Research Report
KTC-05-36/TA-19-05-1I

KENTUCKY TRANSPORTATION CENTER

College of Engineering

AN ANALYSIS OF FATAL TRAFFIC CRASHES IN KENTUCKY AND RECOMMENDED COUNTERMEASURES

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AN ANALYSIS OF FATAL TRAFFIC CRASHES IN KENTUCKY AND RECOMMENDED COUNTERMEASURES

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November 2005

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

The number of traffic fatalities and the fatality rate for traffic crashes has been decreasing across the United States for the past several years. However, the number of fatalities in Kentucky in 2004 was the highest in approximately 30 years. The number of fatalities on public roads in Kentucky increased each year for 1999 through 2004. Also, the fatality crash rate in 2004 increased compared to previous years. This increase in the fatality crash rate in Kentucky has occurred since 1999 while the nationwide rate has decreased.. The rate in Kentucky was 1.71 crashes per 100 million miles (C/100 MVM) in 1999 compared to 2.07 C/100 MVM in 2004. The national rate has been about 1.5 C/100 MCM since 2000.

The objectives of this study were to analyze fatal traffic crashes in Kentucky to identify patterns and causes of these crashes and to recommend potential countermeasures.

2.0 PROCEDURE

The study included the following areas of analysis.

2.1 Trends in Fatal Collisions

Crash data for the five-year period of 2000 through 2004 were analyzed to determine if any trends related to fatal collisions could be identified. Factors such as type of highway, roadway condition, light condition, contributing factors, and type of crash were analyzed.

2.2 Review of Crash Reports

A copy of the crash report for each of the 854 fatal crashes which occurred on public roads in Kentucky in 2004 was obtained. Each crash was reviewed with the factors contributing to the crash identified along with potential countermeasures. Other information such as age of the at-fault driver and type of collision were also summarized.

2.3 County Fatal Crash Rates

Fatal crash rates are calculated by county as part of the annual analysis of crash data in Kentucky (1). From that separate analysis, counties having the highest fatal crashes rates for the five-year period of 2000 through 2004 were identified.

2.4 Roadway Sections with Highest Critical Rate Factors

An analysis program has been developed to identify critical rate factors (CRFs) for roadway sections of various lengths (2). The program was used to identify one-mile and five-mile sections which had a CRF of 1.0 or more considering fatal crashes only.

3.0 RESULTS

3.1 Trends in Fatal Collisions

Crash data for the five years of 2000 through 2004 were analyzed to determine if any trends could be determined. Following is a summary of the results of this analysis for various factors.

Number of Fatalities

As shown in Figure 1, the number of fatalities in Kentucky has increased since 1999 with 2004 having the highest number for the analysis period which started in 1978. The number of fatalities had increased and decreased from year to year since 1978 but an increase for five continuous years had not occurred prior to 1999. The 964 fatalities in 2004 were the highest since 1978 which was the first year in the 27-year analysis period.

Fatality Rate

The fatality rates in Kentucky and in the United States are shown in Figure 2. The rate in Kentucky has been above the national fatality rate for the past 20 years. The difference in these rates has been increasing in the past few years. The rate in Kentucky has decreased substantially since the 1970's but not as much as the decrease nationally.

Land Use

As shown in Figure 3, a high percentage of fatalities occur on rural roads. The largest increase in fatalities in 2004 occurred on rural and limited access highways.

Highway Type

Most fatalities occur on state-numbered routes (Figure 4) followed by US-numbered routes and interstates. There has been an increasing trend on all of these highway types. There was a noticeable increase on interstates in 2004.

The numbers of fatalities on the various interstates are shown in Figure 5. The increase in fatalities in 2004 on interstates was primarily related to the increase in fatal crashes on I-65.

Roadway Conditions

There has been a general increase in fatal collisions on both dry and wet pavement with no change on snow/ice/slush (Figure 6). There has not been any substantial change in the percentage of fatal crashes occurring on a non-dry pavement in this period.

Roadway Character

The largest number of fatal crashes occur on straight and level sections of roadway (Figure 7). Also, the largest increase has occurred on straight and level sections with a general increase at curves.

Light Conditions

There have not been any major difference in the trends as a function of light condition (Figure 8).

Two-Vehicle Fatal Collisions

The most common type of two-vehicle fatal collisions involved an angle impact (Figure 9). The largest increase in two-vehicle fatal collisions has been for angle collisions.

Day of Week

The numbers of fatal collisions by day of week are shown in Figure 10. The days where the largest decrease occurred in 2004 were Sunday and Thursday. The only day where there was a continuous increase for each year was Thursday.

Month

There were several months were the largest number of crashes for the past five years occurred in 2004 (June, August, September, and November) (Figure 11). In June and August there was a continuous increase for each year.

Type of Vehicle

There has been a general increase in the involvement of passenger cars, trucks, and motorcycles in fatal crashes (Figures 12a and 12b). There has been a continuous increase in the number of passenger cars involved.

Driver Residence

There has been an increase in the number of local and in-state drivers involved in fatal crashes (Figure 13). There has very little change in the number of out-of-state drivers.

Driver Sex

The number of both male and female drivers has increased (Figure 14). The percentage of male drivers has remained between 71 and 73 percent.

Driver Age

The largest increase from 2000 to 2004 has occurred for drivers between 25 and 54 years of age (Figure 15). The largest number of crashes involve the 25 to 34 years of age category.

Alcohol Related

The highest number of alcohol-related fatalities occurred in 2004 compared to the previous four years (Figure 16). There has been a general, but not consistent, increase.

Human Contributing Factors

As shown in Figures 17a and 17b, there were several human contributing factors which showed an increase over the study period. Considering factors listed in at least 30 crashes in 2004, the largest percent increases from 2000 to 2004 involved drug involvement, not under proper control, and overcorrecting.

Vehicular Contributing Factors

The factor in this area which showed a large increase in 2004 was tire failure (Figure 18).

Environmental Contributing Factors

There has been a substantial increase in crashes involving slippery surface (Figure 19) and limited view.

Type of Fatal Crash

Various types of fatal crash are shown in Tables 20a through 20h. Some of these types involved a very small number of fatal crashes. The number of fatal pedestrian crashes has not increased. There has been an increasing trend in motorcycle, all terrain vehicle, and truck crashes.

Multiple Fatality Crashes

The number of fatalities resulting from multiple fatality crashes increased in 2004 (Figure 21).

Area Development District

The number of fatalities by area development district (ADD) is shown in Figure 22. The largest numbers occurred in the KIPDA and Bluegrass ADDs. Increases were also noted in the Northern Kentucky, Big Sandy, and Cumberland Valley ADDs.

Highway District

The number of fatalities by highway district is shown in Figure 23. The largest increase occurred in District 7 (which includes Lexington). The largest number of fatalities occurred in District 5 (which includes Louisville). There has also been a substantial increase in District 6 (northern Kentucky).

Type of Collision

The number of fatalities by type of collision is shown in Figures 24a and 24b. There have been increases in various types of single vehicle crashes as well as crashes involving two or more moving vehicles

3.2 Review of Crash Reports

The majority of fatal crashes (62 percent) occurred on a rural, two lane road. This shows where the emphasis with roadway related improvements can have the greatest effect. The next highest percent was about 8 percent on rural interstates and parkways.

The pavement was wet in about 20 percent of the fatal crashes with only about two percent occurring on snow or ice. There was some type of inclement weather in about 16 percent of the crashes.

Approximately one half of the fatal crashes were single vehicle with 41 percent involving two vehicles. The most common multiple vehicle fatal crash involved a head on crash (19 percent) followed by an angle intersection collision (10 percent).

Approximately 38 percent of the fatal crashes occurred during darkness. This compares to about 22 percent of all crashes during darkness.

Information about the vehicle which was identified as the vehicle “primarily at fault” was obtained. The model year of that vehicle showed that about five percent were 20 years or older, with 34 percent 10 years or older, and 69 percent five years or older. One half of the number of vehicles at fault was a passenger car followed by pickup trucks with 20 percent and sport utility vehicles with 11 percent. Only 5.4 percent were either a single unit or combination truck with the same percentage for motorcycles.

Data have shown a general overrepresentation of male drivers involved in fatal collisions. A review of the fatal crashes shows that 72 percent of drivers determined to be “primarily at fault” were male which shows at-fault drivers are not over represented by males or females.

A comparison was also made by driver age to compare the percentage of all drivers by age with the percentage of all drivers involved in fatal crashes by age and also the percentage of drivers determined to be “primarily at fault” by age. Teenage drivers were the most overrepresented when at-fault drivers were compared to all drivers.

There were 90 crashes involving a large truck with about one half of those noting the truck was the vehicle "primarily at fault." Of the 90 trucks, there were 63 with a load with general freight listed most often. There were seven trucks loaded with coal (with three where the truck was listed as the vehicle "primarily at fault") and seven trucks loaded with gravel.

Approximately 40 percent of the crashes occurred on a curve. In about 80 percent of those crashes the police report did not list either a curve warning sign or advisory speed as traffic control. It should be noted that the police report does not always list all the traffic control devices.

Vehicular factors are listed very infrequently as a contributing factor. The most frequent factor was inadequate tire tread which was listed in about two percent. The most common environmental factors were a slippery surface (about seven percent) and a view restriction (about five percent).

Contributing factors relating to the driver were classified in several categories. First, it was noted that alcohol was listed as present in about 26 percent of crashes with drugs noted in about 5 percent. When a specific factor could not be determined, more general factors such as "failure to maintain control" in about 16 percent, overcorrection in about 12.5 percent, and distraction in about 12.4 percent were listed. More specific factors included: excessive speed (11.5 percent), vehicle allowed to cross centerline (6.7 percent), too fast for conditions (6.4 percent), stopped at stop sign and then pulled into path of vehicle (5.5 percent), fell asleep (3.9 percent), improper passing (3.3 percent), turned left into path of opposing vehicle not at traffic signal (3.0 percent), pedestrian collision not at crosswalk (2.1 percent), medical problem (2.1 percent), ran red light (1.8 percent), disregarded traffic signal (1.8 percent), and disregard stop sign (1.6 percent).

A more detailed analysis could be made for a specific human factor. For example, about 70 percent of the crashes involving excessive speed occurred on a rural two lane road. Only about 10 percent were on a rural or urban interstate or parkway.

The circumstances of each crash were reviewed to determine potential countermeasures to either prevent a fatal crash or reduce the severity to less than a fatality. Following is a summary of the countermeasures which were identified as having the potential to reduce the largest number of fatalities. It should be noted that up to three countermeasures were listed for each fatality. For example, a driver might drive through a curve at night (with no indication on the police report of any curve warning sign), allow the passenger side tires of the vehicle drop onto the shoulder, and then overcorrect with their vehicle overturning and the unrestrained driver ejected. Potential countermeasures in this crash would include: additional curve delineation, education about proper steering when tires drop onto the shoulder, and use of a safety belt.

Countermeasure	Potential Number of Fatalities Reduced
Use of a safety belt	279
Alcohol/drugs education and enforcement	232

Additional traffic control/delineation for curves	158
Education about proper steering when tires drop onto the shoulder	108
Speed enforcement	99
Improve clear zone	89
Install milled shoulder rumble strips	79
Install centerline rumble strips	73
Education about driving in adverse weather	63
Retesting of older drivers	52
Improve the graduated driver license law	43
Install cable guardrail in median	25
Not allow ATV on public highway	22
Additional traffic control at stop signs	19
Address driving with suspended or no license	19
Education about fatigue and driving	18
Use of a motorcycle helmet	17
Education about pedestrian nighttime visibility	16
Education about tire maintenance	14
Address clearance intervals at traffic signals	12
Improve roadway drainage	11
Install protected left turn phasing	7
Increase medical review of drivers	7
Clear crash site in shorter time	7
Training for emergency responders	7
Additional parking and rest locations for trucks	6
Additional delineation of objects in clear zone	6
Education about alcohol use by pedestrians	6
Additional/improved work zone traffic control	5
Deer deterrent devices	5
Improve truck underride protection	4
Reduce shoulder dropoffs	4
Improve truck rear delineation	3
Address general truck maintenance	3
Training for young bicyclists	3

Use of a safety belt has the potential to reduce the largest number of fatalities. Considering the number of fatalities involving unrestrained occupants in a vehicle where a safety belt was available, the potential number of fatalities which could be prevented through use of a safety belt was 55 percent. This is very close to the estimates made by NHTSA for the effectiveness of safety belts in preventing fatalities in motor vehicle crashes.

Driver age was related to some of the countermeasures. The problem with oversteering when tires drop onto the shoulder was overrepresented for teenage drivers. Alcohol involvement was overrepresented for drivers 25 through 34 years of age while excessive speed was overrepresented for drivers between the 16 and 34 years of age. The countermeasure for

education for driving during inclement conditions would be directed toward teenage drivers who were overrepresented. About two-thirds of crashes involving driving during inclement conditions occurred on rural, two-lane roads.

3.3 County Fatal Crash Rates

Fatal crash rates in terms of crashes per 100 million vehicle miles (C/100MVM) were calculated for each of Kentucky's 120 counties for the five-year period of 2000 through 2004. Counties were divided into five population categories for analysis so counties with similar characteristics could be compared. Fatal crash rates by county and population category are given in Table 1. A statistical test found that only three counties (Breathitt, Pike and Pulaski Counties) had a critical fatal crash rate. A map of Kentucky showing the two counties with the highest fatal rate in each of the five population categories is shown in Figure 25. The map shows that the counties with the highest fatal crash rates (for their population category) are concentrated in the southeast portion of the state.

A more detailed analysis was conducted for fatal crashes in Pike County. There were 26 fatal crashes in 2004 in Pike County. Routes with the largest number of crashes were US 23 with five, US 460 with four, and KY 194 with three. There was a higher percentage on rural four lane roads and a lower percentage on rural two lane roads than statewide. There was a high percentage of head-on collisions. There were eight crashes involving a truck, including two loaded with coal.

3.4 Roadway Sections with Highest Critical Rate Factors

A program that identifies high crash locations was used to locate sections of highway that had critical fatal rates. The analysis was conducted for one-mile and five-mile section lengths. The computer program uses three years of data so fatal crash data for 2002 through 2004 were used. A total of 164 one-mile sections and 96 five-mile sections were identified with a CRF of 1.00 or more. Lists of these sections are given in Appendix A. The highest number of fatal crashes found in the one-mile sections was four with three of these sections located (US 431 in Muhlenberg County between milepoints 6.0 and 7.0; I-65 in Jefferson County between milepoints 132.2 and 133.2; KY 4 in Fayette County between milepoints 13.7 and 14.7). Following is a list of the 14 one-mile sections which had a CRF of 2.00 or more.

County	Route	Milepoint	Number	CRF
Muhlenberg	US 431	6.0 - 7.0	4	2.82
Bath	KY 1198	2.5 - 3.5	2	2.70
Marshall	KY 348	5.8 - 6.8	3	2.45

Livingston	KY 135	0.5 - 1.5	2	2.40
Casey	KY 1552	3.5 - 4.5	2	2.33
Grayson	KY 479	3.3 - 4.3	2	2.23
Crittenden	KY 91	1.4 - 2.4	2	2.19
Christian	KY 107	32.0 -33.0	2	2.08
Leslie	KY 3424	0.2 - 1.2	2	2.06
Knox	KY 11	12.7 - 13.7	3	2.06
Union	US 60	1.7 - 2.7	3	2.04
Shelby	KY 43	3.4 - 4.4	3	2.04
Floyd	KY 7	0.7 - 1.7	3	2.02
Carter	KY 2	3.8 - 4.8	2	2.02

While there is a limited number of crashes, they can be analyzed to determine any pattern. For example, all of the four crashes on US 431 in Muhlenberg County (milepoint 6.0 to 7.0) involved one vehicle crossing the centerline in a curve into the path of an opposing vehicle. The pavement was wet in three of the four crashes. Also, three of the crashes involved a loaded truck crossing the centerline. A response has been made at this location with additional signing installed. This has involved having two sets of dual 48-inch turn warning signs (with flashing lights on the first set) with advisory speeds and chevron signs through the curve. Curve widening has also been conducted.

The highest number of fatal crashes found in the five-mile sections was nine which was found on KY 61 in Jefferson County between milepoints 2.1 and 7.1. The next highest number of fatal crashes was six which was found at three locations (I-71 in Oldham County between milepoints 12.1 and 17.1; I-65 in Warren County between milepoints 14.1 and 19.1; US 31W in Jefferson County between milepoints 0.5 and 5.5). Following are the three five-mile sections which had a CRF of 2.00 or more.

County	Route	Milepoint	Number	CRF
Livingston	KY 135	0.5-5.5	3	2.34
Grayson	KY 479	3.3-8.3	3	2.08
Pulaski	KY 70	4.4-9.4	4	2.01

4.0 RECOMMENDATIONS

A review of the fatal crash data resulted in a list of the following countermeasures which could be implemented to reduce the number of fatalities. They are divided into various general

categories.

Legislation

a. change the current safety belt law to allow primary enforcement
b. strengthen the current graduated license law
c. require driver retesting (specifically, vision testing)
d. strengthen the restriction of operation of ATVs on public highways

Roadway Improvements

a. include safety improvements as part of the resurfacing program
b. improve curve delineation
c. improve delineation of objects in the clear zone
d. develop a program to remove objects in the clear zone
e. increase use of milled shoulder and centerline rumble strips
f. ensure proper pavement cross slope is provided as part of the resurfacing program
g. ensure an adequate shoulder is provided as part of the resurfacing program

Education

a. develop an educational program and implement a campaign relating to the proper procedure to use when a driver allows tires on their vehicle to travel onto the shoulder (emphasis on teenage drivers)
b. develop an educational program and implement a campaign relating to driving during inclement weather conditions
c. provide education concerning the hazards of driving an ATV on a public road
d. increase awareness of physicians and police officers regarding the medical review board process concerning driver licenses

Enforcement

a. emphasize enforcement of the safety belt law
b. increase alcohol enforcement
c. increase speed enforcement on rural two-lane roads

5.0 REFERENCES

1. Green, E.R.; Agent, K.R.; Pigman, J.P.; and Barrett, M.L., “Analysis of Traffic Crash

Data in Kentucky," KTC-05-19, August 2005.

2. Agent, K.R.; O'Connell, L.; Green, E.R.; Kreis, D.; Pigman, J.P.; Tollner, N. and Thompson, E.; "Development of Procedures for Identifying High-Crash Locations and Prioritizing Safety Improvement, " KTC–3-15, June 2003.

Appendix A. Roadway Sections with CRF of 1.0 or More

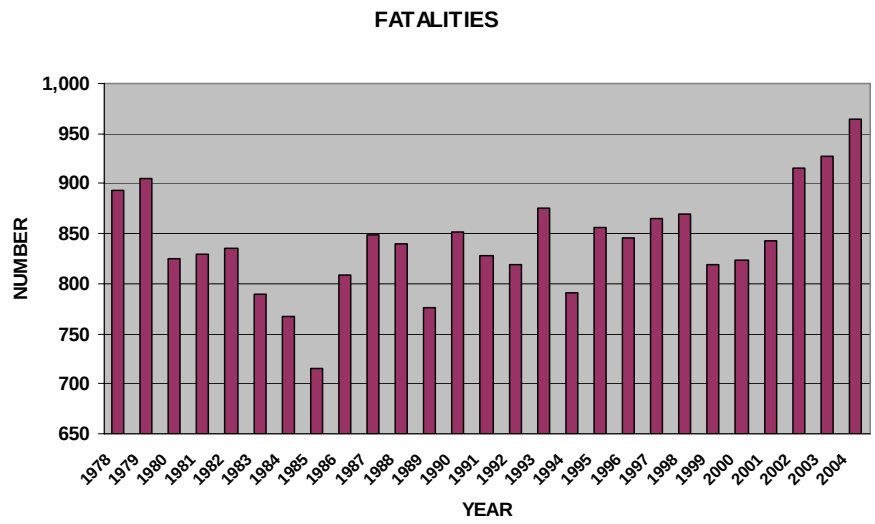

Figure 1. **Yearly Trend in Number of Fatalities**

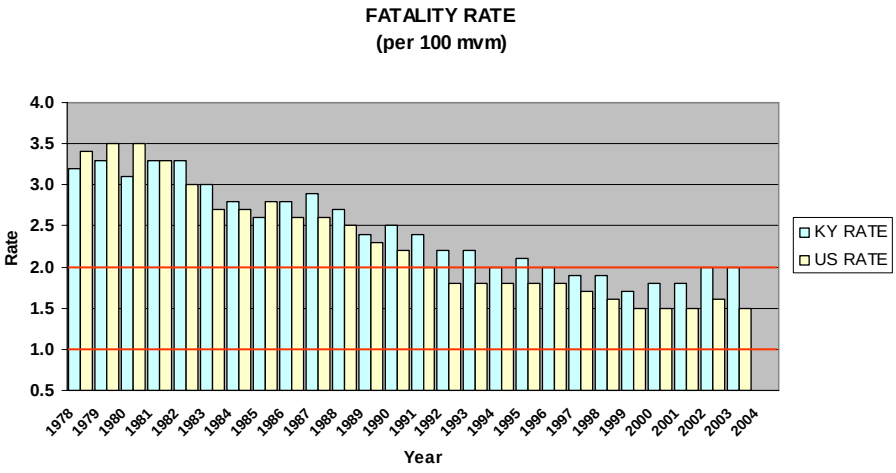

Figure 2. **Yearly Trend in Fatality Rate**

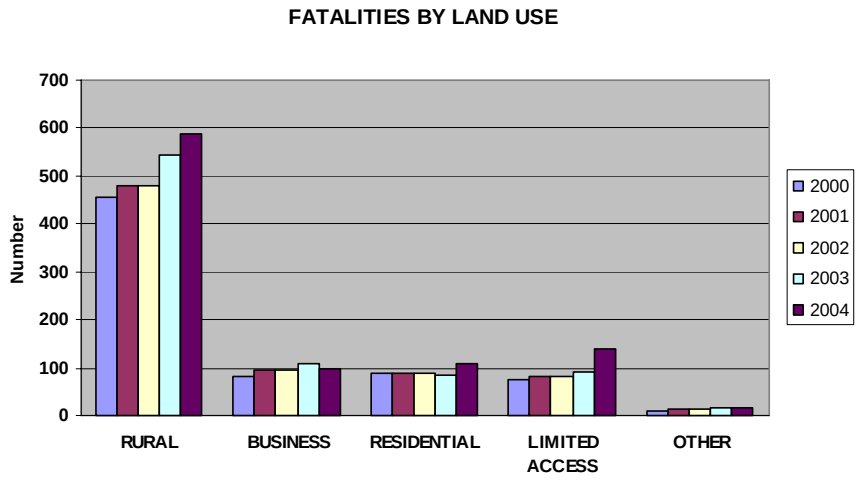

Figure 3. Fatalities by Land Use

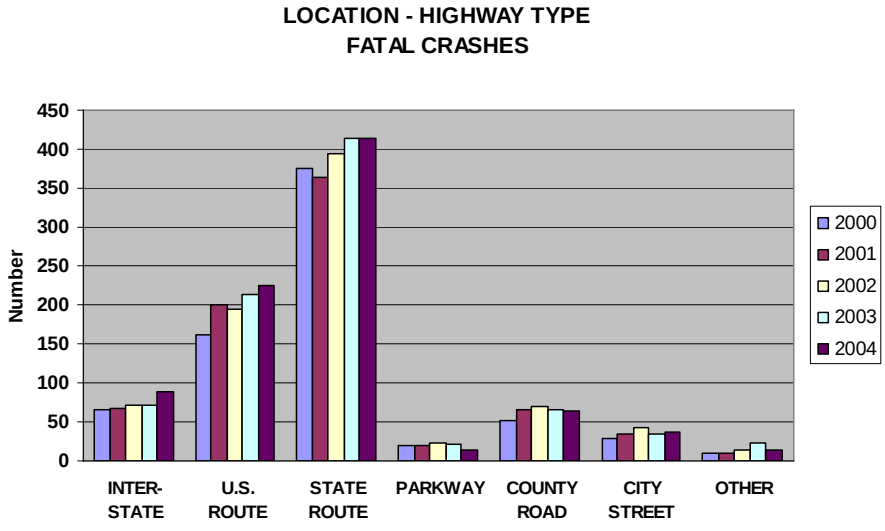

Figure 4. Fatal Crashes by Highway Type

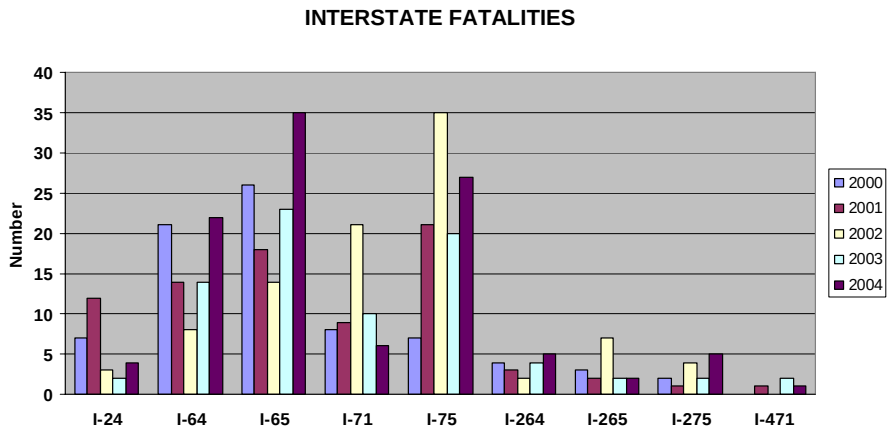

Figure 5. **Fatalities by Interstate**

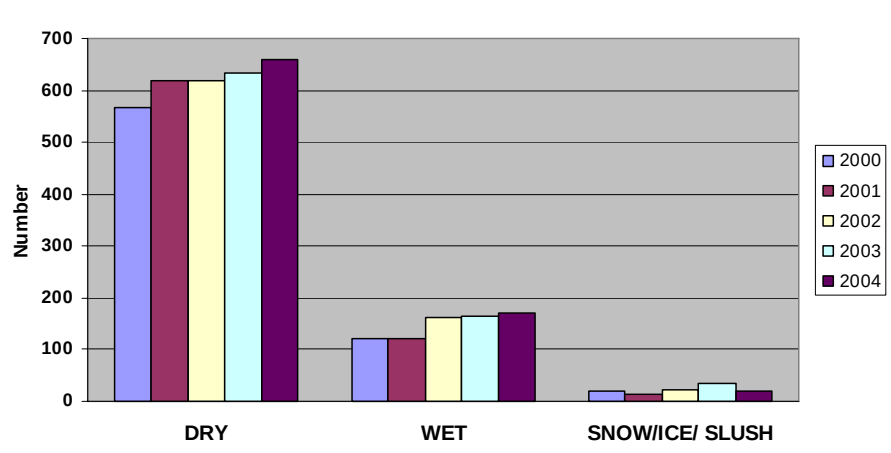

Figure 6. **Fatal Crashes by Roadway Condition**

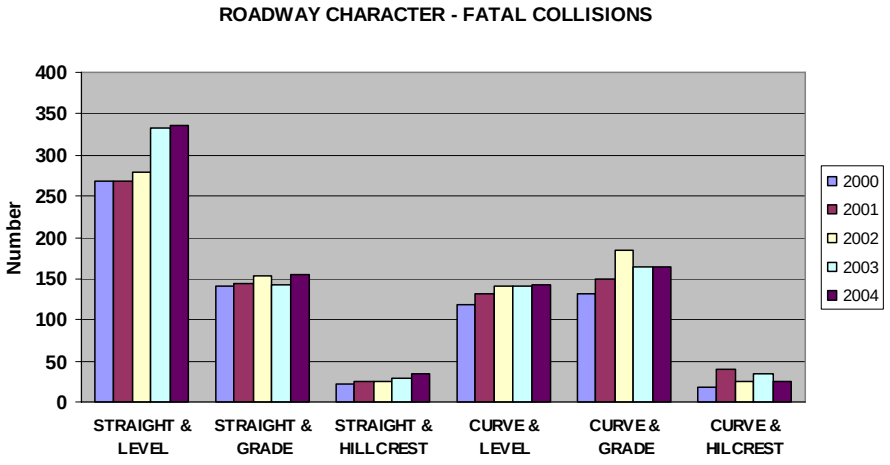

Figure 7. **Fatal Crashes by Roadway Character**

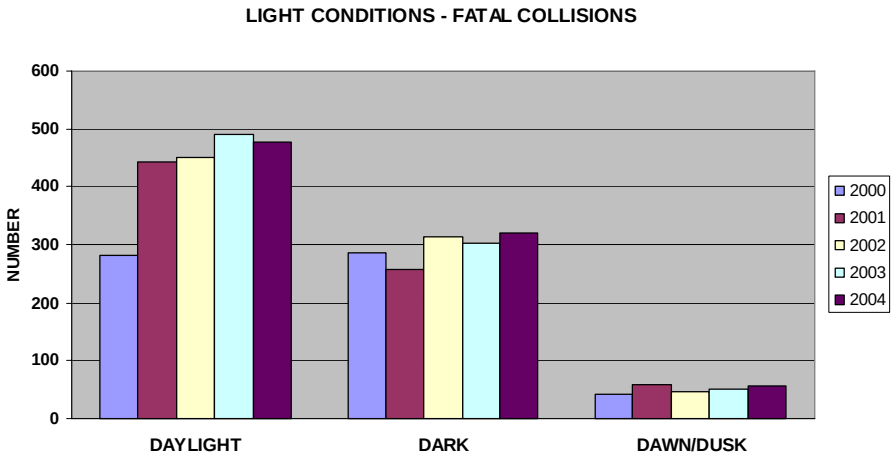

Figure 8. **Fatal Crashes by Light Condition**

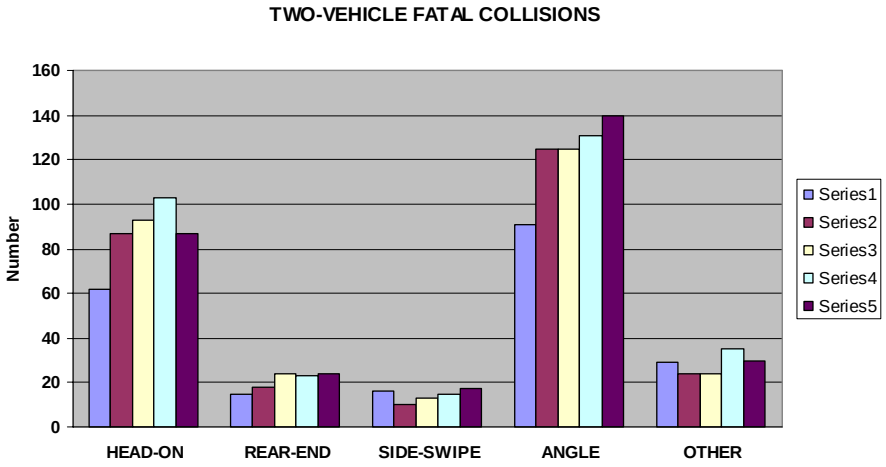

Figure 9. **Fatal Two-Vehicle Crashes**

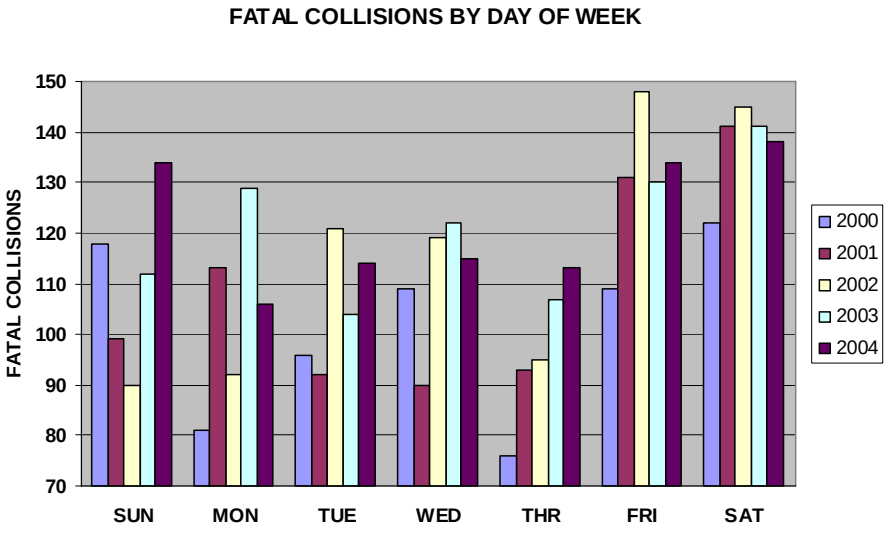

Figure 10. **Fatal Crashes by Day of Week**

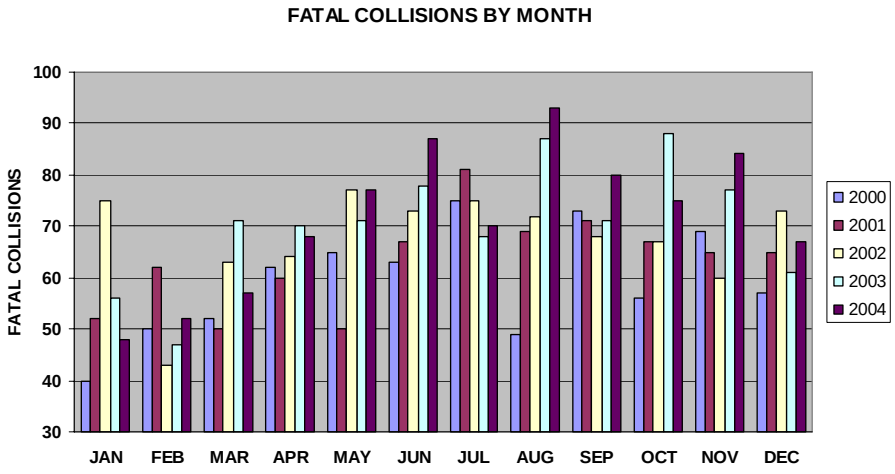

Figure 11. Fatal Crashes by Month

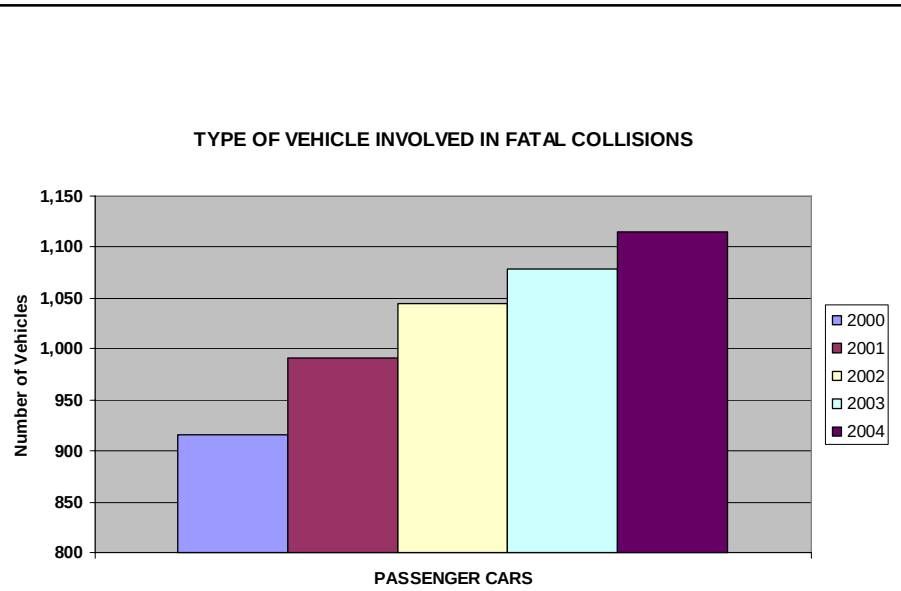

Figure 12a. Fatal Crashes by Type of Vehicle

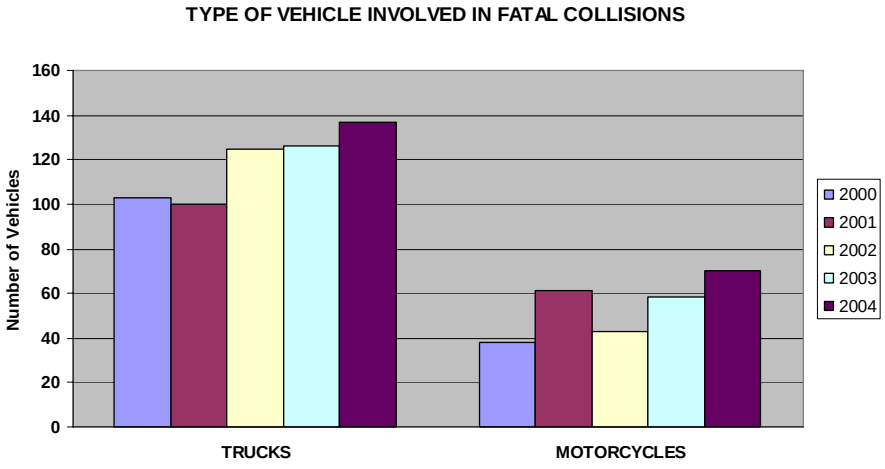

Figure 12b. Fatal Crashes by Type of Vehicle

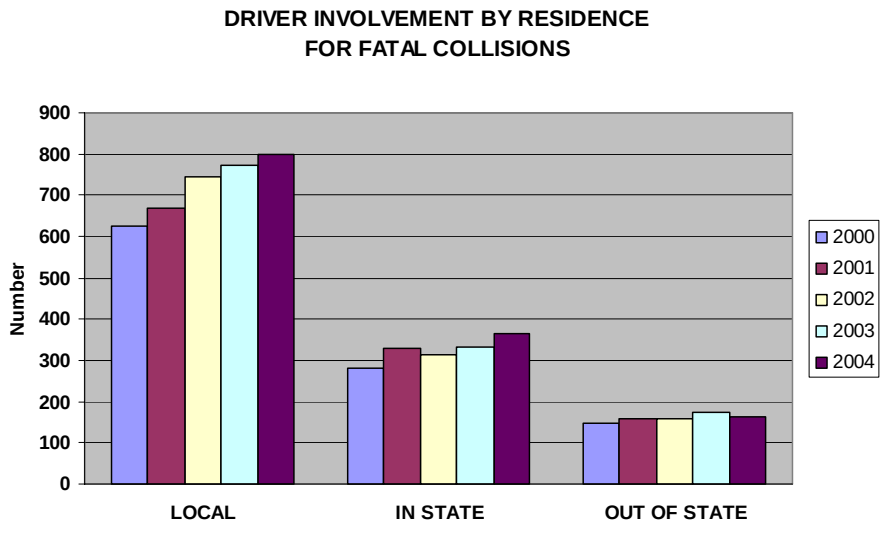

Figure 13. Fatal Crashes by Driver Residence

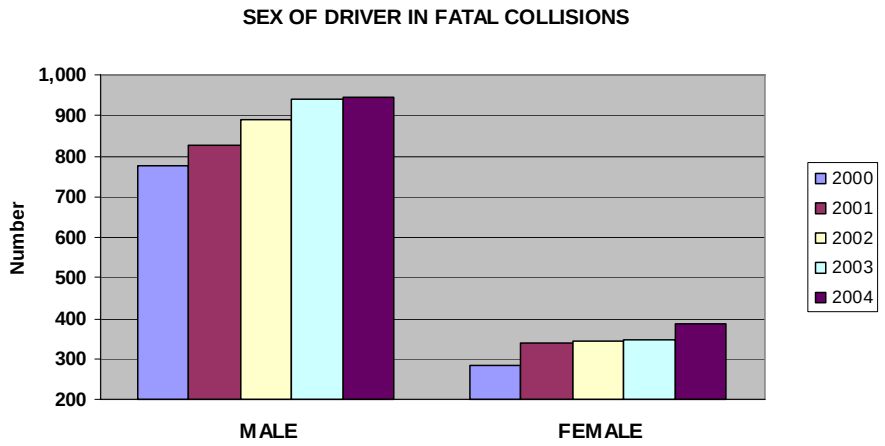

Figure 14. Fatal Crashes by Driver Sex

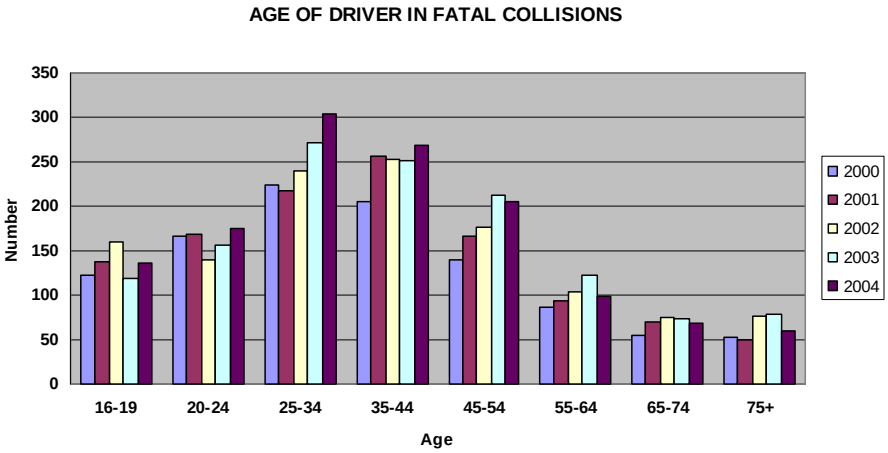

Figure 15. Fatal Crashes by Driver Age

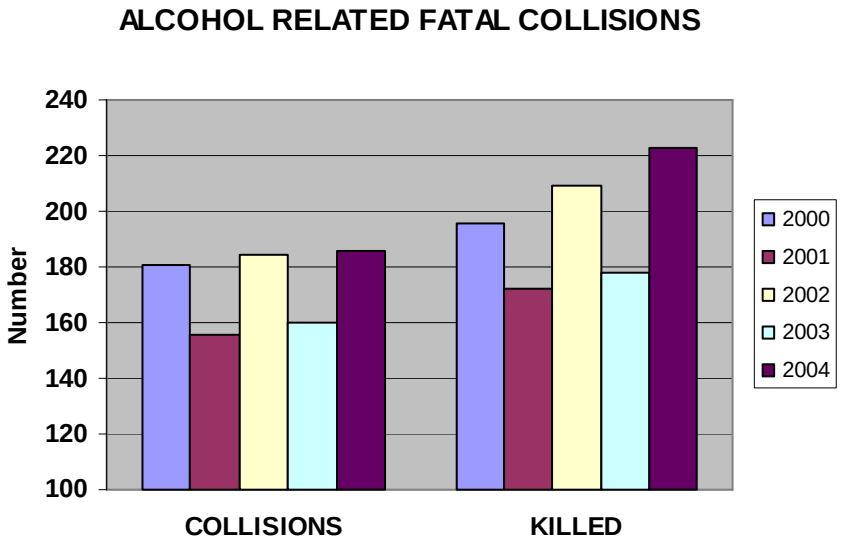

Figure 16. **Alcohol Related Fatal Crashes**

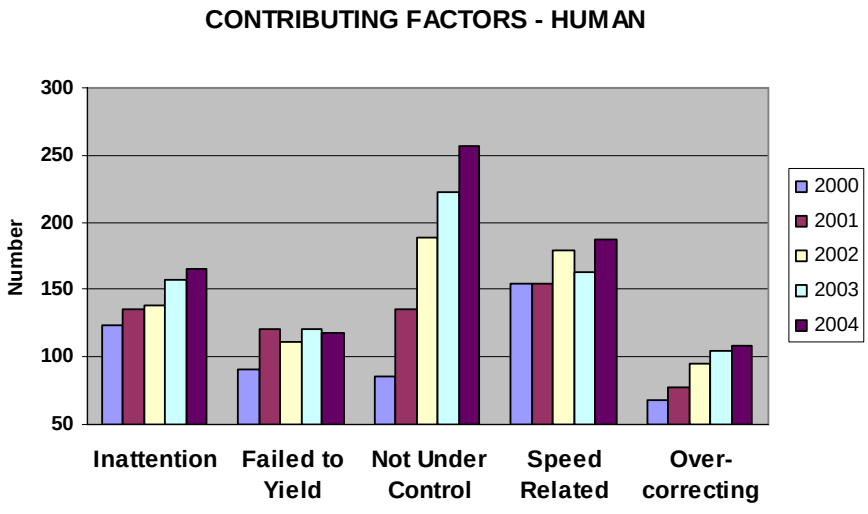

Figure 17a. **Human Contributing Factors in Fatal Crashes**

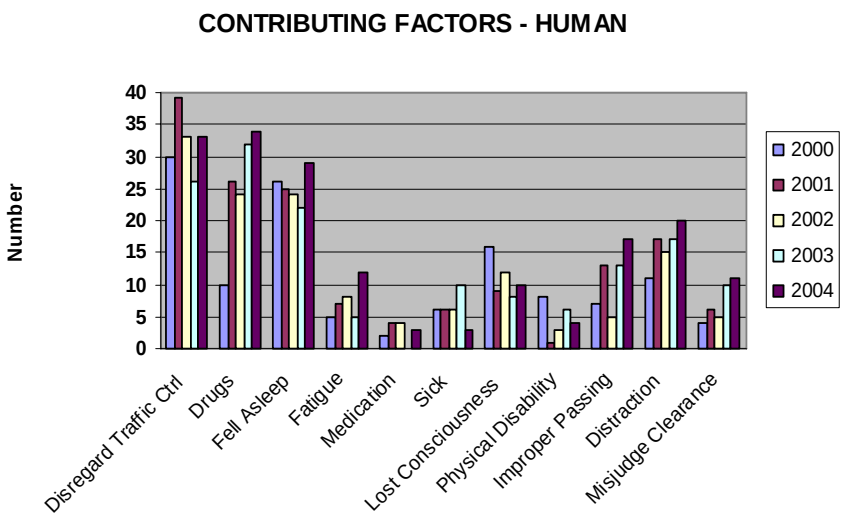

Figure 17b. Human Contributing Factors in Fatal Crashes

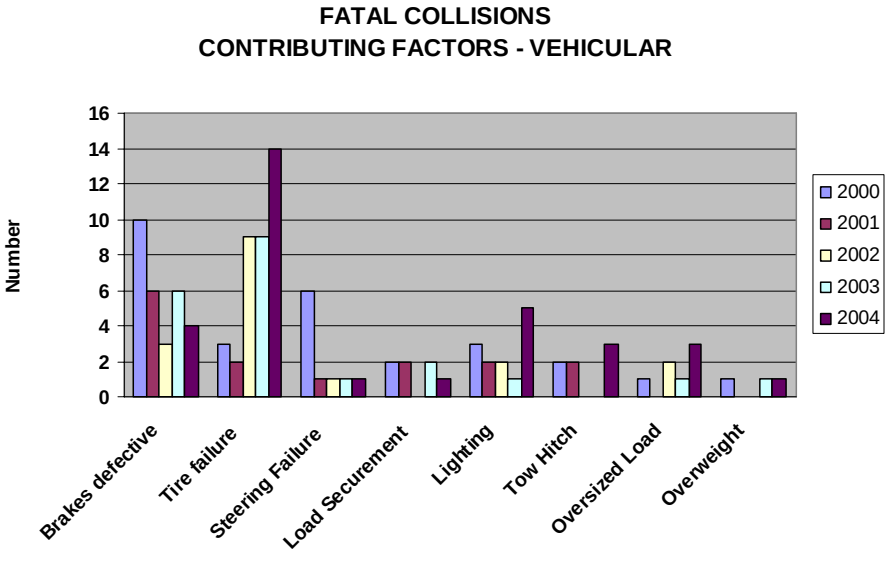

Figure 18. Vehicular Contributing Factors in Fatal Crashes

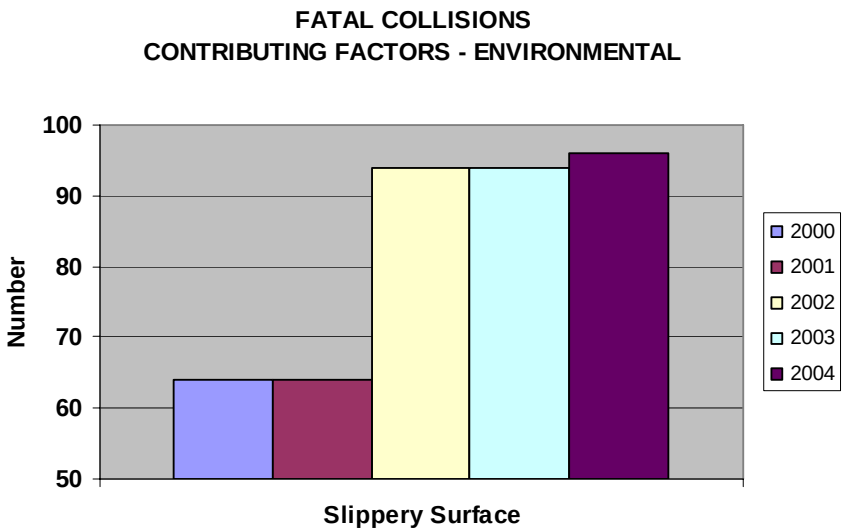

Figure 19. Environmental **Contributing Factors in Fatal Crashes**

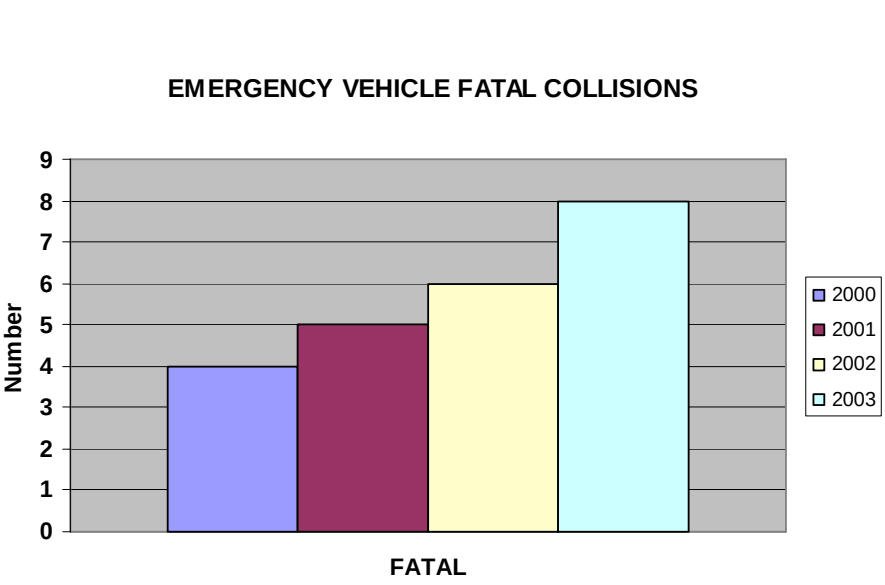

Figure 20a. **Trends in Various Types of Fatal Crashes**

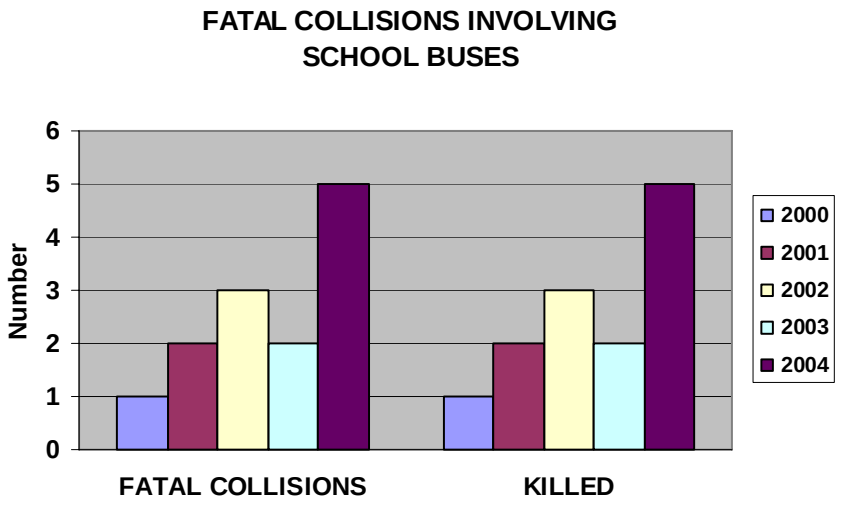

Figure 20b. **Trends in Various Types of Fatal Crashes**

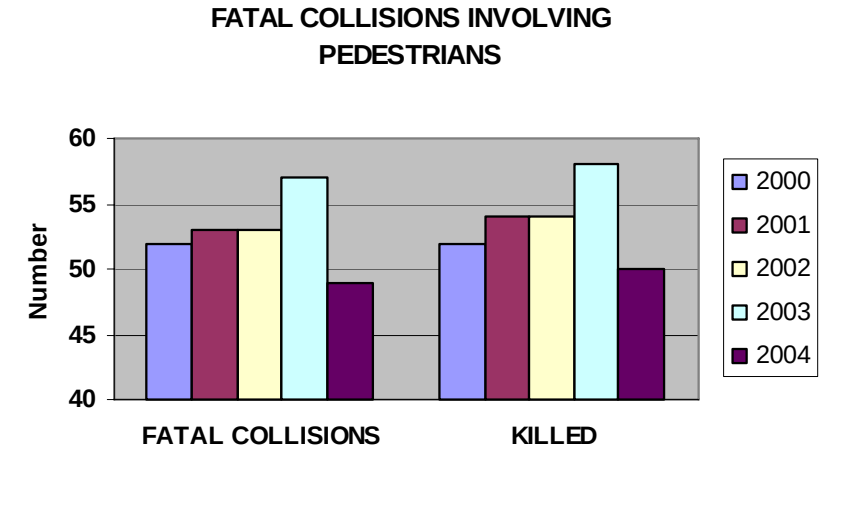

Figure 20c. **Trends in Various Types of Fatal Crashes**

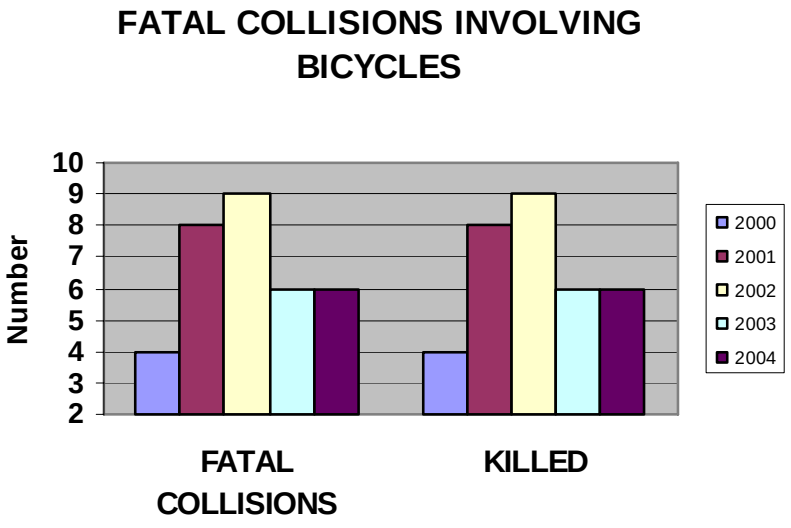

Figure 20d. **Trends in Various Types of Fatal Crashes**

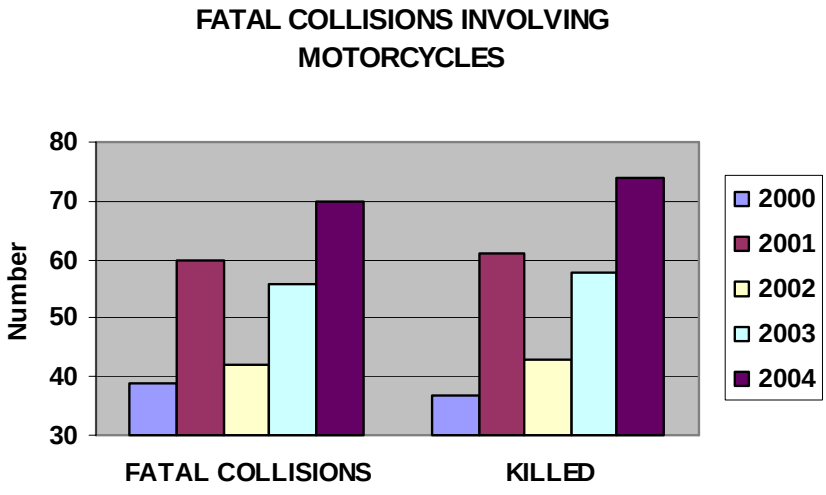

Figure 20e. **Trends in Various Types of Fatal Crashes**

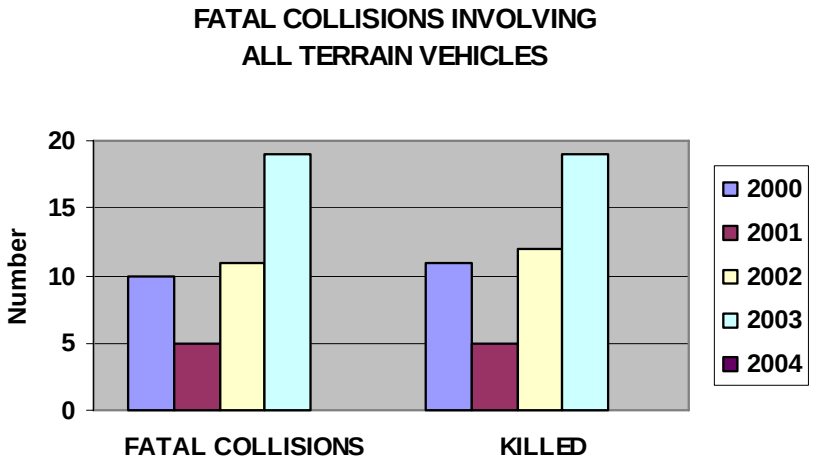

Figure 20f. Trends in Various Types of Fatal Crashes

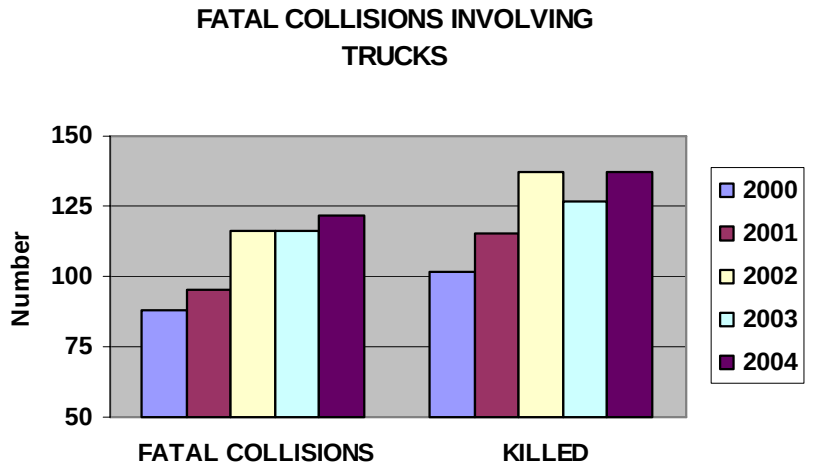

Figure 20g. Trends in Various Types of Fatal Crashes

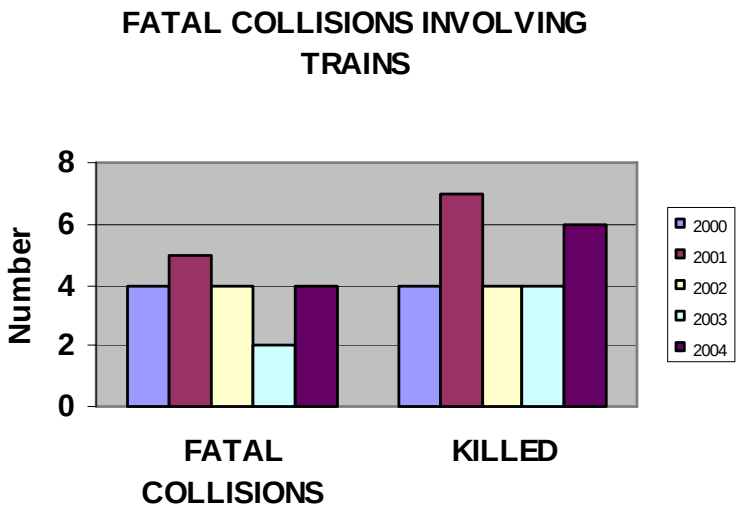

Figure 20h. **Trends in Various Types of Fatal Crashes**

Figure 20b.

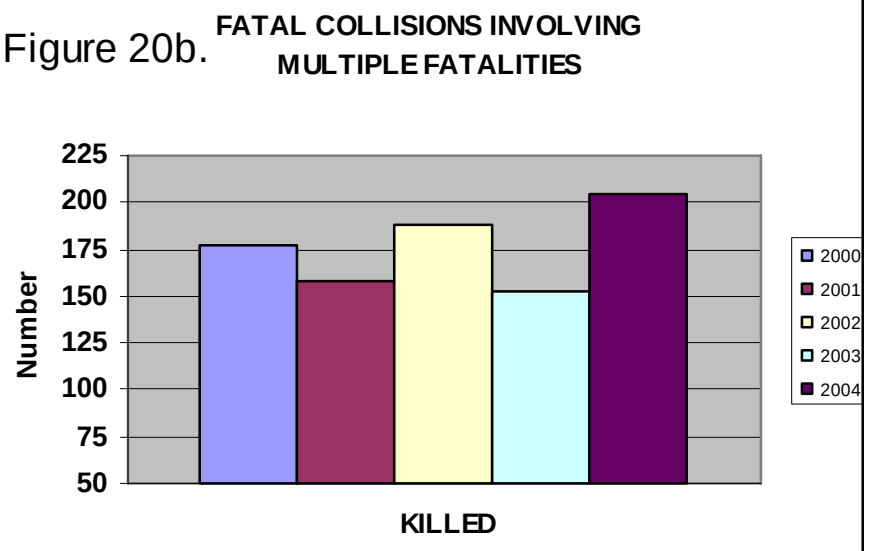

Figure 21. **Trends in Numbers of Multiple Fatal Crashes**

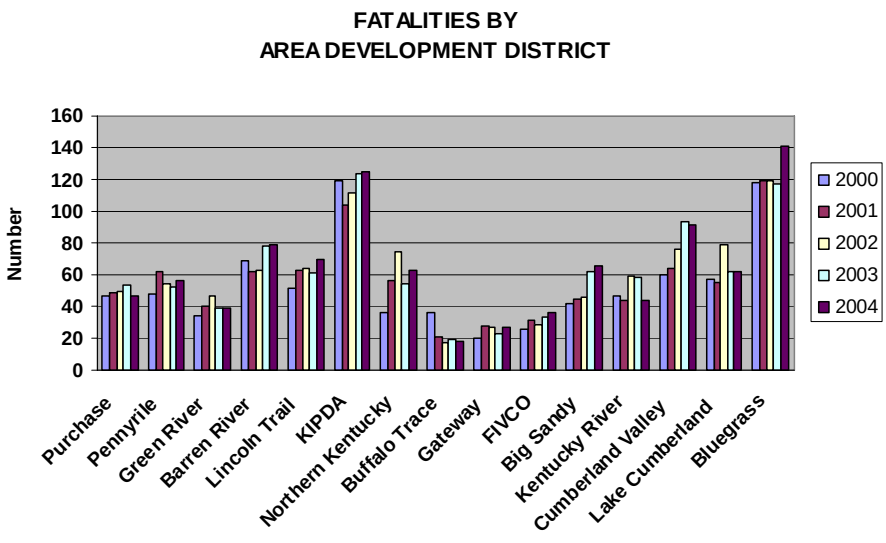

Figure 22. Number of Fatalities by Area Development District

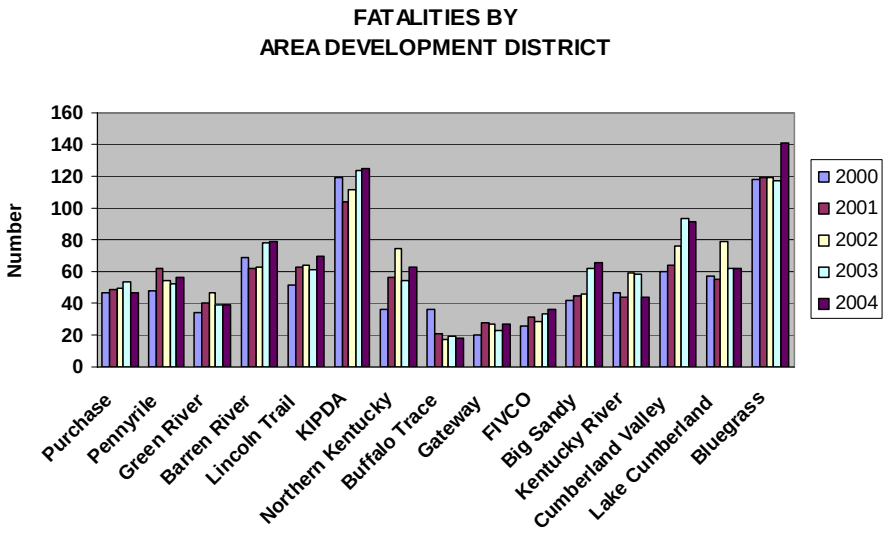

Figure 23. Number of Fatalities by Highway District