24:00 (rate=26.81, mean=24.20).

For *race and lighting condition*, it is found that Other drivers tend to have higher crash proportions at dawn and dark (rates=1.32 and 27.06, means=1.14 and 25.24). For the association between *race and roadway surface*, Hispanic drivers tend to have higher crash proportions on a wet road surface (rate=19.53, mean=17.80). Other drivers tend to have higher crash proportions on a slippery road surface (rate=1.44, mean=1.05).

For *race and first contributing cause-road*, Other drivers tend to have higher crash proportions when there are obstructions (rate=0.34, mean=0.23). The association between *race and first contributing cause-environment* shows that White drivers tend to have slightly higher crash proportions in foggy environment (rate=0.20, mean=0.19). Black drivers have higher crash proportions with load on vehicles (rate=0.09, mean=0.07). Hispanic drivers tend to have higher crash proportions with inclement weather (rate=6.23, mean=4.97). Other drivers tend to have higher crash proportions with parked/stopped vehicles on the roadway (rate=2.95, mean=2.43).

4.2.3.2.Race and Roadway-Related Factors

The factors that are related to the roadway elements of a crash are investigated in this section. Some of these factors are: number of lanes, divided/undivided, roadway system, site location, roadway character, traffic control, and location type, urban/rural, shoulder type, and location on roadway (see Figure 4-1).

As for the association between *race and number of lanes*, Table 4.32 depicts that Black drivers have higher crash proportions at two-lanes highway (rate=35.17, mean=33.98). Hispanic drivers have higher crash proportions at 8-11 lanes highway (rate=4.62, mean=2.92). Other drivers have higher crash proportions at parking lots and 12-16 lanes highway (rates=2.15 and 0.41, means=1.82 and 0.18). Perhaps, more Black people drive on two-lane roads to go to work. Most of the two-lane roads are more likely to be undivided. More Hispanic people live in metropolitan areas where there are freeways to cope with demands, hence, a greater chance to get crashes. Many foreign people are considered as Other race group. It is logical that Other race drivers have higher crash proportions at parking lots or 12-16 lanes highways, because recreation areas are usually having larger parking lots and highways. Large highways most are the divided highways.

Table 4.33 shows that association between race and divided/undivided highway. It depicts that Black drivers have higher crash proportions at undivided highways (rate=55.58, mean=51.53). Other drivers have higher crash proportions at divided highways (rate=54.50, mean=48.47). Similar results as race and number of lanes. This confirms the previous finding that Black drivers have more crashes on two lane undivided highways.

Table 4.32 Race and Number of Lane

Race **# of lanes**	**White**	**Black**	**Hispanic**	**Other**	**Total Mean**
parking lot	4438 (1.82%)	1162 (1.96%)	421 (1.49%)	88 **(2.15%)**	6109 (1.82%)
1	3240 (1.33%)	852 **(1.44%)**	435 **(1.54%)**	56 (1.375)	4583 (1.36%)
2	83421 (34.14%)	20833 **(35.17%)**	8792 (31.17%)	1091 (26.62%)	114137 (33.98%)
3-4	91490 (37.44%)	21641 (36.53%)	10936 **(38.77%)**	1647 **(40.18%)**	125714 (37.43%)
5-7	55073 (22.54%)	12623 (21.31%)	6249 (22.16%)	1051 **(25.64%)**	74996 (22.33%)
8-11	6348 (2.60%)	1965 (3.32%)	1304 **(4.62%)**	149 (3.64%)	9766 (2.91%)
12-16	344 (0.14%)	164 **(0.28%)**	68 (0.24%)	17 (0.41%)	593 (0.18%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	18	761.104	0.001

Table 4.33 Race and Divided/Undivided

Race **divided/undivided**	**White**	**Black**	**Hispanic**	**Other**	**Total Mean**
divided	120242 (49.21%)	26312 (44.42%)	14032 (49.75%)	2234 **(54.50%)**	162820 (48.47%)
undivided	124112 (50.79%)	32928 **(55.58%)**	14173 (50.25%)	1865 (45.50%)	173078 (51.53%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	521.315	0.001

For *race and roadway systems*, White drivers tend to have higher crash proportions on U.S. and state highways (especially U.S. highway with rate=8.38, mean=7.53). Black drivers tend to have higher crash proportions on local streets (rate=37.36, mean=30.06). Hispanic drivers tend to have higher crash proportions on county and turnpike/toll roads (rates=31.41 and 0.69, means=19.57 and 0.42). Other drivers tend to have higher crash proportions on interstate highways (rate=8.49, mean=5.70). Table 5.34 shows the relationship association between *race and site location*. It depicts that White drivers tend to have higher crash proportions at driveway (rate=5.37, mean=5.08). Black drivers tend to have higher crash proportions at railroads and intersections (rates=0.26 and 55.11, means=0.20 and 54.03). Respectively, Hispanic drivers tend to have higher crash proportions not at intersections (rate=38.09, mean=37.62). Other drivers tend to have higher crash proportions at on/off ramps (rate=1.71, mean=1.25).

Table 4.34 Race and Site Location

Race Site Location	White	Black	Hispanic	Other	Total mean
Not intersection	91994 (37.65%)	22006 (37.15%)	10743 **(38.09%)**	1621 **(39.55%)**	126364 (37.62%)
Intersection	131348 (53.75%)	32649 **(55.11%)**	15373 (54.50%)	2112 (51.52%)	181482 (54.03%)
Driveway	13125 **(5.37%)**	2541 (4.29%)	1195 (4.24%)	201 (4.90%)	17062 (5.08%)
Railroad Crossing	453 (0.19%)	152 **(0.26%)**	54 (0.19%)	7 (0.17%)	666 (0.20%)
on/off ramp	2996 (1.23%)	730 (1.23%)	419 **(1.49%)**	70 **(1.71%)**	4215 (1.25%)
Parking lot	4438 (1.82%)	1162 **(1.96%)**	421 (1.49%)	88 **(2.15%)**	6109 (1.82%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	15	243.493	0.001

Table 4.35 depicts the association between *race and roadway character*. It shows that White drivers tend to have higher crash proportions at curve-level trafficways (rate=3.95, mean=3.63). Hispanic drivers tend to have higher crash proportions at straight-level trafficways (rate=91.04, mean=87.73). Other drivers tend to have higher crash proportions at straight-grade trafficways (rate=8.10, mean=7.27).

Table 4.35 Race and Roadway Character

Race Curvature	White	Black	Hispanic	Other	Total mean
straight level	213017 (87.18%)	52436 (88.51%)	25678 (91.04%)	3550 (86.61%)	294681 (87.73%)
straight grade	18218 (7.46%)	4362 (7.36%)	1501 (5.32%)	332 (8.10%)	24413 (7.27%)
curve level	9644 (3.95%)	1690 (2.85%)	711 (2.52%)	158 (3.85%)	12203 (3.63%)
curve grade	3475 (1.42%)	752 (1.27%)	315 (1.12%)	59 (1.44%)	4601 (1.37%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	9	496.620	0.001

For the association between *race and traffic control*, Table 4.36 shows that White drivers tend to have higher crash proportions at special speed zones (rate=12.87, mean=12.20). Black drivers tend to have higher crash proportions at railroad crossings (rate=0.19, mean=0.14). Hispanic drivers tend to have higher crash proportions at no control, stop signs, and yield signs (especially stop signs with rate=17.24, mean=14.61). Other drivers tend to have higher crash proportions at no U-turn areas (rate=0.07, mean=0.04).

Table 4.36 Race and Traffic Control

Race Control	White	Black	Hispanic	Other	Total mean
no control	105085 (43.01%)	25266 (42.65%)	12146 **(43.06%)**	1711 (41.74%)	144208 (42.93%)
special zone	31445 **(12.87%)**	6364 (10.74%)	2665 (9.45%)	517 (12.61%)	40991 (12.20%)
signal	69069 (28.27%)	16558 (27.95%)	7993 (28.34%)	1245 **(30.37%)**	94865 (28.24%)
stop	33875 (13.86%)	9792 (16.53%)	4862 **(17.24%)**	540 (13.17%)	49069 (14.61%)
yield	2955 (1.21%)	767 (1.29%)	390 **(1.38%)**	53 (1.29%)	41.65 (1.24%)
railroad crossing	337 (0.14%)	114 **(0.19%)**	25 (0.09%)	5 (0.12%)	481 (0.14%)
guard	1473 (0.60%)	359 **(0.61%)**	117 (0.41%)	25 (0.61%)	1974 (0.59%)
no u-turn	115 (0.05%)	20 (0.03%)	7 (0.02%)	3 **(0.07%)**	145 (0.04%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	21	806.670	0.001

For race and location type, Table 4.37 depicts that White drivers tend to have higher crash proportions at open country areas (rate=11.07, mean=10.19). Black and Hispanic drivers tend to have higher crash proportions at residential areas (rates=31.80 and 33.67, mean=27.32). Other drivers tend to have higher crash proportions at business areas (rate=65.80, mean=62.49).

Table 4.37 Race and Location Type

Race Location	White	Black	Hispanic	Other	Total mean
business	154849 **(63.37%)**	35818 (60.46%)	16523 (58.58%)	2697 **(65.80%)**	209887 (62.49%)
residential	62459 (25.56%)	18836 **(31.80%)**	9498 **(33.67%)**	978 (23.86%)	91771 (27.32%)
open country	27046 **(11.07%)**	4586 (7.74%)	2184 (7.74%)	424 (10.34%)	34240 (10.19%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	6	1990.608	0.001

As for *race and rural/urban*, Table 4.38 illustrates that White, Hispanic, and Other drivers tend to have higher crash proportions at rural areas (rates=42.32, 50.81, and 43.40). Black drivers tend to have higher crash proportions at urban areas (rate=65.58, mean=58.35).

Table 4.38 Race and rural/urban

Race Rural/urban	White	Black	Hispanic	Other	Total Mean
Rural	103412 **(42.32%)**	20390 (34.42%)	14331 (50.81%)	1779 **(43.40%)**	139912 (41.65%)
Urban	140942 (57.68%)	38850 **(65.58%)**	13874 (49.19%)	2320 (56.60%)	195986 (58.35%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	2298.579	0.001

For *race and type of shoulder*, Table 4.39 indicates that White drivers tend to have higher crash proportions on roadways with unpaved shoulder (rate=43.31, mean=40.64); this result might be related to the run-off- road crashes. Black and Hispanic drivers tend to have higher crash proportions on roadways with paved shoulders (rates=35.79 and 45.08, mean=30.89). Other drivers tend to have higher crash proportions on roadways with curb shoulder (rate=32.59, mean=28.47).

Table 3.39. Race and shoulder type

Race Shoulder Type	White	Black	Hispanic	Other	Total mean
Paved	68589 (28.07%)	21200 **(35.79%)**	12714 **(45.08%)**	1260 (30.74%)	103763 (30.89%)
Unpaved	105827 **(43.31%)**	20280 (34.23%)	8886 (31.51%)	1503 (36.67%)	136496 (40.64%)
Curb	69938 (28.62%)	17760 (29.98%)	6605 (23.42%)	1336 **(32.59%)**	95639 (28.47%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.

Chi-square	6	4875.274	0.001

The association between *race and location on roadway* shows that White drivers tend to have higher crash proportions at shoulder (rate=2.33, mean=2.25). Black drivers tend to have higher crash proportions not on road (rate=3.31, mean=3.18). Hispanic drivers tend to have higher crash proportions on road (rate=93.95, mean=92.91). Other drivers tend to have higher crash proportions on median and turning lane (rates=0.63 and 1.36, means=0.46 and 1.20)

4.2.3.3.Race and Driver-Related Factors

The factors that are related to the drivers involved in crashes are analyzed and associated with race in this section. Some of these factors are: first harmful event (manner of collision, injury severity, alcohol/drug involvement (driving under influences), safety equipment, speed ratio, vehicle fault code, vehicle movement, vehicle year, type of vehicle, residency, and contributing cause of drivers (see Figure 4-1).

As Table 4.40 presents, the association between *race and first harmful event* , White drivers have higher crash proportions on ran-off and overturned (especially overturned with rate=1.13, mean=1.04). Black drivers have higher crash proportions on angle type of collision (rate=27.74, mean=25.83). Hispanic drivers have higher crash proportions on head-on, turn, and sideswipe (especially sideswipe, rate=6.61 and mean=5.57). Other drivers have higher crash proportions on rear-end (rate=38.06, mean=36.66). According to the analysis, White drivers might have higher crash involvement related to alcohol/drug and speeding. Therefore, White drivers' ran-off and overturned crashes involvement might be related to alcohol/drug. Black drivers' angle type of collision might be on intersections. Hispanic drivers' higher crash proportions on sideswipe might be related to passing other vehicles on multi-lane highways. Other drivers' unfamiliarity of roadway designs, controls, or directions might cause them to slow down their vehicles suddenly, which result in rear-end crashes.

Table 4.40 Race and First Harmful Event

Race Harmful Event	White	Black	Hispanic	Other	Total Mean
rear-end	92760 **(37.96%)**	19608 (33.10%)	9223 (32.70%)	1560 **(38.06%)**	123151 (36.66%)
head-on	5149 (2.11%)	1285 **(2.17%)**	668 **(2.37%)**	74 (1.81%)	7176 (2.14%)
angle	61566 (25.20%)	16431 **(27.74%)**	7738 **(27.43%)**	1031 (25.15%)	86766 (25.83%)
turn	35659 (14.59%)	8529 (14.40%)	4893 **(17.35%)**	608 (14.83%)	49689 (14.79%)
sideswipe	12925 (5.29%)	3708 **(6.26%)**	1863 **(6.61%)**	208 (5.07%)	18704 (5.57%)
ran-off	3567 **(1.46%)**	622 (1.05%)	279 (0.99%)	54 (1.32%)	4522 (1.35%)
overturned	2767 **(1.13%)**	447 (0.75%)	234 (0.83%)	46 **(1.12%)**	3494 (1.04%)
all other	29961 (12.26%)	8610 **(14.53%)**	3307 (11.72%)	518 (12.64%)	42396 (12.62%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	21	1262.073	0.001

For the association between *race and injury severity*, Table 4.41 shows that White drivers tend to have higher crash proportions with severe and fatal injuries (rates=11.76 and 1.17, means=11.48 and 1.10). Black drivers tend to have higher crash proportions with minor injury (rate=62.99, mean=61.06). Hispanic drivers tend to have higher crash proportions with no injury (rate=29.24, mean=26.37). Other drivers tend to have slightly higher crash proportions with fatal injury (rate=1.17, mean=1.10). White drivers' high crash proportions with severe or fatal injuries might be related to alcohol/drug or speeding. Other drivers' high crash proportions with fatal injuries might be related to unfamiliarity of design (on on/off ramps or intersections).

Table 4.41 Race and Injury Severity

Race Injury Severity	White	Black	Hispanic	Other	Total Mean
no injury	64093 (26.23%)	15140 (25.56%)	8246 **(29.24%)**	1087 (26.52%)	88566 (25.37%)
minor injury	148665 (60.84%)	37314 (62.99%)	16600 (58.85%)	2507 **(61.16%)**	205086 (61.06%)
severe injury	28746 (11.76%)	6299 (10.63%)	3062 (10.86%)	457 (11.15%)	38564 (11.48%)
fatal	2850 **(1.17%)**	487 (0.82%)	297 (1.05%)	48 **(1.17%)**	3682 (1.10%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	9	281.446	0.001

As Table 4.42 depicts, for the association *between race and alcohol/drugs involved*, White drivers tend to have higher crash proportions with DUI (especially alcohol and drugs involvement with rate=0.78, mean=0.71). Black, Hispanic, and Other drivers do not show significance of higher crash proportions with DUI. More White people drink than any other race.

Table 4.42. Race and Driving Under Influences

Race DUI	White	Black	Hispanic	Other	Total mean
no DUI	214823 (87.91%)	54382 **(91.80%)**	25459 (90.26%)	3746 **(91.39%)**	298410 (88.84%)
alcohol	25364 **(10.38%)**	4177 (7.05%)	2372 (8.41%)	304 (7.42%)	32217 (9.59%)
drugs	470 **(0.19%)**	80 (0.14%)	32 (0.11%)	5 (0.12%)	587 (0.17%)
alcohol & drugs	1909 **(0.78%)**	289 (0.49%)	154 (0.55%)	23 (0.56%)	2375 (0.71%)
undetermined	1788 **(0.73%)**	312 (0.53%)	188 (0.67%)	21 (0.51%)	2309 (0.69%)
Total	244354 (100%)	59240 (100%)	28205 (100%)	4099 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	12	828.220	0.001

Table 4.43 illustrates the relationship between *race and first safety equipment*. It shows that Black and Hispanic drivers tend to have higher crash proportions with no seat-belt in use

(rates=16.74 and 15.44, mean=14.40). Perhaps, this result is an indication of lack of safety education.

Table 4.43 Race and Safety Equipment

Race **Safety Equip.**	**White**	**Black**	**Hispanic**	**Other**	**Total** **mean**
not in use	32680 (13.80%)	9467 **(16.74%)**	4177 **(15.44%)**	412 (10.35%)	46736 (14.40%)
seat belt	199324 (84.16%)	46564 (82.33%)	22618 (83.60%)	3517 (88.37%)	272023 (83.84%)
air bag	1247 (0.53%)	254 (0.45%)	105 (0.39%)	25 (0.63%)	1631 (0.50%)
safety helmet	3224 (1.36%)	198 (0.35%)	131 (0.48%)	19 (0.48%)	3572 (1.10%)
eye protection	60 (0.03%)	3 (0.01%)	3 (0.01%)	3 (0.01%)	69 (0.02%)
other	318 (0.13%)	74 (0.13%)	20 (0.07%)	4 (0.10%)	416 (0.13%)
Total	236853 (100%)	56560 (100%)	27054 (100%)	3980 (100%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	15	947.688	0.001

For the association between *race and vehicle fault code*, Table 4.44 shows that Black drivers tend to have higher crash proportions with not cited for violations (rate=69.22, mean=66.07). Hispanic and Other drivers tend to have higher crash proportions with cited for violations (rates=36.32 and 35.25, mean=33.93). The result might be indicate that there is need for more traffic education for Hispanic drivers.

Table 4.44 Race and Vehicle Fault Code

Race **Fault Code**	**White**	**Black**	**Hispanic**	**Other**	**Total** **mean**
fault	81437 (34.38%)	17407 (30.78%)	9825 **(36.32%)**	1403 **(35.25%)**	110072 (33.93%)
no fault	155416 (65.62%)	39153 (69.22%)	17229 (63.68%)	2577 (64.75%)	214375 (66.07%)
Total	236853 (100%)	56560 (100%)	27054 (100%)	3980 (100%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	344.467	0.001

For *race and speed ratio*, Table 4.45 illustrates that White drivers tend to have higher crash proportions with speed ratio >1.3 (rate=3.31, mean=3.26). Black and Hispanic drivers tend to have higher crash proportions when driving with speed ratio of 0.901-1.1 (rate=21.15, mean=20.42). Other drivers tend to have higher crash proportions when driving at speed ratio <0.7 or 1.101-1.3 (rates=58.47 and 3.62, means=57.96 and 3.23). The result confirms the assumptions that White drivers tend to drive faster than the posted speed, therefore they have more severe and off-road crashes. Other drivers tend to drive below the posted speed due to unfamiliarity of locations or designs.

Table 4.45 Race and Speed Ratio

Race **Speed Ratio**	**White**	**Black**	**Hispanic**	**Other**	**Total mean**
<0.7	138435 **(58.45%)**	32288 (57.09%)	14987 (55.40%)	2327 **(58.47%)**	188037 (57.96%)
0.701-0.9	35464 (14.97%)	8720 **(15.42%)**	4351 **(16.08%)**	592 (14.87%)	49127 (15.14%)
0.901-1.1	47377 (20.00%)	11965 **(21.15%)**	6086 **(22.50%)**	821 (20.63%)	66249 (20.42%)
1.101-1.3	7731 (3.26%)	1792 (3.17%)	805 (2.98%)	144 **(3.62%)**	10472 (3.23%)
>1.301	7846 **(3.31%)**	1795 (3.17%)	825 (3.05%)	96 (2.41%)	10562 (3.26%)
Total	236853 (100%)	56560 (100%)	27054 (100%)	3980 (100%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	12	188.189	0.001

For the association between *race and vehicle movement*, White drivers tend to have higher crash proportions when making right turns (rate=2.79, mean=2.77). Black drivers tend to have higher crash proportions when backing, parked, and driverless or runaway vehicle (especially driverless or runaway vehicle with rate=0.05, mean=0.02). Hispanic drivers tend to have higher crash proportions when changing lanes and passing (especially changing lanes with rate=2.34, mean=2.05). Other drivers tend to have higher crash rates when stalling, making left-turns, and U-turns (especially making U-turns with rate=0.58, mean=0.51).

For *race and vehicle year*, it seems that White and Other drivers tend to have higher crash proportions with vehicle years >95 (rates=0.53 and 0.75, mean=0.50). Black drivers tend to have higher crash proportions with vehicle years <80 (rate=9.43, mean=7.52). Hispanic drivers tend to have higher crash proportion with vehicle years between 81-85 (rate=22.34, mean=17.24). Perhaps, this result is an indication of income.

As for *race and type of vehicle*, White drivers tend to have higher crash proportions when driving trucks, RVs, or motorcycles (especially with RV, rate=0.10 and mean=0.08). Black tend to have higher crash proportions when driving buses (rate=1.33, mean=0.56). Hispanic drivers tend to have higher crash proportions when driving vans (rate=8.10, mean=6.80). Other drivers tend to have higher crash proportions when driving autos and vans (rates=82.39 and 9.17, means=73.03 and 6.80).

Table 4.46. Race and Vehicle Year

Race Vehicle year	**White**	**Black**	**Hispanic**	**Other**	**Total mean**
<80	16882 (7.13%)	5332 **(9.43%)**	2074 (7.67%)	111 (2.79%)	24399 (7.52%)
81-85	37228 (15.72%)	12093 **(21.38%)**	6045 (22.34%)	564 (14.17%)	55930 (17.24%)
86-90	79319 (33.49%)	19521 (34.51%)	9297 (34.36%)	1430 **(35.93%)**	109567 (33.77%)
91-95	99933 (42.19%)	18593 (32.87%)	9257 (34.22%)	1816 **(45.63%)**	129599 (39.94%)
>95	1252 (0.53%)	215 (0.38%)	128 (0.47%)	30 **(0.75%)**	1625 (0.50%)
unknown	2239 (0.95%)	806 (1.43%)	253 (0.94%)	29 (0.73%)	3327 (1.03%)
Total	236853 (100%)	56560 (100%)	27054 (100%)	3980 (100%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	15	3172.022	0.001

As for *race and first contributing cause-driver*, White drivers tend to have higher crash proportions with alcohol involved (rate=1.04, mean=0.93). Black drivers tend to have higher crash proportions with failed to maintain vehicles (rate=0.61 and mean=0.48). Hispanic drivers tend to have higher crash proportions with disregarding traffic signs (rate=2.79, mean=2.37). Other drivers tend to have higher crash proportions when obstructing traffic (rate=0.35, mean=0.21).

4.2.4. RESIDENCY AND CRASH-RELATED FACTORS

Residency is then defined as the local drivers (in the same county as crash location), state drivers (live in Florida), out-state (from different state), and foreign drivers (from other country). This variable is cross tabulated with crash-related factors in this section.

4.2.4.1.Residency and Environment-Related Factors

The environment-related factors used here are the same as the previous sections expect the demographic variable-residency is different. For *residency and weather*, State drivers tend to have higher crash proportions in cloudy, rain, or foggy weather (especially rain and foggy weather, rates=13.25 and 0.69, means=12.28 and 0.42). Out-state and foreign drivers tend to have higher crash proportions on clear days (especially out-state drivers with rate=68.47, mean=67.48).

Table 4.47 depicts, the association between *residency and month*, local residents (in county) tend to have higher crash proportion in the months of September- November (especially September with rate=7.97, mean=7.84). State residents tend to have higher crash proportion in months of May-August (especially June with rate=6.95, mean=6.40). Out-state drivers tend to have higher crash proportions in months of January-April (especially March with rate=12.23, mean=7.68). Foreign drivers tend to have higher crash proportions in December (rate=13.34, mean=11.82). Local residents in month of September are when many high schools or college start and more drivers (especially teenagers) are on the roads to schools. There are more out-state people in Florida in March because of the spring break. Foreign drivers usually come to Florida during Christmas due to nice climate and special events in certain recreation areas, such as Disney World.

Table 4.47 Residency and Month

Residency Month	Local	State	Out-state	Foreign	Total mean
1	17616 (7.06%)	2342 (6.63%)	937 **(8.52%)**	151 (0.72%)	21046 (7.06%)
2	16055 (6.43%)	2285 (6.47%)	1080 **(9.82%)**	170 **(8.34%)**	19590 (6.58%)
3	18657 (7.48%)	2663 (7.54%)	1346 **(12.23%)**	218 (10.69%)	22884 (7.68%)
4	16828 (6.74%)	2388 (6.76%)	831 **(7.55%)**	132 (6.47%)	20179 (6.77%)
5	17155 (6.87%)	2480 (7.02%)	635 (5.77%)	114 (5.59%)	20384 (6.84%)
6	15859 (6.36%)	2455 (6.95%)	648 (5.89%)	100 (4.90%)	19062 (6.40%)
7	19486 (7.81%)	2814 **(7.96%)**	821 (7.46%)	162 (7.95%)	23283 (7.82%)
8	19664 (7.88%)	2911 **(8.24%)**	739 (6.72%)	156 (7.65%)	23470 (7.88%)
9	19877 **(7.97%)**	2773 (7.85%)	558 (5.07%)	141 (6.92%)	23349 (7.84%)
10	30371 **(12.17%)**	4244 (12.01%)	1007 (9.15%)	220 (10.79%)	35842 (12.03%)
11	28375 **(11.37%)**	3972 (11.24%)	1069 (9.72%)	203 (9.96%)	33619 (11.28%)
12	29594 (11.86%)	4006 (11.34%)	1331 **(12.10%)**	272 **(13.34%)**	35203 (11.82%)
Total	249537 (100%)	35333 (100%)	11002 (100%)	2039 (100%)	297911 (100%)

Statistic	DF	Value	Prob.
Chi-square	33	902.068	0.001

As for *residency and day of the week*, local drivers tend to have higher crash proportions on weekdays (especially Wednesday with rate=14.91, mean=14.78). Out-state and foreign drivers tend to have higher crash proportions on weekends (especially Sunday, rates=12.49 and 12.81, mean=10.33).

For *residency and time*, local residents tend to have higher crash proportions between 6:01-12:00 AM (rate=24.52, mean=24.45). State residents tend to have higher crash proportions between 0:00-6:00 AM (rate=8.62, mean=7.01). Out-state drivers tend to have higher crash proportions between 12:01-18:00 PM (rate=44.72, mean=44.33). Foreign drivers tend to have higher crash proportions between 18:01-24:00 PM (rate=26.73, mean=24.20).

For *residency and lighting condition*, local drivers tend to have slightly higher crash proportions at daylight (rate=70.86, mean=70.78). State drivers tend to have higher crash proportions at dawn (rate=1.28, mean=1.14). Out-state drivers tend to have higher crash proportions at dark (rate=27.05, mean=25.24). Foreign drivers tend to have higher crash proportions at dusk (rate=2.98, mean=2.84). As for the association between *residency and roadway surface*, state drivers tend to have higher crash proportions on a wet surface (rate=18.68, mean=17.80). Foreign drivers tend to have higher crash proportions on a dry surface (rate=81.74, mean=80.93).

For the association between *residency and first contributing cause-road*, the result shows that state drivers tend to have higher crash proportions when there is standing water on the roadways (rate=0.84, mean=0.56) Out-state drivers tend to have higher crash proportions when there are constructions (rate=2.26, mean=1.26). Foreign drivers tend to have higher crash proportions when there are obstructions on the roadways (rate=0.47, mean=0.23). For *residency and first contributing cause-environment*, the state drivers tend to have higher crash proportions with foggy weather (rate=0.35, mean=0.19).

4.2.4.2. Residency Roadway-Related Factors

The roadway-related factors associated with residency are listed in Figure 4.1. For *residency and number of lane*, local residents tend to have higher crash proportions at parking lots and two-lanes highway (especially parking lot with rate=1.89, mean=1.82). State residents tend to have higher crash proportions on 12-16 lane highways (rate=0.39, mean=0.18). Out-state drivers tend to have higher crash proportions on 3-4 lane highways (rate=44.69, mean=37.43). Foreign drivers tend to have higher crash proportions on 5-7 and 8-11 lane highways (rates=29.46 and 3.87, means=22.33 and 2.91).

Table 4.48 presents the association between *residency and divided/undivided highway*. It shows that local drivers tend to have higher crash proportions at undivided highway (rate=53.16, mean=51.53). State, out-state, and foreign drivers tend to have higher crash proportions at divided highways (especially foreign drivers with rate=58.66, mean=48.47). Most of local drivers drive on the local streets. More local streets are undivided. Therefore, local drivers tend to have higher crash proportions at undivided highways. Most interstate, U.S., or toll/turnpike are divided highways. State, out-state, and foreign drivers are more likely to drive on this type of highway due to fast and convenience traveling.

Table 4.48 Residency and Divided/Undivided

Residency Divided/Undivided	Local	State	Out-state	Foreign	Total
Divided	131523 (46.84%)	22716 (56.77%)	7203 (56.55%)	1378 (58.66%)	162820 (48.47%)
Undivided	149276 (53.16%)	17296 (43.23%)	5535 (43.45%)	971 (41.34%)	173078 (51.53%)
Total	280799 (100%)	40012 (100%)	12738 (100%)	2349 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	1833.970	0.001

The relationship between *residency and roadway systems*, Table 4.49 illustrates that local drivers tend to have higher crash proportions on county and local roads (especially with local road, rate=32.31 and mean=30.06). State drivers tend to have higher crash proportions on turnpike/toll road (rate=1.24, mean=0.42). Out-state drivers tend to have higher crash proportions on interstate and U.S. highways (especially interstate with rate=14.77, mean=5.70). Foreign drivers seem to have higher crash proportions on state highways (rate=42.61, mean=36.69). The results are expected. Most local drivers travel on county and local roads. For faster, easier, and convenience traveling, first of all, state, out-state, and foreigner drivers have to be on the main highways in order to connect other streets or collectors to reach their destinations.

Table 4.49 Residency and Roadway System Identifier

Residency Road System	Local	State	Out-state	Foreign	Total mean
interstate	11251 (4.01%)	5811 **(14.52%)**	1881 **(14.77%)**	194 (8.26%)	19137 (5.70%)
U.S.	19096 (6.80%)	4341 **(10.85%)**	1574 **(12.36%)**	270 **(11.49%)**	25281 (7.53%)
state	100302 (35.72%)	16673 **(41.67%)**	5277 **(41.43%)**	1001 **(42.61%)**	123253 (36.69%)
county	58517 **(20.84%)**	5377 (13.44%)	1521 (11.94%)	306 (13.03%)	65721 (19.57%)
local	90718 **(32.31%)**	7278 (18.19%)	2404 (18.87%)	560 (23.84%)	100960 (30.06%)
Turnpike/tol l	828 (0.29%)	497 **(1.24%)**	77 **(0.60%)**	18 **(0.77%)**	1420 (0.42%)
forest road	87 (0.03%)	35 **(0.09%)**	4 (0.03%)	0 (0%)	126 (0.04%)
Total	280799 (100%)	40012 (11.91%)	12738 (100%)	2349 (!00%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	18	15545.638	0.001

For *residency and site location*, Table 4.50 shows that local drivers tend to have higher crash proportions at parking lots (rate=1.89, mean=1.82). State drivers tend to have higher crash proportions railroad, on/off ramps, and not at intersections (especially on/off ramps with rate=2.09, mean=1.25). Out-state also have higher crash proportions at on/off ramps (rate=1.96, mean=1.25). Foreign drivers tend to have higher crash proportions at intersections (rate=55.64, mean=54.03) because they are familiar with the intersection design. We need to improve the traffic signs for the areas with many tourists.

Table 4.50 Residency and Site Location

Residency Site Location	Local	State	Out-state	Foreign	Total mean
not intersect	101280 (36.07%)	18598 **(46.48%)**	5611 **(44.05%)**	875 (37.25%)	126364 (37.62%)
intersection	156066 **(55.58%)**	18120 (45.29%)	5989 (47.02%)	1307 **(55.64%)**	181482 (54.03%)
driveway	14521 **(5.17%)**	1777 (4.44%)	671 **(5.27%)**	93 (3.96%)	17062 (5.08%)
railroad cross	528 (0.19%)	120 **(0.30%)**	13 (0.10%)	5 (0.21%)	666 (0.20%)
on/off ramp	3093 (1.10%)	837 (2.09%)	250 **(1.96%)**	35 **(1.49%)**	4215 (1.25%)
parking lot	5311 **(1.89%)**	560 (1.40%)	204 (1.60%)	34 (1.45%)	6109 (1.82%)
Total	280799 (100%)	40012 (100%)	12738 (100%)	2349 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	15	2414.376	0.001

For *residency and roadway character*, local and foreign drivers tend to have higher crash proportions on straight-level trafficways (rates=88.47 and 89.48, mean=87.73). State drivers tend to have higher crash proportions at curves (especially curve-graded, rate=2.01 and mean=1.37). Out-state drivers tend to have higher crash proportions on straight-grade trafficways (rate=10.05, mean=7.27).

As Table 5.51 depicts, the association between *residency and traffic control*, local drivers tend to have higher crash proportions at stop signs (rate=15.51, mean=14.61). State drivers tend to have higher crash proportions at railroad, no U-turn, and locations with no traffic control (especially no U-turn with rate=0.07, mean=0.04). Out-state drivers tend to have higher crash proportions at special speed zones (rate=17.01, mean=12.20). Foreign drivers tend to have higher crash proportions at locations with signals (rate=34.78, mean=28.24). Local drivers are more likely to be on local streets where there are many stop signs. State and out-state drivers are more likely to be on highways where there are more on/off ramps and special speed zones. From Tables 4.51 and 4.52, one can conclude that many foreign drivers tend to have high crash proportion at signalized intersections.

Table 4.51. Residency and Traffic Control

Residency Control	Local	State	Out-state	Foreign	Total mean
no control	118825 (42.32%)	18731 **(46.81%)**	5724 **(44.94%)**	928 (39.51%)	144208 (42.93%)
special zone	32139 (11.45%)	6390 **(15.97%)**	2167 **(17.01%)**	295 (12.56%)	40991 (12.20%)
signal	80736 (28.75%)	10052 (25.12%)	3260 (25.59%)	817 **(34.78%)**	94865 (28.24%)
stop	43558 **(15.51%)**	3929 (9.82%)	1312 (10.30%)	270 (11.49%)	49069 (14.61%)
yield	3421 (1.22%)	526 **(1.31%)**	192 **(1.51%)**	26 (1.11%)	4165 (1.24%)
railroad crossing	385 (0.14%)	87 **(0.22%)**	7 (0.05%)	2 (0.09%)	481 (0.14%)
guard	1625 (0.58%)	270 **(0.67%)**	68 (0.53%)	11 (0.47%)	1974 (0.59%)
no u-turn	110 (0.04%)	27 **(0.07%)**	8 (0.06%)	0 (0%)	145 (0.04%)
Total	280799 (100%)	40012 (100%)	12738 (100%)	2349 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	21	2265.619	0.001

As for *residency and location type*, local drivers tend to have higher crash proportions in residential areas (rate=29.48, mean=27.32). State drivers tend to have higher crash proportions in open country areas (rate=22.91, mean=10.19). Both out-state and foreign drivers have higher crash proportions in business areas (especially foreign drivers with rate=69.22, mean=62.49).

For residency and rural/urban, Table 5.52 shows that local and foreign drivers tend to have higher crash proportions in urban areas (rates=59.66 and 59.43, mean=58.35). State and out-state drivers tend to have higher crash proportions in rural areas (rates=49.07 and 47.51, mean=41.65).

Table 4.52 Residency and Rural/Urban

Residency Rural/Urban	Local	State	Out-state	Foreign	Total mean
Rural	113275 (40.34%)	19632 **(49.07%)**	6052 **(47.51%)**	953 (40.57%)	139912 (41.65%)
Urban	167524 **(59.66%)**	20380 (50.93%)	6686 (52.49%)	1396 **(59.43%)**	195986 (58.35%)
Total	280799 (100%)	40012 (100%)	12738 (100%)	2349 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	1284.671	0.001

The association between *residency and type of shoulder* shows that state drivers tend to have higher crash proportions at locations with unpaved shoulders (rate=43.37, mean=40.64). Foreign drivers tend to have higher crash proportions at locations with paved shoulders (rate=37.16, mean=30.89). As Table 4.53 depicts, the association between *residency and location on roadway*, state drivers tend to have higher crash proportions on medians (rate=0.88, mean=0.46). Foreign drivers tend to have higher crash proportions in turning lanes (rate=1.44, mean=1.20).

Table 4.53 Residency and Location on Roadway

Residency location on road	Local	state	out-state	foreigner	Total mean
on road	251950 **(93.98%)**	35726 (91.67%)	11607 (92.77%)	2160 **(94.45%)**	301443 (92.91%)
not on road	8699 (3.21%)	1228 (3.15%)	355 (2.84%)	51 (2.23%)	10333 (3.18%)
shoulder	5687 (2.10%)	1249 **(3.20%)**	330 **(2.64%)**	30 (1.31%)	7296 (2.25%)
median	1054 (0.39%)	341 (0.88%)	81 (0.65%)	13 (0.87%)	1489 (0.46%)
turning lane	3287 (1.21%)	427 (1.10%)	139 (1.11%)	33 (1.44%)	3886 (1.20%)
Total	270677 (100%)	38971 (100%)	12512 (100%)	2287 (100%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	12	413.834	0.001

4.2.4.3. Residency and Driver-Related Factors

The driver-related factors are listed in Figure 4.1. As for association between *residency and first harmful event*, Table 4.54 shows that local drivers tend to have higher crash proportions with head-on and angle types of collisions (especially angle with rate=26.48, mean=25.83). State drivers tend to have higher crash proportions with rear-end, ran-off, and overturned (especially with overturned, rate=2.19 and mean=1.04). Out-state drivers seem to have higher crash proportions with sideswipes (rate=6.73, mean=5.57). Foreign drivers tend to have higher crash proportions on turning type of collisions (rate=17.33, mean=14.79). Local drivers have higher crash proportions with angle collisions, this might happen on local streets at intersections or in parking lots where there are many conflict points. State drivers have higher crash proportions with overturned and out-state drivers have higher crash proportions with sideswipe, these might happen at on/off ramps where curvature and speeding tend to result in blind spots. Therefore, overturned or sideswipe crashes are more likely to happen. Foreign drivers have higher crash involvement on turning type of collision. This might happen on intersections due to their unfamiliarity of roadway design, control, or direction.

Table 4.54 Residency and First Harmful Event

Residency Event	Local	State	Out-state	Foreign	Total mean
rear-end	100555 (35.81%)	16571 **(41.42%)**	5104 (40.07%)	921 (39.21%)	123151 (36.66%)
head-on	6044 **(2.15%)**	848 (2.12%)	242 (1.90%)	42 (1.79%)	7176 (2.14%)
angle	74353 **(26.48%)**	8834 (22.08%)	2994 (23.50%)	585 (24.90%)	86766 (25.83%)
turn	42999 **(15.31%)**	4564 (11.41%)	1719 (13.50%)	407 **(17.33%)**	49689 (14.79%)
sideswipe	15156 (5.40%)	2544 **(6.36%)**	857 **(6.73%)**	147 (6.26%)	18704 (5.57%)

ran-off	3404 (1.21%)	885 **(2.21%)**	217 **(1.70%)**	16 (0.68%)	4522 (1.35%)
overturned	2359 (0.84%)	875 **(2.19%)**	229 **(1.80%)**	31 (1.32%)	3494 (!.04%)
all others	35929 **(12.80%)**	4891 (12.22%)	1376 (10.80%)	200 (8.51%)	42396 (12.62%)
Total	280799 (100%)	40012 (100%)	12738 (100%)	2349 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	21	2163.785	0.001

Table 4.55 shows the association between *residency and injury severity*. It depicts that local and foreign drivers tend to have higher crash proportions with no injury (rates=26.66 and 28.52, mean=26.37). State drivers tend to have higher crash proportions of fatal injury (rate=1.76, mean=1.10). Out-state drivers tend to have higher crash proportions of severe injury (rate=13.04, mean=11.48).

Table 4.55 Residency and injury severity

Residency Injury Severity	local	state	out-state	foreigner	Total
no injury	74872 **(26.66%)**	9949 (24.87%)	3075 (24.14%)	670 **(28.52%)**	88566 (26.37%)
minor injury	171433 (61.05%)	24460 (61.13%)	7783 (61.10%)	1410 (60.03%)	205086 (61.06%)
severe injury	31756 (11.31%)	4899 (12.24%)	1661 **(13.04%)**	248 (10.56%)	38564 (11.48%)
fatal	2738 (0.98%)	704 **(1.76%)**	219 **(1.72%)**	21 (0.89%)	3682 (1.10%)
Total	280799 (100%)	40012 (100%)	12738 (100%)	2349 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	9	372.521	0.001

To find the association between *residency and alcohol/drugs involved*, Table 4.56 shows that local and foreign drivers tend to have higher crash proportions with no DUI (rates=88.96 and 91.91, mean=88.84). State drivers tend to have slightly higher crash proportions with DUI (rate=0.73, mean=0.71). Out-state drivers tend to have higher crash proportions with alcohol involved (rate=10.34, mean=9.59). Many out-state drivers come to Florida during spring break, and many of them consume alcohol. Looking at the table, it seems that alcohol is more of a problem in the U.S., drugs are more of a problem for foreign visitors.

To determine the relationship between *residency and first safety equipment*, Table 4.57 presents that local drivers tend to have higher crash proportions with seat-belt not in use (rate=14.74, mean=14.40). Local drivers tend to have higher crash proportions with no seatbelts used; perhaps, some of their trips are not too far away from home, they do not think it is necessary to wear seat-belt.

Table 4.56 Residency and Driving Under Influences

Residency DUI	local	state	out-state	foreigner	Total
no DUI	249800 (88.96%)	35254 (88.11%)	11197 (87.90%)	2159 (91.91%)	298410 (88.84%)
alcohol	26679 (9.50%)	4050 **(10.12%)**	1317 **(10.34%)**	171 (7.28%)	32217 (9.59%)
drugs	475 (0.17%)	81 (0.20%)	25 (0.20%)	6 **(0.26%)**	587 (0.17%)
alcohol & drugs	1995 (0.71%)	292 (0.73%)	79 (0.62%)	9 (0.38%)	2375 (0.71%)
un-determined	1850 (0.66%)	335 (0.84%)	120 (0.94%)	4 (0.17%)	2309 (0.69%)
Total	280799 (100%)	40012 (100%)	12738 (100%)	2349 (100%)	335898 (100%)

Statistic	DF	Value	Prob.
Chi-square	12	87.479	0.001

Table 4.57 Residency and Safety Equipment

Residency Safety Equip.	local	state	out-state	foreigner	Total
no in use	39887 **(14.74%)**	5148 (13.21%)	1521 (12.61%)	180 (7.87%)	46736 (14.40%)
seat belt	226180 (83.56%)	33133 (85.02%)	10647 (85.09%)	2063 (90.21%)	272023 (83.84%)
air bag	1345 (0.50%)	185 (0.47%)	80 (0.64%)	21 (0.92%)	1631 (0.50%)
safety helmet	2856 (1.06%)	459 (1.18%)	239 (1.91%)	18 (0.79%)	3572 (1.10%)

eye protection	56 (0.02%)	9 (0.02%)	2 (0.02%)	2 (0.09%)	69 (0.02%)
other	353 (0.13%)	37 (0.09%)	23 (0.18%)	3 (0.13%)	416 (0.13%)
Total	270677 (100%)	38971 (100%)	12512 (100%)	2287 (100%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	15	301.807	0.001

Table 4.58 presents the association between *residency and vehicle fault code*. It shows that out-state and foreign drivers tend to have higher crash proportion with cited violations (rates=36.43 and 34.98, mean=33.93). Out-state and foreign drivers are not familiar with roadway controls or directions in new areas. Thus, they are more likely to make mistakes. They might need brief instructions when they rent the car, or maybe the rental car company should distribute a small brochure explaining to them some safety concerns in Florida.

Table 4.58 Residency and Vehicle Fault Code

Residency Fault code	local	state	out-state	foreigner	Total
fault	91333 (33.74%)	13381 **(34.34%)**	4558 **(36.43%)**	800 **(34.98%)**	110072 (33.93%)
no fault	179344 (66.26%)	25590 (65.66%)	7954 (63.57%)	1487 (65.02%)	214375 (66.07%)
Total	270677 (100%)	38971 (100%)	12512 (100%)	2287 (100%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	3	43.092	0.001

Table 4.59 depicts, the relationship between *residency and speed ratio*, that local drivers tend to have higher crash proportion when driving by exceeding the posted speed at the ratio of >1.3 (rate=3.32, mean=3.26). Foreign drivers tend to have higher crash proportion when driving under the posted speed at the ratio of <0.7 (rate=65.19, mean=57.96). Perhaps, this result implies that local drivers are familiar with their areas, so they drive fast. Foreign drivers tend to slow down when looking of directions or making decisions.

Table 4.59. Residency and Speed Ratio

Residency Speed Ratio	local	state	out-state	foreigner	Total
<0.7	158791 (58.66%)	20497 (52.60%)	7258 (58.01%)	1491 (65.19%)	188037 (57.96%)
0.701-0.9	41202 (15.22%)	5906 (15.15%)	1726 (13.79%)	293 (12.81%)	49127 (15.14%)
0.901-1.1	53024 (19.59%)	9990 (25.63%)	2811 (22.47%)	424 (18.54%)	66249 (20.42%)
1.101-1.3	8670 (3.20%)	1366 **(3.51%)**	393 (3.14%)	43 (1.88%)	10472 (3.23%)
>1.301	8990 **(3.32%)**	1212 (3.11%)	324 (2.59%)	36 (1.57%)	10562 (3.26%)
Total	270677 (100%)	38971 (100%)	12512 (100%)	2287 (100%)	324447 (100%)

Statistic	DF	Value	Prob.
Chi-square	12	967.708	0.001

The association between *residency and vehicle movement* shows that local drivers tend to have higher crash proportions when parking the cars (rate=0.72, mean=0.69). State drivers tend to have higher crash proportions when passing other vehicles (rate=0.80, mean=0.56). Out-state drivers tend to have higher crash proportions when making a U-turn (rate=0.94, mean=0.51). Foreign drivers tend to have higher crash proportions when changing lanes (rate=3.24, mean=2.05).

For the association between *residency and vehicle year*, local drivers tend to have higher crash proportions when driving vehicles with years of <80, 81-85, and 86-90 (especially <80, rate=7.91, mean=7.52). State drivers tend to have higher crash proportions with vehicle years of

91-95 (rate=45.39, mean=39.94). Out-state and foreign drivers tend to have higher crash proportions with vehicle year of >95 (rates=1.51 and 3.85, mean=0.50).

For *residency and type of vehicle*, most local drivers have higher crash proportions when riding a bike (rate=1.18, mean=1.03). State drivers have higher crash proportions when driving a truck (rate=24.87, mean=17.04). Out-state drivers have higher crash proportions when driving RV's (rate=0.67, mean=0.08). Foreign drivers have higher crash proportions when driving autos and vans (especially van, rate=10.89 and mean=6.80).

As for *residency and first contributing cause-driver*, the state drivers have higher crash proportions with careless driving, alcohol involved, following too closely, exceeding safe speed limit, improper passing, driving left of center, and improper load (especially exceeded safety speed limit, rate=1.21 and mean=0.96). Out-state drivers have higher crash proportions with disregarding traffic control (rate=0.17, mean=0.12). Foreign drivers tend to have higher crash proportions with failing to yield, improper lane change, improper turn, disregarding traffic signals, disregarding stop signs, obstructing traffic, and driving the wrong way (especially obstructing traffic, rate=0.61 and mean=0.21).

4.3. SUMMARY AND CONCLUSIONS

One of the most difficult tasks in traffic safety research is to find a suitable exposure measure to be used. In the context of the categorical data used in this analysis, and the difficulty of finding exposure measures suitable for the variables of interest. The methodology of using conditional probabilities as a measure of induced exposure is discussed and used in the analysis presented in this chapter.

The results of *age and crash-related factors* showed that young drivers are over-involved in crashes that are related to speeding. Younger drivers are involved in overturn, off-road, and head-on collisions more than any other age group. Therefore, they were found to be over-involved in crashes that occur on curves. Younger and older drivers tend to be involved in crashes while not using seat-belts, this might explain previous results that these two age groups are generally more involved in injury and fatal crashes. Drivers between the ages of 25 and 44 were found to have a higher percent of crashes while under the influence of alcohol. Younger drivers also have higher proportion of involvement at weekends and night driving conditions. Both young and middle age groups have higher rates of crash involvement in adverse weather conditions. Elderly drivers (80 years and over) are involved in crashes at intersections more than any of the other age groups. About 60 percent of the involvement of this age group take place at intersections. Whether at intersections or at other locations, elderly drivers were found to be over-involved in right and left turns as well as angle collisions. Older drivers tend to avoid bad weather or driving conditions, and therefore their crashes tend to be in clear weather and during daylight. They also tend not to speed. About 70 percent of their crash involvement is substantially below the speed limit (less than 30% below the speed limit). Only three percent of the elderly crashes occur while driving above the speed limit.

In general the analysis indicated that the young and old age groups are usually over-involved in crashes. While the young groups tend to drive in situations or conditions that increase their risk, the elderly drivers tend to avoid adverse conditions in an attempt to compensate for the decline in their driving capabilities. While most of the young drivers over-involvement in crashes could be attributed to risky driving, most of the elderly crashes are due to their declined driving capabilities, such as perception of speed and gaps, not because of risky driving behavior.

For the *gender and crash related factors*, the results showed that male drivers compared to female drivers are over-involved in crashes that are related to speeding. They are involved in head-on collisions more than female drivers. Therefore, they were found to be over-involved in crashes that occur on curves. Male drivers tend to be involved in crashes while not using seat-belts under the influence of alcohol/drugs. This might explain why male drivers tend to be more involved in fatal crashes. Male drivers also have higher proportion of involvement at weekends and night driving conditions. As for female drivers, they are more likely to have crashes that are related to failed to yield, improper turn, and disregarding traffic signs. Therefore, they were found to be over-involved in crashes at intersections and parking lots. Female drivers' higher crash proportions in parking lots might be related to shopping trips, picking up kids, or getting off from school or work. Sometime they might be in a rush doing those activities; hence, they tend to ignore the stop sign or ignore checking the surrounding to make sure that no other car is parking or backing. They have higher proportion of involvement on weekdays. Accordingly, female drivers are found to be more involved in crashes that related to angle and turning maneuvers. For self-security, most female drivers tend to avoid nighttime driving.

For the most part, the analysis indicated that male drivers are usually more involved in crashes than female. They tend to be more confident in driving than female. They tend to drive in situations or conditions that might increase their risk, such as not wearing seat-belt, speeding, and driving under the influences of alcohol or drugs.

As for the *race and crash related factors*, White drivers tend to have higher crash proportions with alcohol involved and speeding. They are more likely to be involved in ran-off and overturned crashes. Therefore, they were found to be over-involved in crashes that occur on curves. As a result, they generally are more involved in fatal crashes.
Whereas the Black drivers are over-involved in crashes that are related to not using seat-belt. They were found to be over-involved in two-lane highways and intersections. Their higher proportions of head-on and sideswipe collisions might be related to crashes occurring on two-lane highways. While having higher crash proportions at intersections, Black drivers tend to have higher proportions with angle collisions. They have higher proportions of crash involvement at railroad crossings; which might be connected to them being over-involved in

crashes in urban areas. Black drivers tend to have higher crash proportions with failing to maintain vehicles and drove vehicle with year before 1980; these results might be related to income. Hispanic drivers, however, have similar crash involvement patterns as the Black drivers. They were found to be over-involved in two-lane highways and intersections. Their higher proportions of head-on collisions might be related to crashes occurring on two-lane highways. While having higher crash proportions at intersections, Hispanic drivers tend to have higher proportions with angle and turning collisions. They tend to have higher crash proportions with disregarding traffic signs as well, and are over-involved in crashes that are related to not using seat-belts. Furthermore, they are more likely to be cited for traffic violations. Other drivers tend to have higher crash proportions on interstate highways or at on/off ramps. They have higher proportions of speeding and fatal crashes and are also more likely to be cited for traffic violations.

Overall, Black and Hispanic drivers seem to have similar crash-related patterns of not wearing seat-belts and being over-involved at intersections and two-lane highways. Perhaps, the result might indicate that they need more traffic safety education. Whereas the White drivers tend to speed and drive under the influences of alcohol and drugs. These two issues are a big concern since they result more severe and fatal injuries. Thus, there is a need for special safety program on be affect. However, Other drivers are a mixture of many different race beside White, Black, and Hispanic drivers. It is difficult to use Other race group as a surrogate of income, education, or culture since it is not defined.

As for *residency and crash related factors*, local drivers have higher crash proportion with no seat-belt used. Their crashes are more likely to occur at intersection with angle and turning maneuvers. State drivers have higher crash proportion with alcohol involved, exceeded safe speed limit, and improper passing out-state drivers have higher crash proportions with DUI and cited for violations. State, out-state, and foreign drivers tend to be over-involved at turnpikes/toll facilities. Foreign drivers tend to have higher crash proportions at signalized intersection with turning maneuvers. Both out-state and foreign drivers are more likely to be cited for traffic violations.

In general, due to comfort and convenience, local drivers have thought that it was unnecessary to a wear seat-belt during a local trips, thus, their crashes are related to this issue. As for the state and out-state drivers, their crashes are related to DUI. Perhaps many of them come to certain attraction areas, such as Daytona or Cocoa beach, during spring break and consume alcohol. Whereas for the foreign drivers, due to the unfamiliarity of roadway design, control, or direction, they might experience difficulty at intersections.

CHAPTER 5
LOGLINEAR MODELING

5.1. METHODOLOGY

The crash data of 1994 and 1995 was obtained from the Florida Department of Highway Safety and Motor Vehicles (DHSMV). The DHSMV data is a relational database that includes 7 files. The files selected for the analysis were the event, drivers, and DOT file.

Conventionally, contingency table analyses have been used in analyzing categorical or qualitative response variables for their statistical relationship. This type of analysis is usually limited to two variables (two-way table) at a time. For tables of order greater than two-way, interactive numerical procedures are utilized which are time consuming since calculations must be carried out to several decimal places to ensure reasonable accuracy of the estimates. Nevertheless, currently computer and software capabilities are able to manipulate sophisticated models, such as log-linear models, to analyze categorical data with more than two variables (Lum, 1989).

The modeling approach in superior to the contingency table approach, which only investigates the relationship between two variables. The capabilities of the modeling approach allows us to see the interaction between the two variables in a three variable relationship. Basically, this means that the relationship between the two variables will always remain the same regardless what the third variable is. Whereas, for the contingency table, to determine if the relationship between the two variables will always stand, we have to fix the third variable at one level and checking the conditional probability for this level. Then, fixing the third variable at second level and checking its probability again until every level in the fixed variable is been analyzed. This process can be tedious and time consuming.

A log-linear model is as a generalized linear model (GLM) for Poisson-distributed data. It specifies how the size of a cell count depends on the levels of the categorical variables for that cell. The nature of this specification relates to the association and interaction structure among the variables. A log-linear model describes the association and interaction patterns among a set of categorical variables (Agresti, 1990). SAS program procedure CATMOD can be used to fit a log-linear model (SAS/STAT users Guide, 1996).

In practice, we try to fit a model so as to avoid using saturated models. A saturated model is the model with as many (maximum possible number) parameters as it has Poisson observations, which is why it has a perfect fit. Therefore, the results of a saturated model are complicated to explain. An unsaturated model is better for analysis because its' fit smoothes the sample data and yields simpler interpretations. For three-way and higher-dimensional tables, unsaturated models can include association terms. The unsaturated log-linear model is more commonly used to describe associations (through two-factor terms) than to describe odds (through single-factor terms). After fitting a log-linear model, we convert estimates of parameters to estimate the conditional odds between variables (Agresti, 1990).

The models used in this research are called hierarchical models; this means that each model includes all lower-order terms composed from variables contained in a higher-order term in the model. When the model contains λ_{ij}^{xy}, for example, it also contains λ_i^x and λ_j^y. A reason for including lower-order terms is that the statistical significance and practical interpretation of a higher-order term depends on how the variables are coded. This is undesirable, but with hierarchical models one gets the same results no matter how variables are coded (Agresti, 1990).

The formulation of a log-linear model with three variables and two-way interaction is as follows:

$$\log m_{ijk} = \upsilon + \lambda_i^x + \lambda_j^y + \lambda_k^z + \lambda_{ij}^{xy} + \lambda_{jk}^{yz} + \lambda_{ik}^{xz} \qquad (1)$$

where $\log m_{ijk}$ = log expected frequency of cell

$m_{ijk} = n\pi_{ijk}$

π_{ijk} = the probabilities for that multinomial distribution form the joint distribution of three categorical responses.

υ=overall effect

λ_i^x=effect due to the ith level of x

λ_j^y=effect due to the jth level of y

λ_k^z=effect due to the kth level of z

λ_{ij}^{xy}=interaction of x at ith level and y at jth level

λ_{ik}^{xz}=interaction of x at ith level and z at kth level

λ_{jk}^{yz}=interaction of y at jth level and z at kth level

Since this model contains an X-Y two-factor term, it permits association between X and Y, controlling for Z. It also permits a X-Z association, controlling for Y, and a Y-Z association, controlling for X (Agresti, 1990).

By using equation (1) for two cells, the log odds (logit) can be determined. Since we are interested in knowing how the independent variables affect the response variables, the logit models were constructed according to the response variables. See the following for the examples of the logit model,

$$\log(m_{ijk} / m_{i1k}) = [\,\upsilon + \lambda_i^x + \lambda_j^y + \lambda_k^z + \lambda_{ij}^{xy} + \lambda_{jk}^{yz} + \lambda_{ik}^{xz}] -$$

$$[\,\upsilon + \lambda_i^x + \lambda_1^y + \lambda_k^z + \lambda_{i1}^{xy} + \lambda_{1k}^{yz} + \lambda_{ik}^{xz}]$$

$$= [\lambda_j^y - \lambda_1^y] + [\lambda_{ij}^{xy} - \lambda_{i1}^{xy}] + [\lambda_{jk}^{yz} - \lambda_{1k}^{yz}] \qquad (2)$$

or

$$\log(m_{ijk} / m_{ij1}) = [\,\upsilon + \lambda_i^x + \lambda_j^y + \lambda_k^z + \lambda_{ij}^{xy} + \lambda_{jk}^{yz} + \lambda_{ik}^{xz}] -$$

$$[\,\upsilon + \lambda_i^x + \lambda_j^y + \lambda_1^z + \lambda_{ij}^{xy} + \lambda_{j1}^{yz} + \lambda_{i1}^{xz}]$$

$$= [\lambda_k^z - \lambda_1^z] + [\lambda_{ik}^{xz} - \lambda_{i1}^{xz}] + [\lambda_{jk}^{yz} - \lambda_{j1}^{yz}] \qquad (3)$$

To better interpret the findings, determining the odds multiplier is very useful. By exponentiating both sides of the logit models, equations (2) and (3) yield

$$m_{ijk} / m_{i1k} = \exp[\lambda_j^y - \lambda_1^y]\exp[\lambda_{ij}^{xy} - \lambda_{i1}^{xy}]\exp[\lambda_{jk}^{yz} - \lambda_{1k}^{yz}] \qquad (4)$$

or

$$m_{ijk} / m_{ij1} = \exp[\lambda_k^z - \lambda_1^z]\exp[\lambda_{ik}^{xz} - \lambda_{i1}^{xz}]\exp[\lambda_{jk}^{yz} - \lambda_{j1}^{yz}] \qquad (5)$$

The first factor for equation (4) is the baseline odds of y being category j relative to first level. The second and third factors are the odds multipliers for x at level i and z at level k. Actually, the reference point can be any level of the response variable as long as it makes sense; it does not have to strictly using only the first level of the response variable. Equation (5) has a similar interpretation.

The following ten models use the methodology explained above. Each model has different response variables; however, the independent variable (age group, gender, race, and residency), which we are interested in, is in all the models.

5.2. ESTIMATED RESULTS

5.2.1. AGE

The following four models use age as the independent variable. The response variables are injury severity, ADT, first harmful event, roadway character, speed ratio, area, and alcohol involvement.

5.2.1.1.Age, Injury Severity, and ADT

This model was estimated to investigate the association between age and both injury severity and Average Daily Traffic per lane (ADT) using 1994's crash data. The model was developed using the methodology explained above with the following variables:

x=age i=level : very young (15 to 19 year-old)
young (20 to 24 year-old)
middle (25 to 64 year-old)
old (65 to 79 year-old)
very old (80+)

y= injury severity j=level: no injury
injury (possible, non-incapacitating, and incapacitating injuries)
fatal (any injury sustained in a motor vehicle crash that results in death within 90 days)

z=ADT/# of Lane k=level: 1 (<10000 veh/lane)
2 (10,001-20,000 veh/lane)
3 (20,001-30,000 veh/lane)
4 (>30,000 veh/lane)

Table 5.1 shows the frequency distribution of variables and predicted frequency distribution from the developed model. This is a three variable model with variables x (age groups), y (injury severity), and z (ADT groups). Normally, G^2, goodness-of-fit statistic and p-value are used to determine the rejection or acceptance of the model. The larger the value of G^2, the more evidence there is against the null hypothesis (H_o), where H_o= model fits the relationship and H_a=model doesn't fit the relationship. Hence, the smaller G^2 is better, but it depends on the degree of freedoms. The larger p (>0.05) indicates that the estimated model fits the relationship. After running through the SAS CATMOD procedure, the best-fitting model contains all three main effects and all three possible two-way interactions as equation 1 with G^2=20.90, df=24, and p-value=0.6448.

Furthermore, a log-linear modeling approach was selected in which the response variable (y) is expressed as a log odds (logit) because it permit the comparison of the odds, For example, the comparison of the odds of injury among the young drivers to the odds of injury among the old drivers. With the logit model, the parameters provide a measure of the magnitude and direction of effects of the independent variables on the response variable (Kim et al., 1995). From the log-linear model equation (1), using injury severity category y, no injury, as the baseline, the logit model for injury severity is as equation (2). After exponentiating both sides of the logit models, the first factor for the equation (4) is the baseline odds of being in injury severity category j relative to no injury, the first level . The second factor is the odds multipliers for age at five age groups. To find the logit model and odds multipliers for ADT at four ADT groups, equations (3) and (5) were applied. The parameter estimates for individual and interaction terms and odds multipliers are presented in the Table 6.2. By using equation (4) and (5), the odds of injury severity and the odds of ADT can be determined.

Table 5.1 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

injury	No-injury				Injury				Fata 1			
ADT Age	1	2	3	4	1	2	3	4	1	2	3	4
15-19	10195 (10195)	2652 (2640)	436 (449)	36 (34)	2939 (2941)	637 (647)	116 (102)	3 (5)	57 (55)	9 (10)	1 (2)	0 (0.2)
20-24	14580 (14534)	4050 (4079)	1102 (1115)	87 (91)	4134 (4180)	1027 (996)	265 (253)	17 (13)	83 (83)	15 (17)	6 (4)	0 (0.6)
25-64	70732 (70787)	19796 (19765)	5564 (5542)	438 (436)	17669 (17614)	4145 (4175)	1068 (1090)	51 (54)	393 (394)	79 (79)	22 (22)	4 (3)
65-79	9294 (9299)	1937 (1938)	300 (293)	27 (28)	2575 (2566)	451 (454)	57 (64)	5 (4)	115 (119)	22 (18)	2 (3)	0 (0.4)
80+	2141 (2127)	367 (378)	46 (49)	2 (2)	631 (647)	110 (97)	15 (12)	0 (0.26)	57 (55)	6 (7)	0 (0.87)	0 (0.05)

Table 5.2 Parameter Estimates of Log-Linear Model of Age, Injury Severity, and ADT

(Parenthesis Numbers are the Odds Multipliers)

Age Groups	Very Young	Young	Middle	Old	Very Old
Age*Injury:					
No-injury	0.1582 (1)	0.1420 (1)	0.1959 (1)	-0.1136 (1)	-0.3825 (1)
Injury	0.1868 (1.03)	0.1676 (1.03)	0.0767 (0.89)	-0.1294 (0.98)	-0.3017 (1.08)
Fatal	-0.3450 (0.60)	-0.3096 (0.64)	-0.2726 (0.63)	0.2430 (1.43)	0.6842 (2.91)
Age*ADT:					
<10,000	-0.0299 (1)	-0.3453 (1)	-0.3466 (1)	0.1355 (1)	0.5863 (1)
10,001-20,000	0.0578 (1.09)	-0.1774 (1.18)	-0.1839 (1.18)	0.00568 (0.88)	0.2978 (0.75)
20,001-30,000	-0.0570 (0.97)	0.1827 (1.70)	0.2018 (1.73)	-0.2279 (0.70)	-0.0996 (0.50)
>30,000	0.0291 (1.06)	0.3400 (1.98)	0.3287 (1.96)	0.08672 (0.95)	-0.7845 (0.25)

Age and Injury Severity:

Table 5.2 shows that the middle age group seems to be the safest group since it has the smallest multiplier in the odds of injury and nearly the smallest multiplier in the odds of fatality. Very young, young, and very old drivers have slightly higher odds of being involved in injury crashes. As found in Abdel-Aty et al. (1998 a & b), very young and young drivers tend to have less driving experience, but more speeding and driving violation maneuvers. This might explain their involvement in serious injury crashes. As for the old and very old groups with fatal crashes, their odds increase greatly. However, old drivers have lower odds of fatality than very old drivers. Although very old drivers were found to drive considerably slow and carefully (Abdel-Aty et al., 1998b), their weak physical status might explain their higher odds of being involved in injury and fatal crashes.

Age and ADT:

The odds of ADT 20,001-30,000 per lane and >30,000 per lane are much higher for young and middle age drivers and much smaller for the very old drivers. This result confirms the conclusion drawn in Abdel-Aty et al. (1998b) that middle age and younger groups tend to be involved in crashes at peak hours when they usually work or go to school. Therefore, the odds of being involved in crashes when ADT>20,000 are higher.

5.2.1.2. Age, ADT, and 1st Harmful Events

This model was estimated to investigate the association between age and both Average Daily Traffic per lane (ADT) and first harmful events (manner of collision) using 1994's crash data. The first harmful events are also known as the collision type. The model was developed using the methodology explained earlier with the following variables:

x=age i=level : very young (15 to 19 year-old)
young (20 to 24 year-old)
middle (25 to 64 year-old)
old (65 to 79 year-old)
very old (80+ year-old)

y=ADT/# of Lane j=level: 1 (<10000 veh/lane)
2 (10,001-20,000 veh/lane)
3 (20,010-30,000 veh/lane)
4 (>30,000 veh/lane)

z=first harmful event k=level: rear-end, angle, turn, sideswipe, and head-on

Table 5.3 shows the frequency distribution of variables and predicted frequency distribution from the developed model. This is a three-variable model with variables x (age groups), y (ADT), and z (first harmful events). The best-fitting model contains all three main effects and all three possible two-way interactions as equation 1 with G^2=52.91, df=48, and p-value=0.2903.

From the log-linear model equation (1), using ADT per lane, ADT<10,000 veh/lane, as the baseline, the logit model for ADT is as in equation (2). After exponentiating both sides of the logit models, the first factor for the equation (4) is the baseline odds of being in ADT category j relative to ADT<10,000 veh/lane, the first level. The second factor is the odds multipliers for age at five age groups. To find the logit model and odds multipliers for the first harmful events at five crash types, equations (3) and (5) were applied. The parameter estimates for individual and interaction terms and odds multipliers are presented in Table 5.4 By using equation (4) and (5), the odds of manner of collision and the odds of various levels of ADT can be determined.

Table 5.3 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

Age Groups ADT|Harmful	very young	young	middle	old	Very old
<10,000 rear-end	4814 (4795)	7227 (7241)	36459 (36442)	4222 (4232)	814 (826)
angle	3167 (3184)	4432 (4435)	20959 (20998)	3516 (3476)	943 (924)
turn	2225 (2232)	2913 (2930)	13258 (13210)	2262 (2285)	637 (638)
sideswipe	610 (611)	999 (979)	4796 (4819)	593 (586)	115 (117)
head-on	260 (254)	417 (404)	1857 (1859)	229 (243)	56 (60)
10,001-20,000 rear-end	1565 (1585)	2562 (2557)	12647 (12646)	1165 (1158)	205 (198)
angle	588 (564)	841 (840)	3928 (3908)	477 (510)	108 (119)
turn	406 (402)	583 (564)	2457 (2500)	363 (341)	82 (83)
sideswipe	177 (180)	297 (309)	1510 (1494)	138 (143)	29 (25)
head-on	53 (57)	85 (97)	447 (440)	54 (45)	11 (10)
20,010-30,000 rear-end	257 (256)	708 (696)	3661 (3679)	199 (199)	36 (31)
angle	60 (67)	170 (168)	857 (836)	56 (64)	6 (14)
turn	9 (5)	10 (12)	53 (58)	6 (5)	3 (1)
sideswipe	58 (53)	144 (155)	806 (799)	46 (45)	6 (7)
head-on	2 (4)	9 (11)	47 (52)	9 (3)	3 (0.6)
>30,000 rear-end	21 (21)	54 (57)	308 (307)	22 (20)	1 (0.6)
angle	4 (4)	9 (9)	43 (44)	5 (4)	0 (0.2)
turn	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
sideswipe	5 (5)	15 (13)	69 (68)	2 (5)	0 (0.2)
head-on	0 (0.4)	2 (1.2)	6 (6)	0 (0.4)	0 (0)

Table 5.4 Parameter Estimates of Log-Linear Model of Age, 1st Harmful Events,

and ADT (Parenthesis Numbers are the Odds Multipliers)

Age Groups	Very Young	Young	Middle	Old	Very Old
Age*Harmful					
Head-on	-0.0230 (1)	0.0518 (1)	0.019 (1)	-0.046 (1)	-0.0018 (1)
Rear-End	0.0588 (1.09)	0.0808 (1.03)	0.1372 (1.13)	-0.0463 (1)	-0.2305 (0.8)
Angle	-0.0435 (0.98)	-0.1023 (0.86)	-0.1070 (0.88)	0.0639 (1.12)	0.1889 (1.21)
Turn	0.00622 (1.03)	-0.1123 (0.85)	-0.1657 (0.83)	0.0494 (1.10)	0.2224 (1.25)
Sideswipe	0.00151 (1.02)	0.0820 (1.03)	0.1165 (1.10)	-0.0210 (1.03)	-0.1790 (0.84)
Age*ADT:					
<10,000	-0.0069 (1)	-0.312 (1)	-0.337 (1)	0.0605 (1)	0.5954 (1)
10,001-20,000	0.0722 (1.08)	-0.1665 (1.16)	-0.2091 (1.14)	-0.0495 (0.90)	0.3529 (0.78)
20,010-30,000	-0.1562 (0.86)	0.1249 (1.55)	0.1496 (1.63)	-0.2186 (0.76)	0.1006 (0.61)
>30,000	0.0909 (1.10)	0.3536 (1.95)	0.3965 (2.08)	0.2076 (1.16)	-1.0489 (0.19)

Age and 1st Harmful Events:

Table 5.4 indicates that compared to head-on, the odds of angle and turning crash types are higher for old and very old drivers. The odds are especially higher for very-old drivers with angle and turning crashes. The results from this model confirm the previous findings in Abdel-Aty et al. (1998b) and Stamatiadis et al. (1991), where papers that elderly drivers were found to be over-involved in right and left turns as well as angle collisions.

The odds multiplier seems to indicate that young and middle age drivers have slightly higher odds of rear-end and sideswipe crashes comparing to other type of crashes. This result might indicate that young and middle age drivers tend to drive in rush hours to go to work or school where heavy traffics is more likely to result rear-end or sideswipe crashes.

5.2.1.3.Age, Roadway Character, and Speed Ratios

This model was estimated to investigate the association between age and both roadway character and speed ratios using 1995's crash data. Roadway character is defined as a roadway segment where crash occurred to be either straight or curve section. A definition of speed ratios is the estimated speed divided at the posted speed. When the speed ratio equals one, it means that the driver is traveling at the posted speed. When the speed ratio is below one, it means the driver is traveling under the posted speed and so forth. The model was developed using the methodology explained in the beginning with variables:

x=age i=level : very young (15 to 19 year-old)
young (20 to 24 year-old)
middle (25 to 64 year-old)
old (65 to 79 year-old)
very old (80+ year-old)

y=roadway character j=level: curve and straight

z=speed ratios k=level: 1 (<0.7)
2 (0.701-0.9)
3 (0.901-1.1)
4 (1.101-1.3)
5 (>1.301)

Table 5.5 presents the frequency distribution of variables. The three-variable model, variables x (all age groups), y (roadway character), and z (speed groups), with all two-way interactions are attempted first; however, the model does not fit and resulted in G^2 =36.58, df=16, and p-value=0.0024. Thus, this model has been rejected due to the small p-value. This means that the relationship with all speed groups will be difficult to explain due to the 3-way interaction. In this rejected model, the residual is quite large for speed ratio group 5. Therefore, the next step is to take out the fifth speed group, which will be treated separately, and run the model with only speed groups 1 to 4 (see Table 5.5). After running through the SAS CATMOD procedure, the best-fitting model contains all three main effects and all three possible two-way interactions as equation 1 with G^2=14.26, df=12, and p-value=0.2843.

From the log-linear model equation (1), using roadway character category y, curve, as the baseline, the logit model for roadway character is as equation (2). After exponentiating both sides of the logit models, the first factor for the equation (4) is the baseline odds of being in roadway character category j relative to curve, the first level. The second factor is the odds multipliers for age at five age groups.

To find the logit model and odds multipliers for the speed ratios at four levels, equations (3) and (5) are required. The parameter estimates for individual and interaction terms are presented in the Table 5.6. By using equation (4) and (5), the odds of roadway character and the odds of speed ratio can be determined.

Table 5.5 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

Character			Curve	section				Straight	section	
Age\speed	1	2	3	4	5	1	2	3	4	5
very young	773	277	688	252	464	17869	5356	7793	1642	1610
	(770)	(291)	(682)	(247)		(17872)	(5342)	(7798)	(1647)	
young	872	308	792	262	506	22726	6779	10101	1918	1712
	(868)	(326)	(784)	(256)		(22730)	(6760)	(10109)	(1924)	
middle	4374	1476	2962	685	1001	125131	32156	41271	5551	4778
	(4417)	(1437)	(2959)	(683)		(125088)	(32194)	(41261)	(5553)	
old	543	138	233	32	43	17207	3857	4007	363	326
	(518)	(146)	(244)	(37)		(17232)	(3849)	(3996)	(358)	
very old	159	40	48	5	16	4840	972	880	119	80
	(148)	(38)	(54)	(12)		(4850)	(974)	(868)	(112)	

Table 5.6 Parameter Estimates of Log-Linear Model of Ages, Roadway Character, and Speed Ratio

(Parenthesis Numbers are the Odds Multipliers)

Age Groups	Very Young	Young	Middle	Old	Very Old
<u>**Age*Curvature**</u>					
straight	-0.1022 (1)	-0.04192 (1)	-0.00288 (1)	0.0775 (1)	0.0695 (1)
curve	0.1022 (1.22)	0.04192 (1.09)	0.00288 (1.00)	-0.0775 (0.85)	-0.0695 (0.87)
<u>**Age*Speed Ratio**</u>					
<0.7	-0.3155 (1)	-0.2979 (1)	-0.0256 (1)	0.2881 (1)	0.3509 (1)
0.701-0.9	-0.1469 (1.18)	-0.1341 (1.18)	-0.0065 (1.02)	0.1654 (0.88)	0.1221 (0.79)
0.901-1.1	0.0400 (1.43)	0.0769 (1.45)	0.0501 (1.08)	0.014 (0.76)	-0.1784 (0.59)
1.101-1.3	0.4224 (2.09)	0.3551 (1.92)	-0.1800 (0.86)	-0.4649 (0.47)	-0.2946 (0.52)

To determine and analyze relationships involving the fifth speed ratio group, the odds of each comparison is required (see Table 5.7).

Table 5.7 Odds of Other Speed Ratio Group Relative to Group 5

Curvature	Curve Section				Straight section			
Age\location	1/5	2/5	3/5	4/5	1/5	2/5	3/5	4/5
very young	1.68	0.63	1.47	0.53	11.1	3.32	4.84	1.02
young	1.72	0.64	1.55	0.51	13.27	3.95	5.90	1.12
middle	4.41	1.44	2.96	0.68	26.18	6.74	8.64	1.16
old	12.05	3.40	5.67	0.88	52.86	11.8	12.3	1.10
very old	9.25	2.38	3.38	0.75	60.64	12.18	10.93	1.40

An example of odds is that for very young drivers in speed ratio group 1 as opposed to speed ratio group 5 in curve section is defined to be

$$\Omega_1 = n_{111} / n_{115} = 770/464 = 1.68 .$$

For young drivers in straight section , the corresponding odds equals

$$\Omega_2 = n_{221} / n_{225} = 22730/1712 = 13.27 .$$

Age and Roadway Character:

Table 5.6 indicates that comparing with curve, the odds of having roadway character on straight section crashes regardless the speed ratio are higher for old and very old drivers. Since old and very old drivers tend not to speed, the crashes occurred on the curve are less likely to happen.

Age and Speed Ratios:

Table 5.6 also shows that comparing with speed ratio group 1, the odds of speed ratio groups 2, 3, and 4 crashes regardless the roadway character are higher for very young and young drivers (especially at speed ratio group 4). This result indicates that very young and young drivers tend to speed; therefore, they are more likely to have crashes on the curves.

Age, Roadway Character, and Speed Ratios:

Table 5.7 implies that the odds of being involved in crashes at the slowest speed group as opposed to the fastest group is much higher on the straight section. As for various age groups at the straight section, the odds of being involved in crashes seem to increase as drivers' age increase for any speed groups as opposed to speed group 5. At the curve section, old drivers, comparing with other age groups, seem to have higher odds of crash involvement in any speed groups relative to speed group 5.

5.2.1.4. Age, Areas, and Alcohol Involved

This model was estimated to investigate the association between age and both location and alcohol involvement. A definition of location is the area where crash occurred at either inside or outside city limits and inside or outside urban area. It is very important to study these variables and their associations among each other. Accordingly one can identify and target the locations where certain age groups are over-involved in crashes that associated with alcohol. The model was developed using the methodology explained in the earlier section with the following variables:

x=age	i=level :	very young (15 to 19 year-old)
		young (20 to 24 year-old)
		middle (25 to 64 year-old)
		old (65 to 79 year-old)
		very old (80+ year-old)
y=alcohol involved	j=level:	yes and no
z=location	k=level:	1 outside city limits, outside urban area
		2 inside city limits, outside urban area
		3 outside city limits, inside urban area
		4 inside city limits, inside urban area

Table 5.8 presents the frequency distribution of variables and predicted frequencies from the model. This is a three variable model with variables x (age groups), y (alcohol involvement), and z (location). The best-fitting model contains all three main effects and all three possible two-way interactions as equation 1 with G^2=20.68, df=12, and p-value=0.0553.

Table 5.8 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

Alcohol	Yes				No			
Age\location	1	2	3	4	1	2	3	4
very young	56	8	97	125	2935	516	11688	21452
	(39)	(5)	(102)	(140)	(2952)	(520)	(11683)	(21437)
young	168	21	482	724	3754	512	16816	32342
	(169)	(17)	(496)	(713)	(3753)	(516)	(16802)	(32353)
middle	1241	105	3320	4784	19559	2424	80090	154157
	(1237)	(113)	(3321)	(4779)	(19562)	(2416)	(80089)	(154162)
old	51	7	163	202	3171	452	10256	19024
	(68)	(7)	(146)	(202)	(3154)	(452)	(10273)	(19024)
Very old	4	2	19	24	555	120	2204	4486
	(6)	(1)	(17)	(25)	(553)	(121)	(2206)	(4485)

From the log-linear model equation (1), using alcohol involved, no involvement, as the baseline, the logit model for alcohol involved relationship is as equation (2). After exponentiating both sides of the logit models, the first factor for the equation 4 is the baseline odds of being in alcohol involved j relative to no involvement, the first level. The second factor is the odds multipliers for age at five age groups. To find the logit model and odds multipliers for the location at four areas, equations (3) and (5) are needed. The parameter estimates for individual and interaction terms and odds multipliers are presented in the Table 5.9 by using equation (4) and (5), the odds of alcohol involvement and the odds of location can be determined.

Table 5.9 Parameter Estimates of Log-Linear Model of Ages, Alcohol Involvement, and Location

(Parenthesis Numbers are the Odds Multipliers)

Age Groups	Very Young	Young	Middle	Old	Very Old
Age*Alcohol					
No	0.3113 (1)	-0.2980 (1)	-0.4683 (1)	0.0679 (1)	0.3871 (1)
Yes	-0.3113 (0.536)	0.2980 (1.815)	0.4683 (2.551)	-0.0679 (0.873)	-0.3871 (0.461)
Age*Location					
1	-0.0218 (1)	-0.0339 (1)	0.0376 (1)	0.1245 (1)	-0.1064 (1)
2	0.0951 (1.12)	-0.163 (0.89)	-0.1984 (0.79)	0.0367 (0.92)	0.2296 (1.4)
3	-0.0159 (1.0)	0.0951 (1.14)	0.0772 (1.04)	-0.0644 (0.83)	-0.092 (1.0)
4	-0.0574 (0.97)	0.1018 (1.15)	0.0836 (1.05)	-0.0968 (0.80)	-0.0312 (1.08)

Age and Alcohol Involvement:

Table 5.9 depicts that the odds of alcohol involved crashes are much higher for young and middle age drivers. The odds are especially higher for middle age drivers when alcohol is involved. In the U.S., the legal drinking age is at and after the age of 21; thus, the odds of alcohol involved crashes are higher for young and middle age drivers since they can legally consume alcohol. Elderly drivers tend not to have many crashes that involved alcohol which might be due to their health problems or life styles. The analysis confirms previous results that drivers between the age of 25 and 44 were found to have higher percentage of crashes while under the influence of alcohol (Abdel-Aty et al., 1998b) and elderly drivers (60 year-old and above) are less likely to be involved with crashes that involve alcohol (Evans, 1991). The middle age drivers are considered as better drivers because they have more driving experience compared to the younger drivers and they have better physical capability compared to the elderly drivers.

Age and Location:

Table 5.9 shows that in comparison to location 1, the odds of in location 2 (inside city limits/outside urban area) are higher for very young and very old drivers. The odds of being involved in crashes at location 3 (outside city limits/inside urban area) and 4 (inside city limits/inside urban area) are higher for young and middle age drivers. The result justifies the findings in the study by Garber and Srinivasan (1991) that elderly driver being involved in a crash is higher at intersection outside cities than at those inside cities. Perhaps there are more elderly drivers living outside-city rural areas and more young and middle age drivers live, go to school, or work in urban areas.

5.2.2. GENDER

The following two models use gender as the independent variable. The response variables are injury severity, driving under the influences, seat-belt use, and vehicle year.

5.2.2.1.Gender, Injury Severity, and DUI

This model was estimated to investigate the association between gender and both driving under the influence of alcohol/drug and injury severity. In this model, injury severity is separated into four categories because the two-way contingency in chapter 5 (gender*injury severity) shown result to be more significant with both minor and severe injuries. For age, injury severity, and ADT, the model fits better when I collapse the minor and severe injuries to only one injury group. Despite that, this model was developed using the method described in the methodology section of this chapter with variables:

x=gender i= level: male and female

y=DUI j= level: yes and no

z= injury severity k=level: no injury

minor injury (possible injuries)

severe injury (non-incapacitating and incapacitating injuries)

fatal (any injury sustained in a motor vehicle crash that results in death within 90 days)

Table 5.10 shows the frequency distribution of variables and predicted frequency distribution from the developed model. This is a three variable model with variables x (gender groups), y (alcohol/drug involved), and z (injury severity). After running through the SAS CATMOD procedure, the best-fitting model contains all three main effects and all three possible two-way interactions as equation 1 with G^2=4.83, df=3, and p-value=0.1844.

Table 5.10 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

gender	male		female	
DUI injury severity	no DUI	yes DUI	no DUI	yes DUI
no injury	46796 (46778)	10262 (10280)	28163 (28180)	3345 (3327)
minor injury	109388 (109400)	12066 (12053)	78970 (78957)	4662 (4674)
severe injury	19896 (19926)	4290 (4260)	12926 (12896)	1452 (1482)
fatality	1598 (1574)	1116 (1140)	673 (697)	295 (271)

From the log-linear model equation 1, using DUI category y, no DUI, as the baseline, the logit model for DUI is as equation 2. After exponentiating both sides of the logit models, the first factor for the equation 4 is the baseline odds of being in DUI category j relative to no DUI, the first level .

Table 5.11 Parameter Estimates of Log-Linear Model of Gender, DUI, and Injury Severity

(Parenthesis Numbers are the Odds Multipliers)

Gender	male	female
Gender*DUI		
no DUI	-0.1553 (1)	0.1553 (1)
yes DUI	0.1553 (1.364)	-0.1553 (0.733)
Gender*Injury severity no injury	-0.00696 (1)	0.00696 (1)
minor injury	-0.0973 (0.914)	0.0973 (1.094)
severe injury	-0.0428 (0.965)	0.0428 (1.036)
Fatality	0.14706 (1.167)	-0.14706 (0.857)

The second factor is the odds multipliers for gender at two gender groups. To find the logit model and odds multipliers for injury severity at four injury groups, equations 3 and 5 are applied. The parameter estimates for individual and interaction terms and odds multipliers are presented in the Table 5.11. By using equation 4 and 5, the odds of DUI and the odds of injury severity can be found.

Gender and DUI:

Table 5.11 shows that male drivers have higher odds of DUI crashes than female drivers. This result indicates that there is a need to emphasized and give more safety programs for those males who drunk and drive.

Gender and Injury Severity:

Table 5.11 shows that male drivers have higher odds of fatality perhaps due to their higher crash proportions with speeding and DUI involvement. Female drivers tend to have higher odds of minor and severe injuries.

5.2.2.2. Gender, Seat-Belt Use, and Vehicle Year

This model was estimated to investigate the association between gender and both seat-belt use and vehicle year. The model was developed using the methodology explained earlier with variables:

x=gender	i= level: male and female
y=seat-belt use	j= level: yes and no
z=vehicle year	k=level: (before 1980)
	(1981-1985)
	(1986-1990)
	(1991-1995)
	(after 1995)

Table 5.12 shows the frequency distribution of variables and predicted frequency distribution from the developed model. This is a three-variable model with variables x (gender), y (seat-belt use), and z (vehicle year). The best-fitting model contains all three main effects and all three possible two-way interactions as equation 1 with G^2=0.92, df=4, and p-value=0.9210.

Table 5.12 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

Gender	Male		female	
Seat-Belt Use/vehicle year	Yes	no	yes	no
>1980	12445	5565	4501	1297
	(12447)	(5563)	(4498)	(1299)
'81-'85	28310	7839	15980	2864
	(28307)	(7842)	(15983)	(2861)
'86-'90	53833	9887	40002	4770
	(53820)	(9900)	(40015)	(4757)
'91-'95	64407	7829	50531	3955
	(64415)	(7820)	(50522)	(3964)
1995+	876	117	537	39
	(881)	(112)	(532)	(44)

From the log-linear model equation 1, using seat-belt use category y, yes seat-belt use, as the baseline, the logit model for seat-belt use is as equation 2. After exponentiating both sides of the logit models, the first factor for the equation 4 is the baseline odds of being in seat-belt use category j relative to yes seat-belt use, the first level. The second factor is the odds multipliers for gender. To find the logit model and odds multipliers for vehicle year at five vehicle-year levels, equations 3 and 5 are required.

The parameter estimates for individual and interaction terms and odds multipliers are presented in Table 5.13. By using equation 3 and 5, the odds of the relationship between gender and seat-belt use and the odds of vehicle-year can be determined.

Table 5.13 Parameter Estimates of Log-Linear Model of Gender, Seat-Belt Use, and Vehicle-Year

(Parenthesis Numbers are the Odds Multipliers)

Gender	male	female
<u>Gender*Seat-Belt Use</u>		
Yes	-0.1091 (1)	0.1091 (1)
No	0.1091 (1.24)	-0.1091 (0.804)
<u>Gender*Vehicle-Year</u>		
before 1980	0.2456 (1)	-0.2456 (1)
1981-1985	0.0226 (0.80)	-0.0226 (1.25)
1986-1990	-0.1151 (0.697)	0.1151 (1.435)
1991-1995	0.1418 (0.90)	-0.1418 (1.111)
after 1995	-0.2949 (0.58)	0.2949 (1.72)

Gender and Seat-Belt Use:

Table 5.13 shows that male drivers have higher odds of no seat-belt use crashes than female drivers. Again, this result indicates that there is a need to emphasized and give more safety programs for those who do not want to wear seat-belts.

Gender and Vehicle-Year:

Table 5.13 shows that male drivers have higher odds of driving old vehicles (vehicle year before 1980).

5.2.3. RACE

The following two models use race as the independent variable. The response variables are roadway character, injury severity, and site location.

5.2.3.1.Race, Roadway Character, and Injury Severity

This model was estimated to investigate the association between race and both roadway character and injury severity. A definition of roadway character is define as a roadway segment were crash occurred to be either straight or curve section regardless level or grade roadway. The model was developed using the methodology described before in this chapter with variables:

x=race   i =level: White
Black
Hispanic
Other

y= roadway character   j = level: curve and straight

z= injury severity   k=level: no injury
minor injury (possible injuries)

<u>severe injury</u> (non-incapacitating and incapacitating injuries)

<u>fatal</u> (any injury sustained in a motor vehicle crash that results in death within 90 days)

Table 5.14 shows the frequency distribution of variables and predicted frequency distribution from the developed model. This is a three variable model with variables x (race groups), y (roadway character), and z (injury severity). After running through the SAS CATMOD procedure, the best-fitting model contains all three main effects and all three possible two-way interactions as equation 1 with $G^2=12.20$, df=9, and p-value=0.2022.

Table 5.14 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

race	White		Black		Hispanic		Other	
roadway character injury severity	Straight	Curve	Straight	Curve	Straight	Curve	Straight	Curve
no injury	60981 (60981)	3112 (3112)	14553 (14571)	587 (569)	7989 (7974)	257 (272)	1037 (1035)	50 (52)
minor injury	141129 (141129)	7536 (7549)	35861 (35846)	1453 (1468)	16001 (16026)	599 (574)	2378 (2381)	129 (126)
severe injury	26667 (26699)	2079 (2047)	5960 (5950)	339 (349)	2931 (2912)	131 (150)	428 (425)	29 (32)
fatality	2458 (2439)	392 (411)	424 (431)	63 (56)	258 (267)	39 (30)	39 (41)	9 (7)

From the log-linear model equation 1, using roadway character category y, straight, as the baseline, the logit model for roadway character is as equation 2. After exponentiating both sides of the logit models, the first factor for equation 4 is the baseline odds of being in roadway character category j relative to straight, the first level . The second factor is the odds multipliers for race at four race groups. To find the logit model and odds multipliers for injury severity at four injury groups, equations 3 and 5 are applied.

The parameter estimates for individual and interaction terms and odds multipliers are presented in the Table 5.15. By using equations 4 and 5, the odds of roadway character and injury severity can be found.

Table 5.15 Parameter Estimates of Log-Linear Model of Race, Roadway Character, and Injury Severity

(Parenthesis Numbers are the Odds Multipliers)

Race	White	Black	Hispanic	Other
Race*Roadway character				
Straight	-0.0851 (1)	0.0485 (1)	0.1155 (1)	-0.0789 (1)
Curve	0.0851 (1.186)	-0.0485 (0.907)	-0.1155 (0.794)	0.0789 (1.17)
Race*Injury severity				
no injury	-0.0553 (1)	0.022 (1)	0.0697 (1)	-0.0364 (1)
minor injury	-0.0340 (1.02)	0.1046 (1.086)	-0.0499 (0.887)	-0.0207 (1.016)
severe injury	0.235 (1.337)	0.0311 (1.01)	-0.0326 (0.903)	-0.2335 (0.821)
Fatality	-0.1457 (0.914)	-0.1577 (0.836)	0.128 (0.944)	0.2906 (1.386)

Race and Roadway Character:

Table 5.15 shows that White and Other race drivers have higher odds of crashes on curve sections compared to straight section roadways. Chapter 5 analyzes the relationship between race and speed ratio. The results indicate that the Other race group tend to have higher crash proportions when driving at speeds exceeding 10% to 30% the posted speed. Whereas the White drivers tend to have higher crash proportions when driving at speeds exceeding 30% the posted speed. Therefore, the result from this model might be related to speeding.

Race and Injury Severity:

Table 5.15 shows that White and Black drivers have higher odds of minor and severe injuries compared to no injury. Other race drivers have slightly higher odds of minor injury but even higher odds of fatality compared to no injury. Hispanic drivers, however, do not have high odds in injury compared to no injury.

5.2.3.2.Race, Site Location, and Roadway Character

This model was estimated to investigate the association between race and both yes at/not at intersection and roadway character. The model was developed using the methodology explained before with variables:

x=race	i =level:	White
		Black
		Hispanic
		Other
y=intersection	j = level:	yes and no
z= roadway character	k = level:	curve and straight

Table 5.16 shows the frequency distribution of variables and predicted frequency distribution from the developed model. This is a three-variable model with variables x (race), y (intersection), and z (roadway character). The best-fitting model contains all three main effects and all three possible two-way interactions, equation 1 with G^2=6.47, df=3, and p-value=0.0908.

From the log-linear model equation 1, using intersection category y, not at intersection, as the baseline, and the logit model for yes at / not at intersection as equation 2. After exponentiating both sides of the logit models, the first factor for the equation 4 is the baseline odds of being in intersection category j relative to not at intersection, the first level. The second factor is the odds multipliers for race.

Table 5.16 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

race	White		Black		Hispanic		Other	
intersection	no	Yes	no	yes	no	yes	no	yes
roadway character								
straight	85035	126985	20780	31796	10216	15083	1512	2040
	(85052)	(126967)	(20745)	(31831)	(10239)	(15060)	(1506)	(2046)
curve	6959	4363	1226	853	527	290	109	72
	(6941)	(4381)	(1261)	(818)	(504)	(313)	(115)	(66)

To find the logit model and odds multipliers for roadway character at straight or curve section, equations 3 and 5 are needed. The parameter estimates for individual and interaction terms and odds multipliers are presented in Table 5.17. By using equation 3 and 5, the odds of at / not at intersection and the relationship between race and roadway character can be determined.

Table 3.17 Parameter Estimates of Log-Linear Model of Race, Intersection, and Roadway Character

(Parenthesis Numbers are the Odds Multipliers)

Race	White	Black	Hispanic	Other
Race* Intersection				
no	-0.0102	-0.0239	-0.00278	0.03688
	(1)	(1)	(1)	(1)
yes	0.0102	0.0239	0.00278	-0.03688
	(1.02)	(1.05)	(1)	(0.93)
Race*Roadway Character				
straight	-0.1084	0.0389	0.1446	-0.0751
	(1)	(1)	(1)	(1)
curve	0.1084	-0.0389	-0.1446	0.0751
	(1.24)	(0.925)	(0.749)	(1.162)

Race and yes at / not at Intersection:

Table 5.17 shows that White and Black drivers have higher odds of crashes at intersections. Chapter 5 analyzes the relationship between race and first harmful event. The findings indicates that Black drivers tend to have higher crash proportions with angle collisions. Accordingly, Black drivers might be over-involved in angle crashes at intersections.

5.2.4. RESIDENCY

The following two models use residency as the independent variable. The response variables are roadway character, injury severity, area, and DUI.

5.2.4.1.Residency, Roadway Character, and Injury Severity

This model was estimated to investigate the association between residency and both roadway character and injury severity. A roadway character is defined as a roadway segment were a crash occurred at either a straight or curve section regardless of level or grade of roadway. The model was developed using the methodology described earlier in this chapter, with variables:

x=residency	i =level:	local
		state
		out-state
		foreigner
y= roadway character	j = level:	curve and straight
z= injury severity	k=level:	no injury
		minor injury (possible injuries)
		severe injury (non-incapacitating and incapacitating injuries)
		fatal (any injury sustained in a motor vehicle crash that results in death within 90 days)

Table 5.18 shows the frequency distribution of the variables and predicted frequency distribution from the developed model. This is a three variable model with variables x (residency groups), y (roadway character), and z (injury severity). After running through the SAS

CATMOD procedure, the best-fitting model contains all three main effects and all three possible two-way interactions, equation 1 with G^2=4.67, df=9, and p-value=0.8619.

Table 5.18 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

Residency	local		state		out-state		foreigner	
Roadway character injury severity	Straight	Curve	Straight	Curve	Straight	Curve	Straight	Curve
no injury	71650 (71656)	3222 (3216)	9351 (9341)	598 (608)	2913 (2919)	162 (156)	646 (644)	24 (26)
minor injury	163777 (163745)	7656 (7687)	22872 (22900)	1588 (1560)	7365 (7371)	418 (412)	1355 (1353)	55 (57)
severe injury	29729 (29752)	2027 (2004)	4479 (4462)	420 (436)	1546 (1538)	115 (123)	232 (234)	16 (14)
fatality	2389 (2392)	349 (346)	583 (582)	121 (122)	190 (187)	29 (32)	17 (19)	4 (2)

From the log-linear model equation 1, using roadway character category y, straight, as the baseline, the logit model for roadway character is as equation 2. After exponentiating both sides of the logit models, the first factor for the equation 4 is the baseline odds of being in roadway character category j relative to straight, the first level . The second factor is the odds multipliers for residency, at four groups. To find the logit model and odds multipliers for injury severity, at four injury groups, equations 3 and 5 are applied. The parameter estimates for individual and interaction terms and odds multipliers are presented in the Table 5.19. By using equation 4 and 5, the odds of roadway character and the odds of injury severity can be found.

Table 5.19 Parameter Estimates of Log-Linear Model of Residency, Roadway Character, and Injury Severity

(Parenthesis Numbers are the Odds Multipliers)

Residency	local	state	out-state	foreigner
Residency*Roadway Character				
Straight	0.0543 (1)	-0.1319 (1)	-0.0333 (1)	0.1109 (1)
Curve	-0.0543 (0.897)	0.1319 (1.302)	0.0333 (1.069)	-0.1109 (0.801)
Residency*Injury severity				
no injury	0.0912 (1)	-0.1174 (1)	-0.1559 (1)	0.1821 (1)
minor injury	0.0697 (0.978)	-0.0686 (1.05)	-0.0776 (1.08)	0.0765 (0.90)
severe injury	0.0301 (0.941)	-0.0381 (1.083)	0.0210 (1.19)	-0.013 (0.823)
Fatality	-0.191 (0.754)	0.2241 (1.41)	0.2125 (1.45)	-0.1868 (0.691)

Residency and Roadway Character:

Table 5.19 shows that state and out-state crash victims have higher odds of being on curve sections compared to straight section roadway when a crash occurred.

Race and Injury Severity:

Table 5.19 shows that state and out-state drivers have higher odds of minor, severe injuries, and fatality compared to no injury. The results might imply that local drivers do not have many injury crashes occurring near were they live since they are more familiar with their own surroundings.

5.2.4.2.Residency, Area, and DUI

This model was estimated to investigate the association between residency and both DUI (alcohol/drug involved) and injury severity. The model was developed using the methodology explained before in this chapter with variables:

x=residency	i =level: local state out-state foreigner
y= DUI	j= level: no and yes
z= injury severity	k=level: no injury minor injury (possible injuries) severe injury (non-incapacitating and incapacitating injuries) fatal (any injury sustained in a motor vehicle crash that results in death within 90 days)

Table 5.20 shows the frequency distribution of variables and predicted frequency distribution from the developed model. This is a three-variable model with variables x (residency), y (DUI), and z (injury severity). The best-fitting model contains all three main effects and all three possible two-way interactions, equation 1 with G^2=14.98, df=9, and p-value=0.0915.

Table 5.20 Frequency Distribution of Variables

(Parenthesis values are the predicted frequencies from the model)

Residency	Local		state		out-state		foreigner	
DUI injury severity	no	yes	no	yes	no	yes	no	yes
no injury	63435 (63453)	11437 (11418)	8389 (8341)	1560 (1608)	2553 (2569)	522 (506)	582 (595)	88 (75)
minor injury	157567 (157576)	13866 (13857)	22354 (22354)	2106 (2106)	7102 (7100)	681 (683)	1335 (1328)	75 (81)
severe injury	27115 (27071)	4641 (4685)	4073 (4133)	826 (766)	1407 (1397)	254 (264)	227 (221)	21 (27)
fatality	1683 (1700)	1055 (1038)	438 (426)	266 (278)	135 (131)	84 (88)	15 (15)	6 (6)

From the log-linear model equation 1, using DUI category y, no DUI involved, as the baseline. The logit model for DUI is equation 2. After exponentiating both sides of the logit models, the first factor for equation 4 is the baseline odds of being in DUI category j relative to no DUI involved , the first level . The second factor is the odds multipliers for residency.

To find the logit model and odds multipliers for injury severity, equations 3 and 5 are applied. The parameter estimates for individual and interaction terms and odds multipliers are presented in the Table 5.21. By using equation 4 and 5, the odds of DUI and the odds of injury severity can be found.

Table 5.21 Parameter Estimates of Log-Linear Model of Residency, Roadway Character, and Injury Severity

(Parenthesis Numbers are the Odds Multipliers)

Residency	local	state	out-state	foreigner
Residency*DUI				
no	-0.0246 (1)	-0.0590 (1)	-0.0695 (1)	0.1531 (1)
yes	0.0246 (1.05)	0.0590 (1.13)	0.0695 (1.15)	-0.1531 (0.736)
Residency*Injury severity				
no injury	0.0963 (1)	-0.1212 (1)	-0.1525 (1)	0.1774 (1)
minor injury	0.0771 (0.98)	-0.0642 (1.06)	-0.0647 (1.09)	0.0518 (0.88)
severe injury	0.327 (1.36)	-0.0352 (1.09)	0.0263 (1.20)	-0.3181 (0.61)
fatality	-0.5004 (0.55)	0.2206 (1.41)	0.1909 (1.41)	0.0889 (0.92)

Residency and DUI:

Table 5.21 shows that all groups, except foreign, have higher odds of DUI involved crashes. The results might confirm the findings from the previous model that foreign drivers do not have high odds in injury or fatality since they tend not to drive under influence of alcohol/drug. Also, it points to a need for more aggressive education to reduce the number of people driving under the influence of alcohol.

5.3. CONCLUSIONS

The findings on modeling the relationship between age, injury severity, and ADT suggest that the injury severity is related to age and that old and very-old drivers are more likely to be killed in traffic crashes probably due to their declination of physical strength. Moreover, average daily traffic per lane (ADT/lane) is related to age and, in particular, the odds of ADT>20,000 per lane are much higher for young and middle age drivers and much smaller for the very old drivers. This result might imply that elderly drivers tend to avoid traveling in peak periods. The result from modeling the relationships between age, ADT, and first harmful event show that the first harmful event or crash types are related to age. Very-old drivers have a tendency of being involved in angle and turning crashes possibly due to their slower perception and reaction times. Whereas the middle age drivers tend to have higher odds of being involved in rear-end and sideswipe. Analyses on modeling the relationships between age, roadway character, and speed ratio indicated that young and very-young drivers might have a problem with speeding regardless of the roadway character. Old and very old drivers have higher involvement on straight roadway section on any speed ratios. Modeling the relationships between age, alcohol involvement, and location indicates that the odds of alcohol involved crashes are much higher for young and middle age drivers. Young and middle age drivers involved in crashes have greater tendency inside and outside city limits and inside urban areas.

Modeling the relationship between gender, DUI, and injury severity shows that male drivers have higher odds of DUI crashes than female drivers. Moreover, male drivers have higher odds of fatality perhaps due to their higher crash proportions while speeding and DUI involvement (Abdel-Aty et. al., 1998). Female drivers tend to have higher odds of minor and severe injuries. Modeling the relationship between gender, seat-belt used, and vehicle year shows that male drivers have higher odds of no seat-belt use crashes than female drivers. The model also shows that male drivers have higher odds of driving on old vehicles (vehicle year before 1980). A reason for this result might be that female drivers are more comfortable driving new vehicles because of more concern of personal safety and security. From the above results for gender, it seems that male drivers are more likely to be involved in crashes with either driving under the influence or not wearing seat-belts. Therefore, they have higher tendency of having fatal crashes. It is worth mentioning that to reduce the loss of another human being, there is a need for more safety education that emphasizes these two issues: DUI and seat-belts.

Modeling the relationship between race, roadway character, and injury severity shows that White and Other race drivers have higher odds of crashes on curve sections compared to straight section roadway. This might be an indication of a speeding problem. The model also shows that White and Black drivers have higher odds of minor and severe injuries comparing to no injury. Other race drivers have slightly higher odds of minor injury but much higher odds of fatality comparing to no injury. Hispanic drivers, however, do not show high odds in injury comparing to no injury. Modeling the relationship between race, intersection, and injury severity shows that White and Black drivers have higher odds of crashes at intersections.

The relationships between residency, roadway character, and injury severity shows that state and out-state crash victims have higher odds of crash involvement on curve sections comparing to straight section roadway when crash occurred. Furthermore, the model also shows that state and out-state drivers have higher odds of minor, severe injuries, and fatality compared with no injury. The result might imply that most of the local drivers do not have many injury crashes occurring in the vicinity of their residences since they are more familiar with their own areas. Modeling the relationship between residency, DUI, and injury severity shows that, excluding foreign drivers, all other drivers have higher odds of DUI involved crashes. The result might confirm the findings from the previous model that foreign drivers do not have high odds in injury or fatality since they tend not to involve in driving under influence of alcohol/drug.

CHAPTER 6
SUMMARY AND RECOMMENDATIONS

6.1.SUMMARY

This research illustrates a full range of methodological approaches to analyze the Florida crash data. To show general trends, descriptive statistic of crash rates was first introduced using exposure data (e.g., population or number of licensed drivers). To identify high-risk groups in certain Florida counties, the concept of relative risk was applied. Also, the method of conditional probability was used to investigate the drivers' demographic differences in crash involvement. Finally, analyzing the categorical data using log-linear modeling, I was able to determine the association between the different demographic factors and type, severity, and involvement of crashes. The following sections summarize the results of each demographic group with crash-related factors.

6.1.1. age

Using the number of licensed drivers to determine the crash rates showed that the relationship between age and crash involvement follows the classic U-shape, with very high rates for age groups of 15-19 and 20-24. Injury crash involvement rates generally follow the same trend, but fatal crash involvement rates start to go up dramatically after the age of 64 and the rates are very high for drivers of the age 80 and above; meanwhile, the age groups of 25-34, 35-44, 45-54, and 55-64 have relatively lower crash rates and the curve is almost flat. Although, initially, there were eleven age groups in the crash rate analysis, according to the above results, we were able to categorized the age groups into teenage (15-19), young (20-24), middle (25-64), old (65-79), and very old (80+) to simplify the analysis for other methods. The technique of relative risk also showed that the teenage and young drivers have higher risk than the remaining groups. Elderly drivers, however, did not seem to have high risk with total crashes. Nonetheless, for residents-only crashes, certain counties (i.e., Dade, Escambia, Sarasota, Dixie, etc.) showed that elderly drivers do have some risk.

Utilizing contingency tables to determine the crash proportions allow us to target certain age groups in particular conditions. For example, (1) drivers' between the age 19-24 tend to have higher crash involvements with head-on collision, on two-lane, on rural, on undivided highways, on curves, while not wearing seat-belt, while cited for violation, and while speeding; (2) ages between 25-64 tend to have higher crash involvements with rear-end and sideswipe collisions, on freeway, and associated with DUI; (3) elderly drivers tend to have higher crash involvements with angle and turning collisions, at intersections, while cited for violation, disregarding traffic sign or control. To ease the understanding of many associations between age and crash-related factors, Table 6.1 presents the conditions that different age groups are over-involved in crashes.

Table 6.1 Age and crash-related factors

Demoraphic variable	AGE				
crash-related factors\group	15-19	20-24	25-64	65-79	80+
ENVIRONMENTAL-RELATED					
*weather	rain/cloudy	fog	fog	clear	clear
*roadway surface	wet, slippery	wet, slippery	wet, slippery	dry	dry
*month	9-10	3-4, 7-8	5-9	1-4	11-12
*day	weekend	weekend	evenly	weekday	weekday
*time	18:01-24:00	0:00-6:00	6:01-12:00	6:01-12:00	6:01-12:00
ROADWAY-RELATED					
*divided/undivided highway	undivided	undivided	divided	divided	divided
*number of lanes	2	2	8+	4	parking lot
*roadway system	local,county	local,county	interstate	US	local,state, US
*traffic control	no control special zone	no control special zone	no control	signal, stop	signal, stop
*roadway character	curve level	curve level straight level	evenly	straight level	straight level
*shoulder type	unpaved	paved	paved	curb	curb
*site location	non-intersections	non-intersections	on/off ramps	intersection	intersection
*urban/rural	rural	rural	evenly	urban	urban
*location type	residential	residential	business	business	business
*location on roadway	shoulder	median	median	on road	turning lane
DRIVER-RELATED					
*first harmful event	head-on, ran-off overturned	sideswipe, ran-off overturned	sideswipe rear-end	angle, turn	angle, turn
*injury severity	no injury, minor	no injury	evenly	severe, fatal	severe, fatal
*alcohol/drugs involved	no	alcohol	alcohol/drugs	no	no
*seat-belt use	no	no	yes	yes	yes
*speed ratio	>10%-30% of PS	>10%-30% of PS	near PS	<30% of PS	<30% of PS
*fault	yes	yes	no	yes	yes
*vehicle movement	go straight passing	go straight	stalled	turning, backing changing lane	turning, backing, chaning lane
*vehicle year	1986-1990	1991-1995	1995 and after	1991 and after	before 1980

Note: Evenly means that there is no specific higher proportion in any conditions. Note: PS means the posted speed.

By applying the log-linear modeling, the results confirm some of the previous findings. For example, teenage and young drivers are over-involved in crashes that are related to speeding; hence, crashes are more likely to occur on roadway curve section. Middle age drivers have a higher crash involvement with driving under the influence of alcohol/drugs. Elderly drivers have higher odds of being involved in severe and fatal crashes due to their physical conditions. They also have a greater chance of being involved in angle and turning collisions; this might be related to intersections where perception/reaction time affect the driving performance.

6.1.2. gender

Applying the number of licensed drivers to determine the crash rate of certain groups also showed that males and females have almost the same crash involvement trends, however, males' rates were roughly 50 percent higher. The concept of relative risk did not apply for gender and county since each county has relatively similar populations of males and females, the result would only show that males have higher risk in most of the counties.

Analyzing contingency tables to determine the relationships between gender and crash-related factors showed that, for instance, male drivers tend to speed, not wear seat-belt, be more involved in severe or fatal injury crashes; female drivers tend to have a high crash involvement at intersections and parking lots, angle and turning collisions, and disregarding stop and yield signs. Table 6.2 summarizes the relationship between gender and crash-related factors.

Table 6.2 Gender and crash-related factors

Demoraphic variable	GENDER	
crash-related factors\group	male	female
ENVIRONMENTAL-RELATED		
*weather	foggy	cloudy , rain
*roadway surface	slippery	slippery
*month	1-3, 6-7, 12	5, 8-11
*day	weekends	weekdays
*time	nighttime	daytime
ROADWAY-RELATED		
*divided/undivided highway	evenly	evenly
*number of lanes	2, 8+	parking lot, 3-4, 5-7
*roadway system	interstate, turnpike/toll	local, county
*traffic control	no control, special zone	signal, stop, yield
*roadway character	curve and straight grade curve level	straight level
*shoulder type	paved, unpaved	curb
*site location	not intersection, on/off ramp	intersection, driveway
*urban/rural	rural	urban
*location type	open country	business, residential
*location on roadway	shoulder, median	on road, turning lane
DRIVER-RELATED		
*first harmful event	head-on, ran-off overturned	angle, turn
*injury severity	severe, fatal	minor
*alcohol/drugs involved	yes	no
*seat-belt use	no	yes
*speed ratio	>10%-30% of PS	near PS+I27
*fault	yes	no
*vehicle movement	backing, passing lane changing	slowing/stopped stalled, turn
*vehicle year	before 1980	after 1991

Note: Evenly means that there is no specific higher proportions in any conditions.

To determine the relationships between gender and DUI, seat-belt use, injury severity, and vehicle year, log-linear modeling showed that male drivers have higher odds of being involved in crashes while DUI and being involved in crashes while not wear seat-belts; consequently, they also have higher odds of fatality. In addition, male drivers tend to have higher odds of driving older vehicles while being involved in crashes. Female drivers, for personal safety and security concerns, tend to drive newer vehicles.

6.1.3. race

The descriptive statistics showed that the relationship between residents' total crash involvement by race and age per 100 race population/year follows the traditional U-shape for all races except the Black drivers. The Black drivers, however, did not have the highest crash rates in the very young age group but at ages between 35 to 44. This is a unique result that is different from the original assumptions that young and elderly drivers have higher risk. To determine the association between race and county of total crashes, the concept of relative risk shows that Black drivers are over-involved in crashes in many counties; they also have higher risk ratios. In most counties, however, Hispanic drivers do not have high risk, but in certain counties, they have very high-risk ratios (i.e., Gadsden, Desoto, Glades, Liberty, etc.,).

Applying contingency tables to determine the relationships between race and crash-related factors showed that, for example, White drivers tend to speed, being involved in crashes while DUI; Black and Hispanic drivers tend not to wear seat-belts. To epitomize the overall results for the associations between race and crash-related factors conditional probability was used, see Table 6.3.

Table 6.3 Race and crash-related factors

Demographic variable	RACE			
crash-related factors\group	White	Black	Hispanic	Other
ENVIRONMENTAL-RELATED				
*weather	fog	rain	rain	rain
*roadway surface	evenly	evenly	wet	slippery
*month	1-3	9-Apr	7, 12	8-11
*day	weekdays	weekends	weekends	evenly
*time	12:01-18:00	0:00-6:00	6:01-12:00	18:01-24:00
ROADWAY-RELATED				
*divided/undivided highway	divided	undivided	divided	divided
*number of lanes	2	1-2	1, 3-4, 8-11	parking lots, 3-4, 5-7
*roadway system	US, state	local	county, turnpike/toll	interstate
*traffic control	no control special zone	railroad crossing guard	no control, stop, yield	signal
*roadway character	curve level and grade straight grade	straight grade	straight level	curve grade straight grade
*shoulder type	unpaved	paved	paved	curb
*site location	no intersection	intersection	on/off ramp, not intersection	no intersection, ramp, parking lots
*urban/rural	rural	urban	rural	rural
*location type	open country	residential	residential	business
*location on roadway	shoulder	both on road not on road	on road	median, turning lane
DRIVER-RELATED				
*first harmful event	rear-end, ran-off, overturned	head-on, sideswipe	head-on, angle, turn, sideswipe	rear-end, overturned
*injury severity	severe, fatal	no injury, minor	no injury	minor, fatal
*alcohol/drugs involved	yes	no	no	no
*seat-belt use	yes	no	no	yes
*speed ratio	>30% of PS	near and below PS	near and below PS	>10% of PS
*fault	yes	no	yes	yes
*vehicle movement	right turns	backing, parked	changing lanes passing	left turn, u-turn, stalling
*vehicle year	1995 and after	before 1980	1981-1985	after 1995

note: Evenly means that there is no specific higher proportion in any condition. PS means posted speed.

As for the analysis on race and crash-related factors using log-linear modeling, the relationships between race, roadway character, injury severity, and site location showed that White and Other race drivers have higher odds of crashes on curve sections compared to straight section roadway. This might be an indication of a speeding problem. Furthermore, White and Black drivers have higher odds of minor and severe injuries compared to no injury. The Other drivers also have slight higher odds of minor injury but much higher odds of fatality compared to no injury. White and Black drivers have higher odds of crashes at intersections. This result might be related to improper turning and following to closely.

6.1.4. residency

Using the number of visitors per year, it was possible to find the non-residents' crash rates. In this case, non-Florida-residents are either out-of -state or foreign visitors. Since the age categories for non-residents' crashes are different from the total and residents-only crashes, they are not comparable. However, figures for non-residents' crashes all showed U-shape relationship and those young drivers (18-25) have the highest rates. Elderly non-residents, over the age of 65, rates start to go up dramatically. As for the method of relative risk, exposure measurement for non-residents was not available. However, we addressed total crashes (both residents of Florida and non-residents) and residents-only crashes rate in each county. Again, both crash rates are not comparable since one uses population (total crashes) and the other use the number of licensed drivers (residents-only) as exposure measurements.

To summarize the overall results for residency and crash-related factors using conditional probability, Table 6.4 shows that local drivers tend to be over-involved in crashes related to speeding and not wearing seat-belts. State and out-state drivers have higher involvement with DUI and severe and fatal injuries. Foreign drivers have more problems at intersections and freeway with turning and rear-end collisions.

As for the analysis on residency and crash-related factors using log-linear modeling, the relationships between residency, roadway character, injury severity, and DUI showed that out-state drivers have higher odds of crash involvement on curve sections compared to straight section roadways when the crash occurred. Moreover, state and out-state drivers have higher odds of minor, severe injuries, and fatality compared with no injury. The findings might imply that most of the local drivers do not have many injury crashes occurring in the vicinity of their residences since they are more familiar with their own areas. In the case of DUI, all other drivers, except foreign drivers, have higher odds of DUI involved crashes. The result might confirm that foreign drivers do not have high odds in injury or fatality since they tend not to be involved in driving under the influence of alcohol.

The objective of this research is to view the overall crash involvement related to demographic and crash contributing factors. Using the results as references or considerations of certain crash conditions should benefit the future study. The following sections include some of the recommendations drawn from this research.

Table 6.3 Residency and crash-related factors

Demoraphic variable	RESIDENCY			
crash-related factors\group	local	state	out-state	foreign
ENVIRONMENTAL-RELATED				
*weather	evenly	cloudy, rain, fog	clear	clear
*roadway surface	evenly	wet	evenly	dry
*month	9-11	5-8	1-4	12
*day	weekdays	Friday and weekends	weekends	weekends
*time	6:01-12:00	0:00-6:00	12:01-18:00	18:01-24:00
ROADWAY-RELATED				
*divided/undivided highway	undivided	divided	divided	divided
*number of lanes	parking lots, 2	12-16	3-4	5-7, 8-11
*roadway system	county, local	interstate, US, state, turnpike/toll, forest road	interstate, US, state, turnpike/toll	US, state, turnpike/toll
*traffic control	stop	no control, special zone, yield, railroad crossing	no control, special zone, yield	signal
*roadway character	straight level	curve level and grade	straight grade curve grade & level	straight level
*shoulder type	curb	unpaved	unpaved	paved, curb
*site location	parking lots	railroad, on/off ramps, not at intersection	on/off ramp	intersection
*urban/rural	urban	rural	rural	urban
*location type	residential	open country	business	business
*location on roadway	on road	shoulder, median	shoulder, median	on road, median turning lane
DRIVER-RELATED				
*first harmful event	head-on	rear-end, ran-ff, overturned	sideswipe	rear-end, turning
*injury severity	no injury	severe, fatal	severe, fatal	no injury
*alcohol/drugs involved	no	alcohol	alcohol	drug
*seat-belt use	no	yes	yes	yes
*speed ratio	>30% of PS	>10% of PS	near PS	<30% of PS
*fault	no	yes	yes	yes
*vehicle movement	parking	passing	u-turn	change lanes
*vehicle year	before '80, '81-'90	1991-1995	after 1991	after 1991

Note: Evenly means that there is no specific higher proportion in any condition. PS means posted speed.

6.2. RECOMMENDATIONS

Due to the fact that this research is addressing the overall relationship between demographic variables and crash-related factors, it can be extended to further study. For example, using the conditional probability analysis, it was found that young drivers, ages 15-24, have higher crash proportions on weekend and nighttime. Therefore, one might hypothesize that this issue might be related to alcohol/drugs involvement (i.e. three-way tables might provide more information). The research also showed that young drivers are over-involved in crashes that are related to speeding. They are involved in overturn, off-road, and head-on collisions more than any other age groups. Young drivers also have higher crash proportions on undivided, rural, or two-lane highways; perhaps, the passing maneuvers are the reason. There are many ways, conceivably, that will reduce young drivers' crash occurrences and severity at such locations. One is to educate those youngsters by requiring them to take the extensive and specific drivers education before they get their licenses. Since those young drivers have less driving experience, this driver education will show those youngsters defensive driving techniques that aimed at facilitating the recognition of potentially hazardous situations and thus avoiding them.

Another way to reduce young drivers' crash occurrences and severity is to improve the roadway by widening the shoulders and adding medians. However, this alternative is very costly and it is not a permanent solution to solve young drivers' problems because their riskier behaviors would still not change. Another method that might be useful is to install special signs or signals at the locations where there are more crash occurrences to remind the drivers to be more careful.

Drivers between the ages of 25-44 were found to have a higher percentage of crashes while under the influence of alcohol. The solutions for such problem are to heavily penalize those drunk drivers and force them to take driver-education or a driver-improvement course. If their DUI problems proceed, their licenses should be suspended.

Typically, elderly drivers have many years of driving experience but are losing or have lost some of their sensory and physical capabilities. Consequently, they are less able to cope with a complex driving situation. Elderly drivers were found to have problems at intersections or parking lots. They have more severe and fatal injuries and more angle and turning crashes. The hypothesis is that those elderly drivers when trying to make left or right turns have difficulty in perceiving and judging the speed and gaps between vehicles, therefore turning type of crashes occur. Whereas at the parking lots, when other vehicles pull out suddenly, elderly drivers due to their slower perception and reaction times would not be able to stop their vehicles, therefore collisions occur. It is also possible that elderly drivers when backing the vehicles, due to their neck stiffness, would not fully see the rear, therefore, crashes occur.

There are several ways to minimize elderly drivers' problems. For example, periodic reexamination of elderly drivers above 65 is probably a good solution to screen some their problems. This periodic reexamination should test elderly drivers' day/night visions and reaction times. If the elderly driver did not pass one of the tests, specific restrictions on his/her license could be imposed (i.e., no nighttime driving). In this case, there is a need to provide alternative transportation for the elderly. Another alternative is to reduce elderly drivers' crash occurrences at intersections is to redesign the traffic control to have sufficient times of protected turn signals for locations that have many elderly drivers. Nevertheless, one has to consider the problems with capacity and delays when increasing the green time for the turning signals.

The analysis on other demographic variables such as gender, race, and residency also showed that certain groups have similar problems as different age groups posses. For example, the findings indicated the following:

- Teenage and young, males, White, and local drivers tend to have higher crash involvement with speeding.
- Teenage and young, Black, and local drivers tend to have higher crash involvement at undivided highways.
- Teenage and young, males, White, state and out-state drivers tend to have higher crash involvement at curve sections of trafficway.
- Teenage, male, White, state and out-state drivers tend to have higher crash involvement on shoulders.
- Teenage, male, Black and Hispanic, and local drivers tend to have higher crash involvement with head-on collisions.
- Teenage and young, male, White, and state drivers tend to have higher crash involvement with ran-off and overturned crashes.
- Teenage, male, Hispanic, and state drivers tend to have higher crash involvement while passing other vehicles.
- Teenage and young, males, Black and Hispanic, state and out-state drivers tend to have higher crash involvement at special zone or locations with no control.
- Teenage and young, male, White, local drivers tend to have higher crash involvement on two-lane highways.
- Teenage, male, White, state and out-state drivers tend to have higher crash involvement on unpaved shoulders.
- Teenage and young, male, Black and Hispanic, and local drivers tend to have higher crash involvement of not wearing seat-belts.
- Young and middle age, male, Other, state, out-state, and foreign drivers tend to have higher crash involvement on medians.
- Young and middle age, male, White, and state drivers tend to have higher crash involvement with DUI.

- Young and middle age, Black and Hispanic, and out-state drivers tend to have higher crash involvement with sideswipe crashes.
- Middle age, White and Other, state and foreign drivers tend to have higher crash involvement with rear-end collisions.
- Old and very old, female, Black, and foreign drivers tend to have higher crash involvement at intersections.
- Old and very old, male, Hispanic, and local drivers tend to have higher crash involvement at stop signs.
- Old and very old, female, Other, and foreign drivers tend to have higher crash involvement at signalized locations.
- Very old, female, Other, and foreign drivers tend to have higher crash involvement on turning lanes.
- Old and very old, male, Hispanic, and foreign drivers tend to have higher crash involvement while changing lanes.
- Old and very old, female, Black, local and foreign drivers tend to have higher crash involvement at urban areas.
- Old and very old, female, and Hispanic drivers tend to have higher crash involvement with angle and turning types of collisions.
- Old and very old, female, Other, local and foreign drivers tend to have higher crash involvement on curbs.
- Old and very old, male, White, state and out-state drivers tend to have higher crash involvement with severe or fatal injuries.
- Very old, female, Other, and local drivers tend to have higher crash involvement on parking lots.
- Very old, male, Black, and local drives tend to have higher crash involvement while driving older vehicles (before 1980).

Listing and classifying different crash-related factors with various demographic groups could make further suggestions. For instance, teenage and young, male, Black and Hispanic, and local drivers tend to have higher crash involvement of not wearing seat-belts. To resolve this problem of no seat-belt use, the government already passed the law of "buckle-up or fine". This is a very active way of spreading the message to the public. Perhaps, the majority of people while traveling on the roads would consider using seat-belts most of the time not only for their own safety but to avoid getting fines as well.

Another important traffic safety issue in Florida is the foreign drivers; there are nearly 42 million out-state and foreign visitors per year (Florida Visitor Study, 1995). The analysis showed that the foreign drivers tend to have a higher crash proportions related to intersections and freeways; they have a higher tendency of being involved in rear-end and turning collisions. Moreover, they tend to drive below the speed limit or change lanes before crashes occur. Since foreign drivers usually are not familiar with our roadway designs and directions, and traffic controls, these results are all logical. On freeways, due to unfamiliarity with locations, foreign drivers tend to drive slowly while trying to figure out the signs and directions. Sometimes they suddenly change lanes or exit the roadways, the time is usually not sufficient to make such corrections. Whereas at intersections, foreign drivers sometime are not familiarize with our intersections' designs and traffic controls, they are not sure when they are permitted to go (i.e., mainly when left turns is protected/permitted and right turn on red), therefore, the angle type of collisions occurs. There are two improvements for those foreign drivers and we should apply both of them simultaneously. One is at the rental car agencies by giving out maps of the locations of interest and simple brochures that describe some traffic rules and regulations, for example at intersections whether controlled by signals or stop/yield signs. The simple brochures should be easy and straightforward to the reader, perhaps include different languages. The other improvement is to improve the signs at major tourist attractions, such as Cocoa and Daytona beaches, Disney world, and Bush Garden, to make the signs more understandable and readable to the foreign drivers. For example, the signs can have symbols that represent those places since some foreign drivers might not fully understand the words. It is also necessary to have more signs indicating the directions at least two miles before the nearest exit (McShane and Roess, 1990). However, the sign designs should not confuse and distract the drivers.

The above assumptions and recommendations are based on many statistical analyses in this research. Therefore, it might benefit the future research on traffic safety. Future research could be focus more on a particular group with certain crash situations or locations, for example:

- teenage/young, male, White, and/or out-state drivers on curve with various speed ratio,
- teenage/young, male, Hispanic, and/or state drivers on two-lane undivided highways with passing maneuver,
- young/middle age, male, White, local and/or state drivers on weekend with DUI,
- teenage/young, male, Black or Hispanic, and/or local drivers with no seat-belt use and injury severity,
- elderly drivers, female, Black, and/or foreign drivers at intersection or parking lots with different collision types,
- middle age, Black or Hispanic, and/or local drivers at railroad crossing at rural/urban areas, etc.

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APPENDIX A

RELATIVE RISK

Table A.1 Percentage of population by age and county (total crashes)

County	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75-79	80-84	85+	Total
Dade	0.074	0.081	0.196	0.202	0.154	0.112	0.052	0.046	0.036	0.026	0.022	1575563
Duval	0.070	0.081	0.193	0.186	0.132	0.086	0.039	0.036	0.025	0.017	0.134	622194
Hillsborough	0.078	0.089	0.204	0.207	0.155	0.103	0.049	0.045	0.033	0.022	0.016	698032
Pinellas	0.054	0.056	0.150	0.171	0.141	0.122	0.078	0.077	0.063	0.046	0.040	740459
Polk	0.077	0.078	0.174	0.182	0.141	0.116	0.065	0.065	0.048	0.032	0.022	346949
Palm Beach	0.056	0.057	0.162	0.178	0.141	0.114	0.075	0.076	0.065	0.045	0.032	786150
Orange	0.084	0.094	0.215	0.210	0.149	0.099	0.046	0.041	0.029	0.018	0.015	598609
Volusia	0.065	0.070	0.156	0.171	0.136	0.120	0.078	0.078	0.059	0.039	0.029	339065
Escambia	0.088	0.100	0.209	0.190	0.145	0.110	0.049	0.045	0.031	0.020	0.014	211353
Broward	0.059	0.063	0.184	0.193	0.145	0.109	0.065	0.061	0.052	0.040	0.029	1112842
Alachua	0.117	0.185	0.195	0.181	0.125	0.074	0.037	0.032	0.025	0.016	0.014	154733
Lake	0.056	0.049	0.119	0.140	0.120	0.125	0.089	0.162	0.065	0.044	0.031	154602
Leon	0.115	0.178	0.185	0.196	0.142	0.077	0.033	0.027	0.023	0.013	0.011	171398
Marion	0.065	0.059	0.149	0.167	0.139	0.134	0.084	0.085	0.059	0.036	0.022	181145
Manatee	0.058	0.055	0.142	0.158	0.130	0.122	0.088	0.088	0.074	0.050	0.036	192281
Sarasota	0.041	0.183	0.101	0.128	0.116	0.114	0.083	0.085	0.068	0.047	0.034	305215
Seminole	0.083	0.074	0.198	0.229	0.175	0.103	0.045	0.038	0.026	0.017	0.013	263606
Lee	0.060	0.057	0.155	0.136	0.141	0.136	0.092	0.090	0.067	0.041	0.025	303320
Brevard	0.069	0.068	0.171	0.194	0.150	0.128	0.066	0.066	0.046	0.026	0.016	361318
St. Johns	0.074	0.073	0.160	0.202	0.160	0.113	0.068	0.062	0.044	0.025	0.020	77639
Gadsden	0.099	0.096	0.213	0.197	0.137	0.101	0.046	0.038	0.034	0.022	0.017	31967
Putnam	0.083	0.059	0.152	0.177	0.146	0.134	0.085	0.070	0.047	0.027	0.020	55872
Bay	0.083	0.087	0.187	0.205	0.157	0.114	0.057	0.047	0.031	0.019	0.013	106598
St. Lucie	0.069	0.068	0.158	0.181	0.132	0.125	0.078	0.079	0.060	0.033	0.018	139193
Jackson	0.098	0.113	0.174	0.186	0.138	0.105	0.053	0.045	0.037	0.029	0.022	34167
Osceola	0.083	0.076	0.171	0.197	0.165	0.110	0.057	0.054	0.042	0.026	0.019	106774
Highlands	0.060	0.050	0.110	0.130	0.105	0.143	0.110	0.106	0.093	0.057	0.037	64425
Pasco	0.053	0.046	0.115	0.136	0.123	0.144	0.104	0.103	0.085	0.053	0.037	262901
Columbia	0.095	0.088	0.174	0.205	0.163	0.108	0.050	0.049	0.033	0.021	0.013	36061
Hardee	0.099	0.099	0.194	0.173	0.136	0.098	0.058	0.056	0.041	0.026	0.019	16238
Suwannee	0.096	0.075	0.158	0.182	0.153	0.123	0.062	0.059	0.039	0.030	0.023	22381
Indian River	0.062	0.058	0.131	0.159	0.131	0.130	0.090	0.094	0.075	0.042	0.028	84854
Santa Rosa	0.086	0.085	0.198	0.222	0.160	0.115	0.047	0.039	0.023	0.014	0.011	73826
Desoto	0.070	0.087	0.168	0.174	0.136	0.120	0.073	0.069	0.046	0.035	0.022	20618
Madison	0.094	0.097	0.216	0.187	0.127	0.107	0.050	0.045	0.034	0.023	0.020	12949
Walton	0.079	0.073	0.146	0.187	0.159	0.143	0.069	0.058	0.037	0.029	0.020	25360
Taylor	0.070	0.078	0.186	0.198	0.152	0.118	0.062	0.053	0.040	0.026	0.018	13436
Monroe	0.047	0.062	0.189	0.204	0.173	0.129	0.065	0.057	0.038	0.024	0.012	70921
Levy	0.071	0.067	0.150	0.175	0.151	0.139	0.075	0.072	0.052	0.027	0.021	23375
Hernando	0.063	0.044	0.091	0.137	0.133	0.140	0.115	0.120	0.085	0.047	0.025	104674
Nassau	0.088	0.082	0.205	0.208	0.174	0.110	0.048	0.039	0.023	0.015	0.008	36629
Marion	0.065	0.059	0.149	0.167	0.139	0.134	0.084	0.085	0.059	0.036	0.022	181145
Okaloosa	0.088	0.095	0.211	0.223	0.147	0.109	0.043	0.036	0.025	0.014	0.010	121207
Sumter	0.073	0.069	0.127	0.150	0.147	0.133	0.089	0.088	0.061	0.039	0.023	28517
Bradford	0.081	0.098	0.224	0.193	0.143	0.100	0.048	0.045	0.030	0.020	0.017	18499
Jefferson	0.098	0.077	0.198	0.183	0.144	0.096	0.058	0.053	0.043	0.028	0.022	9925
Citrus	0.054	0.042	0.105	0.130	0.135	0.156	0.109	0.106	0.079	0.051	0.033	92134
Clay	0.090	0.077	0.203	0.230	0.171	0.106	0.039	0.033	0.024	0.016	0.012	94121
Hendry	0.098	0.095	0.209	0.195	0.139	0.113	0.043	0.038	0.032	0.021	0.016	21553
Washington	0.096	0.071	0.138	0.177	0.156	0.127	0.069	0.058	0.048	0.034	0.026	14294
Holmes	0.091	0.101	0.167	0.169	0.150	0.119	0.054	0.055	0.041	0.030	0.023	13215
Baker	0.112	0.113	0.203	0.210	0.149	0.099	0.038	0.028	0.022	0.015	0.011	15150
Charlotte	0.044	0.046	0.106	0.112	0.120	0.159	0.118	0.119	0.086	0.055	0.034	114270
Dixie	0.078	0.082	0.166	0.186	0.144	0.150	0.067	0.058	0.035	0.026	0.009	9025
Gilchrist	0.093	0.114	0.148	0.178	0.165	0.120	0.050	0.049	0.038	0.023	0.022	8809
Hamilton	0.112	0.112	0.210	0.185	0.134	0.090	0.044	0.038	0.031	0.024	0.019	9200
Okeechobee	0.075	0.072	0.127	0.145	0.115	0.095	0.057	0.049	0.043	0.209	0.013	31141
Calhoun	0.086	0.097	0.180	0.176	0.168	0.112	0.049	0.048	0.037	0.028	0.019	9678
Franklin	0.085	0.068	0.137	0.191	0.168	0.136	0.059	0.054	0.052	0.027	0.022	7739
Glades	0.082	0.072	0.158	0.138	0.158	0.143	0.070	0.078	0.062	0.030	0.009	6849
Flagler	0.053	0.054	0.119	0.140	0.136	0.141	0.112	0.110	0.082	0.035	0.019	31448
Lafayette	0.069	0.107	0.268	0.175	0.116	0.114	0.049	0.047	0.032	0.013	0.011	4650
Union	0.049	0.059	0.161	0.131	0.073	0.472	0.018	0.015	0.011	0.006	0.005	16763
Collier	0.057	0.054	0.155	0.164	0.140	0.140	0.086	0.084	0.062	0.037	0.023	154667
Wakulla	0.093	0.097	0.172	0.207	0.156	0.114	0.053	0.043	0.026	0.022	0.016	11883
Gulf	0.080	0.075	0.181	0.190	0.151	0.127	0.067	0.046	0.036	0.026	0.020	9322
Liberty	0.087	0.128	0.229	0.183	0.129	0.096	0.048	0.035	0.031	0.019	0.015	4687

Table A.2 Percentage of crash involvement by age and county (total crashes)

County	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75-79	80-84	85+	Total
Dade	0.087	0.143	0.271	0.207	0.130	0.081	0.031	0.021	0.014	0.008	0.006	70924
Duval	0.110	0.151	0.268	0.205	0.123	0.065	0.026	0.022	0.016	0.008	0.006	22315
Hillsborough	0.119	0.151	0.265	0.203	0.124	0.065	0.025	0.021	0.014	0.008	0.005	40583
Pinellas	0.105	0.118	0.238	0.197	0.127	0.081	0.037	0.036	0.028	0.020	0.012	24627
Polk	0.129	0.139	0.234	0.189	0.122	0.078	0.034	0.032	0.023	0.013	0.007	12618
Palm Beach	0.093	0.119	0.248	0.208	0.121	0.074	0.035	0.036	0.031	0.022	0.013	27223
Orange	0.112	0.153	0.279	0.205	0.118	0.066	0.023	0.019	0.013	0.007	0.004	24158
Volusia	0.124	0.135	0.225	0.186	0.117	0.079	0.038	0.038	0.027	0.018	0.011	13594
Escambia	0.123	0.142	0.241	0.199	0.128	0.073	0.033	0.029	0.017	0.008	0.006	9040
Broward	0.090	0.119	0.265	0.215	0.130	0.070	0.028	0.027	0.024	0.019	0.012	34123
Alachua	0.153	0.214	0.227	0.180	0.105	0.057	0.019	0.016	0.013	0.009	0.006	4701
Lake	0.121	0.129	0.209	0.178	0.099	0.084	0.046	0.056	0.035	0.022	0.021	2169
Leon	0.153	0.229	0.222	0.180	0.113	0.052	0.017	0.015	0.009	0.006	0.005	6013
Marion	0.112	0.122	0.225	0.187	0.120	0.087	0.045	0.040	0.036	0.016	0.010	4044
Manatee	0.109	0.131	0.243	0.189	0.120	0.076	0.036	0.035	0.029	0.018	0.012	4111
Sarasota	0.112	0.105	0.200	0.193	0.132	0.088	0.045	0.043	0.038	0.028	0.017	5333
Seminole	0.141	0.138	0.248	0.204	0.127	0.067	0.026	0.019	0.014	0.009	0.005	4829
Lee	0.114	0.127	0.240	0.189	0.122	0.081	0.035	0.035	0.030	0.018	0.010	9894
Brevard	0.125	0.124	0.236	0.208	0.116	0.073	0.034	0.035	0.025	0.014	0.009	5889
St. Johns	0.151	0.113	0.222	0.215	0.122	0.056	0.047	0.036	0.019	0.011	0.010	1547
Gadsden	0.138	0.159	0.242	0.206	0.122	0.068	0.023	0.014	0.011	0.012	0.006	665
Putnam	0.138	0.120	0.220	0.193	0.120	0.073	0.039	0.054	0.024	0.010	0.010	1028
Bay	0.175	0.146	0.235	0.186	0.104	0.063	0.033	0.024	0.018	0.012	0.004	2784
St. Lucie	0.127	0.131	0.237	0.204	0.115	0.069	0.036	0.033	0.026	0.015	0.006	2855
Jackson	0.158	0.127	0.221	0.194	0.111	0.093	0.034	0.022	0.011	0.013	0.016	551
Osceola	0.128	0.149	0.255	0.205	0.127	0.067	0.026	0.018	0.013	0.007	0.005	2542
Highlands	0.122	0.117	0.177	0.180	0.115	0.102	0.046	0.053	0.045	0.029	0.013	993
Pasco	0.129	0.108	0.207	0.170	0.118	0.079	0.048	0.054	0.041	0.029	0.018	4713
Columbia	0.167	0.133	0.199	0.175	0.130	0.091	0.038	0.038	0.015	0.008	0.004	713
Hardee	0.167	0.161	0.194	0.174	0.114	0.094	0.033	0.030	0.010	0.023	0.000	299
Suwannee	0.169	0.186	0.209	0.130	0.120	0.083	0.037	0.030	0.013	0.003	0.020	301
Indian River	0.131	0.093	0.199	0.183	0.112	0.086	0.046	0.063	0.050	0.021	0.016	1538
Santa Rosa	0.176	0.132	0.242	0.214	0.106	0.070	0.023	0.017	0.011	0.007	0.001	1353
Desoto	0.111	0.146	0.224	0.198	0.178	0.079	0.026	0.017	0.006	0.009	0.006	343
Madison	0.217	0.157	0.240	0.147	0.097	0.051	0.028	0.037	0.014	0.005	0.009	217
Walton	0.132	0.161	0.224	0.218	0.111	0.066	0.041	0.016	0.016	0.009	0.007	441
Taylor	0.211	0.122	0.211	0.190	0.116	0.068	0.034	0.024	0.010	0.000	0.014	294
Monroe	0.055	0.095	0.262	0.233	0.209	0.077	0.022	0.022	0.013	0.008	0.004	1480
Levy	0.149	0.131	0.170	0.188	0.155	0.095	0.036	0.039	0.024	0.003	0.012	336
Hernando	0.152	0.100	0.188	0.170	0.133	0.081	0.051	0.053	0.040	0.020	0.013	1365
Nassau	0.164	0.154	0.217	0.199	0.109	0.082	0.027	0.020	0.014	0.012	0.002	512
Marion	0.091	0.107	0.188	0.172	0.113	0.195	0.031	0.032	0.040	0.018	0.013	2108
Okaloosa	0.141	0.151	0.255	0.201	0.109	0.065	0.029	0.021	0.014	0.009	0.006	2290
Sumter	0.113	0.138	0.187	0.195	0.138	0.090	0.046	0.038	0.027	0.019	0.008	477
Bradford	0.161	0.122	0.203	0.166	0.129	0.090	0.048	0.032	0.030	0.014	0.005	434
Jefferson	0.177	0.158	0.241	0.138	0.113	0.084	0.025	0.020	0.025	0.005	0.015	203
Citrus	0.143	0.108	0.174	0.174	0.124	0.090	0.046	0.055	0.043	0.028	0.013	1406
Clay	0.165	0.135	0.238	0.215	0.128	0.054	0.020	0.022	0.010	0.007	0.005	1336
Hendry	0.126	0.137	0.270	0.210	0.109	0.077	0.014	0.019	0.025	0.005	0.008	366
Washington	0.157	0.177	0.187	0.187	0.141	0.051	0.025	0.035	0.010	0.015	0.015	198
Holmes	0.128	0.170	0.234	0.177	0.156	0.043	0.043	0.021	0.007	0.014	0.007	141
Baker	0.132	0.145	0.281	0.202	0.105	0.070	0.022	0.022	0.013	0.004	0.004	228
Charlotte	0.101	0.102	0.190	0.168	0.113	0.099	0.070	0.055	0.047	0.034	0.020	1676
Dixie	0.186	0.096	0.246	0.168	0.096	0.066	0.054	0.042	0.024	0.006	0.018	167
Gilchrist	0.182	0.081	0.192	0.263	0.111	0.091	0.010	0.020	0.051	0.000	0.000	99
Hamilton	0.162	0.108	0.300	0.131	0.115	0.123	0.031	0.008	0.008	0.015	0.000	130
Okeechobee	0.151	0.124	0.239	0.180	0.112	0.073	0.044	0.029	0.023	0.019	0.006	482
Calhoun	0.150	0.093	0.234	0.196	0.103	0.112	0.037	0.019	0.028	0.009	0.019	107
Franklin	0.200	0.136	0.192	0.200	0.096	0.104	0.024	0.032	0.008	0.008	0.000	125
Glades	0.108	0.118	0.258	0.247	0.108	0.065	0.032	0.032	0.022	0.011	0.000	93
Flagler	0.137	0.096	0.222	0.183	0.135	0.087	0.046	0.039	0.032	0.007	0.016	437
Lafayette	0.178	0.111	0.378	0.156	0.089	0.022	0.022	0.044	0.000	0.000	0.000	45
Union	0.161	0.140	0.323	0.194	0.075	0.086	0.022	0.000	0.000	0.000	0.000	93
Collier	0.102	0.108	0.228	0.212	0.136	0.083	0.046	0.035	0.025	0.016	0.007	3015
Wakulla	0.154	0.136	0.195	0.190	0.149	0.095	0.027	0.018	0.014	0.018	0.005	221
Gulf	0.116	0.189	0.221	0.211	0.095	0.084	0.011	0.042	0.011	0.000	0.021	95
Liberty	0.221	0.163	0.174	0.221	0.070	0.093	0.023	0.012	0.000	0.012	0.012	86

Table A.3 Relative risk for age and county (total crashes)

County	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75-79	80-84	85+
Dade	1.18	1.77	1.39	1.03	0.84	0.73	0.59	0.46	0.40	0.31	0.29
Duval	1.58	1.86	1.39	1.10	0.93	0.76	0.65	0.61	0.63	0.49	0.04
Hillsborough	1.52	1.70	1.30	0.98	0.80	0.63	0.52	0.46	0.44	0.35	0.30
Pinellas	1.93	2.11	1.58	1.15	0.90	0.66	0.48	0.47	0.44	0.43	0.31
Polk	1.67	1.78	1.34	1.04	0.86	0.68	0.52	0.49	0.48	0.42	0.34
Palm Beach	1.67	2.09	1.54	1.17	0.86	0.64	0.47	0.48	0.47	0.49	0.41
Orange	1.34	1.63	1.30	0.98	0.79	0.67	0.49	0.47	0.45	0.39	0.28
Volusia	1.91	1.94	1.45	1.09	0.86	0.66	0.49	0.49	0.47	0.48	0.37
Escambia	1.41	1.43	1.15	1.04	0.88	0.67	0.67	0.65	0.56	0.40	0.43
Broward	1.53	1.88	1.44	1.11	0.90	0.65	0.43	0.45	0.46	0.47	0.41
Alachua	1.32	1.16	1.16	1.00	0.84	0.77	0.52	0.52	0.52	0.57	0.41
Lake	2.15	**2.65**	1.76	1.28	0.82	0.67	0.51	0.35	0.54	0.49	0.69
Leon	1.32	1.29	1.20	0.92	0.80	0.68	0.52	0.55	0.38	0.47	0.43
Marion	1.72	2.07	1.51	1.12	0.86	0.65	0.53	0.47	0.60	0.44	0.47
Manatee	1.89	2.40	1.72	1.20	0.93	0.63	0.41	0.40	0.39	0.36	0.34
Sarasota	**2.72**	0.57	1.99	1.51	1.14	0.77	0.54	0.50	0.55	0.60	0.50
Seminole	1.71	1.87	1.25	0.89	0.73	0.65	0.59	0.51	0.55	0.51	0.40
Lee	1.91	2.23	1.54	1.39	0.86	0.59	0.38	0.39	0.45	0.45	0.40
Brevard	1.81	1.83	1.38	1.07	0.78	0.57	0.52	0.53	0.54	0.55	0.54
St. Johns	2.04	1.55	1.39	1.06	0.76	0.49	0.69	0.58	0.43	0.45	0.48
Gadsden	1.40	1.66	1.13	1.05	0.89	0.67	0.49	0.35	0.31	0.56	0.35
Putnam	1.66	2.03	1.44	1.09	0.82	0.54	0.46	0.78	0.52	0.36	0.50
Bay	2.11	1.67	1.25	0.91	0.66	0.55	0.57	0.51	0.60	0.64	0.33
St. Lucie	1.85	1.93	1.50	1.13	0.87	0.55	0.46	0.42	0.43	0.46	0.36
Jackson	1.62	1.12	1.27	1.04	0.80	0.89	0.65	0.48	0.29	0.44	0.73
Oscecola	1.55	1.95	1.49	1.04	0.77	0.61	0.45	0.34	0.32	0.29	0.27
Highlands	2.04	2.33	1.61	1.39	1.09	0.71	0.42	0.50	0.49	0.51	0.35
Pasco	2.41	2.33	1.80	1.25	0.96	0.54	0.46	0.53	0.48	0.55	0.48
Columbia	1.75	1.51	1.14	0.85	0.80	0.85	0.76	0.77	0.46	0.41	0.32
Hardee	1.69	1.62	1.00	1.00	0.84	0.95	0.58	0.54	0.25	0.89	0.00
Suwannee	1.76	2.48	1.33	0.71	0.78	0.68	0.59	0.51	0.34	0.11	0.87
Indian River	2.13	1.59	1.52	1.15	0.85	0.67	0.51	0.67	0.67	0.50	0.56
Santa Rosa	2.05	1.55	1.22	0.97	0.66	0.61	0.49	0.43	0.49	0.51	0.14
Desoto	1.59	1.68	1.34	1.14	1.31	0.66	0.36	0.25	0.13	0.25	0.26
Madison	2.31	1.61	1.11	0.79	0.76	0.48	0.56	0.82	0.40	0.20	0.47
Walton	1.67	2.21	1.54	1.16	0.70	0.46	0.59	0.27	0.43	0.31	0.34
Taylor	**3.01**	1.57	1.13	0.96	0.76	0.58	0.55	0.45	0.26	0.00	0.75
Monroe	1.16	1.54	1.39	1.14	1.20	0.60	0.34	0.38	0.34	0.34	0.35
Levy	2.10	1.96	1.13	1.07	1.02	0.69	0.47	0.53	0.46	0.11	0.58
Hernando	2.43	2.28	2.05	1.24	1.00	0.58	0.44	0.45	0.47	0.42	0.53
Nassau	1.86	1.88	1.06	0.96	0.63	0.75	0.57	0.51	0.60	0.78	0.23
Marion	1.40	1.82	1.26	1.03	0.81	**1.45**	0.37	0.38	0.67	0.50	0.61
Okaloosa	1.60	1.60	1.21	0.90	0.74	0.60	0.68	0.57	0.54	0.63	0.57
Sumter	1.54	2.01	1.47	1.30	0.94	0.68	0.52	0.43	0.45	0.48	0.37
Bradford	1.99	1.25	0.91	0.86	0.90	0.90	1.00	0.72	1.00	0.68	0.28
Jefferson	1.81	2.03	1.22	0.75	0.79	0.87	0.42	0.37	0.57	0.18	0.68
Citrus	**2.64**	**2.58**	1.66	1.34	0.92	0.58	0.42	0.52	0.55	0.56	0.39
Clay	1.84	1.76	1.18	0.93	0.75	0.51	0.52	0.68	0.41	0.42	0.44
Hendry	1.28	1.44	1.29	1.08	0.79	0.68	0.32	0.51	0.76	0.26	0.52
Washington	1.63	2.47	1.36	1.06	0.91	0.40	0.37	0.61	0.21	0.45	0.58
Holmes	1.40	1.68	1.40	1.05	1.04	0.36	0.79	0.39	0.17	0.48	0.31
Baker	1.18	1.28	1.38	0.96	0.71	0.71	0.57	0.79	0.60	0.30	0.41
Charlotte	2.31	2.20	1.79	1.49	0.94	0.62	0.60	0.47	0.55	0.62	0.58
Dixie	2.39	1.17	1.48	0.90	0.67	0.44	0.81	0.72	0.68	0.23	**1.93**
Gilchrist	1.95	0.71	1.29	1.47	0.68	0.75	0.20	0.41	**1.34**	0.00	0.00
Hamilton	1.45	0.96	1.43	0.71	0.86	**1.36**	0.69	0.20	0.25	0.63	0.00
Okeechobee	2.03	1.72	1.88	1.25	0.97	0.77	0.77	0.59	0.54	0.09	0.47
Calhoun	1.74	0.96	1.30	1.12	0.61	1.00	0.76	0.39	0.75	0.33	0.96
Franklin	2.35	2.00	1.40	1.05	0.57	0.76	0.41	0.59	0.15	0.29	0.00
Glades	1.31	1.65	1.64	1.79	0.68	0.45	0.46	0.41	0.35	0.36	0.00
Flagler	**2.59**	1.79	1.86	1.31	1.00	0.62	0.41	0.35	0.39	0.19	0.85
Lafayette	**2.59**	1.04	1.41	0.89	0.77	0.19	0.45	0.95	0.00	0.00	0.00
Union	**3.27**	2.35	2.00	1.48	1.04	0.18	**1.23**	0.00	0.00	0.00	0.00
Collier	1.79	2.02	1.48	1.29	0.97	0.60	0.54	0.42	0.40	0.43	0.31
Wakulla	1.65	1.40	1.13	0.92	0.96	0.84	0.51	0.42	0.52	0.82	0.28
Gulf	1.44	**2.53**	1.22	1.11	0.63	0.66	0.16	0.92	0.29	0.00	1.04
Liberty	**2.53**	1.27	0.76	1.21	0.54	0.97	0.49	0.33	0.00	0.61	0.80

Table A.4 Percentage of licensed drivers by age and county (residents-only crashes)

County	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75-79	80-84	85+	Total
Dade	0.048	0.097	0.252	0.225	0.161	0.108	0.042	0.031	0.019	0.011	0.006	1592743
Duval	0.053	0.097	0.258	0.233	0.158	0.091	0.038	0.032	0.022	0.012	0.006	553867
Hillsborough	0.052	0.092	0.246	0.228	0.162	0.098	0.042	0.036	0.025	0.014	0.007	723932
Pinellas	0.042	0.069	0.192	0.198	0.156	0.111	0.062	0.064	0.051	0.034	0.020	751928
Polk	0.051	0.086	0.198	0.193	0.153	0.119	0.065	0.060	0.041	0.023	0.012	345275
Palm Beach	0.037	0.068	0.199	0.202	0.147	0.105	0.066	0.067	0.055	0.035	0.018	869519
Orange	0.049	0.099	0.273	0.233	0.152	0.090	0.037	0.031	0.020	0.011	0.005	659612
Volusia	0.047	0.078	0.191	0.189	0.149	0.118	0.069	0.068	0.049	0.028	0.015	354687
Escambia	0.058	0.098	0.238	0.213	0.157	0.107	0.046	0.040	0.026	0.013	0.006	225729
Broward	0.038	0.074	0.229	0.225	0.159	0.097	0.047	0.047	0.039	0.028	0.016	1194577
Alachua	0.053	0.120	0.261	0.221	0.154	0.083	0.036	0.032	0.022	0.012	0.006	157190
Lake	0.042	0.064	0.155	0.164	0.133	0.141	0.095	0.089	0.061	0.036	0.020	154802
Leon	0.058	0.124	0.259	0.224	0.164	0.080	0.031	0.026	0.019	0.010	0.005	166093
Marion	0.048	0.071	0.168	0.173	0.144	0.130	0.086	0.083	0.056	0.028	0.011	196880
Manatee	0.039	0.068	0.176	0.181	0.142	0.117	0.077	0.079	0.061	0.038	0.022	191132
Sarasota	0.035	0.057	0.153	0.167	0.145	0.129	0.086	0.089	0.070	0.044	0.025	279897
Seminole	0.061	0.090	0.232	0.238	0.179	0.096	0.037	0.031	0.020	0.011	0.005	265089
Lee	0.041	0.065	0.178	0.178	0.147	0.128	0.081	0.078	0.057	0.032	0.014	334555
Brevard	0.050	0.074	0.207	0.213	0.150	0.123	0.062	0.056	0.038	0.019	0.008	389767
St. Johns	0.052	0.074	0.191	0.217	0.179	0.116	0.060	0.053	0.033	0.018	0.007	87310
Gadsden	0.061	0.110	0.225	0.222	0.155	0.104	0.043	0.035	0.023	0.014	0.007	28146
Putnam	0.058	0.083	0.179	0.185	0.158	0.134	0.070	0.062	0.042	0.021	0.009	48984
Bay	0.063	0.095	0.231	0.216	0.157	0.110	0.049	0.038	0.023	0.012	0.006	124137
St. Lucie	0.045	0.074	0.192	0.201	0.142	0.118	0.073	0.070	0.049	0.025	0.010	141808
Jackson	0.086	0.101	0.192	0.196	0.158	0.116	0.050	0.043	0.030	0.019	0.009	32194
Oscecola	0.056	0.096	0.242	0.220	0.161	0.103	0.044	0.036	0.024	0.013	0.006	120672
Highlands	0.046	0.071	0.159	0.159	0.130	0.062	0.107	0.112	0.086	0.046	0.022	61789
Pasco	0.043	0.065	0.162	0.168	0.139	0.119	0.081	0.087	0.072	0.043	0.021	265674
Columbia	0.072	0.090	0.193	0.206	0.167	0.121	0.055	0.046	0.030	0.015	0.006	34519
Hardee	0.072	0.119	0.240	0.190	0.137	0.095	0.049	0.043	0.030	0.017	0.007	17751
Suwannee	0.070	0.088	0.177	0.184	0.166	0.137	0.062	0.051	0.033	0.021	0.011	23693
Indian River	0.041	0.061	0.155	0.164	0.131	0.124	0.091	0.098	0.075	0.041	0.020	95858
Santa Rosa	0.081	0.084	0.220	0.228	0.165	0.113	0.046	0.033	0.018	0.009	0.003	84946
Desoto	0.053	0.094	0.203	0.158	0.147	0.122	0.070	0.065	0.048	0.028	0.012	18485
Madison	0.072	0.104	0.193	0.199	0.157	0.122	0.051	0.043	0.030	0.019	0.011	11579
Walton	0.063	0.083	0.177	0.194	0.161	0.142	0.070	0.054	0.031	0.016	0.008	22245
Taylor	0.059	0.095	0.190	0.201	0.168	0.126	0.058	0.044	0.032	0.019	0.008	13615
Monroe	0.026	0.064	0.222	0.236	0.191	0.118	0.054	0.042	0.027	0.014	0.006	83468
Levy	0.054	0.079	0.168	0.188	0.165	0.138	0.073	0.064	0.040	0.022	0.010	22587
Hernando	0.043	0.059	0.133	0.151	0.137	0.141	0.104	0.109	0.075	0.035	0.013	103627
Nassau	0.060	0.090	0.217	0.226	0.176	0.117	0.047	0.032	0.021	0.010	0.004	43991
Marion	0.048	0.071	0.168	0.173	0.144	0.130	0.086	0.083	0.056	0.028	0.011	196880
Okaloosa	0.067	0.100	0.241	0.222	0.151	0.109	0.044	0.034	0.020	0.008	0.003	139011
Sumter	0.048	0.077	0.160	0.170	0.145	0.139	0.083	0.082	0.056	0.027	0.012	27075
Bradford	0.075	0.097	0.200	0.207	0.166	0.119	0.048	0.040	0.027	0.014	0.006	15862
Jefferson	0.076	0.090	0.201	0.204	0.177	0.106	0.050	0.043	0.028	0.017	0.008	8497
Citrus	0.042	0.058	0.135	0.148	0.139	0.152	0.103	0.101	0.070	0.037	0.017	93794
Clay	0.070	0.096	0.222	0.236	0.181	0.101	0.035	0.028	0.017	0.009	0.004	101769
Hendry	0.061	0.115	0.258	0.199	0.145	0.104	0.045	0.036	0.021	0.011	0.005	24313
Washington	0.071	0.094	0.187	0.184	0.166	0.124	0.055	0.050	0.036	0.022	0.010	14492
Holmes	0.076	0.087	0.191	0.189	0.164	0.129	0.056	0.046	0.033	0.018	0.011	12802
Baker	0.081	0.108	0.224	0.220	0.164	0.108	0.038	0.026	0.017	0.009	0.004	13629
Charlotte	0.035	0.053	0.131	0.144	0.135	0.151	0.107	0.106	0.075	0.043	0.020	112773
Dixie	0.065	0.076	0.167	0.182	0.171	0.155	0.069	0.057	0.033	0.017	0.007	8636
Gilchrist	0.065	0.082	0.190	0.195	0.167	0.134	0.060	0.051	0.034	0.016	0.006	7732
Hamilton	0.084	0.117	0.188	0.196	0.166	0.117	0.046	0.039	0.024	0.018	0.006	7763
Okeechobee	0.054	0.088	0.194	0.181	0.148	0.134	0.071	0.061	0.040	0.021	0.009	29039
Calhoun	0.079	0.102	0.189	0.196	0.158	0.119	0.051	0.045	0.031	0.019	0.011	7687
Franklin	0.061	0.076	0.177	0.182	0.175	0.149	0.065	0.051	0.036	0.019	0.010	7329
Glades	0.049	0.081	0.176	0.161	0.158	0.159	0.082	0.062	0.041	0.024	0.007	4038
Flagler	0.042	0.058	0.137	0.160	0.144	0.163	0.111	0.098	0.057	0.022	0.008	34372
Lafayette	0.086	0.100	0.198	0.184	0.159	0.127	0.048	0.043	0.029	0.018	0.009	3159
Union	0.081	0.102	0.213	0.221	0.163	0.107	0.043	0.034	0.021	0.010	0.005	6066
Collier	0.039	0.066	0.191	0.180	0.146	0.133	0.081	0.073	0.051	0.027	0.013	174467
Wakulla	0.080	0.088	0.185	0.223	0.185	0.111	0.048	0.039	0.023	0.011	0.006	12346
Gulf	0.072	0.090	0.185	0.185	0.163	0.136	0.065	0.051	0.030	0.017	0.008	9851
Liberty	0.075	0.103	0.196	0.205	0.157	0.122	0.051	0.042	0.024	0.018	0.007	3807

Table A.5 Percentage of crashes involvement by age and county (residents-only crashes)

County	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75-79	80-84	85+	Total
Dade	0.087	0.142	0.271	0.208	0.130	0.082	0.031	0.021	0.014	0.008	0.006	67237
Duval	0.111	0.152	0.274	0.207	0.123	0.063	0.023	0.020	0.014	0.007	0.005	19504
Hillsborough	0.116	0.148	0.269	0.206	0.126	0.065	0.024	0.020	0.013	0.008	0.005	35666
Pinellas	0.107	0.116	0.241	0.200	0.128	0.077	0.036	0.034	0.028	0.021	0.013	20570
Polk	0.133	0.141	0.235	0.191	0.122	0.077	0.032	0.030	0.020	0.012	0.007	10533
Palm Beach	0.093	0.120	0.253	0.211	0.120	0.071	0.032	0.035	0.030	0.022	0.013	23961
Orange	0.113	0.157	0.283	0.206	0.117	0.064	0.020	0.018	0.012	0.007	0.004	20918
Volusia	0.133	0.137	0.223	0.182	0.117	0.076	0.036	0.037	0.029	0.019	0.012	8821
Escambia	0.129	0.147	0.247	0.198	0.123	0.069	0.030	0.029	0.015	0.007	0.006	6257
Broward	0.093	0.121	0.268	0.219	0.129	0.069	0.027	0.027	0.024	0.012	0.012	41613
Alachua	0.155	0.221	0.225	0.181	0.104	0.055	0.017	0.016	0.012	0.008	0.006	5612
Lake	0.123	0.130	0.214	0.184	0.102	0.078	0.043	0.051	0.035	0.019	0.020	2641
Leon	0.156	0.233	0.222	0.174	0.112	0.051	0.018	0.015	0.009	0.006	0.004	7280
Marion	0.120	0.130	0.225	0.192	0.112	0.081	0.043	0.039	0.032	0.015	0.010	4810
Manatee	0.113	0.132	0.250	0.188	0.121	0.073	0.034	0.031	0.028	0.018	0.011	5067
Sarasota	0.115	0.103	0.208	0.196	0.128	0.082	0.042	0.042	0.038	0.028	0.017	6241
Seminole	0.144	0.139	0.249	0.203	0.123	0.067	0.027	0.022	0.014	0.008	0.005	5912
Lee	0.116	0.129	0.243	0.191	0.119	0.078	0.033	0.034	0.028	0.018	0.010	11292
Brevard	0.128	0.124	0.235	0.209	0.118	0.073	0.034	0.033	0.024	0.014	0.009	7276
St. Johns	0.157	0.119	0.225	0.201	0.119	0.065	0.044	0.032	0.018	0.013	0.007	1835
Gadsden	0.149	0.150	0.232	0.222	0.107	0.065	0.022	0.018	0.013	0.013	0.008	766
Putnam	0.139	0.124	0.232	0.184	0.114	0.071	0.042	0.049	0.026	0.010	0.009	1294
Bay	0.164	0.143	0.242	0.189	0.106	0.063	0.031	0.024	0.020	0.013	0.005	3120
St. Lucie	0.130	0.132	0.234	0.205	0.116	0.070	0.034	0.032	0.025	0.014	0.006	3551
Jackson	0.161	0.140	0.232	0.185	0.107	0.074	0.032	0.028	0.013	0.013	0.016	634
Oscecola	0.141	0.157	0.252	0.189	0.122	0.061	0.025	0.022	0.017	0.008	0.006	2829
Highlands	0.131	0.118	0.191	0.170	0.115	0.100	0.048	0.044	0.044	0.025	0.013	1217
Pasco	0.133	0.113	0.208	0.173	0.117	0.077	0.044	0.052	0.038	0.028	0.017	5639
Columbia	0.167	0.141	0.214	0.168	0.133	0.082	0.034	0.031	0.017	0.007	0.005	827
Hardee	0.170	0.165	0.196	0.184	0.117	0.075	0.028	0.034	0.011	0.020	0.000	358
Suwannee	0.168	0.190	0.214	0.139	0.115	0.078	0.035	0.021	0.016	0.008	0.016	374
Indian River	0.139	0.099	0.199	0.194	0.111	0.083	0.043	0.049	0.049	0.021	0.014	1838
Santa Rosa	0.182	0.134	0.237	0.206	0.110	0.068	0.027	0.017	0.011	0.007	0.001	1540
Desoto	0.114	0.159	0.242	0.193	0.159	0.065	0.029	0.016	0.011	0.007	0.004	446
Madison	0.209	0.154	0.241	0.138	0.115	0.040	0.028	0.032	0.028	0.004	0.012	253
Walton	0.135	0.174	0.229	0.222	0.098	0.052	0.039	0.017	0.015	0.009	0.009	459
Taylor	0.223	0.145	0.212	0.178	0.106	0.056	0.028	0.025	0.011	0.006	0.011	359
Monroe	0.069	0.100	0.266	0.265	0.149	0.078	0.023	0.021	0.012	0.011	0.005	1494
Levy	0.156	0.145	0.171	0.192	0.149	0.083	0.033	0.028	0.026	0.007	0.009	422
Hernando	0.156	0.097	0.186	0.173	0.134	0.078	0.049	0.053	0.043	0.019	0.012	1668
Nassau	0.173	0.146	0.214	0.191	0.114	0.090	0.027	0.023	0.011	0.009	0.002	555
Marion	0.105	0.132	0.219	0.202	0.124	0.076	0.031	0.037	0.042	0.019	0.011	2269
Okaloosa	0.153	0.149	0.252	0.201	0.106	0.062	0.029	0.020	0.015	0.006	0.006	2652
Sumter	0.121	0.142	0.205	0.195	0.116	0.097	0.032	0.036	0.030	0.019	0.006	527
Bradford	0.171	0.141	0.200	0.178	0.125	0.080	0.039	0.024	0.029	0.008	0.004	510
Jefferson	0.177	0.172	0.223	0.158	0.098	0.079	0.014	0.028	0.028	0.005	0.019	215
Citrus	0.141	0.111	0.186	0.168	0.124	0.088	0.044	0.053	0.046	0.027	0.013	1714
Clay	0.168	0.140	0.242	0.205	0.122	0.059	0.021	0.021	0.011	0.007	0.005	1604
Hendry	0.115	0.148	0.272	0.214	0.113	0.070	0.014	0.019	0.016	0.008	0.008	485
Washington	0.158	0.172	0.213	0.172	0.113	0.059	0.023	0.032	0.018	0.023	0.018	221
Holmes	0.146	0.181	0.236	0.139	0.146	0.056	0.049	0.021	0.007	0.014	0.007	144
Baker	0.175	0.148	0.242	0.199	0.104	0.067	0.030	0.017	0.007	0.003	0.007	297
Charlotte	0.114	0.103	0.197	0.172	0.107	0.098	0.066	0.050	0.045	0.031	0.018	2025
Dixie	0.181	0.093	0.245	0.191	0.098	0.064	0.039	0.034	0.029	0.010	0.015	204
Gilchrist	0.194	0.081	0.194	0.250	0.113	0.089	0.008	0.024	0.040	0.008	0.000	124
Hamilton	0.180	0.131	0.279	0.164	0.107	0.090	0.033	0.008	0.008	0.000	0.000	122
Okeechobee	0.139	0.122	0.253	0.194	0.120	0.065	0.038	0.022	0.021	0.017	0.007	581
Calhoun	0.140	0.132	0.221	0.199	0.103	0.096	0.037	0.022	0.029	0.007	0.015	136
Franklin	0.182	0.147	0.189	0.196	0.126	0.098	0.028	0.014	0.014	0.007	0.000	143
Glades	0.137	0.127	0.265	0.255	0.098	0.049	0.029	0.020	0.010	0.010	0.000	102
Flagler	0.145	0.113	0.206	0.183	0.122	0.082	0.050	0.046	0.031	0.008	0.015	524
Lafayette	0.254	0.119	0.305	0.136	0.085	0.051	0.017	0.034	0.000	0.000	0.000	59
Union	0.154	0.137	0.333	0.179	0.085	0.085	0.026	0.000	0.000	0.000	0.000	117
Collier	0.110	0.117	0.251	0.210	0.129	0.070	0.040	0.031	0.020	0.014	0.008	3564
Wakulla	0.149	0.141	0.210	0.199	0.138	0.083	0.022	0.018	0.022	0.014	0.004	276
Gulf	0.109	0.182	0.236	0.209	0.109	0.091	0.000	0.036	0.009	0.000	0.018	110
Liberty	0.216	0.186	0.186	0.206	0.052	0.093	0.021	0.010	0.010	0.010	0.010	97

Table A.6 Relative risk for age and county (residents-only crashes)

County	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75-79	80-84	85+
Dade	1.81	1.46	1.08	0.92	0.81	0.75	0.73	0.68	0.73	0.74	1.12
Duval	2.10	1.57	1.06	0.89	0.78	0.70	0.61	0.61	0.65	0.63	0.93
Hillsborough	2.23	1.61	1.09	0.90	0.78	0.66	0.58	0.56	0.53	0.55	0.71
Pinellas	2.55	1.68	1.26	1.01	0.82	0.69	0.58	0.53	0.54	0.60	0.64
Polk	2.62	1.64	1.19	0.99	0.80	0.65	0.50	0.49	0.49	0.53	0.57
Palm Beach	2.50	1.78	1.27	1.04	0.81	0.67	0.49	0.51	0.53	0.63	0.72
Orange	2.30	1.59	1.03	0.89	0.77	0.71	0.54	0.57	0.57	0.64	0.77
Volusia	2.83	1.75	1.17	0.96	0.78	0.64	0.52	0.55	0.58	0.69	0.81
Escambia	2.23	1.50	1.04	0.93	0.78	0.65	0.66	0.73	0.56	0.54	1.06
Broward	2.42	1.63	1.17	0.97	0.81	0.71	0.57	0.58	0.61	0.41	0.76
Alachua	2.90	1.84	0.86	0.82	0.68	0.67	0.47	0.50	0.54	0.65	0.89
Lake	2.93	2.04	1.38	1.13	0.77	0.55	0.45	0.58	0.57	0.51	1.02
Leon	2.68	1.88	0.86	0.78	0.68	0.63	0.57	0.57	0.47	0.64	0.89
Marion	2.50	1.82	1.34	1.11	0.78	0.63	0.50	0.47	0.56	0.55	0.85
Manatee	2.90	1.94	1.42	1.04	0.86	0.62	0.44	0.40	0.45	0.48	0.52
Sarasota	3.33	1.82	1.36	1.17	0.88	0.63	0.49	0.47	0.55	0.65	0.69
Seminole	2.36	1.55	1.07	0.85	0.69	0.70	0.73	0.71	0.68	0.73	1.04
Lee	2.83	1.98	1.37	1.07	0.81	0.60	0.41	0.44	0.50	0.57	0.72
Brevard	2.57	1.67	1.14	0.98	0.79	0.59	0.54	0.58	0.63	0.74	1.04
St. Johns	3.02	1.62	1.18	0.92	0.66	0.56	0.73	0.61	0.55	0.70	0.96
Gadsden	2.44	1.37	1.03	1.00	0.69	0.63	0.52	0.52	0.56	0.90	1.17
Putnam	2.39	1.51	1.29	1.00	0.72	0.53	0.60	0.80	0.61	0.48	1.01
Bay	2.62	1.49	1.05	0.87	0.68	0.57	0.63	0.64	0.85	1.09	0.93
St. Lucie	2.93	1.77	1.22	1.02	0.82	0.59	0.46	0.46	0.51	0.55	0.64
Jackson	1.88	1.39	1.21	0.94	0.68	0.64	0.63	0.66	0.42	0.67	1.69
Oscecola	2.52	1.64	1.04	0.86	0.76	0.59	0.58	0.61	0.69	0.67	0.93
Highlands	2.87	1.65	1.20	1.07	0.88	1.61	0.44	0.40	0.52	0.55	0.61
Pasco	3.10	1.73	1.28	1.03	0.84	0.65	0.54	0.60	0.53	0.65	0.81
Columbia	2.31	1.57	1.11	0.82	0.80	0.68	0.62	0.69	0.56	0.48	0.78
Hardee	2.37	1.38	0.81	0.97	0.85	0.79	0.57	0.78	0.37	1.12	0.00
Suwannee	2.42	2.15	1.21	0.76	0.69	0.56	0.56	0.42	0.49	0.38	1.50
Indian River	3.41	1.63	1.28	1.18	0.85	0.67	0.47	0.50	0.65	0.52	0.71
Santa Rosa	2.25	1.59	1.08	0.90	0.67	0.61	0.58	0.51	0.61	0.76	0.40
Desoto	2.55	2.45	2.00	1.55	1.62	0.85	0.91	0.58	0.59	0.56	0.67
Madison	0.35	0.25	0.15	0.08	0.09	0.05	0.08	0.13	0.21	0.06	0.50
Walton	2.13	2.09	1.29	1.14	0.61	0.37	0.56	0.32	0.49	0.54	1.11
Taylor	3.75	1.53	1.11	0.89	0.63	0.44	0.48	0.58	0.35	0.29	1.40
Monroe	2.70	1.57	1.20	1.13	0.78	0.66	0.42	0.51	0.44	0.77	0.89
Levy	2.91	1.84	1.01	1.02	0.91	0.60	0.46	0.44	0.65	0.33	0.91
Hernando	3.59	1.63	1.41	1.15	0.98	0.55	0.47	0.48	0.58	0.53	0.92
Nassau	2.86	1.62	0.99	0.85	0.65	0.77	0.57	0.74	0.52	0.93	0.47
Martin	2.20	1.85	1.30	1.17	0.86	0.59	0.36	0.45	0.75	0.69	1.00
Okaloosa	2.27	1.50	1.04	0.90	0.70	0.57	0.67	0.59	0.76	0.72	1.80
Sumter	2.54	1.85	1.28	1.15	0.80	0.69	0.39	0.44	0.54	0.71	0.47
Bradford	2.27	1.45	1.00	0.86	0.76	0.67	0.81	0.58	1.07	0.57	0.63
Jefferson	2.32	1.92	1.11	0.78	0.55	0.75	0.28	0.65	0.98	0.27	2.47
Citrus	3.34	1.92	1.37	1.14	0.89	0.58	0.43	0.52	0.66	0.73	0.77
Clay	2.39	1.45	1.09	0.87	0.67	0.58	0.59	0.75	0.63	0.79	1.23
Hendry	1.88	1.29	1.06	1.08	0.78	0.68	0.32	0.52	0.77	0.78	1.76
Washington	2.24	1.82	1.14	0.94	0.68	0.47	0.41	0.63	0.51	1.05	1.81
Holmes	1.92	2.09	1.23	0.73	0.89	0.43	0.87	0.46	0.21	0.75	0.65
Baker	2.16	1.37	1.08	0.90	0.64	0.62	0.80	0.64	0.39	0.38	1.61
Charlotte	3.28	1.93	1.50	1.19	0.79	0.65	0.62	0.47	0.60	0.71	0.91
Dixie	2.80	1.22	1.46	1.05	0.57	0.41	0.57	0.60	0.90	0.57	2.15
Gilchrist	2.96	0.99	1.02	1.28	0.68	0.66	0.13	0.47	1.19	0.49	0.00
Hamilton	2.15	1.12	1.49	0.84	0.64	0.77	0.72	0.21	0.33	0.00	0.00
Okeechobee	2.58	1.39	1.30	1.07	0.82	0.49	0.53	0.37	0.52	0.83	0.81
Calhoun	1.76	1.30	1.17	1.01	0.65	0.81	0.72	0.49	0.94	0.39	1.33
Franklin	3.00	1.93	1.07	1.08	0.72	0.66	0.43	0.28	0.39	0.36	0.00
Glades	2.81	1.58	1.50	1.59	0.62	0.31	0.36	0.32	0.24	0.41	0.00
Flagler	3.44	1.95	1.50	1.15	0.85	0.50	0.45	0.47	0.53	0.34	1.94
Lafayette	2.96	1.19	1.54	0.74	0.53	0.40	0.35	0.79	0.00	0.00	0.00
Union	1.91	1.34	1.56	0.81	0.53	0.80	0.60	0.00	0.00	0.00	0.00
Collier	2.86	1.76	1.32	1.17	0.88	0.53	0.50	0.42	0.39	0.51	0.64
Wakulla	1.85	1.61	1.13	0.89	0.74	0.75	0.45	0.46	0.96	1.32	0.61
Gulf	1.52	2.02	1.28	1.13	0.67	0.67	0.00	0.72	0.30	0.00	2.39
Liberty	2.90	1.79	0.95	1.01	0.33	0.76	0.40	0.25	0.43	0.58	1.51

Table A.7 Percentage of population by race and county (total crashes)

county\row%	White	Black	Hispanic	Other	Population
Dade	30.4	19.2	49	1.4	1937094
Duval	71.2	24.2	2.4	2.2	672971
Hillsborough	72.9	12.8	12.6	1.7	834054
Pinellas	88.7	7.6	2.2	1.5	851659
Polk	82.1	13.2	3.7	1	405382
Palm Beach	79.3	12	7.5	1.2	863518
Orange	73.4	14.8	9.3	2.5	677491
Volusia	86.2	8.9	4	0.9	370712
Escambia	75.5	19.9	1.8	2.8	262798
Broward	75.1	14.9	8.4	1.6	1255488
Alachua	74.8	18.8	3.7	2.7	181596
Lake	87.6	9	2.7	0.7	152104
Leon	71.8	24	2.6	1.6	192493
Marion	83.5	12.6	2.9	1	194833
Manatee	87	7.6	4.4	1	211707
Sarasota	92.9	4.2	2.1	0.8	277776
Seminole	83.3	8.1	6.5	2.1	287529
Lee	88.4	6.4	4.4	0.8	355113
Brevard	87.5	7.7	3.1	1.7	398978
St. Johns	88	8.3	2.9	0.8	83829
Gadsden	39.9	57.9	1.8	0.4	41105
Putnam	78.6	18.5	2.3	0.6	65070
Bay	85.1	10.4	1.9	2.6	126994
St. Lucie	79.6	16.1	3.6	0.7	150171
Jackson	71.1	25.8	2.3	0.8	41375
Oscecola	81.1	5.3	11.9	1.7	107728
Highlands	84.4	9.6	5	1	68432
Pasco	94.1	1.9	3.2	0.8	281131
Collumbia	79.8	18.1	1.2	0.9	42613
hardee	71.1	5.2	23	0.7	19499
Suwannee	80.2	16.2	2.6	1	26780
Indian River	87.5	8.4	3	1.1	90208
Santa Rosa	92.3	3.9	1.7	2.1	81608
Desoto	74.9	15.6	8.1	1.4	23865
Madison	57.3	41.6	0.9	0.2	16569
Walton	90.2	6.5	1.3	2	27760
Taylor	80	17.7	0.5	1.8	17111
Monroe	81.4	5.2	11.9	1.5	78024
Levy	85.2	12.3	1.7	0.8	25923
Hernando	92.6	3.7	2.7	1	101115
Nassau	88.3	10.3	0.8	0.6	43941
marion	83.5	12.6	2.9	1	194833
Okaloosa	85.2	8.9	2.9	3	143776
Sumter	80.2	16.2	2.6	1	31577
Bradford	77.6	20.3	1.4	0.7	22515
Jefferson	55	42.9	1.6	0.5	11296
Citrus	95	2.1	1.6	1.3	93515
Clay	90.2	5	2.8	2	105986
Hendry	58.9	16.5	22	2.6	25773
Washington	82.4	14.6	0.8	2.2	16919
Holmes	92.2	4.8	1.4	1.6	15778
Baker	84.2	14.3	0.9	0.6	18486
Charlotte	93.3	3.5	2.2	1	110975
Dixie	90.3	8.7	0.8	0.2	10585
Gilchrist	89.8	8.3	1.6	0.3	9667
Hamilton	58.3	38.7	2.4	0.6	10930
Okeechobee	80.8	6.2	11.9	1.1	29627
Calhoun	81.7	15.1	1.9	1.3	11011
Franklin	85.9	12.5	1.1	0.5	8967
Glades	75.4	12.2	6.6	5.8	7591
Flagler	86.4	7.7	4.5	1.4	28701
Lafayette	81.5	14.1	4.2	0.2	5578
Union	73.6	22.8	2.8	0.8	10252
Collier	82.3	3.8	13.2	0.7	152099
Wakulla	84.7	12.9	0.6	1.8	14202
Gulf	80.5	18.8	0.3	0.4	11504
Liberty	81.5	16.7	1.3	0.5	5569

Table A.8 Percentage of crash involvement by race and county (total crashes)

county\row%	White	Black	Hispanic	Other	# of Crashes
Dade	49.63	21.92	27.27	1.18	70924
Duval	70.57	26.94	1.17	1.32	22315
Hillsborough	76.79	15.88	5.93	1.4	40583
Pinellas	85.25	11.48	2	1.27	24627
Polk	79.39	15.64	4.18	0.78	12618
Palm Beach	76.48	17.81	4.75	0.97	27223
Orange	71.1	18.08	8.14	2.67	24158
Volusia	85.1	11.61	2.69	0.61	13594
Escambia	78.75	18.75	1.24	1.26	9040
Broward	71.61	23.04	4.04	1.31	34123
Alachua	76.6	20.17	1.17	2.06	4701
Lake	85.49	11.84	2.16	0.51	2171
Leon	67.42	30.63	0.81	1.13	6013
Marion	84.08	13.72	1.63	0.57	4044
Manatee	83	11.7	4.79	0.51	4111
Sarasota	92.22	5.82	1.41	0.53	5333
Seminole	82.54	12.18	4.1	1.18	4829
Lee	80.88	12.22	5.9	1	9894
Brevard	86.57	11.07	1.43	0.93	5889
St. Johns	88.56	10.28	0.71	0.45	1547
Gadsden	38.5	55.19	6.02	0.3	665
Putnam	79.28	17.8	2.43	0.49	1028
Bay	88.47	9.3	0.75	1.47	2784
St. Lucie	74.19	21.47	3.5	0.84	2855
Jackson	79.49	20.33	0.18	0	551
Oscecola	75.96	8.18	12.94	2.91	2543
Highlands	76.84	16.31	6.04	0.81	993
Pasco	94.55	2.89	1.74	0.83	4713
Collumbia	80.22	18.79	0.56	0.42	713
hardee	71.24	10.03	18.73	0	299
Suwannee	78.41	17.94	3.32	0.33	301
Indian River	82.7	15.07	1.84	0.39	1520
Santa Rosa	92.76	6.13	0.37	0.74	1353
Desoto	72.3	12.83	14.58	0.29	343
Madison	63.59	35.02	0.92	0.46	217
Walton	90.93	7.03	1.81	0.23	441
Taylor	81.29	18.03	0.34	0.34	294
Monroe	86.67	6.3	6.38	0.65	1380
Levy	80.95	15.48	2.38	1.19	336
Hernando	93.63	5.27	0.95	0.15	1365
Nassau	86.13	13.09	0.39	0.39	512
marion	86.29	8.87	4.35	0.49	1838
Okaloosa	89.83	7.99	0.61	1.57	2290
Sumter	80.29	16.14	2.94	0.63	477
Bradford	86.64	12.67	0	0.69	434
Jefferson	66.01	33	0.99	0	203
Citrus	95.59	3.41	0.64	0.36	1406
Clay	91.02	7.04	0.82	1.12	1336
Hendry	59.02	19.4	19.95	1.64	366
Washington	87.37	11.11	0.51	1.01	198
Holmes	95.74	3.55	0.71	0	141
Baker	86.84	11.84	0.44	0.88	228
Charlotte	92.49	6.26	0.89	0.36	1677
Dixie	89.22	8.98	1.2	0.6	167
Gilchrist	95.96	2.02	2.02	0	99
Hamilton	73.48	24.24	2.27	0	132
Okeechobee	84.44	7.88	7.26	0.41	482
Calhoun	81.31	17.76	0	0.93	107
Franklin	88	10.4	1.6	0	125
Glades	66.67	11.83	13.98	7.53	93
Flagler	84.9	11.67	2.06	1.37	437
Lafayette	84.44	11.11	4.44	0	45
Union	78.49	20.43	1.08	0	93
Collier	79.54	8.42	11.11	0.93	3015
Wakulla	86.43	12.67	0.45	0.45	221
Gulf	86.32	12.63	0	1.05	95
Liberty	86.05	9.3	4.65	0	86

Table A.9 Relative risk for race and county (total crashes)

County	White	Black	Hispanic	Other	# Crashes*100/population
Dade	1.63	1.14	0.56	0.84	3.66
Duval	0.99	1.11	0.49	0.60	3.32
Hillsborough	1.05	1.24	0.47	0.82	4.87
Pinellas	0.96	1.51	0.91	0.85	2.89
Polk	0.97	1.18	1.13	0.78	3.11
Palm Beach	0.96	1.48	0.63	0.81	3.15
Orange	0.97	1.22	0.88	1.07	3.57
Volusia	0.99	1.30	0.67	0.68	3.67
Escambia	1.04	0.94	0.69	0.45	3.44
Broward	0.95	1.55	0.48	0.82	2.72
Alachua	1.02	1.07	0.32	0.76	2.59
Lake	0.98	1.32	0.80	0.73	1.43
Leon	0.94	1.28	0.31	0.71	3.12
Marion	1.01	1.09	0.56	0.57	2.08
Manatee	0.95	1.54	1.09	0.51	1.94
Sarasota	0.99	1.39	0.67	0.66	1.92
Seminole	0.99	1.50	0.63	0.56	1.68
Lee	0.91	1.91	1.34	1.25	2.79
Brevard	0.99	1.44	0.46	0.55	1.48
St. Johns	1.01	1.24	0.24	0.56	1.85
Gadsden	0.96	0.95	**3.34**	0.75	1.62
Putnam	1.01	0.96	1.06	0.82	1.58
Bay	1.04	0.89	0.39	0.57	2.19
St. Lucie	0.93	1.33	0.97	1.20	1.90
Jackson	1.12	0.79	0.08	0.00	1.33
Oscecola	0.94	1.54	1.09	1.71	2.36
Highlands	0.91	1.70	1.21	0.81	1.45
Pasco	1.00	1.52	0.54	1.04	1.68
Collumbia	1.01	1.04	0.47	0.47	1.67
hardee	1.00	1.93	0.81	0.00	1.53
Suwannee	0.98	1.11	1.28	0.33	1.12
Indian River	0.95	1.79	0.61	0.35	1.68
Santa Rosa	1.00	1.57	0.22	0.35	1.66
Desoto	0.97	0.82	1.80	0.21	1.44
Madison	1.11	0.84	1.02	**2.30**	1.31
Walton	1.01	1.08	1.39	0.12	1.59
Taylor	1.02	1.02	0.68	0.19	1.72
Monroe	1.06	1.21	0.54	0.43	1.77
Levy	0.95	1.26	1.40	1.49	1.30
Hernando	1.01	1.42	0.35	0.15	1.35
Nassau	0.98	1.27	0.49	0.65	1.17
marion	1.03	0.70	1.50	0.49	0.94
Okaloosa	1.05	0.90	0.21	0.52	1.59
Sumter	1.00	1.00	1.13	0.63	1.51
Bradford	1.12	0.62	0.00	0.99	1.93
Jefferson	1.20	0.77	0.62	0.00	1.80
Citrus	1.01	1.62	0.40	0.28	1.50
Clay	1.01	1.41	0.29	0.56	1.26
Hendry	1.00	1.18	0.91	0.63	1.42
Washington	1.06	0.76	0.64	0.46	1.17
Holmes	1.04	0.74	0.51	0.00	0.89
Baker	1.03	0.83	0.49	1.47	1.23
Charlotte	0.99	1.79	0.40	0.36	1.51
Dixie	0.99	1.03	1.50	**3.00**	1.58
Gilchrist	1.07	0.24	1.26	0.00	1.02
Hamilton	1.26	0.63	0.95	0.00	1.21
Okeechobee	1.05	1.27	0.61	0.37	1.63
Calhoun	1.00	1.18	0.00	0.72	0.97
Franklin	1.02	0.83	1.45	0.00	1.39
Glades	0.88	0.97	**2.12**	1.30	1.23
Flagler	0.98	1.52	0.46	0.98	1.52
Lafayette	1.04	0.79	1.06	0.00	0.81
Union	1.07	0.90	0.39	0.00	0.91
Collier	0.97	**2.22**	0.84	1.33	1.98
Wakulla	1.02	0.98	0.75	0.25	1.56
Gulf	1.07	0.67	0.00	**2.63**	0.83
Liberty	1.06	0.56	**3.58**	0.00	1.54