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UMTRI 97-24

Michigan Fatal-Traffic-Crash Patterns: 1993-1995

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Transportation Research Institute

June 1997

UMTRI The University of Michigan Transportation Research Institute

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTRI-97-24		

4. Title and Subtitle

Michigan Fatal-Traffic-Crash Patterns: 1993-1995

5. Report Date

June 1997

6. Performing Organization Code

[illegible]

7. Author(s)

Streff, F.M., Kostyniuk, L.P.

8. Performing Organization Report No.

UMTRI-97-24

9. Performing Organization Name and Address

The University of Michigan
Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

CP-97-01

12. Sponsoring Agency Name and Address

Michigan Office of Highway Safety Planning

13. Type of Report and Period Covered

Final Report
1/97 - 6/97

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report details data regarding possible causes of and prevention implications for deaths due to traffic crashes in Michigan from January 1993 through December 1995. Selected results in brief:

- Time series analysis found no statistically significant change in crash deaths in 1993-1995 compared to previous years.
- Peak months for fatal crashes were August through November. Peak days for fatal crashes were Friday, Saturday, and Sunday. These are periods during which more hazardous, recreational travel occurs. Enforcement and public information campaigns should target high incident periods, using campaign efforts emphasizing safety during recreational driving.
- The proportion of fatal crashes that occur on high speed interstate roads is quite low, considering the high volumes of vehicles that travel on them. In rural areas, most fatal crashes occur on major collectors and local roads which tend to be two-lane roads with speed limits of 55-miles per hour. In urban areas, the majority of the fatal crashes occur on arterials, the main nonfreeway, high-volume streets in the city. These data suggest that increased enforcement is warranted for noninterstate-type roads.
- The number and rate of fatal crashes per registered vehicle has increased for both motorcycles and pickup trucks since 1993. The most direct way to influence the death rate for these vehicle types is to continue to promote motorcycle helmet use and safety belt use among users of these vehicles. Pickup truck occupants have historically had the lowest belt use rates of any vehicle type, making this group a prime target for intervention.
- Among drivers, females age 16-20, males age 21-54, and females age 70+, numbers of fatal crashes and fatal crash rates have increased steadily since 1993. These trends should be carefully tracked in subsequent years to determine if they continue.
- Male drivers age 16-20 had the highest rates of fatal crash involvement by a factor of about 2 to 1, making them a prime target group for immediate prevention intervention.
- Male drivers predominate had-been drinking (HBD) fatal crashes, and young males (age 16-20) are at particularly high risk for involvement in a HBD fatal crash. The involvement of young females (age 16-20) in HBD fatal crashes has increased since 1993. Because of this trend, efforts should be made to target young females for HBD crash prevention programs, while not overlooking the fact that the majority of HBD fatal drivers at all ages are male. Young males typically experienced more prior license suspensions, DWI convictions, speeding tickets and other moving violations than did females.

17. Key Words	18. Distribution Statement
Fatal, traffic crash, statistics	Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	81	

Reproduction of completed page authorized

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Michigan Office of Highway Safety Planning nor the U.S. Department of Transportation, National Highway Traffic Safety Administration.

Prepared in cooperation with the Michigan Office of Highway Safety Planning and U.S. Department of Transportation National Highway Traffic Safety Administration through Highway Safety Project # CP-97-01

ACKNOWLEDGMENTS

The authors gratefully acknowledge Jean T. Shope of UMTRI for her input and review, which were invaluable to the completion of this report. We thank Lisa Molnar and Laura Johnson, also from UMTRI, for their assistance in the research and preparation of this report.

The Michigan Department of Commerce, Michigan Department of State, and Michigan Department of Transportation provided us with information used in the calculation of crash and fatality rates, for which we are very grateful.

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Introduction

This report details facts and figures relevant to a better understanding of possible causes of and possible prevention implications for deaths due to traffic crashes in the state of Michigan during the period January 1993 through December 1995. The report is divided into six primary sections. The first section, *Statistical Trend Analysis* details results of analyses to determine if there was an increase in deaths from 1993, and if there was, to determine the magnitude and possible explanations for the increase. The second section, *Fatal Crashes*, focuses on general information about fatal crashes. The next section, *Vehicles in Fatal Crashes,* looks within crashes to focus on the vehicles involved in fatal crashes. *Drivers in Fatal Crashes*, the section that follows, describes facts related to the drivers of the vehicles involved. The fifth section, *Persons Killed in Crashes*, details information about those killed in crashes. The final section, *Special Topics*, discusses information related to two key issues related to traffic crash deaths, namely had-been-drinking fatal crashes and police-reported safety belt and motorcycle helmet use in fatal crashes.

Information about fatal crashes that occurred in Michigan was obtained from the Fatal Accident Reporting System (FARS), compiled by the National Highway Traffic Safety Administration (NHTSA). FARS data cover all fatal crashes in the United States. This data source (FARS) was selected for analyses because of the thorough and consistent nature with which the data are collected and reported. These crash data were examined for patterns and trends among the general population and by gender and age. Age groups selected for examination were under 21, 21 to 34, 35 to 54, 55 to 69, and over 70 years of age. These groupings were chosen because of their relevance to various driver policies. For example, the zero tolerance laws target drivers under 21, as does the new graduated license entry system. A possible future graduated driver exit system would most likely be concerned with drivers over 70 years of age.

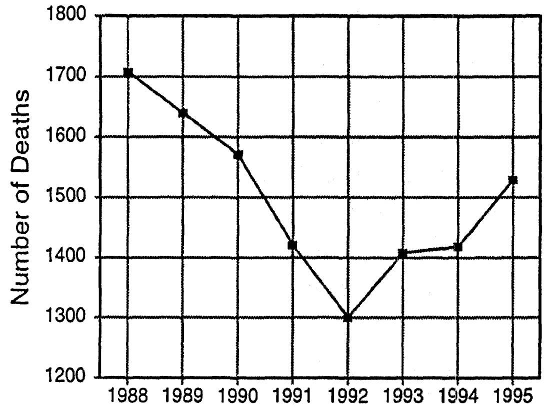
The population fatal crash rate, or the number of fatal crashes per person was calculated so that it could be easily compared with other causes of death from the public health perspective. Fatal crash rates were also determined by licensed driver population and by vehicle miles of travel (VMT) to control for exposure to crash risk. In determining the crash rates by VMT, information obtained from the Michigan Department of Transportation (MDOT) was used for all calculations, except those involving gender and age group classifications. VMT data for age and gender groups were obtained from the National Personal Transportation Study (NPTS).

Statistical Trend Analyses

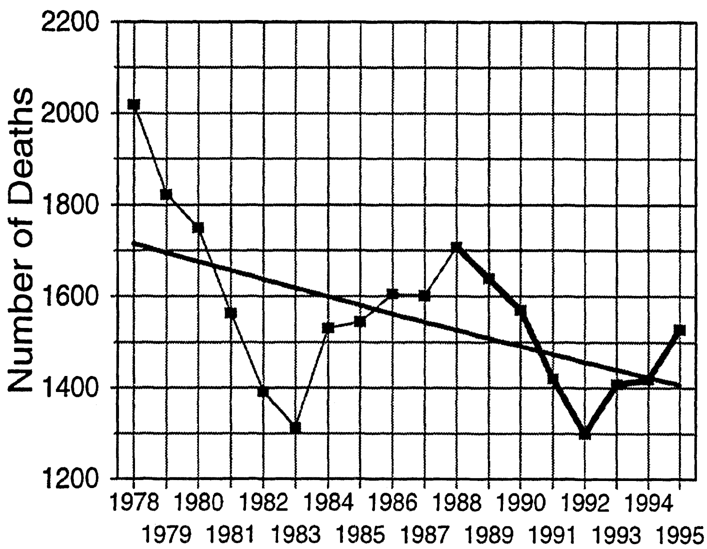
The genesis of this project was the question, Why, after a five-year period of constant decline in the number of persons killed in traffic crashes, did Michigan experience an increase in deaths after 1992? In order to answer this question, we must first determine if there was indeed a meaningful increase in deaths since 1992 accounting for factors known to affect fatality incidence like VMT and economic conditions. If there was a meaningful increase, we need to determine the magnitude and possible explanations for the increase.

The chart to the right shows the number of persons killed in traffic crashes in Michigan during the years 1988-1995. This chart clearly shows a four-year period of declining deaths followed by three years of increased deaths. However, we get a different perspective on the perceived change when we examine a longer time-series of data.

Number of Deaths on Michigan Roads per Year



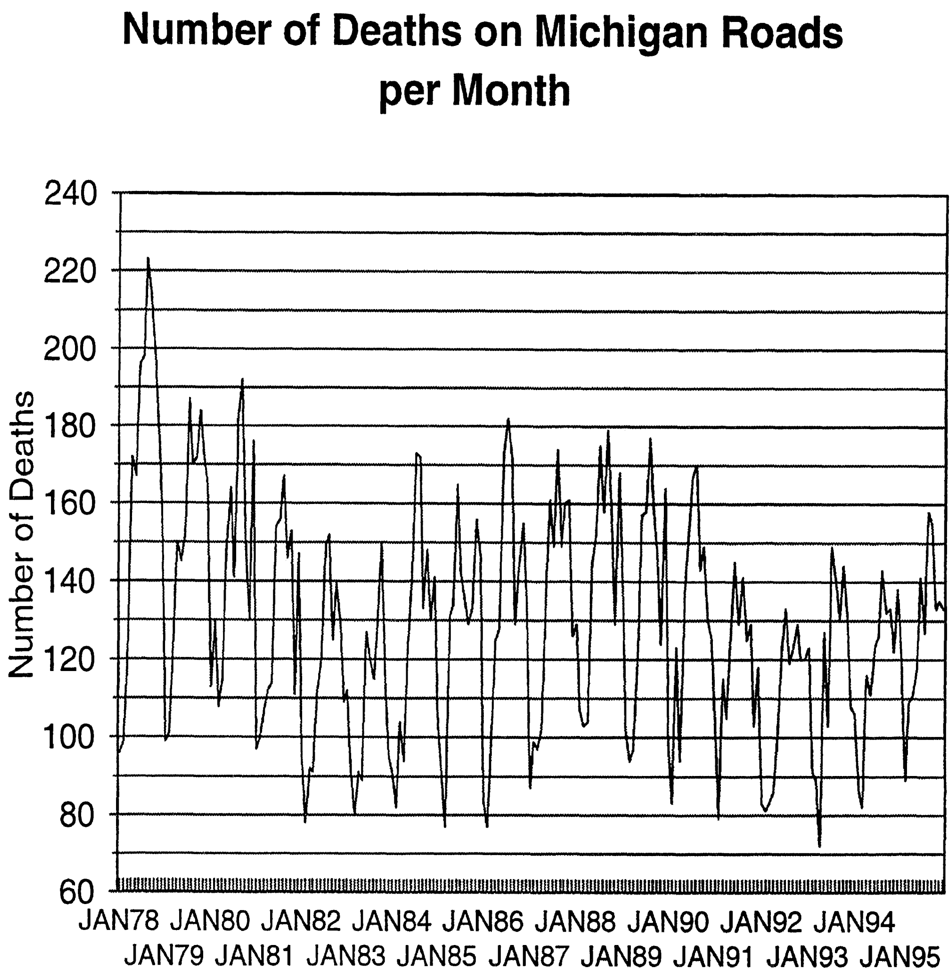
Number of Deaths on Michigan Roads per Year



The chart to the left shows the number of persons killed in traffic crashes each year beginning with 1978. In this longer time-series chart, we can see that the 1988-1995 time slice presented earlier (marked with the thicker line in this chart) may only be part of a long-term downward trend in traffic deaths in Michigan since 1978 (illustrated by the straight line). If this is true, then the perceived upswing in deaths since 1992 is only the result of normal and expected variation around a more general, downward trend.

In order to determine if the perceived increase in deaths since 1992 is within the expected year-to-year variation or is truly an increase that merits concern we must analyze the patterns in the data. Our most effective analysis strategies involve mathematical modeling that requires more data points than are available in the annual data. Therefore, we analyze time-series crash data on a monthly rather than annual basis.

The chart to the right shows monthly traffic crash death frequencies for Michigan 1978-1995. The seasonal variation in the number of persons killed in traffic crashes within each year is quite evident in this chart, but the annual changes that seemed so clear in the earlier charts become more difficult to observe when examined using a monthly time series. Fortunately, we have available to us a set of statistical techniques, generally called time-series analysis, that enable us to accurately model these types of data so we can determine if perceived changes are "real" or are simply part of the expected variation seen from month-to-month, year-to-year.



In order to measure and understand changes in crash death frequencies, we need to know more than the temporal patterns that exist in the crash data alone. We also need to be able to account for several other factors that change and that may have an impact on crash frequency and injury severity. As the amount of travel increases (as measured by VMT or vehicle miles of travel), the opportunity for and subsequent chance of collision also increases. Economic conditions may also have an effect on crash death frequency. A good economy, as measured by low unemployment, will cause increased travel related to business activity (e.g., going to/from work, shipping goods). Furthermore, in good economic times people have more disposable income and engage in more recreational travel. This has an important effect on traffic crash fatalities independent of the effect economic conditions have on VMT because recreational travel is often more hazardous than nonrecreational travel, with an increased likelihood of alcohol-impaired driving, travel on more hazardous rural roads, etc. The amount of alcohol consumed within the state also may affect crash death frequencies through an increase in had-been-drinking crashes that are on average more hazardous than nonalcohol-involved collisions.

As mentioned earlier, time-series analytic techniques allow researchers to explore the temporal patterns seen in the month-to-month data. These techniques also allow us to simultaneously account for multiple additional explanatory variables (VMT, economic conditions and alcoholic beverage consumption). These models also allow us to examine the data to identify changes in expected patterns or trends in the time-series. These expected changes most often occur as the result of a new law or special program (such as the 1992 drunk driving laws). In the case of the current question, we are interested in knowing if the pattern of data for the period 1993-1995 differs from what we would expect given what we know from previous years.

In order to determine if the pattern of data for the period 1993-1995 differs from what we would expect given what we know from previous years, we used Autoregressive Integrated Moving Average (ARIMA) models from a statistical package called the SAS System for Forecasting Time Series. This package first requires us to enter monthly time-series data for each of the variables of interest (i.e., number of crash deaths, VMT, economic conditions, and alcoholic beverage consumption). Next, several statistical time-series models are fit iteratively until the model that best explains the patterns and relationships in the data is found. We then add an additional variable to the model we just selected to determine if the time period of interest differs from what the statistical model would have predicted. This new variable is often called the intervention variable because it most often is used to represent an a priori intervention such as a new traffic safety program or a new law. In our current use, this intervention variable was used to examine if the pattern of data for the period 1993-1995 differs from what was expected.

The final analytic model used (to answer the question about whether the pattern of data for the period 1993-1995 differs from what we would expect given what we know from previous years) included variables to account for the time-series trend, VMT, economic conditions (as measured by the unadjusted unemployment rate), and beverage alcohol sales. The statistical criteria for model fit showed the selected model fit the data well (r-squared=0.62). Based on this model, we found that there was no statistically significant change in crash deaths in Michigan in the period 1993-1995 compared to previous years. Similar models developed for had-been-drinking fatal crashes also failed to find a significant change from pre-1993 levels (additional details for both models can be found in Appendix 1).

The final ARIMA models confirmed that economic conditions as measured by the unadjusted unemployment rate were closely and negatively related to fatal crash incidence. In other words, we found that when unemployment increases, the number of persons killed in fatal crashes decreases and conversely, that when unemployment decreases, the number of persons killed in crashes increases.

"No statistically significant change..." What does that phrase mean? It means that although there is an observable upward trend in crash deaths in the last three years, the increase is not different than what would have been expected based on historical trends, economic conditions, VMT, and alcoholic beverage sales. We cannot say that crash deaths in the state of Michigan have been on the rise significantly since 1993. Such a statement is unsupported by the data.

Fatal Crashes

A brief description of the general layout used within each of the remaining sections of the report is in order. Each section consists of two basic parts. The first part of each section is made up of charts and tables with accompanying text describing the data presented. The second part of each section is an overview of the issues highlighted by the data in the section. These data can be translated into an understanding of what contributes to fatal crashes and how we may be able to prevent these crashes in the future.

Before you begin to explore the data within the following sections, we would like to point out that it is difficult to discern temporal "trends" in a time frame of only three years. Therefore, we advise readers to consider any perceived 3-year trends as speculative and requiring follow-up investigation in subsequent years. Continuing in future years the effort begun in this report will increase the value and meaning of temporal trends identified in the subsequent reports.

Finally, it should be remembered that fatal crashes are only a portion of all the crashes that occur each year. Thus, this report is a useful companion to the Michigan Traffic Crash Facts series of reports that present the overall, comprehensive view of crash patterns in the state of Michigan.

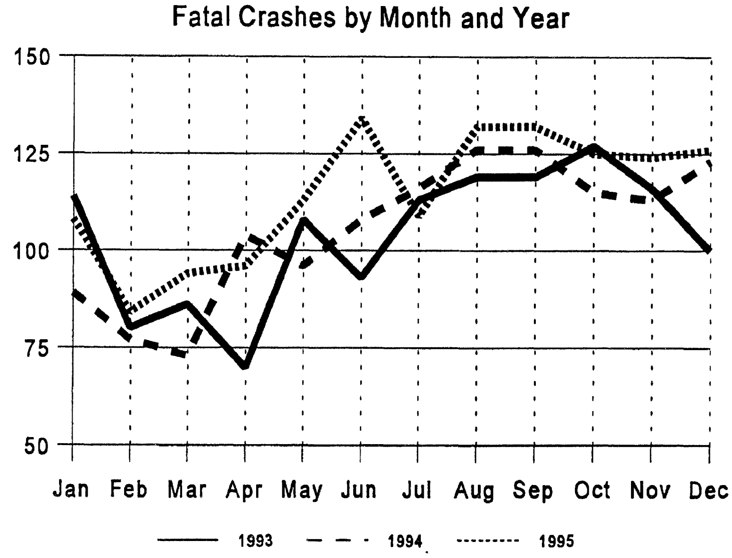
Number and rate

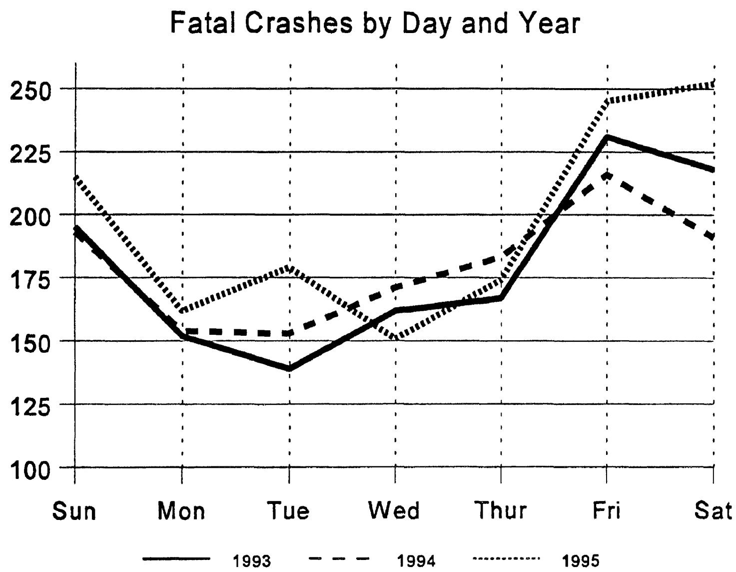
The table below shows the number of fatal crashes, as well as fatal crash rates per million vehicle miles of travel, per one-hundred thousand registered vehicles, per one-hundred thousand persons in the population, and per one-hundred thousand licensed drivers, by year.

Number and Rate of Fatal Crashes					
Year	Number of Fatal Crashes	Rate per 1M VMT	Rate per 100K Registered Vehicles	Rate per 100K Population	Rate per 100K Licensed Drivers
1993	1265	14.76	8.21	13.38	19.40
1994	1261	14.80	7.98	13.29	19.10
1995	1378	16.08	8.54	14.43	20.66

When they occur

The chart to the right shows the distribution of fatal crashes by month. While there are differences among the years, there is no apparent pattern to these differences. There is, however, an overall consistent pattern across the months. The fewest fatal crashes occurred in February, March and April and the most fatal crashes occurred in August, September, October and November.

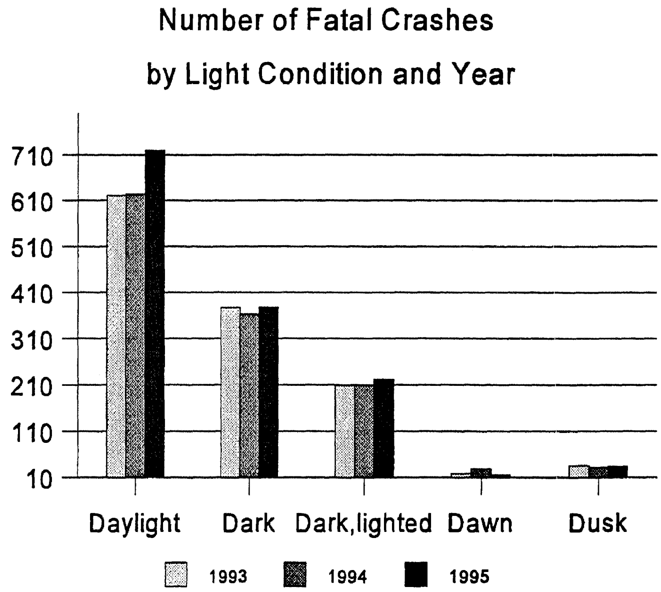




The chart to the left shows that fatal crashes consistently occurred most often on Friday, Saturday, and Sunday.

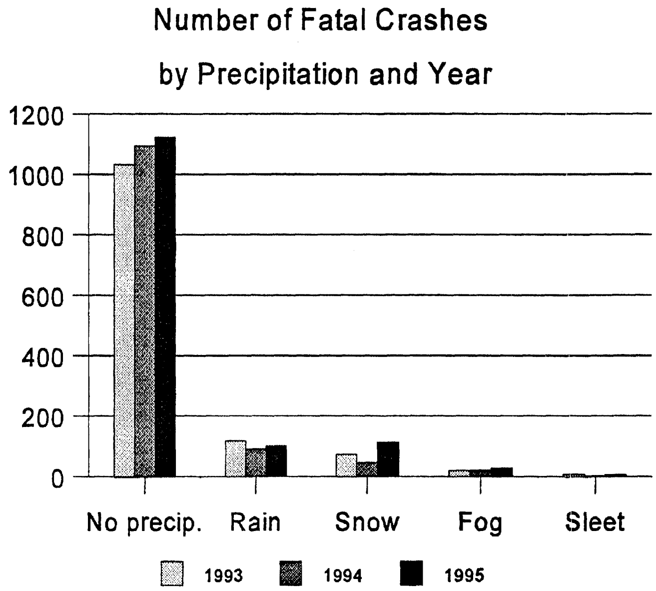
Lighting conditions

It can be seen from the chart on the right that most fatal crashes occurred under daylight conditions. Each year, half of the fatal crashes occurred in daylight, close to 28 percent in dark conditions, 16 percent in dark, but lighted conditions and 5 percent at either dusk or dawn.



Precipitation

The chart to the right shows that fatal crashes occurred most frequently under conditions of no precipitation. Every year approximately 83% of all fatal crashes occurred in no precipitation conditions, about 8 percent in rain, about 6 percent in snow, 2 percent in fog, and less than 1 percent in sleet.

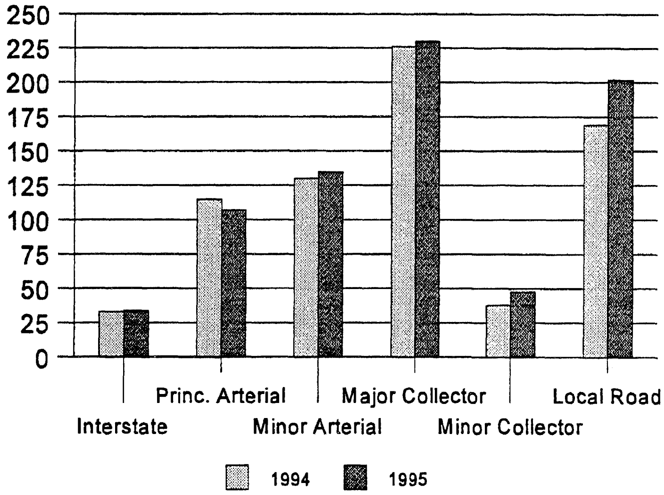


Road classification

About one-half of the fatal crashes in the three year period from 1993 to 1995 occurred on rural roads and half on urban roads. The following charts show the number of fatal crashes on rural and urban roads by road class for the years 1994 and 1995. Much of the data for this classification was missing for 1993 and are not included. An explanation of the road classification categories can be found in Appendix 2.

Number of Fatal Crashes on Rural Roads

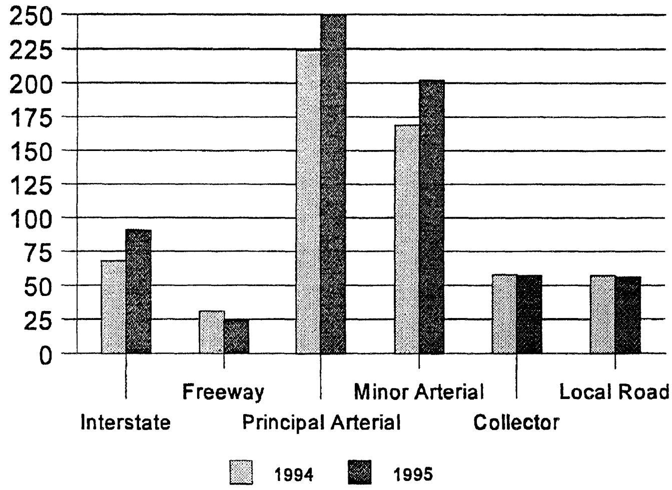
By Road Class and Year



The chart on the left shows that most of the fatal crashes that occurred on rural roads occurred on major collectors and on local roads. The pattern of occurrence by road type is consistent from year to year.

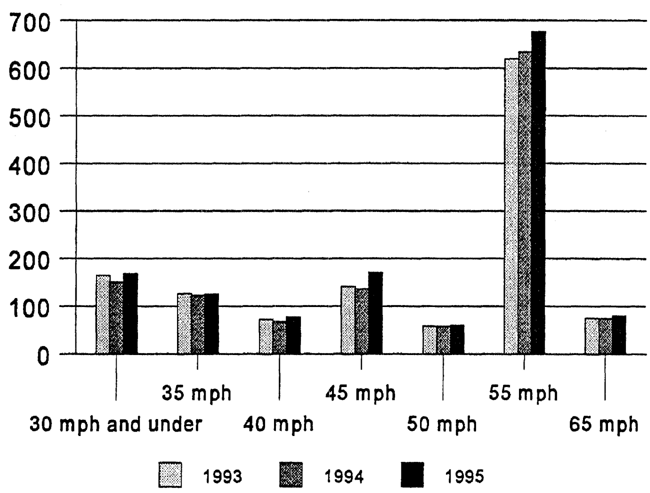
Number of Fatal Crashes on Urban Roads

By Road Class and Year



The chart on the right shows that most of the fatal crashes on urban roadways occurred on arterials. Again, the pattern of occurrence is consistent for the years examined.

Number of Fatal Crashes by Speed Limit and Year



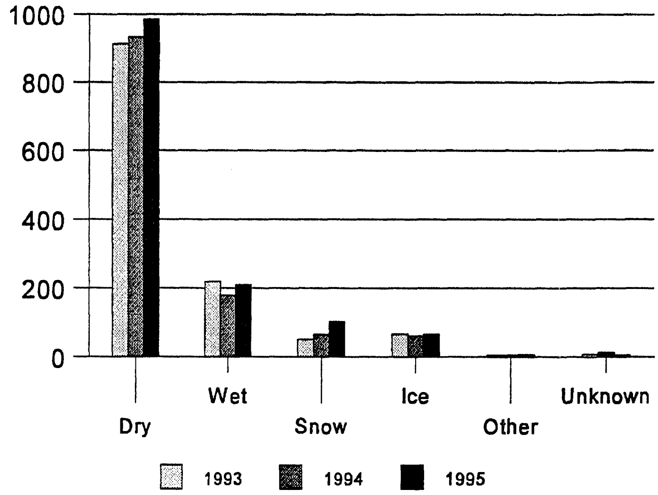
Speed limit

Examining fatal crashes by the speed limit at the location of the crash shows that most of these crashes occurred in speed zones of 55 mph. The pattern of location of fatal crashes by speed limit is consistent across the years examined.

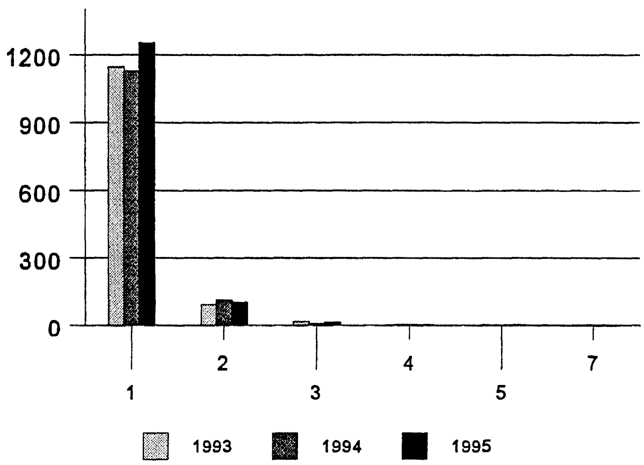
Road condition

There is an overall pattern of fatal crash occurrence by road condition. Just over 70% of the fatal crashes occurred on dry pavement. Between 14% and 17% occurred on wet pavement. About 5% occurred on icy pavement and from 4% to 7% on snowy pavement.

Number Fatal Crashes by Road Surface Condition and Year



Number of Fatal Crashes by Number of Persons Killed and Year



Deaths per crash

In about 90% of the fatal crashes over the three-year period examined, one person was killed per crash. In about 8 percent of the crashes, two people were killed.

Average Number of Injuries in a Fatal Crash by Injury Severity and Year					
Year	Uninjured	Minor	Moderate	Severe	Killed
1993	0.54	0.20	0.29	0.54	1.1
1994	0.61	0.26	0.30	0.47	1.2
1995	0.54	0.27	0.32	0.50	1.1

The table above shows that the average number and severity of injuries in a fatal crash has not changed over the three-year period. It can be seen from this table that for every 10 fatal crashes, approximately 27 persons were involved. Of these, approximately 5 sustained no injuries, two sustained C-level (minor) injuries, 3 sustained B-level (moderate) injuries, five sustained A-level (severe) injuries and about 11 were killed.

Overview

There are few apparent year-to-year trends in the number or rate of fatal crashes in Michigan during 1993 to 1995. Although the time-series statistical analyses described earlier showed that the observed increase in crash deaths from 1993 to 1995 was not greater than we would have predicted based on previous trends, we should be mindful of the fact that the 1995 fatal crash frequency and fatal crash rates are 5-10% higher than in 1993. Whether this finding is a statistical aberration (as is suggested by the results of the earlier reported time-series statistical analyses) or the beginning of a new trend toward higher death counts and/or rates should be examined closely in the future.

Peak months for fatal crashes were fairly consistent from year to year, generally higher in August, September, October, and November. Similarly, peak days for fatal crashes were consistently Friday, Saturday, and Sunday. It is likely that the type of travel occurring during these peak periods differs from that of nonpeak periods. Specifically, these are periods during which a larger proportion of travel is recreational travel which is typically more hazardous than business- and work-related travel. As will be shown in a later section, these periods are also consistent with a higher incidence of had-been-drinking fatal crashes. One implication of these findings for planning targeted enforcement and public information campaigns seems clear. The focus should be on high incident periods, using specialized campaign efforts and materials to emphasize safety during recreational driving trips.

The proportion of fatal crashes that occur on the high speed interstate roads is quite low, considering the high volumes of vehicles that travel on them. In rural areas, most of the fatal crashes occur on major collectors and local roads which tend to be two-lane roads with speed limits of 55 miles per hour. In urban areas, the majority of the fatal crashes occur on arterials, which are the main nonfreeway, high-volume streets in the city. These findings have serious implications for the placement of police road patrols.

Many factors affect decisions made about the placement and activities of police road patrols. One basic conflict regarding placement of patrols is between maintaining safe and legal driving speeds for the largest number of vehicles (or largest proportion of the driving population), and maintaining safe and legal driving speeds on lower-volume roads that have a higher death rate than the more traveled (and safer) interstate highways. Currently, the existing contingencies affecting officer behavior strongly support working the relatively safe interstate highways for a variety of practical (e.g., large numbers of speeding vehicles, high activity levels can be demonstrated), as well as political reasons (e.g., maintaining a federally mandated average speed on the interstates). While these extant contingencies are unlikely to change soon, fatal crash data suggest that increased enforcement attention is warranted for the more hazardous, noninterstate roads in Michigan.

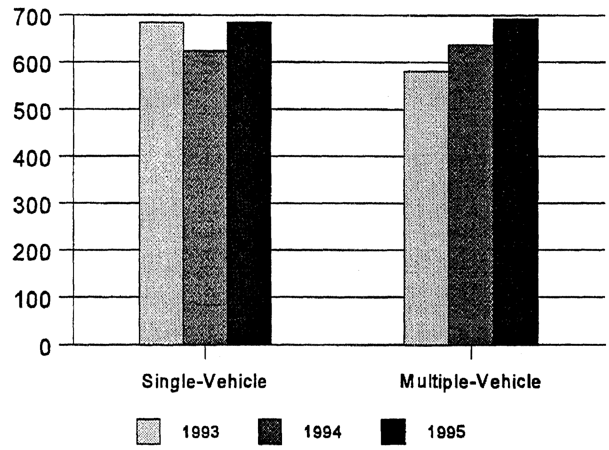
We found that there has been little change in the proportion of crashes that occurred during daylight versus nighttime lighting conditions, and unfortunately no reliable exposure data (e.g., VMT by time of day) exist to permit us to examine specifically the extent to which daylight versus nighttime fatal crash rates differ. On the other hand, we do know that: (1) in general, many more miles are driven during daylight hours than are driven during nighttime hours, and (2) daylight versus nondaylight fatal crashes are distributed about 50-50%. We can, therefore, safely speculate that nighttime driving is more hazardous than daytime driving, adding another factor to the implications for the development and marketing of prevention program efforts.

Vehicles in Fatal Crashes

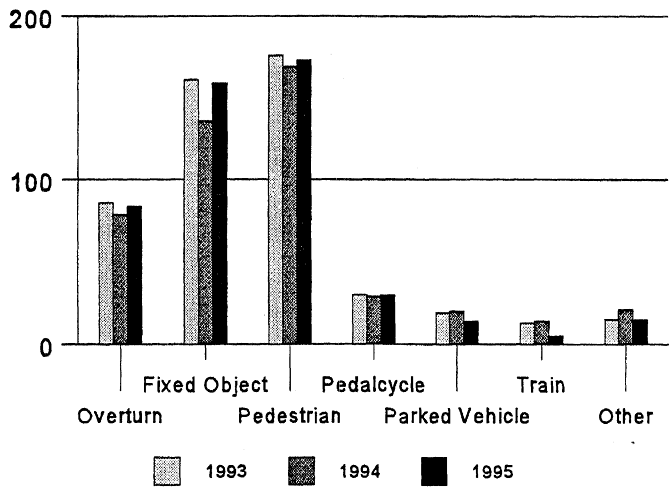
Single-vehicle involvement

The chart to the right shows the numbers of fatal single-vehicle and multivehicle crashes. In 1994 and 1995, the number of single vehicle and multiple vehicle fatal crashes were about the same. In 1993, there were slightly more single-vehicle fatal crashes than multivehicle fatal crashes.

Number of Single and Multiple Vehicle Fatal Crashes by Year



Number of Single Vehicle Fatal Crashes by Type and Year



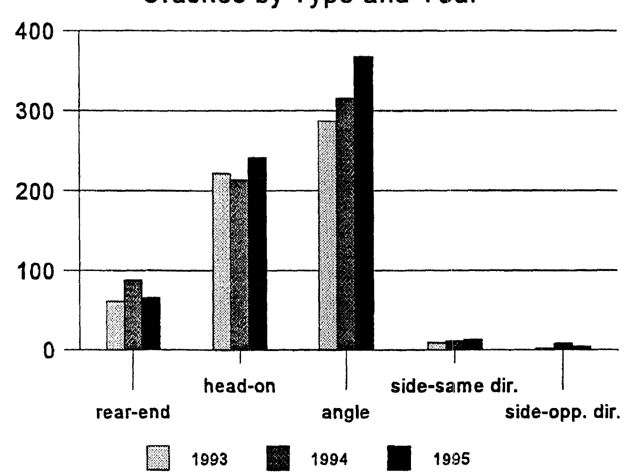
Single-vehicle crash configuration

There is a consistent pattern in the types of single-vehicle fatal crashes in the three years examined. Collisions with pedestrians and with fixed objects accounted for most of these crashes, followed in frequency by overturns.

Multiple-vehicle crash configuration

The chart to the right shows fatal multivehicle crashes by the type of collision. The pattern over the three years is consistent, with angle collisions accounting for about one-half and head-on collisions accounting for approximately one-third of the fatal multivehicle crashes each year.

Number of Fatal Multiple Vehicle Crashes by Type and Year



Vehicle body type

Number and Rate of Fatal Crashes by Vehicle Body Type and Year			
Year	Body Type	Number of Fatal Crashes	Rate per 1,000 Registered Vehicles
1993	Car	1208	0.226
1994		1195	0.220
1995		1282	0.232
1993	Pickup	283	0.267
1994		312	0.281
1995		368	0.318
1993	Motorcycle	56	0.496
1994		71	0.606
1995		83	0.697
1993	Heavy Truck	111	1.052
1994		173	1.617
1995		162	1.515

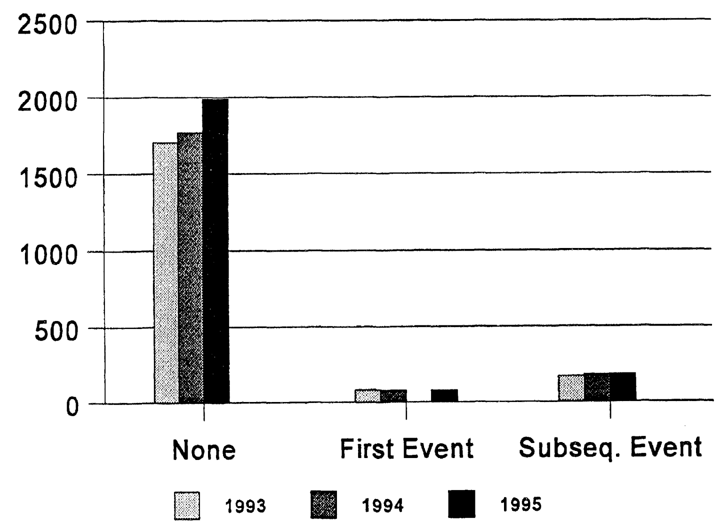
As can be seen in the table to the left, the number and rate of fatal crashes involving cars has changed little since 1993. Fatal crashes involving heavy trucks increased considerably between 1993 and 1994, but remained about the same in 1995. The number and rate of fatal crashes involving pickup trucks and the number and rate of fatal crashes involving motorcycles have each increased steadily since 1993.

Rollover

Twelve percent of vehicles involved in fatal crashes experienced a rollover. In 4% of the cases the rollover was the first event in the crash. In 8% of the cases the rollover was a subsequent event.

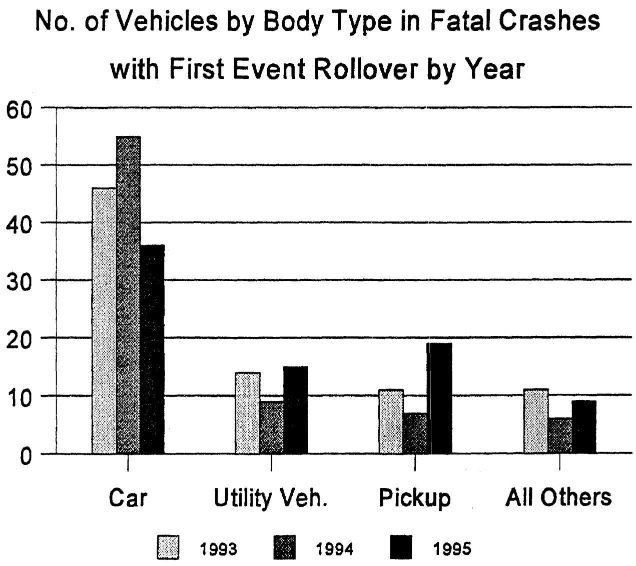
No. of Vehicles in Fatal Crashes

by Rollover Occurrence and Year



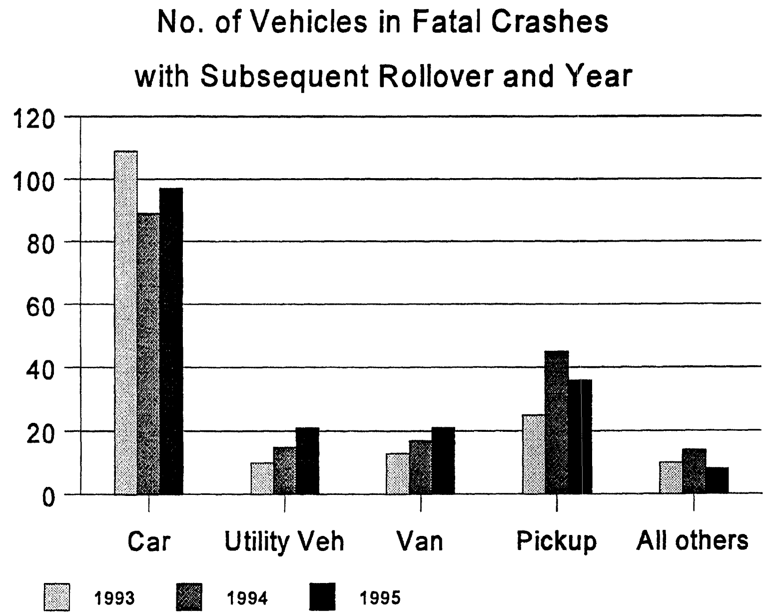
First-event rollovers by vehicle body type

Approximately 80 vehicles per year, involved in a fatal crash, experienced a rollover as a first event of the crash. The car vehicle body type accounted for about 68% of these first-event rollovers. Utility vehicles and pickups accounted for close to 16% each over the three-year period. Very few vans were involved in first-event rollovers and are included in the "all others" category.



Subsequent-event rollovers by body type

There were about 175 vehicles each year involved in fatal crashes where a rollover occurred as a subsequent event. Cars accounted for about one-half of the subsequent-event rollovers, utility-vehicle bodies for about 10%, vans for about 10% and pickups for 20%.



Overview

Results presented in this section show that about half of the fatal crashes involved a single vehicle and about half involved multiple vehicles. This finding has remained steady since 1993. When a single vehicle was involved in a fatal crash, the vehicle was most likely to strike a pedestrian or a fixed object. One strategy to reduce the toll exacted by these types of single-vehicle crashes is to increase the separation between vehicles and pedestrians/fixed objects. We see this strategy used on interstate highways and intercity parkways with pedestrian bridges. Obviously this solution can be quite expensive and is not feasible for many locations. Pedestrian deaths may also be reduced through the implementation of programs designed to increase awareness of the serious nature of the issue with both drivers and pedestrians. Perhaps the best way to protect persons involved in single-vehicle collisions with fixed objects or overturn crashes is to promote safety belt use, thus decreasing the probability of ejection or striking parts of the vehicle interior in an overturn or fixed object collision.

The number and rate of fatal crashes per registered vehicle has increased steadily for both motorcycles and pickup trucks since 1993. As was stated earlier, using only three years to detect a trend must be done with caution, but the trends for these two vehicle body types may be sufficient to warrant attention in the near future, and should be monitored closely. The source of these possible changes is unclear; however, perhaps the most direct way to influence the death rate for these vehicle types is to continue to promote motorcycle helmet use and safety belt use among users of these vehicle types. Indeed, pickup truck occupants have historically had the lowest belt use rates of any vehicle type, making this group a prime target for intervention.

Since 1993, rollovers have occurred in about 12% of fatal crashes. While the number and proportion of rollovers in fatal crashes varies between vehicle body types and years, there is little systematic variation. Regardless of the vehicle type, the best way to protect occupants involved in a rollover crash is to ensure that they are using the safety belt available to them in their seating position.

Drivers in Fatal Crashes

Number and rate

Number and Rate of Fatal Crashes by Driver Gender, Age Group, and Year						
Year	Driver Gender	Age Group	Number of Fatal Crashes	Rate per 10K Licensed Drivers	Rate per 100M VMT	Rate per 10K Population
1993	Male	16-20 years	205	7.58	7.33	6.14
1994			229	8.46	7.96	6.86
1995			205	7.48	6.86	6.05
1993	Female	16-20 years	72	2.86	3.49	2.21
1994			85	3.34	3.94	2.61
1995			115	4.42	5.04	3.49
1993	Male	21-34 years	505	5.31	2.88	5.01
1994			543	5.76	3.08	5.49
1995			549	5.91	3.10	5.65
1993	Female	21-34 years	176	1.84	1.77	1.71
1994			154	1.63	1.52	1.51
1995			178	1.92	1.75	1.78
1993	Male	35-54 years	425	3.46	1.88	3.35
1994			461	3.66	1.95	3.55
1995			537	4.16	2.18	4.02
1993	Female	35-54 years	169	1.35	1.30	1.29
1994			171	1.33	1.24	1.27
1995			213	1.62	1.47	1.54
1993	Male	55-69 years	133	2.60	1.41	2.49
1994			130	2.54	1.36	2.45
1995			151	2.93	1.54	2.85
1993	Female	55-69 years	58	1.11	1.06	0.97
1994			48	0.92	0.86	0.81
1995			59	1.12	1.02	1.00

1993	Male	70+ years	106	3.86	3.96	3.48
1994			107	3.75	3.77	3.43
1995			125	4.22	4.15	3.92
1993	Female	70+ years	58	1.88	3.82	1.18
1994			66	2.06	4.12	1.32
1995			75	2.24	4.45	1.49

The table above shows that among drivers, females age 16-20, males age 21-54, and females age 70+ each had numbers of fatal crashes and fatal crash rates that increased steadily since 1993. Although no consistent temporal trend in the data can be seen, males age 16-20 consistently had the highest rates of fatal crash involvement among the groups examined by a factor of about 2 to 1.

License status

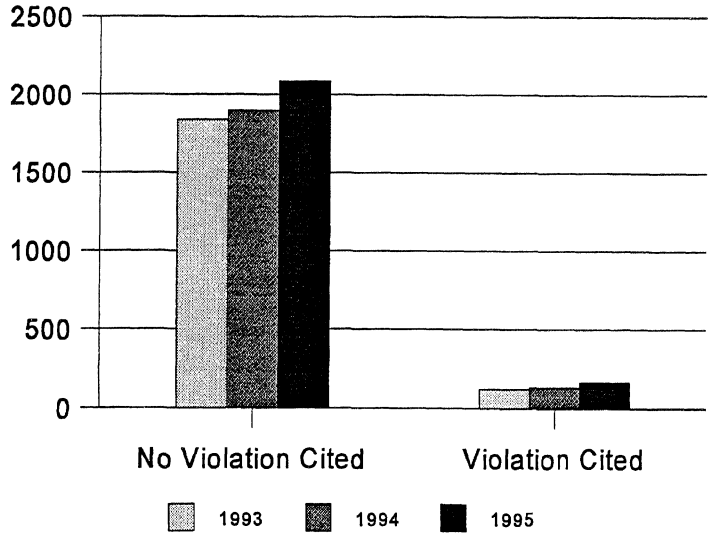
Number of Fatal Crashes by Driver Gender, Age Group, License Status, and Year							
Year	Gender	Age Group	Valid	Expired	Revoked	Suspended	No License
1993	Male	16-20 years	175	1	0	11	16
1994			209	0	0	10	10
1995			179	2	1	10	12
1993	Female	16-20 years	70	0	0	2	0
1994			81	0	0	1	2
1995			107	0	0	4	4
1993	Male	21-34 years	414	41	2	30	11
1994			453	37	6	21	15
1995			474	22	1	27	19
1993	Female	21-34 years	163	6	0	2	3
1994			140	5	0	7	1
1995			166	4	1	4	1
1993	Male	35-54 years	373	23	3	11	7
1994			415	21	3	6	4
1995			467	26	3	27	7
1993	Female	35-54 years	162	5	0	1	1
1994			167	1	0	0	2
1995			201	4	0	4	3
1993	Male	55-69 years	126	2	0	1	0
1994			124	2	0	1	3
1995			143	4	1	2	0
1993	Female	55-69 years	54	2	0	0	0
1994			48	0	0	0	0
1995			56	0	0	2	1
1993	Male	70+ years	102	2	0	0	0
1994			104	1	0	0	0

1995			122	1	0	2	0
1993	Female	70+ years	56	1	0	1	0
1994			66	0	0	0	0
1995			75	0	0	0	0

The table above shows no apparent temporal trends in the data from 1993 to 1995. Driving without a license or on an invalid license is consistently much more prevalent among male drivers than female drivers.

Violations cited

No. of Drivers in Fatal Crashes by Violation Citation Occurrence and Year



Over 90% of drivers involved in fatal crashes were not charged with any violation. This pattern is consistent over the 3-year period. In the remaining cases, drivers were cited with some violation, however, there is no pattern in the types of violations cited.

Overview

Among drivers, females age 16-20, males age 21-54, and females age 70+ each had numbers of fatal crashes and fatal crash rates that have increased steadily since 1993. These trends should be carefully tracked in subsequent years to determine if these patterns continue. Although no consistent temporal trend in the data can be seen, males age 16-20 consistently had the highest rates of fatal crash involvement among the groups examined by a factor of about 2 to 1, making them a prime target group for immediate prevention intervention.

While it is true that most drivers involved in fatal crashes are driving with a valid license, over 10% of the male drivers age 16-69 involved in fatal crashes were driving without a valid license. There is no temporal trend to these findings, but these figures are sufficiently troubling to warrant continued scrutiny and committed prevention efforts.

Among the most frustrating findings was the fact that over 90% of drivers involved in fatal crashes were not charged with any violation. There has been no real change in this proportion since 1993, but given the serious nature of the crash outcomes experienced, we would have expected to have seen a larger proportion of drivers cited for violating some traffic law leading to the collision.

Persons Killed in Crashes

Seating position -- Number and rate

Number and Rate of Fatal Injuries by Occupant Position and Year			
Year	Occupant Position	Number of Deaths	Rate per 100K Population
1993	Driver	843	8.914
1994		852	8.976
1995		919	9.624
1993	Front Center	11	0.116
1994		8	0.084
1995		9	0.094
1993	Front Right	214	2.262
1994		218	2.297
1995		249	2.607
1993	Rear Left	43	0.455
1994		40	0.421
1995		36	0.377
1993	Rear Center	13	0.137
1994		18	0.190
1995		10	0.105
1993	Rear Right	38	0.402
1994		41	0.432
1995		51	0.534

As can be seen in the table to the left, Michigan has experienced small but consistent upward trends in the number and rate of fatal injury among drivers, front-right passengers, rear-right passengers and since 1993.

Number and Rate of Fatal Injuries Among Pedestrians		
Year	Number of Deaths	Rate per 100K Population
1993	215	2.273
1994	217	2.286
1995	220	2.304

The table on the left shows that the number and rate of pedestrian fatalities has been relatively stable over the three-year period examined.

Gender and age -- Number and rate

Number and Rate of Fatal Injuries by Gender, Age Group, and Year						
Year	Gender	Age Group	Number of Vehicle Occupant Deaths	Rate per 10K Population	Number of Pedestrian Deaths	Rate per 10K Population
1993	Male	0-4 years	6	0.16	2	0.05
1994			14	0.39	8	0.22
1995			18	0.52	1	0.03
1993	Female	0-4 years	10	0.29	0	0.00
1994			14	0.41	4	0.11
1995			9	0.27	2	0.06
1993	Male	5-15 years	27	0.34	13	0.16
1994			35	0.44	12	0.15
1995			26	0.32	13	0.16
1993	Female	5-15 years	31	0.41	8	0.11
1994			25	0.33	7	0.09
1995			32	0.42	10	0.13
1993	Male	16-20 years	111	3.32	4	0.12
1994			149	4.46	14	0.41
1995			117	3.45	8	0.23
1993	Female	16-20 years	51	1.56	3	0.09
1994			55	1.69	4	0.12
1995			86	2.61	3	0.09
(continued on next page)						

Number and Rate of Fatal Injuries by Gender, Age Group, and Year (continued)						
Year	Gender	Age Group	Number of Vehicle Occupant Deaths	Rate per 10K Population	Number of Pedestrian Deaths	Rate per 10K Population
1993	Male	21-34 years	274	2.72	36	0.36
1994			249	2.52	28	0.28
1995			260	2.68	26	0.27
1993	Female	21-34 years	106	1.03	12	0.12
1994			88	0.86	6	0.06
1995			105	1.05	16	0.16
1993	Male	35-54 years	190	1.50	47	0.37
1994			191	1.47	30	0.23
1995			220	1.65	44	0.33
1993	Female	35-54 years	97	0.74	14	0.11
1994			96	0.71	13	0.10
1995			111	0.80	19	0.14
1993	Male	55-69 years	73	1.37	10	0.19
1994			68	1.28	15	0.28
1995			73	1.38	19	0.36
1993	Female	55-69 years	50	0.84	3	0.05
1994			49	0.82	9	0.15
1995			55	0.93	5	0.08
1993	Male	70+ years	92	3.02	15	0.49
1994			83	2.66	18	0.58
1995			95	2.98	19	0.60
1993	Female	70+ years	75	1.53	17	0.34
1994			86	1.73	13	0.26
1995			103	2.04	2	0.04

The first part of the table on the previous page shows a small but steady increase in fatal injury frequency and rates among males age 0-4 and a larger increase among females age 16-20 since 1993. We can also see that the number and rate of fatal injuries has increased steadily among females over age 55 since 1993.

There is a small increase in the number and rate of fatalities among male pedestrians over the age of 55 over the three-year period between 1993 and 1995. There are no consistent trends obvious in the numbers and rates of pedestrian fatalities for the other groups of pedestrians. However, the numbers and rates of fatalities for males are higher than for females in each age group.

Overview

Michigan has experienced small, consistent increases in the number and rate of fatal injury among drivers, front-right passengers and rear-right passengers. Small, steady increases were also noted among males age 0-4, females age 16-20, and females over age 55. While each of these changes is small, it will be important to continue to monitor these statistics to assist with selecting target populations for future program efforts.

Special Topics

Had-Been-Drinking Fatal Crashes

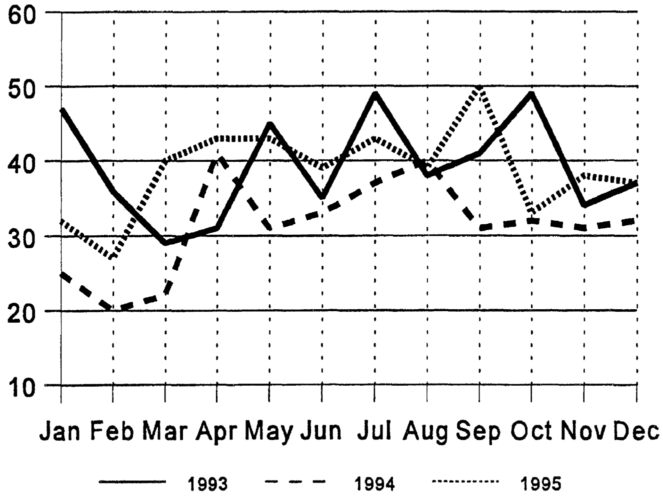
About a third of all fatal crashes in Michigan from 1993 through 1995 were classified as had-been-drinking (HBD) crashes. As can be seen in the tables below, the number of HBD crashes, HBD crash rates, as well as the number and rate at which persons were killed in HBD crashes were about the same for 1993 and 1995, but were noticeably lower for 1994.

Numbers and rates

Number and Rate of HBD Fatal Crashes by Year						
Year	Number of HBD Crashes	Rate per 1M VMT	Rate per 100K Registered Vehicles	Rate per 100K Population	Rate per 100K Licensed Drivers	Rate per 1M Gallons of Alcoholic Beverages Sold
1993	471	5.50	6.87	4.98	7.22	2.00
1994	375	4.40	5.35	3.95	5.68	1.61
1995	464	5.41	6.51	4.86	6.95	1.99

Number and Rate of Persons Killed in HBD Fatal Crashes by Year			
Year	Number of Persons Killed	Rate per 100K Population	Rate per 1M Gallons of Alcoholic Beverages Sold
1993	526	5.56	2.24
1994	422	4.44	1.81
1995	519	5.43	2.22

Number of Had-Been-Drinking
Fatal Crashes By Month and Year

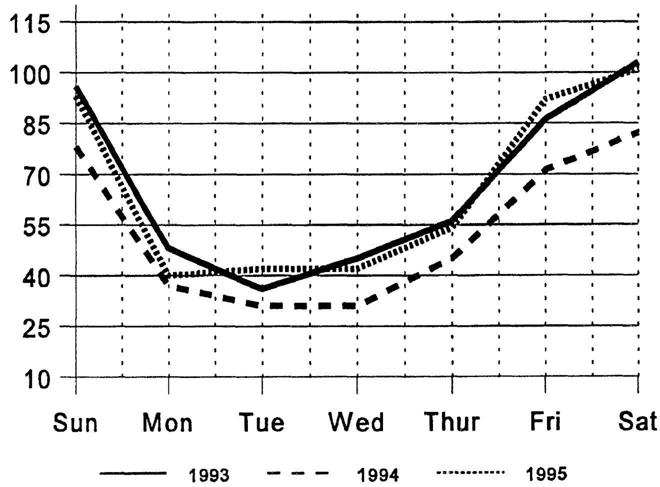


When they occur

As can be seen in the chart to the left, there are differences from year to year, but these differences have no apparent pattern. Overall, HBD crashes were at their lowest levels in the months of November through March and at their highest levels during April through October.

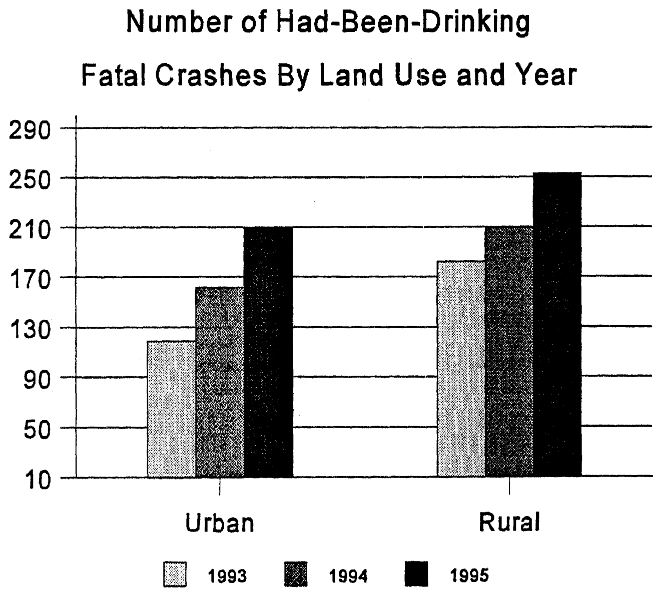
The chart to the right shows that HBD crashes consistently occurred most often on Friday, Saturday, and Sunday.

Number of Had-Been-Drinking
Fatal Crashes By Day and Year



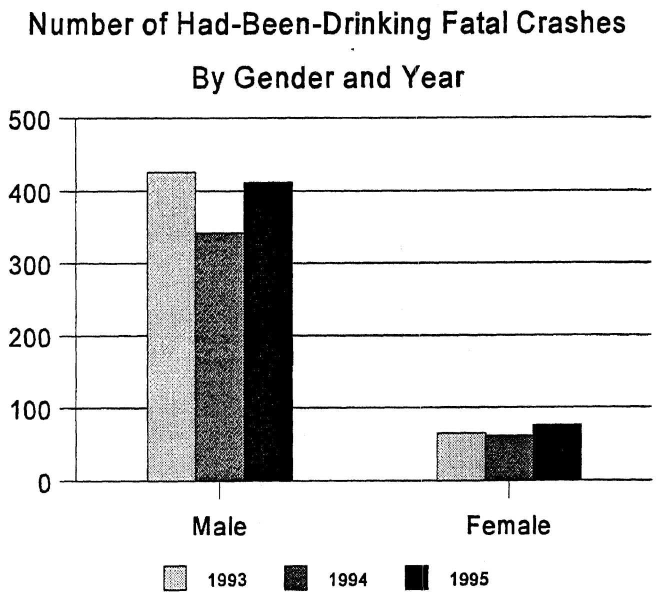
Road classification

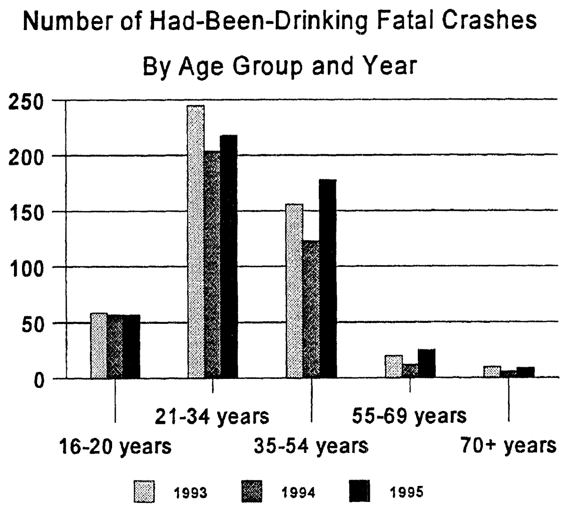
The chart to the right shows not only that HBD fatal crashes occurred most often in rural areas, but also that the difference in the frequency of urban versus rural HBD fatal crashes has declined a little between 1993 and 1995.



Driver characteristics

The proportion of HBD female drivers involved in fatal crashes has increased slightly since 1993.





The distribution of HBD drivers by age group has changed little since 1993.

The table below shows a small but steady decrease in the number and rate of HBD fatal crashes among male drivers in the 16-20 year age category. It also shows a small but steady increase in HBD fatal crash involvements among females in the 16-20 and in the 35-54 year age groups. No other trends are discernable.

Number and Rate of Fatal Crashes Involving HBD Drivers by Gender, Age Group, and Year						
Year	Driver Gender	Driver Age Group	Number of HBD Crashes	Rate per 100 Million VMT	Rate per 100K Licensed Drivers	Rate per 100K Population
1993	Male	16-20 years	54	1.93	19.98	16.16
1994			47	1.63	17.36	14.07
1995			46	1.54	16.78	13.57
1993	Female	16-20 years	5	0.24	1.98	1.53
1994			10	0.46	3.92	3.07
1995			11	0.48	4.23	3.34
1993	Male	21-34 years	210	1.20	22.07	20.83
1994			181	1.03	19.21	18.31
1995			184	1.04	19.80	18.94
1993	Female	21-34 years	35	0.35	3.67	3.41
1994			23	0.23	2.44	2.26
1995			34	0.33	3.67	3.40
1993	Male	35-54 years	136	0.60	11.08	10.73
1994			98	0.42	7.77	7.54
1995			149	0.61	11.54	11.14
1993	Female	35-54 years	20	0.15	1.60	1.53
1994			25	0.18	1.94	1.86
1995			29	0.20	2.20	2.10
1993	Male	55-69 years	17	0.18	3.32	3.18
1994			10	0.10	1.95	1.88
1995			23	0.23	4.47	4.34
1993	Female	55-69 years	3	0.06	0.57	0.50
1994			2	0.04	0.38	0.34
1995			2	0.03	0.38	0.34

1993	Male	70+ years	9	0.34	3.28	2.95
1994			6	0.21	2.10	1.92
1995			9	0.30	3.04	2.82
1993	Female	70+ years	1	0.07	0.33	0.20
1994			0	0.00	0.00	0.00
1995			0	0.00	0.00	0.00

As shown in the table below, there are no real trends in license status of drivers for any of the gender and age group categories.

Number of Fatal Crashes Involving HBD Drivers by Gender, Age Group, License Status, and Year							
Year	Driver Gender	Driver Age Group	Valid	Expired	Revoked	Suspended	None
1993	Male	16-20 years	44	1	0	4	5
1994			38	0	0	5	4
1995			37	1	0	4	4
1993	Female	16-20 years	5	0	0	0	0
1994			9	0	0	1	0
1995			9	0	0	0	2
1993	Male	21-34 years	152	29	2	19	6
1994			140	21	4	8	7
1995			142	14	1	18	8
1993	Female	21-34 years	31	2	0	1	1
1994			18	1	0	4	0
1995			31	1	1	0	1
1993	Male	35-54 years	114	9	3	4	6
1994			78	13	3	1	1
1995			109	18	3	17	2
1993	Female	35-54 years	17	2	0	1	0
1994			25	0	0	0	0
1995			25	2	0	1	1
1993	Male	55-69 years	17	0	0	0	0
1994			10	0	0	0	0
1995			20	1	1	1	0
1993	Female	55-69 years	2	1	0	0	0
1994			2	0	0	0	0
1995			2	0	0	0	0
1993	Male	70+ years	7	1	0	0	0

1994			6	0	0	0	0
1995			8	0	0	1	0
1993	Female	70+ years	0	0	0	1	0
1994			0	0	0	0	0
1995			0	0	0	0	0

As shown in the table below, there are no real trends in vehicle ownership of drivers for any of the gender and age group categories except for males age 21-34 where the number of HBD fatal involvements in vehicles *not* owned by the driver has steadily decreased over the three-year time period.

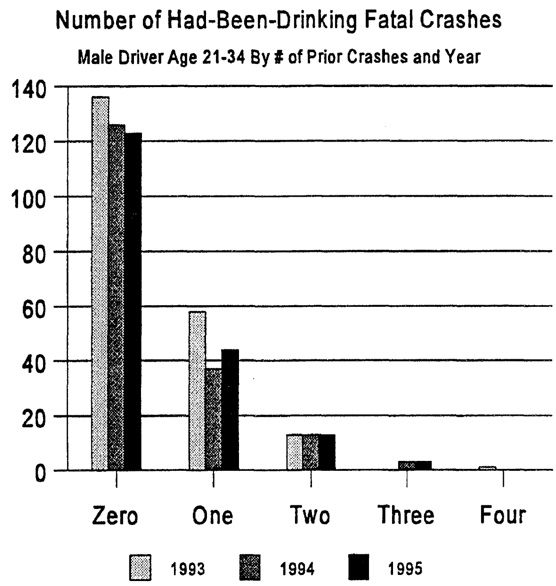
Number of Fatal Crashes Involving HBD Drivers by Gender, Age Group, Vehicle Ownership, and Year							
Year	Driver Gender	Driver Age Group	Not Registered	Driver Owned	Driver not Owner	Business	Rental
1993	Male	16-20 yrs.	0	20	26	3	0
1994			0	12	31	0	1
1995			2	15	27	1	0
1993	Female	16-20 yrs.	0	1	2	0	0
1994			0	0	9	0	0
1995			0	5	6	0	0
1993	Male	21-34 years	4	109	74	3	1
1994			4	89	63	12	2
1995			2	104	55	4	1
1993	Female	21-34 years	0	21	13	0	0
1994			1	11	10	0	0
1995			0	19	11	1	0
1993	Male	35-54 years	5	75	40	6	0
1994			1	59	29	3	1
1995			1	93	41	4	1
1993	Female	35-54 years	0	10	8	0	0
1994			0	15	4	1	0
1995			0	17	10	0	0
1993	Male	55-69 yrs.	1	12	3	1	0
1994			0	8	1	1	0
1995			0	17	3	1	0
1993	Female	55-69 yrs.	0	0	2	0	0
1994			0	2	0	0	0
1995			0	0	2	0	0

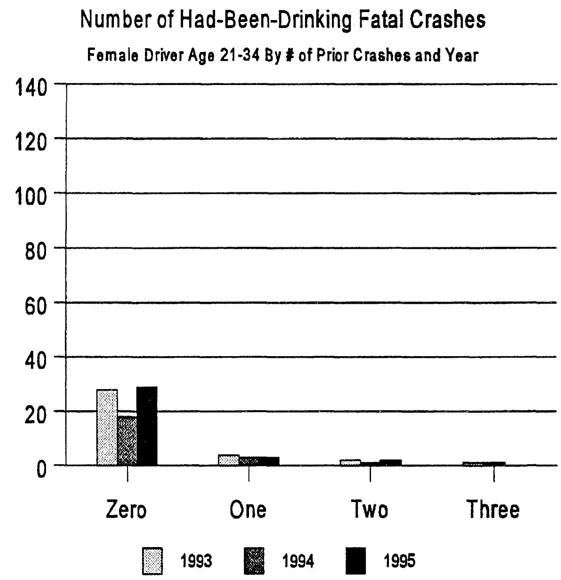
1993	Male	70+ yrs.	0	6	1	0	0
1994			0	5	1	0	0
1995			0	7	1	0	0
1993	Female	70+ yrs.	0	1	0	0	0
1994			0	0	0	0	0
1995			0	0	0	0	0

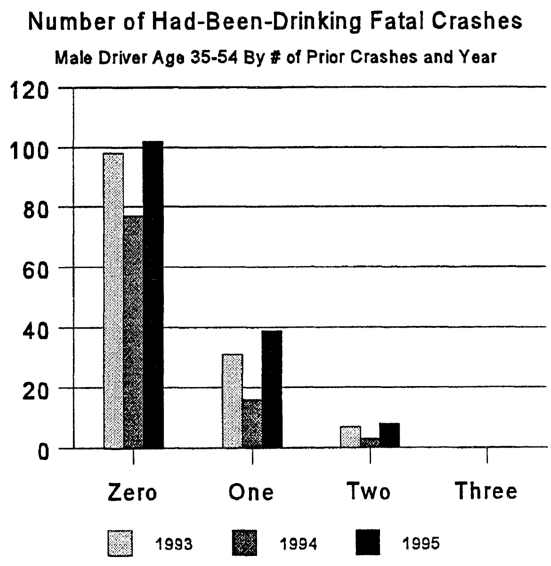
The following section examines HBD fatal crashes of drivers over 21 years of age by prior crashes, suspensions, prior DWIs and violations by four distinct age categories and gender. Young driver (16-20 year old) HBD fatal crashes are described in a later section.

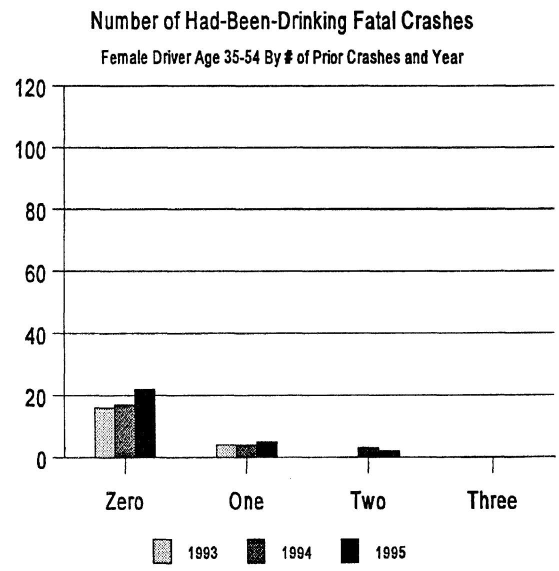
Please note that the data on prior convictions are gathered from Michigan's driver history files. These files maintain alcohol-impaired driving convictions for ten years after the conviction and most other convictions for seven years after the conviction.

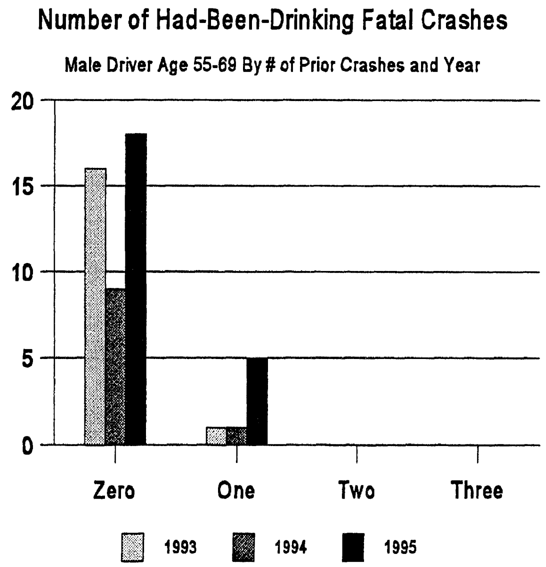
The following series of charts shows that most drivers had no crashes prior to the HBD-fatal crash reported here, although among all men the percentage with prior crashes is about 30% and, among women between 21 and 54 years of age, the percentage with prior crashes is closer to 20%. Among women age 55 and above prior crash history is negligible.

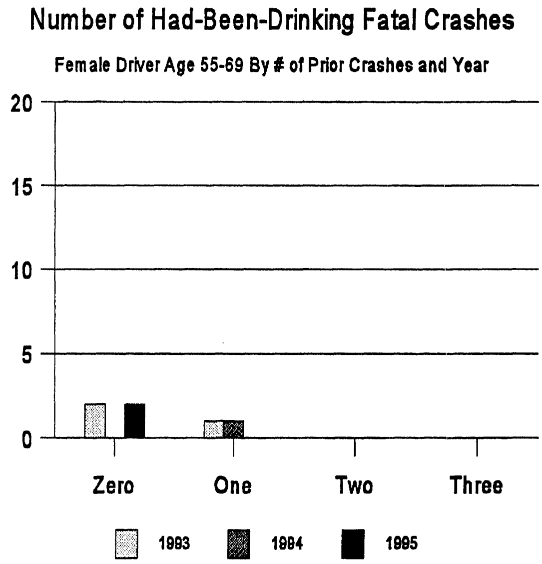


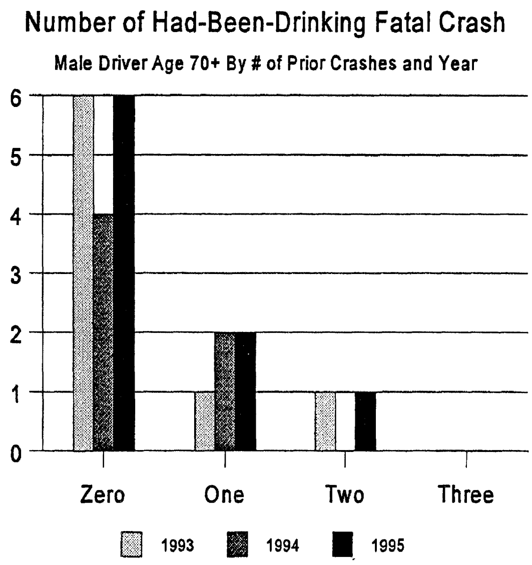


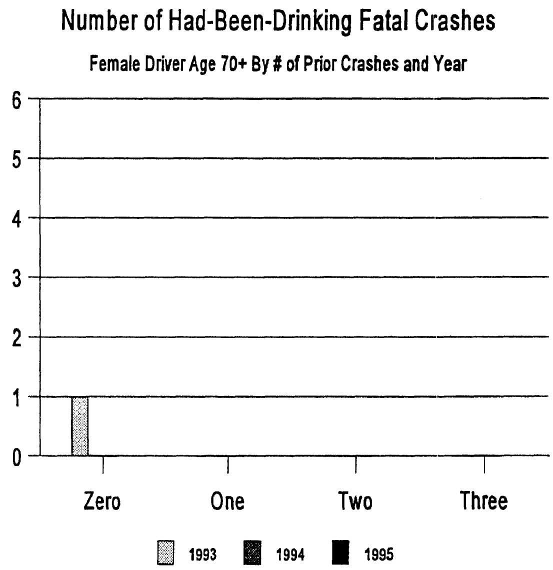




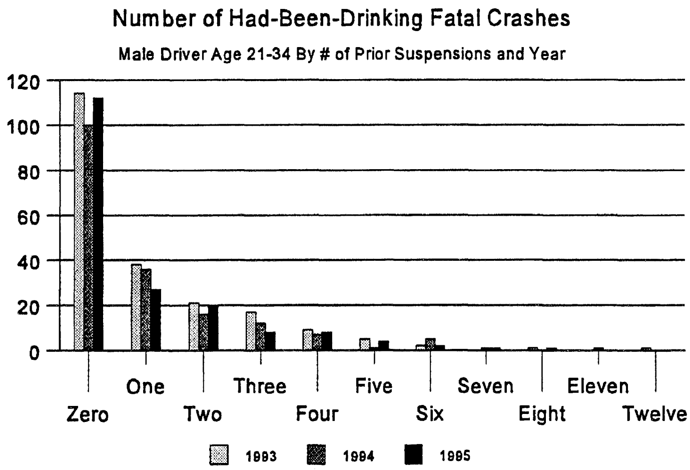

Number of Had-Been-Drinking Fatal Crashes
Male Driver Age 55-69 By # of Prior Crashes and Year
20
15
10
5
0
Zero
One
Two
Three
1993
1994
1995

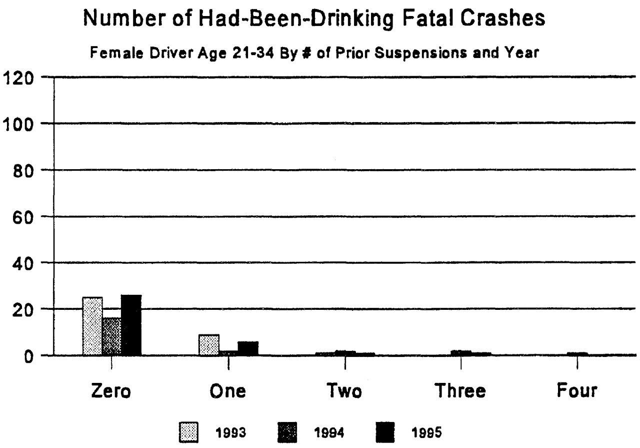

Number of Had-Been-Drinking Fatal Crashes
Female Driver Age 55-69 By # of Prior Crashes and Year
20
15
10
5
0
Zero
One
Two
Three
1993
1994
1995

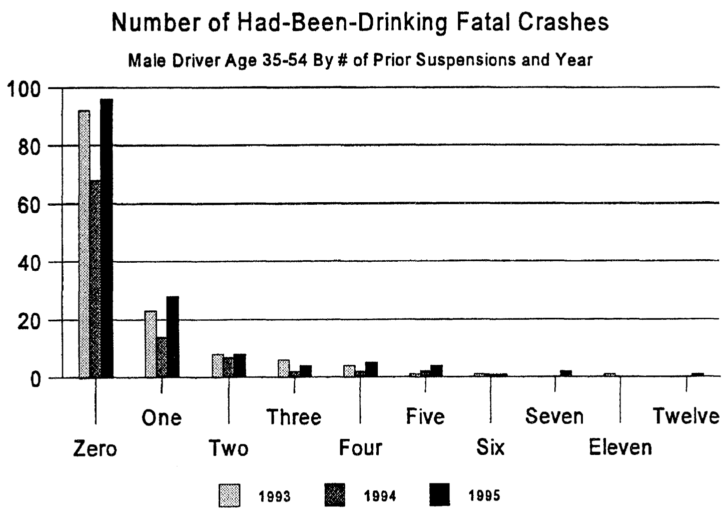

Number of Had-Been-Drinking Fatal Crash
Male Driver Age 70+ By # of Prior Crashes and Year
6
5
4
3
2
1
0
Zero
One
Two
Three
1993
1994
1995

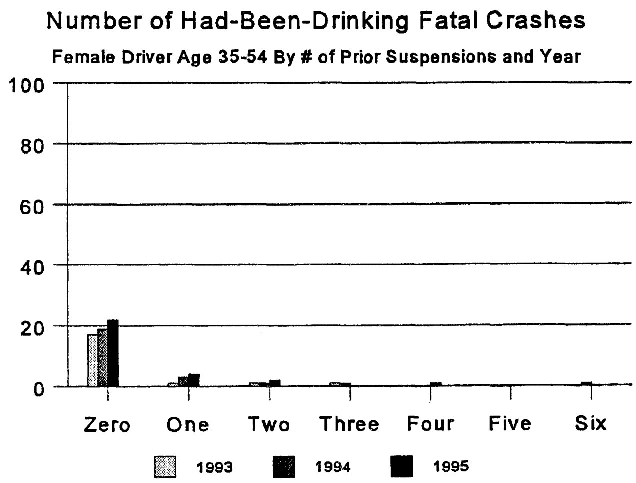

Number of Had-Been-Drinking Fatal Crashes
Female Driver Age 70+ By # of Prior Crashes and Year
6
5
4
3
2
1
0
Zero
One
Two
Three
1993
1994
1995

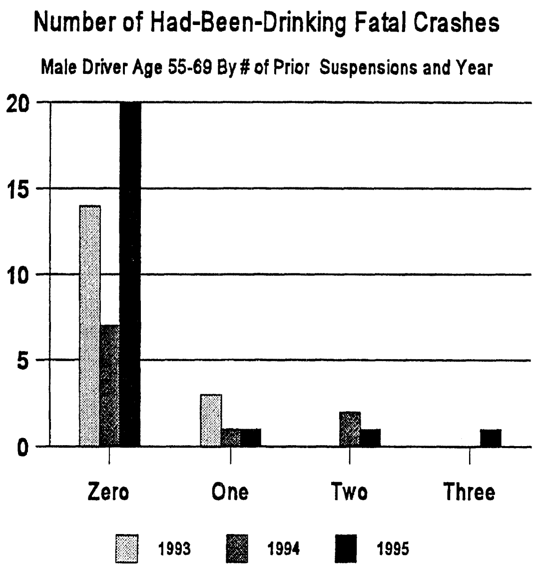
Overall, the next set of charts shows that men have consistently more suspensions prior to the HBD-fatal crash examined here and that the number of such suspensions is lower in each successively older age group. However, the charts clearly show that most drivers have no license suspensions prior to the HBD-fatal crash also investigated here. In addition there has been no consistent change in these data since 1993.



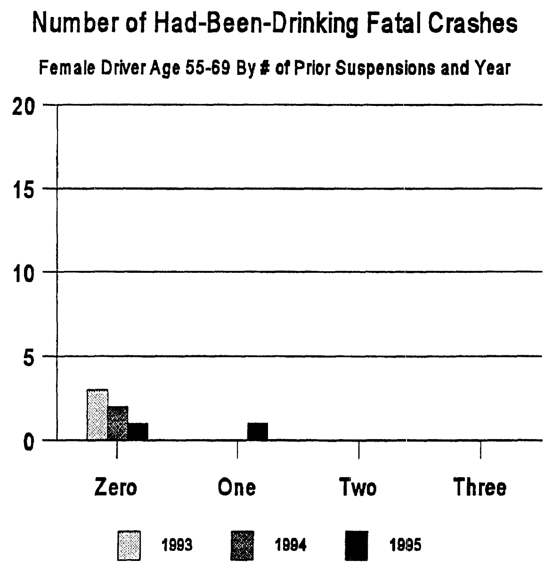




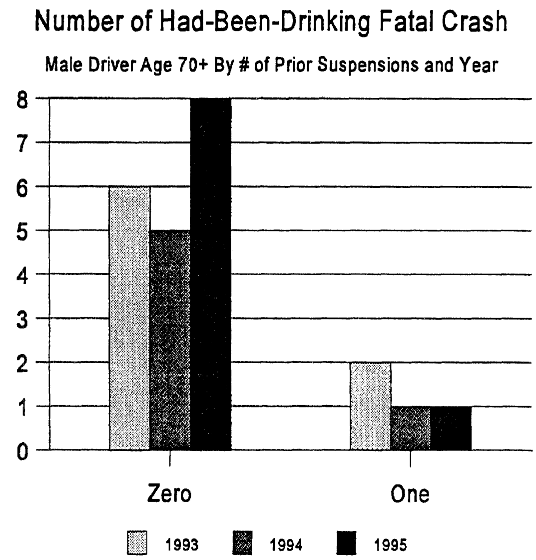




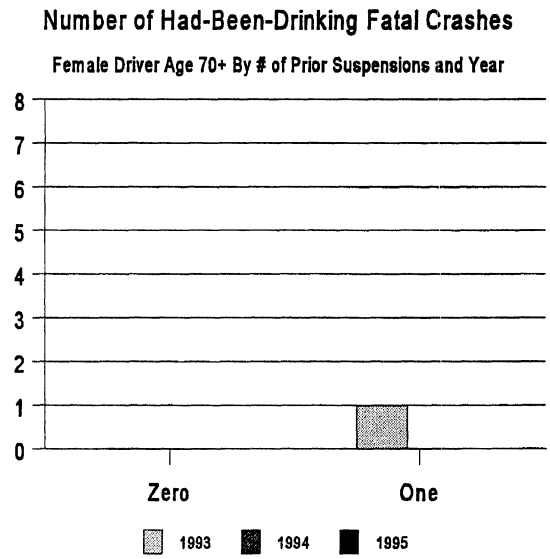
Number of Had-Been-Drinking Fatal Crashes
Male Driver Age 55-69 By # of Prior Suspensions and Year
20
15
10
5
0
Zero
One
Two
Three
1993
1994
1995



Number of Had-Been-Drinking Fatal Crashes
Female Driver Age 55-69 By # of Prior Suspensions and Year
20
15
10
5
0
Zero
One
Two
Three
1993
1994
1995

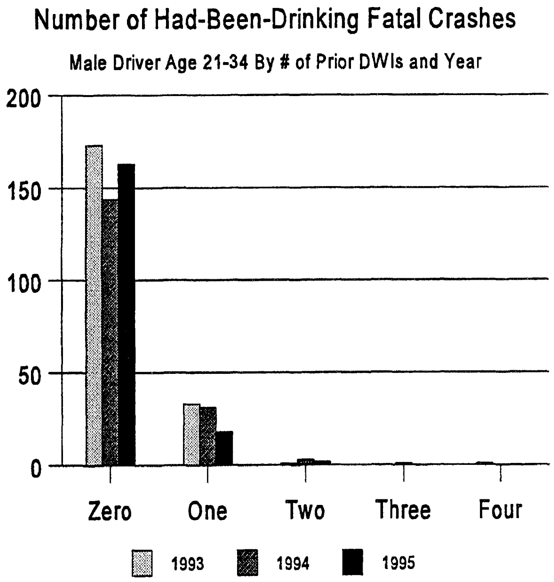


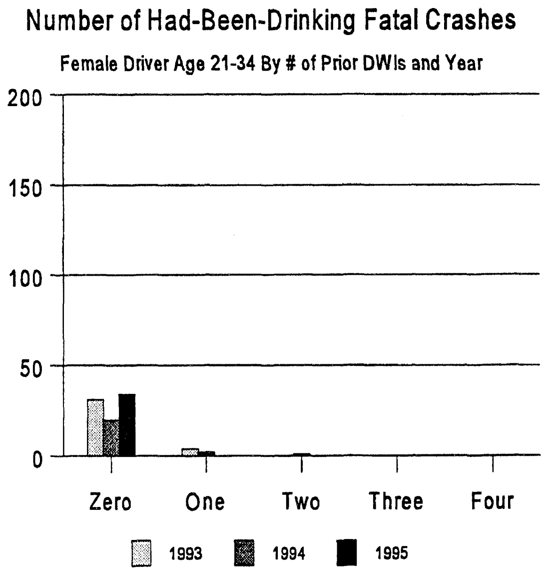
Number of Had-Been-Drinking Fatal Crash
Male Driver Age 70+ By # of Prior Suspensions and Year
8
7
6
5
4
3
2
1
0
Zero
One
1993
1994
1995

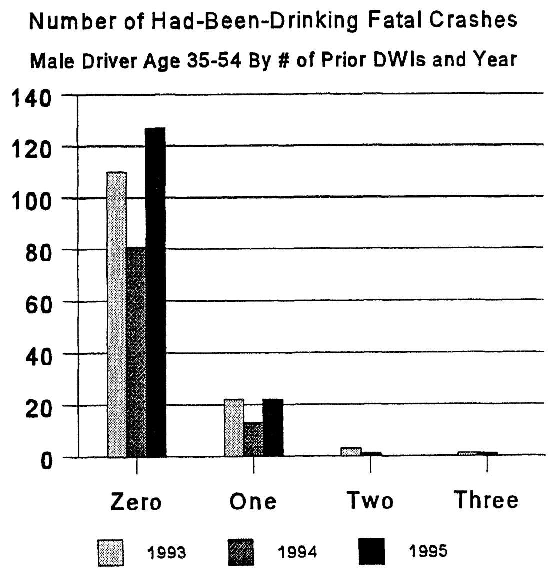


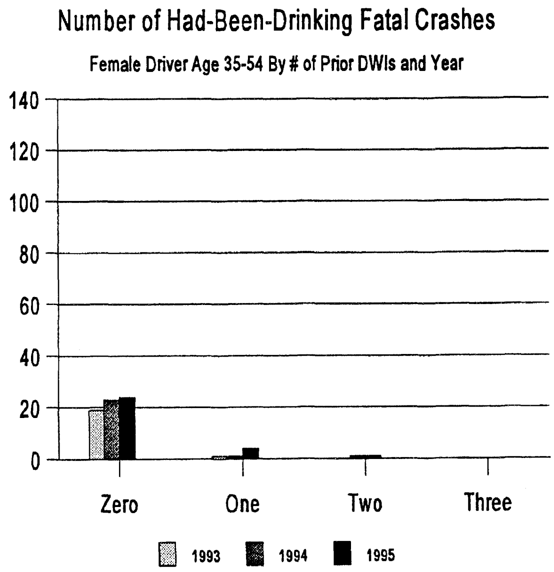
Number of Had-Been-Drinking Fatal Crashes
Female Driver Age 70+ By # of Prior Suspensions and Year
8
7
6
5
4
3
2
1
0
Zero
One
1993
1994
1995

As can be seen from the next set of charts, most drivers had no DWI convictions prior to the HBD-fatal crash investigated here. In addition, there has been no consistent change in these data since 1993.



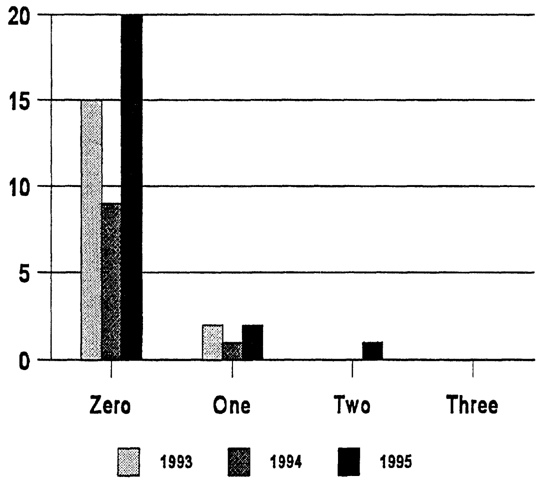






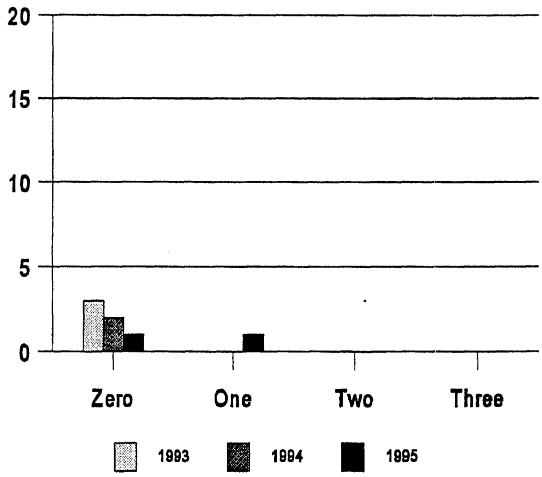
Number of Had-Been-Drinking Fatal Crashes

Male Driver Age 55-69 By # of Prior DWIs and Year



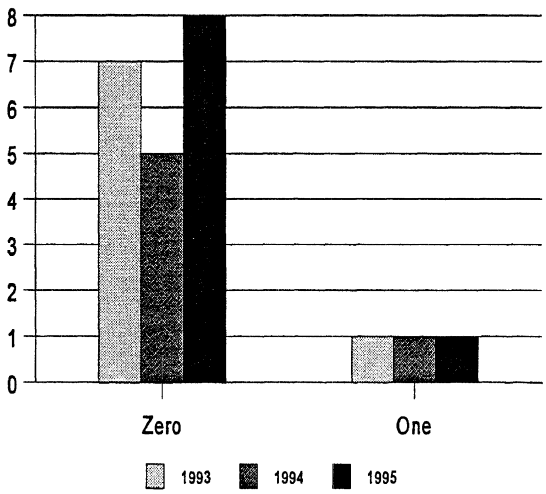
Number of Had-Been-Drinking Fatal Crashes

Female Driver Age 55-69 By # of Prior DWIs and Year



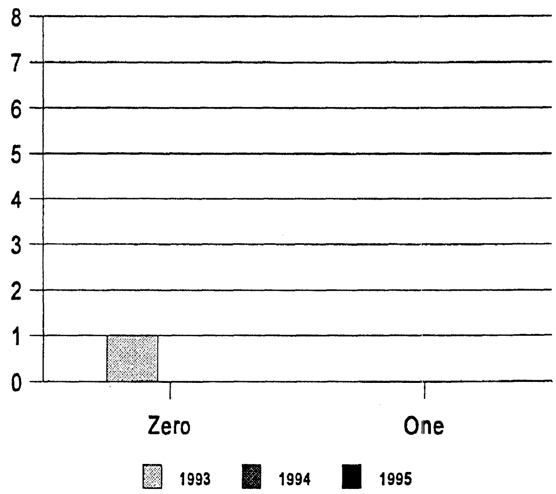
Number of Had-Been-Drinking Fatal Crashes

Male Driver Age 70+ By # of Prior DWIs and Year

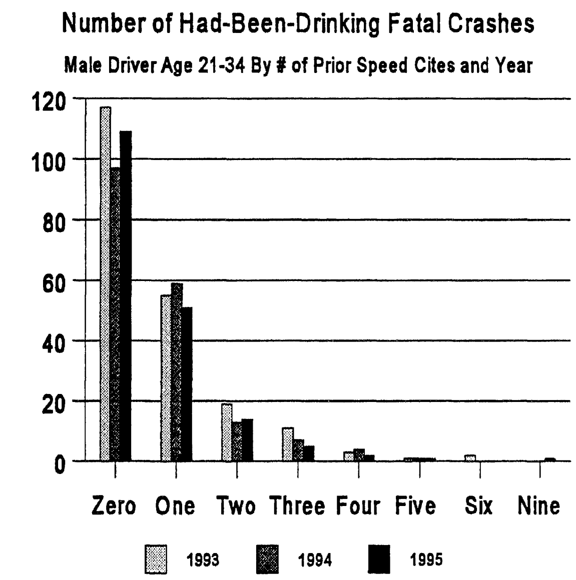


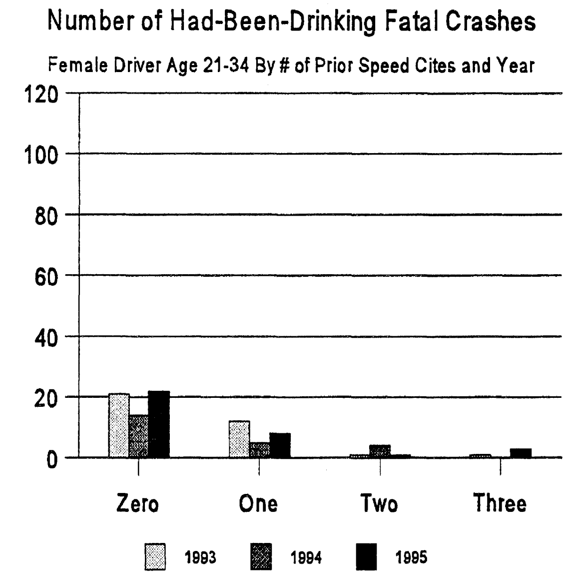
Number of Had-Been-Drinking Fatal Crashes

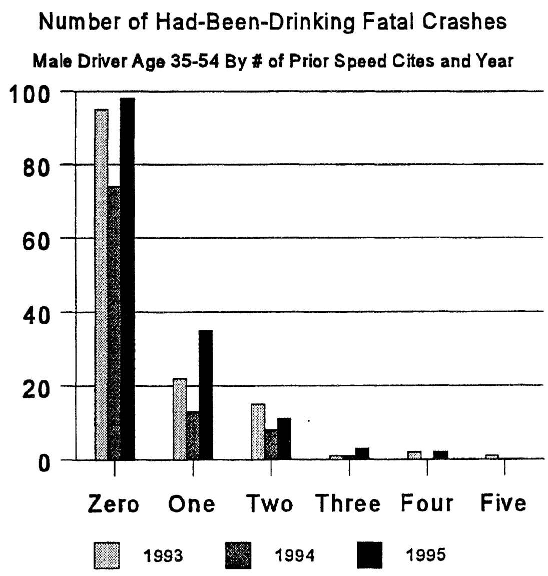
Female Driver Age 70+ By # of Prior DWIs and Year

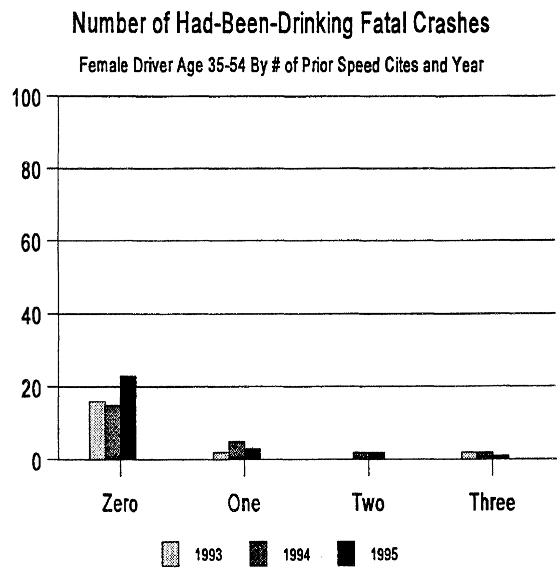


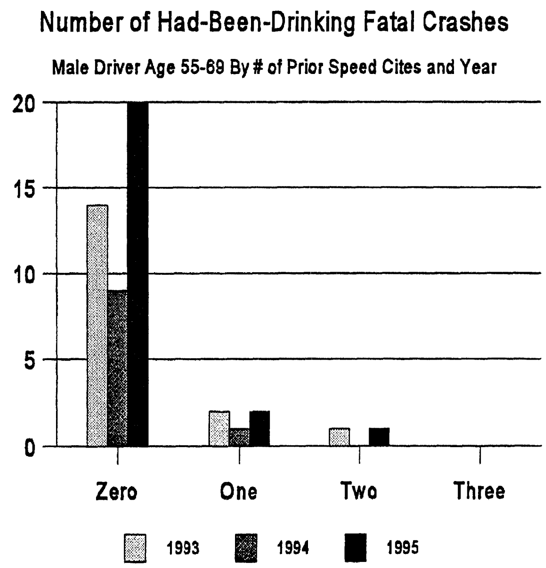
As can be seen from the next set of charts, most drivers had no speeding citations prior to the HBD-fatal crash investigated here. In addition, there has been no consistent change in these data since 1993.



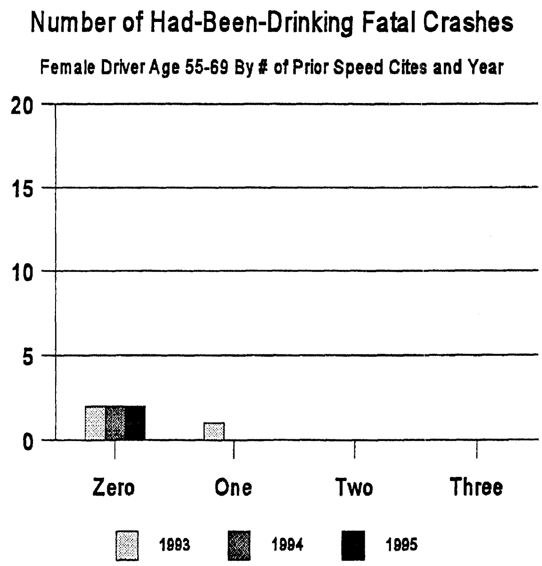




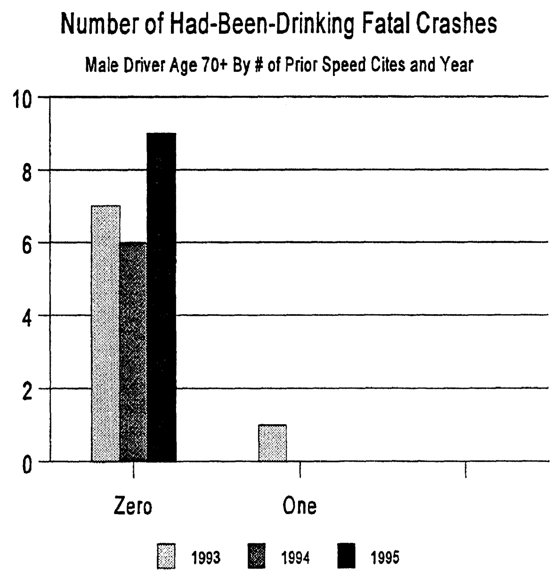




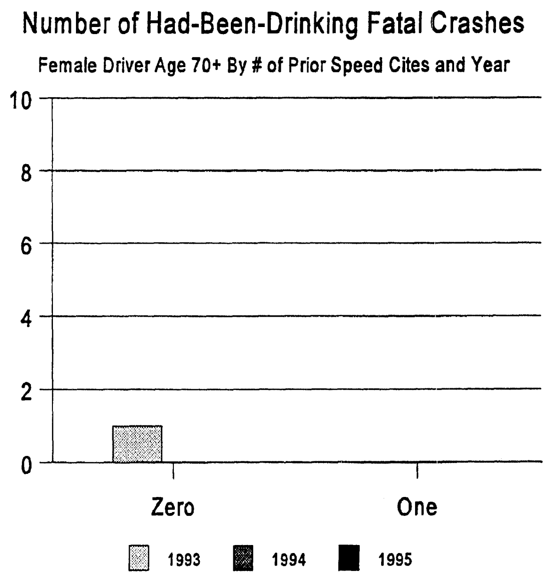
Number of Had-Been-Drinking Fatal Crashes
Male Driver Age 55-69 By # of Prior Speed Cites and Year
20
15
10
5
0
Zero
One
Two
Three
1993
1994
1995



Number of Had-Been-Drinking Fatal Crashes
Female Driver Age 55-69 By # of Prior Speed Cites and Year
20
15
10
5
0
Zero
One
Two
Three
1993
1994
1995

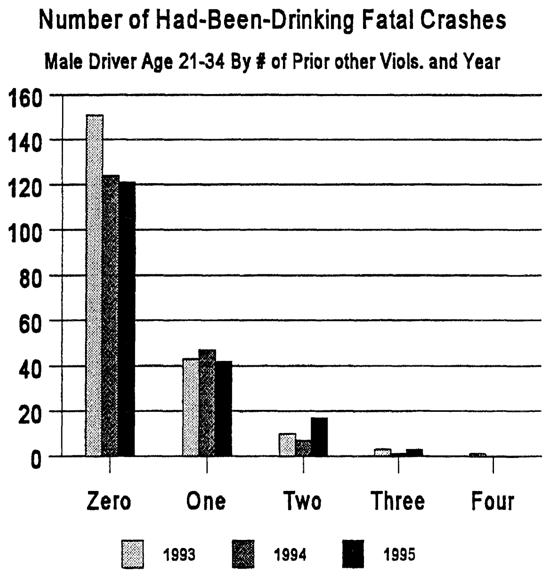


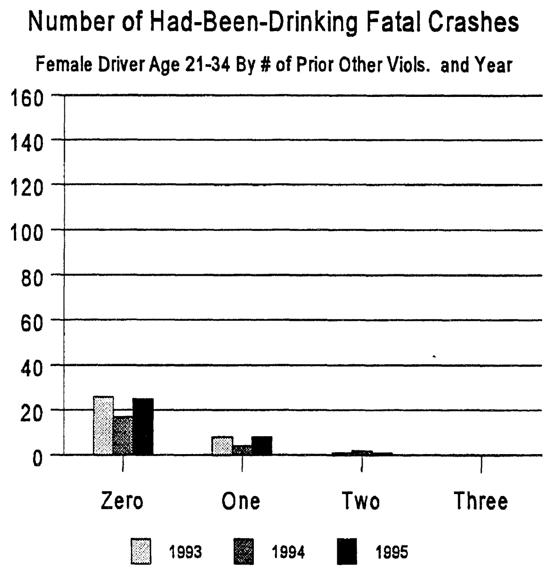
Number of Had-Been-Drinking Fatal Crashes
Male Driver Age 70+ By # of Prior Speed Cites and Year
10
8
6
4
2
0
Zero
One
1993
1994
1995

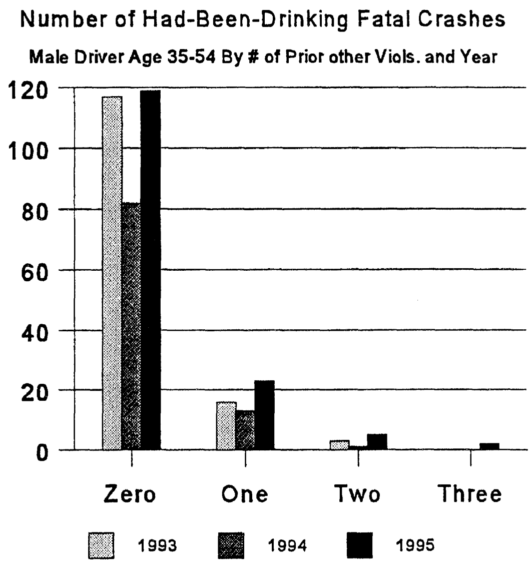


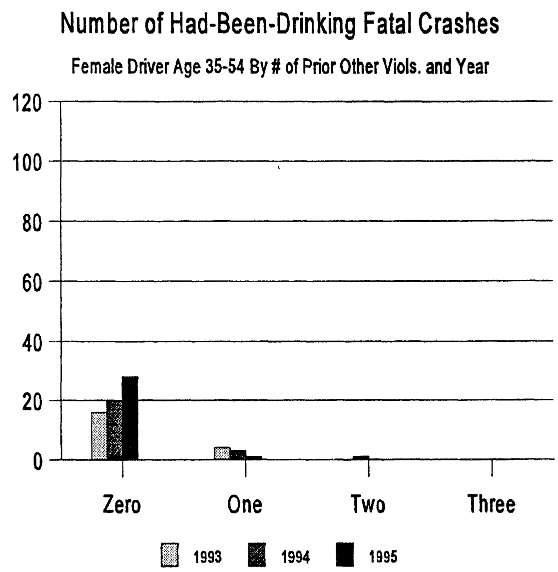
Number of Had-Been-Drinking Fatal Crashes
Female Driver Age 70+ By # of Prior Speed Cites and Year
10
8
6
4
2
0
Zero
One
1993
1994
1995

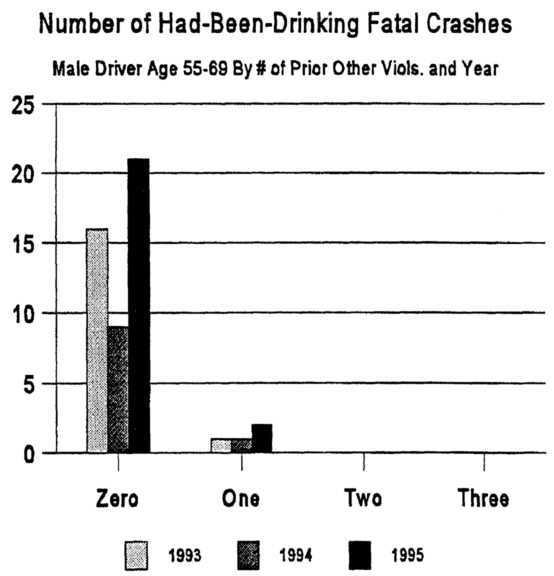
As can be seen from the next set of charts, most drivers had no other moving violations prior to the HBD-fatal crash investigated here. In addition, there has been no consistent change in these data since 1993.



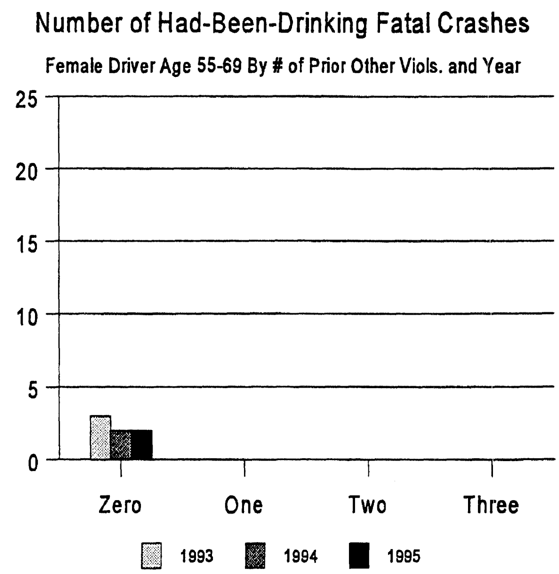




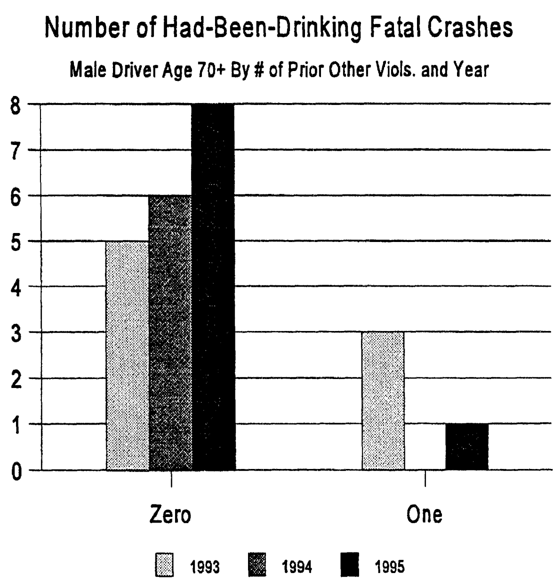




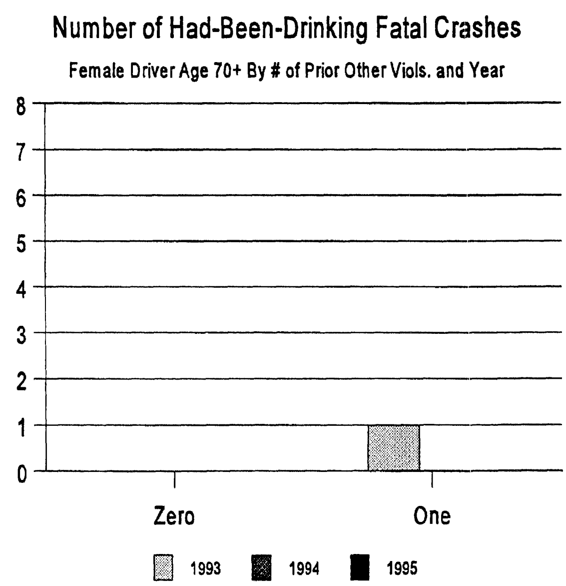
Number of Had-Been-Drinking Fatal Crashes
Male Driver Age 55-69 By # of Prior Other Viols. and Year
25
20
15
10
5
0
Zero
One
Two
Three
1993
1994
1995



Number of Had-Been-Drinking Fatal Crashes
Female Driver Age 55-69 By # of Prior Other Viols. and Year
25
20
15
10
5
0
Zero
One
Two
Three
1993
1994
1995



Number of Had-Been-Drinking Fatal Crashes
Male Driver Age 70+ By # of Prior Other Viols. and Year
8
7
6
5
4
3
2
1
0
Zero
One
1993
1994
1995



Number of Had-Been-Drinking Fatal Crashes
Female Driver Age 70+ By # of Prior Other Viols. and Year
8
7
6
5
4
3
2
1
0
Zero
One
1993
1994
1995

Overview

As was discussed earlier, had-been-drinking (HBD) crashes, crash rates, and fatal injuries in HBD crashes were about the same in 1993 and 1995, but were noticeably lower in 1994. Unfortunately, there seems to be little available in the data to help us understand why the numbers for 1994 are so much lower than 1993 or 1995. Clearly, these figures should be followed closely in the future to better understand possible trends in this important area.

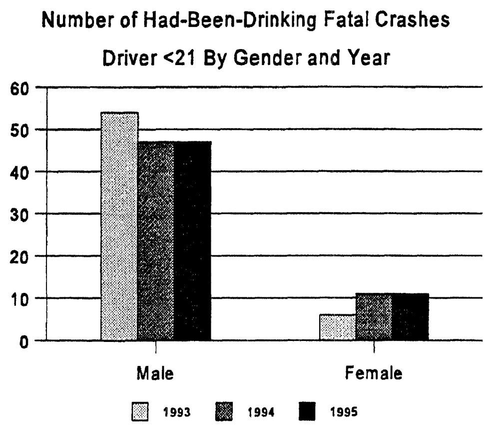
Had-been-drinking crashes occurred most often on Friday, Saturday and Sunday and during the months of April through October. These periods would be excellent times for special programs focused on preventing drinking and driving.

Male drivers predominate HBD fatal crashes, and young males (age 16-20) are at particularly high risk for involvement in a HBD fatal crash. The involvement of young females (age 16-20) in HBD fatal crashes has increased steadily since 1993. Because of this apparent trend, efforts should be made to target young females for HBD crash prevention programs, but one should not overlook the fact that the majority of HBD fatal drivers at all ages are male.

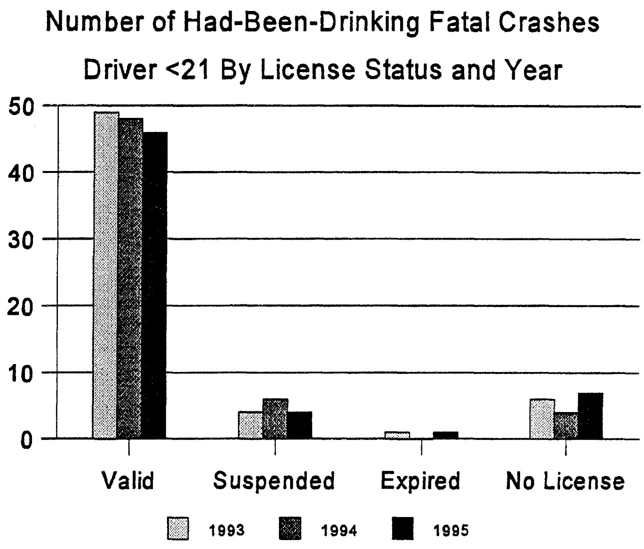
Drinking drivers less than 21 years of age

As can be seen in the table below, the number of had-been-drinking (HBD) crashes, persons killed, and HBD crash rates for HBD drivers under age 21 have declined slightly from 1993 to 1995.

Number and Rate of Fatal Crashes Involving HBD Drivers Less than 21 Years of Age				
Year	Number of HBD Crashes	Number of Persons Killed	Crash Rate per 1M VMT	Crash Rate per 100K Licensed Drivers
1993	60	74	0.0123	11.49
1994	57	69	0.0113	10.84
1995	57	67	0.0108	10.67

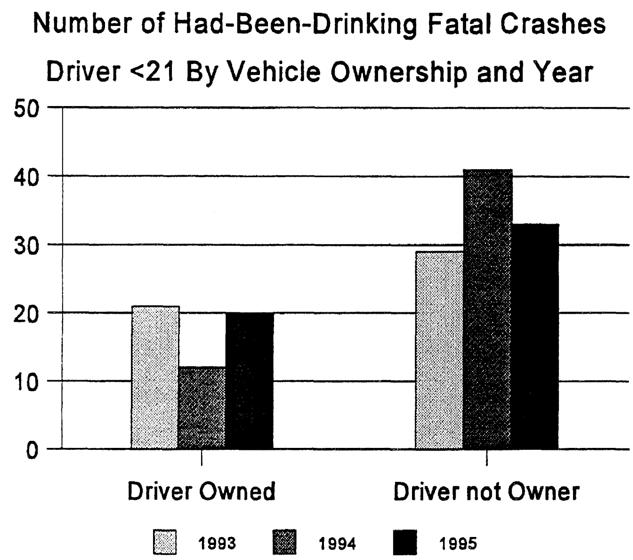


The chart to the left shows that about 80% of HBD fatal crashes involving drivers under age 21 involve males.

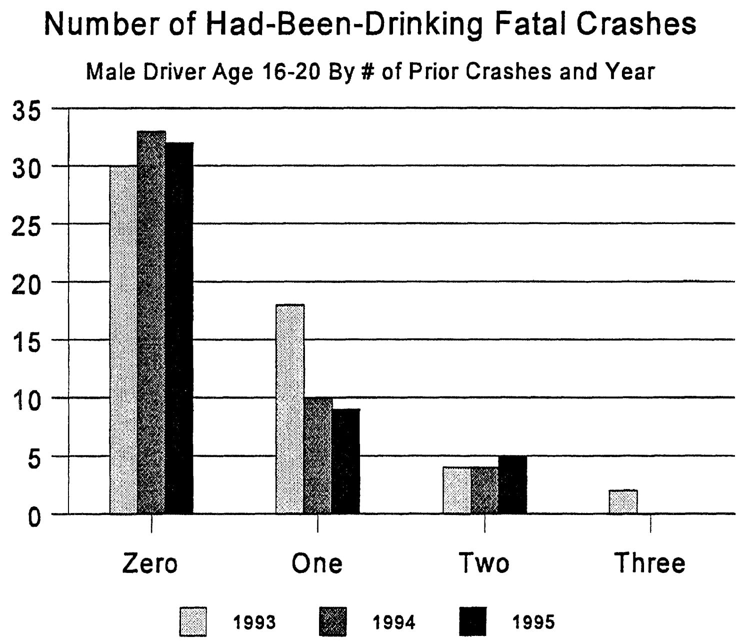


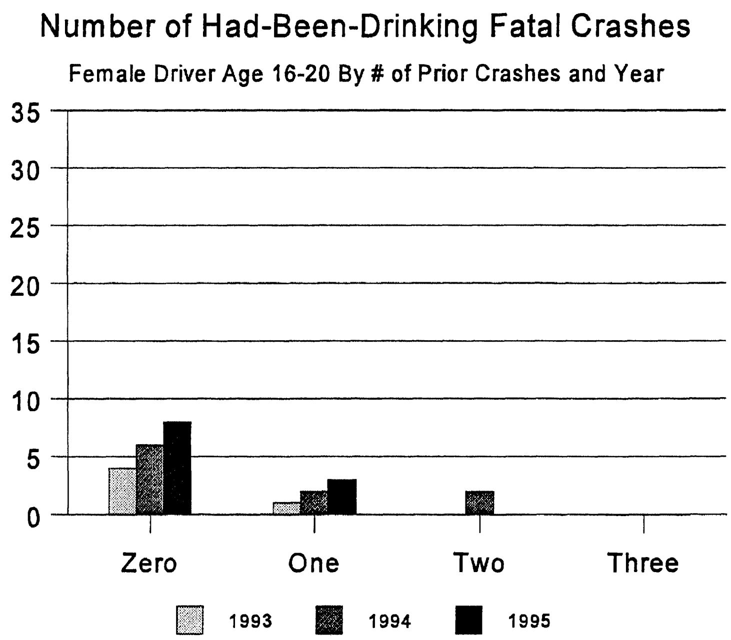
About 80% of HBD drivers less than 21 years of age involved in fatal crashes had valid driving licenses at the time of their crash (about 80%). The proportion of these drivers with a valid license has changed little from 1993 to 1995.

About 65% of the time, young HBD drivers involved in fatal crashes do not own the vehicle they are driving at the time of the crash. There is no systematic difference in the proportions from 1993 to 1995.

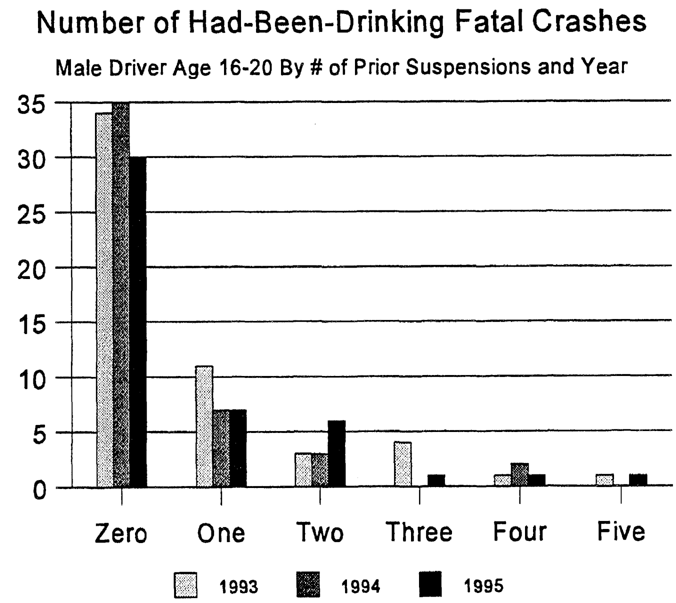


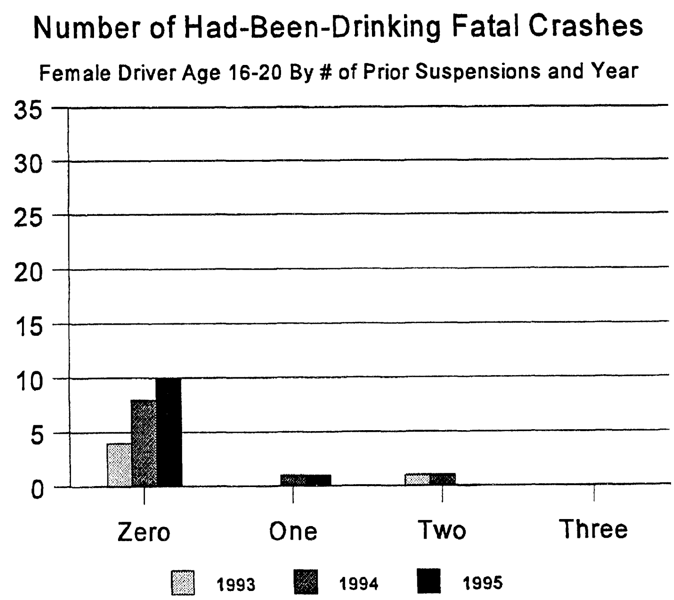
The charts below show little difference in the proportion of drivers with prior crashes between males and females and little change from year to year in the number of prior crashes young HBD drivers had been involved in prior to their current collision.



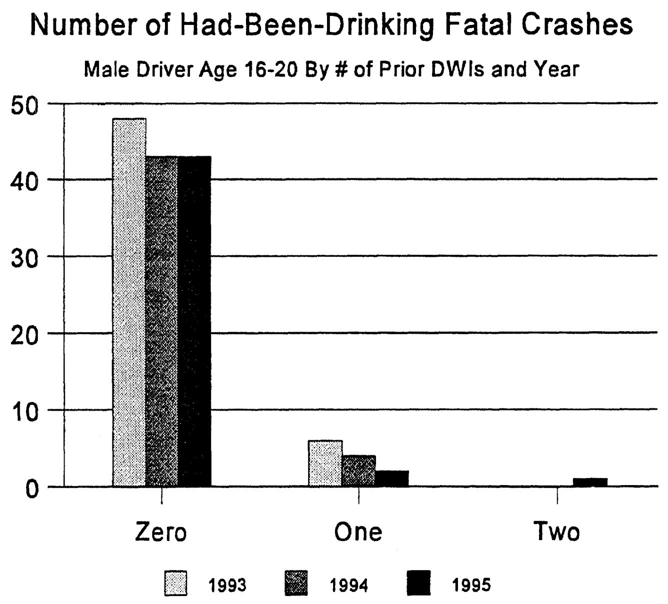


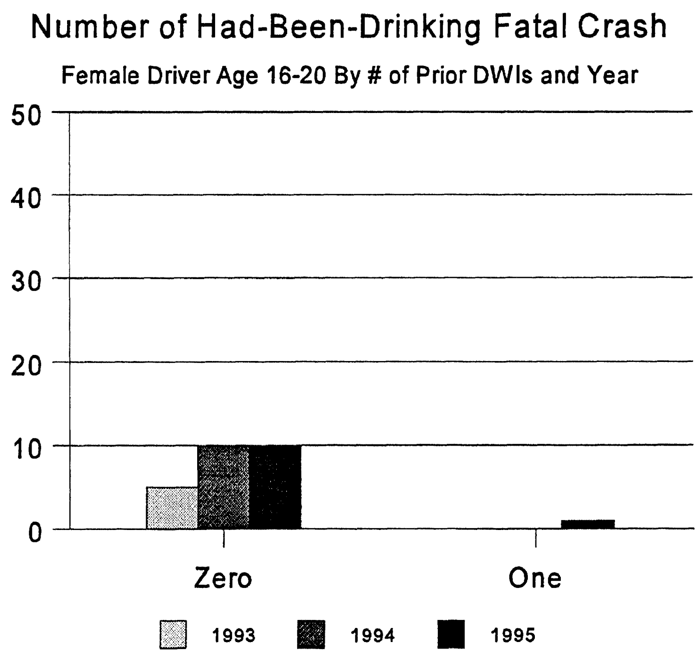
The charts below show males had considerably more experience with license suspensions than did females prior to the reported collision. However, there was little change from year to year in the number of prior license suspensions young HBD drivers had prior to their current collision.



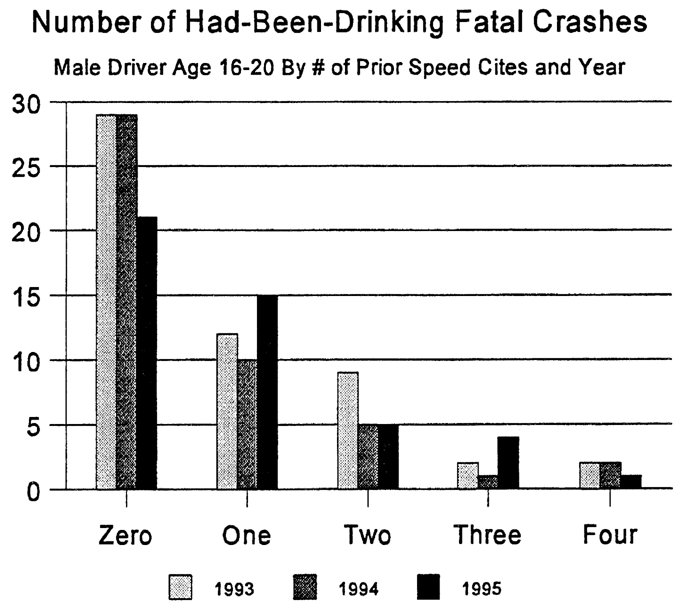


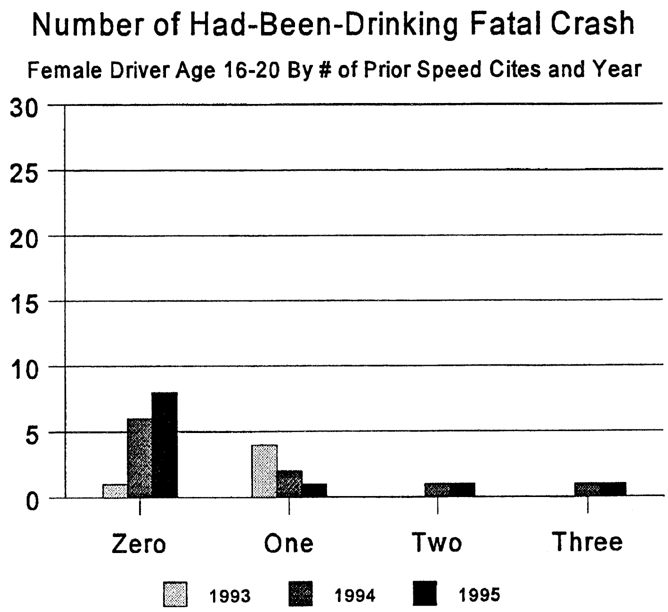
The charts below show little difference in the proportion of prior DWIs between males and females and little change from year to year in the number of prior DWI convictions young HBD drivers had been involved in prior to the reported collision.



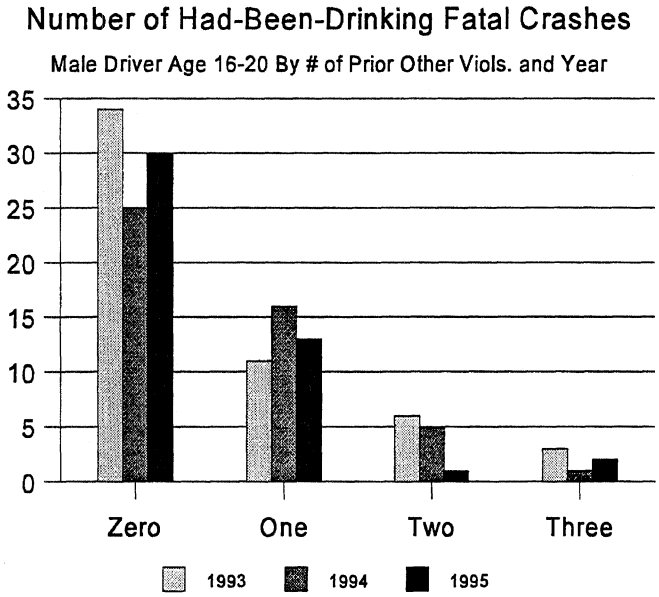


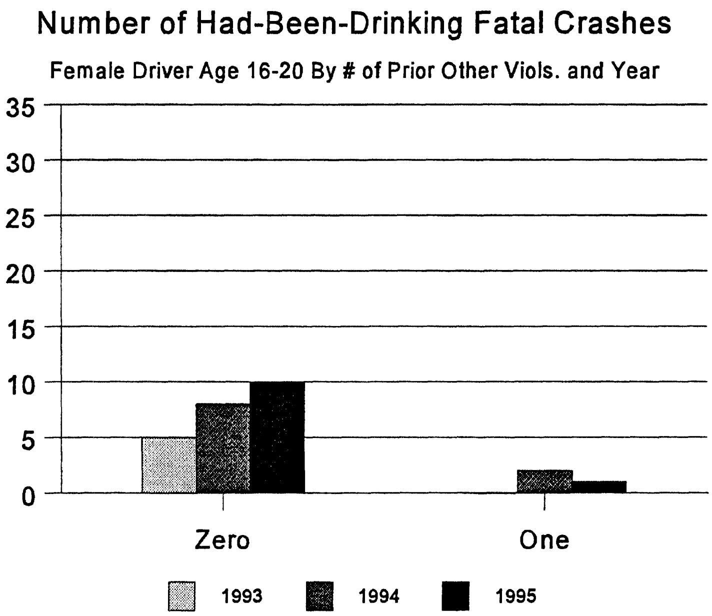
The charts below show that young males experience more speeding citations than young females prior to the reported collision. However, there was little change from year to year in the number of speeding citations young HBD drivers had received prior to their current collision.





The charts below show that young males typically experience more citations for other violations than young females prior to the reported fatal crash. This finding changed little from year to year.





Overview

The number and rate of HBD young drivers (age 16-20) involved in fatal crashes remained consistent from 1993 to 1995. As was the case for HBD fatal crashes overall, most of these drivers are male. Most of these drivers had valid licenses and did not own the car they were driving at the time of the crash.

There were no year-to-year trends associated with the number of crashes, license suspensions, DWIs, speeding tickets, or other moving violations these young drivers experienced prior to the HBD crash. However, young males typically experienced more prior license suspensions, DWI convictions, speeding tickets, and other moving violations than did their female counterparts.

It is our hope that relatively new programs such as graduated licensing and zero tolerance of alcohol consumption among minors who are driving will be effective in reducing these figures. However, continued study of this age group will be necessary to measure and understand effects of the programs as well as to identify any gaps that may have been left in the new policies.

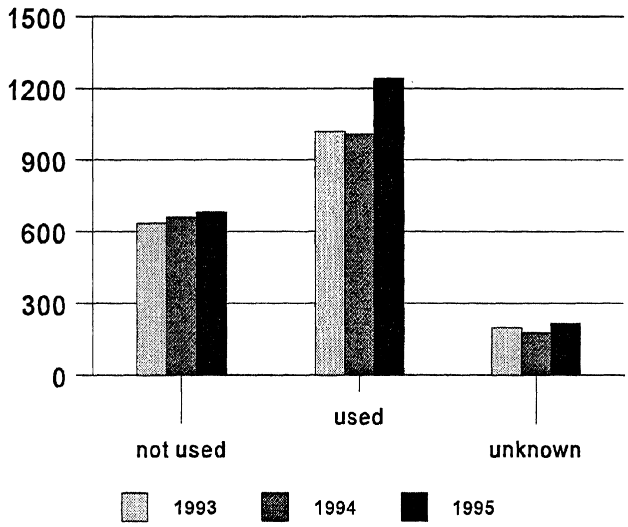
Safety System Use

Safety Belts

In the time period from 1993 through 1995, over 3,000 persons per year were involved in, but not necessarily killed in, a fatal vehicle crash in Michigan. The following table shows the number of drivers and passengers present in these crashes.

Number of Occupants in Vehicles Involved in Fatal Crashes by Year			
Year	Number of Drivers	Number of Passengers	Total
1993	1854	1209	3063
1994	1930	1211	3141
1995	2145	1310	3455

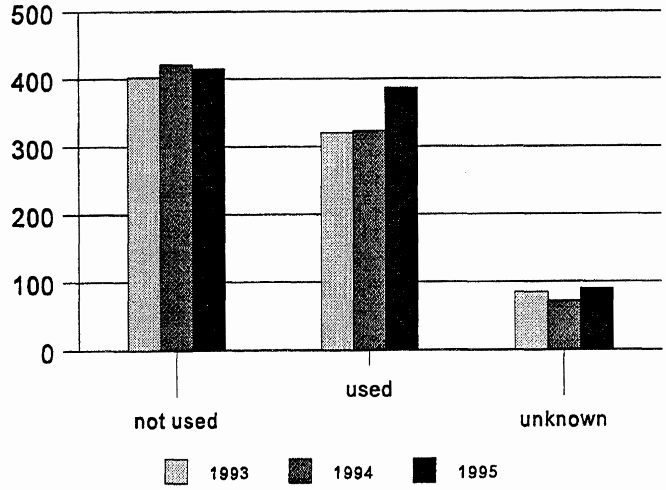
Frequency of Safety Belt Use by Drivers in Fatal Crashes by Year



Driver belt use

About a third of drivers involved in fatal crashes were not using safety belts in each of the three years examined.

Frequency of Safety Belt Use by Drivers in Crashes Where Driver was Killed by Year



Over half of the drivers who were killed in a crash over the three years examined were not using a safety belt.

Drivers' Safety Belt Use and Survival in Fatal Crash by Gender, Age, and Year								
Year	Gender	Age Group	Survived			Killed		
			Safety Belt Used	Safety Belt Not Used	% Belt Use	Safety Belt Used	Safety Belt Not Used	% Belt Use
1993	Male	16-20	75	44	63.0	23	35	39.7
1994			69	48	59.0	24	59	28.9
1995			67	47	58.8	24	39	38.1
1993	Female	16-20	35	7	83.3	14	8	63.6
1994			34	9	79.1	23	12	65.7
1995			49	16	75.4	27	17	61.4
1993	Male	21-34	157	92	63.1	49	126	28.0
1994			212	91	70.0	35	128	21.5
1995			210	98	68.2	41	109	27.3
1993	Female	21-34	79	19	80.6	31	31	50.0
1994			65	19	77.4	23	29	44.2
1995			89	13	87.3	31	32	49.2
1993	Male	35-54	199	43	82.2	43	86	33.3
1994			220	46	82.7	39	99	28.3
1995			262	51	83.7	45	106	29.8
1993	Female	35-54	80	17	82.5	35	25	58.3
1994			80	13	86.0	38	28	57.6
1995			107	20	84.3	31	35	47.0
1993	Male	55-69	56	10	84.8	18	38	32.1
1994			55	11	83.3	20	32	38.5
1995			64	13	83.1	26	31	45.6
1993	Female	55-69	22	1	95.7	13	19	40.6
1994			26	0	100.0	11	8	57.9
1995			23	0	100.0	16	13	55.2
1993	Male	70+	26	2	92.9	43	29	59.7
1994			32	4	88.9	28	37	43.1

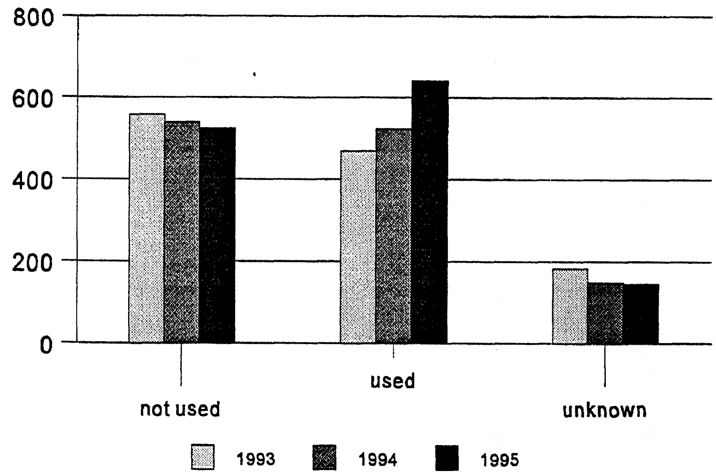
1995			37	7	84.1	39	33	54.2
1993	Female	70+	13	3	81.3	21	17	55.3
1994			16	2	88.9	33	10	76.7
1995			17	1	94.4	39	13	75.0

The table above shows the survival and safety belt use of drivers involved in fatal crashes by gender, age group, and year. The pattern of survival and belt use are consistent over the years examined. Safety belt use was consistently more frequent among survivors of fatal crashes than among those killed. Among survivors of fatal crashes, safety belt use increased with age and women were more likely than men to be using safety belts in each age group except the oldest.

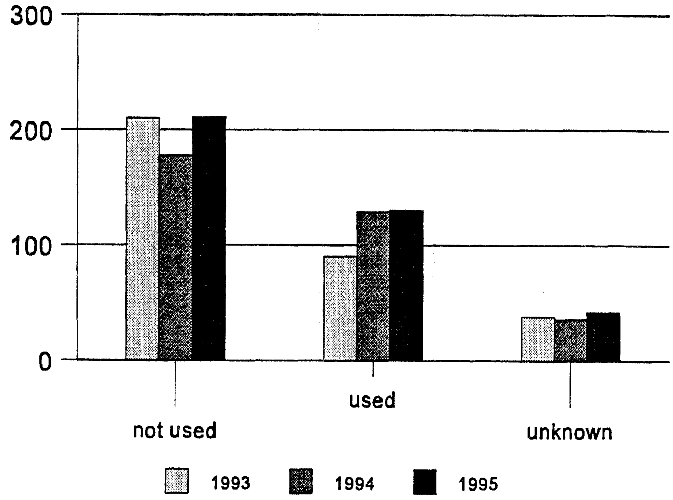
Passenger belt use

The proportion of passengers in vehicles involved, though not necessarily killed, in fatal crashes that were not using safety belts has been decreasing slightly from 1993 to 1995. In 1993, 46 percent of passengers in such crashes were not restrained, and in 1995 this dropped to 40 percent.

Frequencey of Safety Belt Use by Passengers in Fatal Crashes by Year



Frequency of Safety Belt Use by Passengers in Crashes where Passenger was Killed



More than half the passengers that were killed in fatal crashes from 1993 through 1995 were not using safety belts. The proportion of these unbelted passengers, however, has been decreasing over this time period from 62 percent in 1993 to 55 percent in 1995.

Passengers' Safety Belt Use and Survival in Fatal Crashes by Gender, Age, and Year								
			Survived			Killed		
Year	Gender	Age Group	Safety Belt Used	Safety Belt Not Used	% Belt Use	Safety Belt Used	Safety Belt Not Used	% Belt Use
1993	Male	16-20	24	48	33.3	6	29	17.1
1994			28	55	33.7	8	31	20.5
1995			36	55	39.6	6	23	20.7
1993	Female	16-20	26	35	42.6	5	16	23.8
1994			34	41	45.3	6	6	50.0
1995			31	17	64.6	8	30	21.1
1993	Male	21-34	40	64	38.5	4	42	8.7
1994			43	75	36.4	10	36	21.7
1995			34	60	36.2	6	40	13.0
1993	Female	21-34	29	33	46.8	8	24	25.0
1994			33	36	47.8	9	13	40.9
1995			45	30	60.0	8	20	28.6
1993	Male	35-54	24	29	45.3	2	22	8.3
1994			12	21	36.4	4	12	25.0
1995			26	22	54.2	8	13	38.1
1993	Female	35-54	40	12	76.9	8	18	30.8
1994			42	18	70.0	7	14	33.3
1995			54	14	79.4	9	19	32.1
1993	Male	55-69	5	5	50.0	3	2	60.0
1994			7	3	70.0	1	6	14.3
1995			11	4	73.3	1	3	25.0
1993	Female	55-69	12	11	52.2	8	8	50.0
1994			20	6	76.9	19	8	70.4
1995			30	7	81.1	14	9	60.9
1993	Male	70+	6	5	54.5	6	8	42.9
1994			7	4	63.6	7	4	63.6

1995			8	8	50.0	5	5	50.0
1993	Female	70+	23	13	63.9	20	12	62.5
1994			18	5	78.3	26	9	74.3
1995			31	17	64.6	25	16	61.0

The table above shows the frequency of safety belt use among passenger survivors and victims of fatal crashes by gender, age group, and year. Overall, there is an increase in safety belt use among survivors between 1993 and 1995. Belt use among surviving passengers increased with age and women had higher use than men in every age group. The survivability of passengers in fatal crashes decreased with age.

Survival and Use of Safety Restraints by Passengers Age 15 and Under									
Year	Age Group	Survived				Killed			
		CRD	Safety Belt	None	% Restraint Use	CRD	Safety Belt	None	% Restraint Use
1993	0-4	35	26	16	79.2	2	4	5	54.5
1994		32	14	10	82.1	4	7	8	57.9
1995		46	26	14	83.7	12	4	7	69.6
1993	5-15	0	86	78	52.4	0	14	27	34.1
1994		1	95	89	51.9	0	19	32	37.3
1995		0	122	65	65.2	1	23	27	47.1

The table above shows that the use of safety restraint systems among children has been increasing over the three-year period. It appears that children under five years of age are more likely to be restrained than children between five and fifteen years of age. The pattern of higher survival rates for persons using restraints is also evident from this table.

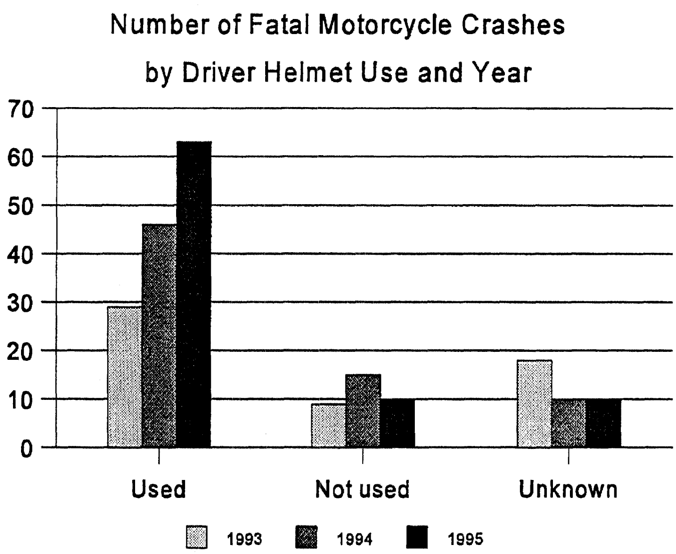
Overview

One must be particularly cautious when interpreting safety belt use data collected from police crash reports. Even in fatal crashes, belt use tends to appear higher than was actually the case because of biases caused by having persons self-report belt use to the investigating officer. Belt use rates for fatally injured persons, however, may be more accurate than for others, if fatally injured persons are not extricated from the vehicle prior to the officers noting their belt use.

The previous results show that for drivers, about one-half of those killed were wearing belts. This proportion has not changed since 1993. On the other hand, fatally injured passengers were reported to be using belts more than half the time, and the proportion of fatally injured passengers wearing belts has increased each year since 1993. While this result may not sound positive at first, recall that as we approach 100% belt use, we also approach 100% belt use among persons fatally injured in crashes.

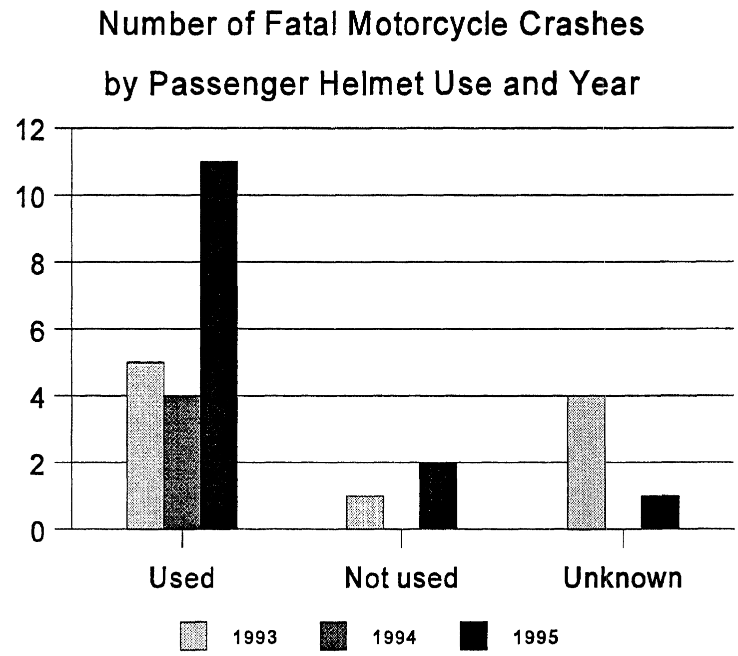
Among both driver and passenger groups, males in fatal crashes were less likely to use belts than females. This was particularly true for young males (age 16-20). This finding is quite consistent with UMTRI roadside safety belt use observations for the state of Michigan as a whole.

Motorcycle Helmets



The chart on the left shows that drivers of motorcycles involved in fatal crashes, though not necessarily killed, were likely to be wearing helmets. There was an increase in helmet use among motorcycle drivers from 52% in 1993 to 76% in 1995.

Very few motorcycles involved in fatal crashes carried passengers. The chart on the left shows that these passengers were more likely than not to be wearing a helmet.



The following table shows the number of motorcyclists that were involved in fatal crashes over the period between 1993 and 1995. The table shows that there is a high usage rate of helmets. However, it also shows that when a motorcycle is involved in a fatal crash, it is very likely that the motorcyclist is the one who is killed.

Survival and Helmet Use of Motorcyclists Involved in Fatal Crashes by Year							
Year	Driver or Passenger	Survived			Killed		
		Helmet	No Helmet	% Helmet Use	Helmet	No Helmet	% Helmet Use
1993	Driver	1	2	33.33	28	7	80.00
1994		4	0	100.00	42	15	73.68
1995		7	0	100.00	56	10	84.85
1993	Passenger	2	0	100.00	3	1	75.00
1994		0	0	0.00	4	0	100.00
1995		5	1	83.33	6	1	85.71

Overview

The comparison of helmet use among motorcyclists involved in fatal crashes between 1993 and 1995 indicates that helmet use is increasing. However, it is quite clear that in these fatal crashes, it is very likely that it is the motorcyclist who is killed, whether a helmet is worn or not.

Summary and Discussion of Report Findings

Statistical Trend Analyses

Analytic models were developed to answer the question about whether the pattern of data for the period 1993-1995 differs from what we would expect given what we know from previous years included variables to account for the time-series trend, VMT, economic conditions (as measured by the unadjusted unemployment rate), and beverage alcohol sales. The statistical criteria for model fit showed the selected model fit the data well (r-squared=0.62). Based on this model, we found that there was no statistically significant change in crash deaths in Michigan in the period 1993-1995 compared to previous years. Similar models developed for had-been-drinking fatal crashes also failed to find a significant change from pre-1993 levels.

What if the analyses found that there was a significant increase in crash deaths starting in 1993, what could we say about the *cause* of the change? When scientists think of cause-and-effect relationships, they think of "causes" as those conditions that are "necessary and sufficient" to produce the observed effect. That means that in order for a given condition to be determined to be the cause of an observed effect that condition must be present every time the effect is observed (i.e., the condition is necessary to produce the observed effect), and no additional conditions must be necessary to produce the observed effect (i.e., the condition alone is sufficient to cause the observed effect). How does this logic apply to our understanding of possible causes of changes in observed frequencies of crash deaths?

The real "cause" of a fatal crash as opposed to a nonfatal crash is the amount of force that is exerted on the occupants involved in the crash. While this statement may sound trite at first, we must keep in mind that the amount of force a crash generates and how a person's body responds to that force are the only determinants of the nature and extent of injuries the person sustains. All other factors (e.g., age and gender of the occupant, alcohol involvement, etc.) only help us to understand conditions under which a crash itself or death in a crash is more or less likely.

For example, when one examines the information presented later in this report, one sees that alcohol is involved in a large number of fatal crashes, but not all fatal crashes involve alcohol. Indeed, research from roadside alcohol surveys suggest that those people that do drive after having consumed alcohol don't often get arrested, let alone become involved in a fatal crash. Therefore, alcohol cannot be said to "cause" fatal crashes, but it can be said to contribute to the likelihood of a crash occurring and given a crash, one involving alcohol is more likely to involve serious injuries to involved persons than a crash that does not involve alcohol.

So, rather than addressing "causes" of fatal traffic crashes per se, this report has presented information about fatal crash patterns during the period 1993-1995 (the most recent 3 years of crash data available). These data can be used constructively in the design and implementation of programs targeting special problems or conditions that contribute to an increased likelihood of a fatal crash.

Fatal Crashes

Peak months for fatal crashes were fairly consistent from year to year, generally higher in August, September, October, and November. Similarly, peak days for fatal crashes were consistently Friday, Saturday, and Sunday. These are periods during which we would expect to have a larger proportion of travel being represented by generally more hazardous, recreational travel than business- and work-related travel. These periods are also consistent with a higher incidence of had-been-drinking fatal crashes.

One implication of these findings for planning targeted enforcement and public information campaigns seems clear. The focus should be on high incident periods, using specialized campaign efforts and materials to emphasize safety during recreational driving trips.

The proportion of fatal crashes that occur on the high speed interstate roads is quite low, considering the high volumes of vehicles that travel on them. In rural areas, most of the fatal crashes occur on major collectors and local roads which tend to be two-lane roads with speed limits of 55 miles per hour. In urban areas, the majority of the fatal crashes occur on arterial streets, which are the main nonfreeway, high-volume roads in the city. These findings have serious implications for the placement of police road patrols.

Many factors affect decisions made about the placement and activities of police road patrols. One basic conflict regarding placement of patrols is between maintaining safe and legal driving speeds for the largest number of vehicles (or largest proportion of the driving population) and maintaining safe and legal driving speeds on lower-volume roads that have a higher death rate than the more traveled (and safer) interstate highways. Currently, the existing contingencies affecting officer behavior strongly support working the relatively safe interstate highways for a variety of practical (e.g., large numbers of speeding vehicles, high activity levels can be demonstrated) as well as political reasons (e.g., maintaining a federally mandated average speed on the interstates). While these extant contingencies are unlikely to change soon, fatal crash data suggest that increased enforcement attention is warranted for noninterstate roads in Michigan.

We found that there has been little change in the proportion of crashes that occurred during daylight versus nighttime lighting conditions, and unfortunately no reliable exposure data (e.g., VMT by time of day) exist to permit us to examine specifically the extent to which daylight versus nighttime fatal crash rates differ. On the other hand, we do know that: (1) in general, many more miles are driven during daylight hours than are driven during nighttime hours, and (2) daylight versus nondaylight fatal crashes are distributed about 50-50%. We can, therefore, safely speculate that nighttime driving is more hazardous than daytime driving, adding another factor to the implication for the development and marketing of prevention program efforts.

Vehicles in Fatal Crashes

About half of Michigan's fatal crashes involved a single vehicle and about half involved multiple vehicles. This finding has remained steady since 1993. When a single vehicle was involved in a fatal crash, the vehicle was most likely to strike a pedestrian or a fixed object. One strategy to reduce the toll exacted by these types of single-vehicle crashes is to increase the separation between vehicles and pedestrians/fixed objects. We see this strategy used on interstate highways and intercity parkways with pedestrian bridges. Obviously this solution can be quite expensive and isn't feasible for many locations. Pedestrian deaths may also be reduced through the implementation of programs designed to increase awareness of the serious nature of the issue with both drivers and pedestrians. Perhaps the best way to protect persons involved in single-vehicle collisions with fixed objects or overturn crashes is to promote safety belt use, thus decreasing the probability of ejection or striking parts of the vehicle interior in an overturn or fixed object collision.

The number and rate of fatal crashes per registered vehicle has increased steadily for both motorcycles and pickup trucks since 1993. As was stated earlier, using only three years to detect a trend must be done with caution, but the trends for these two vehicle body types may be sufficient to warrant attention in the near future, and should be monitored closely. The source of these possible changes is unclear; however, perhaps the most direct way to influence the death rate for these vehicle types is to continue to promote motorcycle helmet use and safety belt use among users of these vehicle types. Indeed, pickup truck occupants have historically had the lowest belt use rates of any vehicle type, making this group ripe for intervention.

Since 1993, rollovers have occurred in about 12% of fatal crashes. While the number and proportion of rollovers in fatal crashes varies between vehicle body types and years, there is little systematic variation. Regardless of the vehicle type, the best way to protect occupants involved in a rollover crash is to try to ensure they are using the safety belt available to them in their seating position.

Drivers in Fatal Crashes

Females age 16-20, males age 21-54, and females age 55 and over each had numbers of fatal crashes and fatal crash rates that have increased steadily since 1993. These apparent trends should be carefully tracked in subsequent years to determine if these patterns continue.

Although no consistent temporal trend in the data can be seen, males age 16-20 consistently had the highest rates of fatal crash involvement among the groups examined by a factor of about 2 to 1, making them a prime target group for immediate prevention intervention.

While it is true that most drivers involved in fatal crashes are driving with a valid license, over 10% of the male drivers age 16-69 were driving without a valid license. There is no temporal trend to these findings, but these figures are sufficiently troubling to warrant continued scrutiny and committed prevention efforts.

Among the most frustrating findings was the fact that over 90% of drivers involved in fatal crashes were not charged with any violation. There has been no real change in this proportion since 1993, but given the serious nature of the crash outcomes experienced, we would have expected to have seen a larger proportion of drivers cited for violating some traffic law leading to the collision.

Had-Been-Drinking Fatal Crashes

Had-been-drinking (HBD) crashes, crash rates, and fatal injuries in HBD crashes were about the same in 1993 and 1995, but were noticeably lower in 1994. Unfortunately, there seems to be little available in the data to help us understand why the numbers for 1994 are so much lower than 1993 or 1995. Clearly, these figures should be followed closely in the future to better understand possible trends in this important area.

Had-been-drinking crashes occurred most often on Friday, Saturday, and Sunday and during the months of April through October. These periods would be excellent times for special programs focused on preventing drinking and driving.

Male drivers predominate HBD fatal crashes, and young males (age 16-20) are at particularly high risk for involvement in a HBD fatal crash. The involvement of young females (age 16-20) in HBD fatal crashes has increased steadily since 1993. Because of this apparent trend, efforts should be made to target young females for HBD crash prevention programs, but one should not overlook the fact that the majority of HBD fatal drivers at all ages are male. Indeed, young males typically experienced more prior license suspensions, DWI convictions, speeding tickets, and other moving violations than did their female counterparts.

Safety Belt Use

For drivers, about one-half of those killed were wearing belts. This proportion has not changed since 1993. On the other hand, fatally injured passengers were reported to be using belts more than half the time, and the proportion of fatally injured passengers wearing belts has increased each year since 1993. While this result may not sound positive at first, recall that as we approach 100% belt use we also approach 100% belt use among persons fatally injured in crashes.

Among both driver and passenger groups, males in fatal crashes were less likely to use belts than females. This was particularly true for young males (age 16-20). This finding is quite consistent with UMTRI roadside safety belt use observations for the state of Michigan as a whole.

Motorcycle Helmet Use

The comparison of helmet use among motorcyclists involved in fatal crashes between 1993 and 1995 indicates that helmet use is increasing. However, it is quite clear that in these fatal crashes, it is very likely that it is the motorcyclist who is killed, whether a helmet is worn or not.

Summary

- There was no statistically significant change in crash deaths in Michigan in the period 1993-1995 compared to previous years.
- Peak months for fatal crashes were August through November.
- Peak days for fatal crashes were Friday, Saturday, and Sunday.
- In rural areas, most of the fatal crashes occur on major collectors and local roads which tend to be two-lane roads with speed limits of 55 miles per hour.
- In urban areas, the majority of the fatal crashes occur on arterial streets, which are the main nonfreeway, high-volume roads in the city.
- Fatal crash data suggest that increased enforcement attention is warranted for noninterstate roads in Michigan.
- When a single vehicle was involved in a fatal crash, the vehicle was most likely to strike a pedestrian or a fixed object.
- The number and rate of fatal crashes per registered vehicle has increased steadily for both motorcycles and pickup trucks since 1993.
- Females age 16-20, males age 21-54, and females age 55 and over each had numbers of fatal crashes and fatal crash rates that have increased steadily since 1993.
- Males age 16-20 consistently had the highest rates of fatal crash involvement among the groups examined by a factor of about 2 to 1.
- While it is true that most drivers involved in fatal crashes are driving with a valid license, over 10% of the male drivers age 16-69 involved in fatal crashes were driving without a valid license.
- Over 90% of drivers involved in fatal crashes were not charged with any violation.

- Had-been-drinking crashes, crash rates, and fatal injuries in HBD crashes were about the same in 1993 and 1995, but were noticeably lower in 1994. Unfortunately, there seems to be little available in the data to help us understand why the numbers for 1994 are so much lower than 1993 or 1995. Clearly, these figures should be followed closely in the future to better understand possible trends in this important area.

- Had-been-drinking crashes occurred most often on Friday, Saturday, and Sunday and during the months of April through October.

- Male drivers predominate HBD fatal crashes, and young males (age 16-20) are at particularly high risk for involvement in a HBD fatal crash.

- The involvement of young females (age 16-20) in HBD fatal crashes has increased steadily since 1993.

- For drivers, about one-half of those killed were wearing belts. This proportion has not changed since 1993.

- Fatally-injured passengers were reported to be using belts more than half the time, and the proportion of fatally injured passengers wearing belts has increased each year since 1993.

- Among both driver and passenger groups, males in fatal crashes were less likely to use belts than females. This was particularly true for young males (age 16-20).

- The comparison of helmet use among motorcyclists involved in fatal crashes between 1993 and 1995 indicates that helmet use is increasing. However, it is quite clear that in these fatal crashes, it is very likely that it is the motorcyclist who is killed, whether a helmet is worn or not.

Appendix 1 — Time-Series Analysis Details

All Crashes — Fatalities

Statistics of Fit

COUNT: Frequency Count

VMT + UNEMP + SPIRIT + BEER + Ramp:JAN1993 + ARIMA(1,0,1)(0,1,1)s

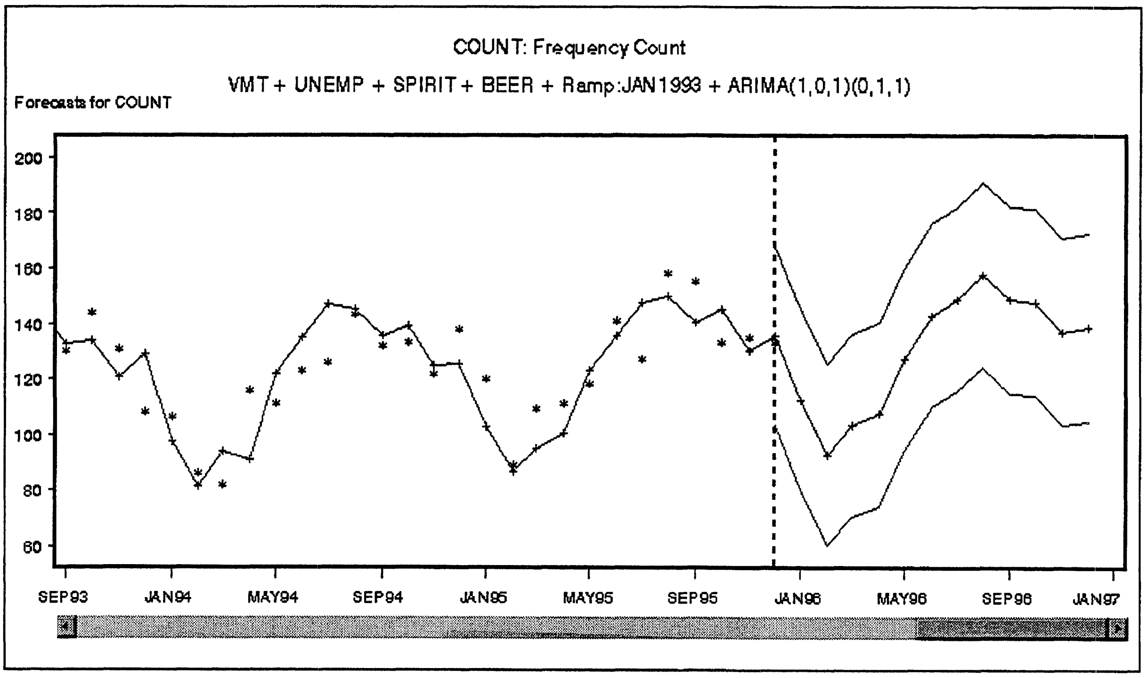
Statistic of Fit	Value
Mean Square Error	299.595275
Root Mean Square Error	17.308821
Mean Absolute Percent Error	11.176610
Mean Absolute Error	13.814927
R-Square	0.619886

Parameter Estimates

COUNT: Frequency Count

VMT + UNEMP + SPIRIT + BEER + Ramp:JAN1993 + ARIMA(1,0,1)(0,1,1)s

Model Parameter	Estimate	Std. Error	T	Prob>|T|
Moving Average, Lag 1	0.90669	0.0401	22.6188	0.0001
Seasonal Moving Average, Lag 12	0.79890	0.0629	12.7038	0.0001
Autoregressive, Lag 1	0.99750	0.0056	177.8373	0.0001
VMT	7.51774	11.9924	0.6269	0.5315
UNEMP	-2.88376	1.0068	-2.8643	0.0046
SPIRIT	-6.6791E-6	0.000013	-0.5300	0.5967
BEER	-0.0000126	0.000029	-0.4370	0.6626
Ramp:JAN1993	0.01578	0.0153	1.0308	0.3039



Had-Been-Drinking Fatalities

Statistics of Fit

COUNT: Frequency Count

VMT + UNEMP + SPIRIT + BEER + Ramp:JAN1993 + ARIMA(1,0,0)(0,1,1)s

Statistic of Fit	Value
Mean Square Error	123.145932
Root Mean Square Error	11.097114
Mean Absolute Percent Error	16.770918
Mean Absolute Error	8.657463
R-Square	0.668649

Parameter Estimates

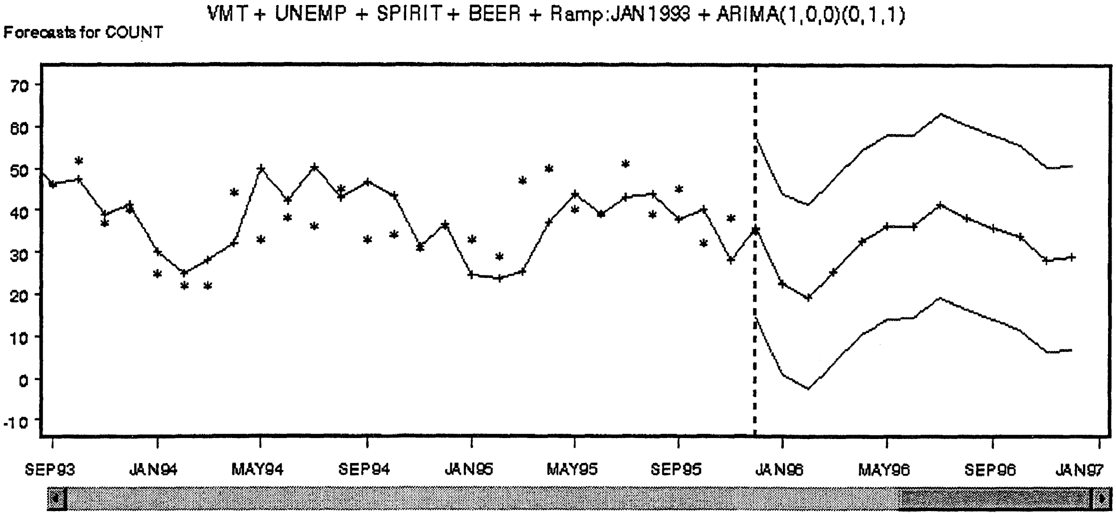
COUNT: Frequency Count

VMT + UNEMP + SPIRIT + BEER + Ramp:JAN1993 + ARIMA(1,0,0)(0,1,1)s

Model Parameter	Estimate	Std. Error	T	Prob>|T|
Intercept	-2.96275	0.8126	-3.6460	0.0003
Seasonal Moving Average, Lag 12	0.73744	0.0613	12.0231	0.0001
Autoregressive, Lag 1	0.24364	0.0680	3.5806	0.0004
VMT	0.97945	6.0830	0.1610	0.8722
UNEMP	-1.33202	0.6503	-2.0482	0.0419
SPIRIT	-7.2456E-6	8.328E-6	-0.8700	0.3854
BEER	-0.0000238	0.000020	-1.2044	0.2299
Ramp:JAN1993	-0.00669	0.0059	-1.1364	0.2572

COUNT: Frequency Count

VMT + UNEMP + SPIRIT + BEER + Ramp:JAN1993 + ARIMA(1,0,0)(0,1,1)



Appendix 2 — Functional Road Classifications

Because some readers may not be familiar with the various functional road classification terms, a few words of explanation are in order. For both rural and urban areas, the classification of interstate roads refers to roads with the interstate designation, for example, I-96 or I-75. These roads serve long distance travel across the country and with very few exceptions, are high speed, limited access, multilane, freeways. The interstate roads are considered part of the total arterial system for both rural and urban areas. However, in the FARS data, the interstate roads are treated separately.

Rural Roads

The rural arterial system consists of routes that serve statewide travel. Rural principal arterials include all rural freeways and most other heavily traveled state routes. Rural minor arterials fill in the road network that provides linkage between cities and larger towns. These roads typically are two-lane facilities, designed for relatively high travel speeds and minimum interference to through traffic.

Rural collector routes generally serve intracounty trips. Predominant travel distances are shorter than those on rural arterial routes, and these roads are designed for more moderate speeds. Major collectors serve county seats not on arterial routes, larger towns not directly served by the higher system, and other traffic generators of intracounty importance. Minor rural collectors provide service to the remaining smaller communities and link locally important traffic generators with their rural hinterland.

Rural local roads primarily provide access to land adjacent to the collector system and serve travel over relatively short distances.

Urban Streets

In urban areas, freeways are part of the principal arterial system but are generally broken out and treated separately from other principal arterial facilities. Nonfreeway principal arterials are the other major routes that serve major centers of activity, serve the highest traffic volume corridors, and carry a high proportion of the total urban area travel on a minimum of mileage. On principal arterials, service to abutting land is subordinate to travel service to major traffic movements. Urban minor arterials interconnect and augment the urban principal arterial system. They accommodate trips of moderate length and place more emphasis on land access than the higher system. Such facilities provide intercommunity continuity, but ideally do not penetrate neighborhoods.

The urban collector street system provides both land access service and traffic circulation within residential neighborhoods and commercial and industrial areas. Collector streets may penetrate neighborhoods and distribute trips from the arterials through the area to their ultimate destinations.

The local street system comprises all facilities not in one of the higher systems. It primarily permits direct access to abutting lands and connections to the collectors. It offers the lowest levels of mobility and service to through traffic usually is deliberately discouraged.

For more information on functional road classifications see: *Highway Functional Classification: Concepts, Criteria and Procedures*. U.S. Department of Transportation, Federal Highway Administration. Washington, D.C.: U.S. Government Printing Office, 1974, pp II-8 through II-14.

Appendix 3 — Covariate Data

Covariates in the ARIMA time-series analysis included: unemployment rate, alcohol consumption, and vehicle miles of travel in Michigan. Data were required for each of these variables for each month for the years, 1978 to 1995. The following documents the procedures of obtaining or developing these data for the ARIMA analysis.

Unemployment Rate

The monthly unemployment rates for Michigan for the years 1978 to 1995 were obtained from the Bureau of Labor Statistics Data of the U.S. Department of Labor. The rates, not adjusted for seasons, were used and are listed in the following table.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
78	8	8	7.6	6.8	6.3	6.9	7.1	7.1	6.2	6	6.2	6.5
79	7.7	7.7	7.8	7.5	6.9	7.5	7.9	8.6	7.7	7.6	7.9	8.5
80	10.4	10.7	10.7	12.9	13.8	14.3	14.5	13.6	12.8	11.9	11.8	11.7
81	13.4	13.2	13	11.7	11.3	11.8	12	11.9	11.3	11.2	12	14.7
82	16.4	16.1	16	15.3	14.6	15	15.2	15	14.7	15.3	15.8	15.9
83	17.1	16.4	16	15	14.4	14.5	14	13.5	12.8	12.4	12.2	12.2
84	12.9	12.5	12.2	11.4	11	11.4	11.2	10.7	10.3	10.1	10.3	10.3
85	11.2	11.1	11	10.2	9.7	10.3	10.2	9.7	9.3	9	9	8.8
86	9.9	9.8	9.7	8.9	8.7	9	9.1	8.3	8.2	8	7.9	7.8
87	9	8.8	8.8	8.1	7.9	8.4	9	7.9	7.6	7.3	7.5	7.6
88	9	8.9	8.7	7.8	7.3	7.8	7.8	7.3	6.8	6.6	6.6	6.6
89	7.6	7.5	7.5	6.8	6.5	7.3	7.6	6.9	6.8	6.8	7	6.9
90	9.1	8.3	8.1	7.4	7.2	7.7	7.9	7.2	7	6.9	7.4	7.3
91	8.8	10.6	10.6	9.8	9.1	9.6	9.5	8.8	8.7	8.6	8.7	8.8
92	10.3	10.2	10.2	9.2	8.8	9.3	9.5	8.4	8.1	7.7	7.6	7.3
93	8.1	7.9	7.8	7.1	6.8	7.4	7.5	6.7	6.5	6.2	6.3	6.3
94	7.3	7.2	6.9	6	5.7	6.1	6.4	5.4	5.2	4.9	4.8	4.8
95	6.1	6.1	6	5.4	5.2	5.8	6.2	5	4.8	4.5	4.7	4.5

Alcohol Consumption

Alcohol consumption in Michigan was estimated by the monthly beer and distilled liquor sales in the state. The data on beer sales were obtained from the Michigan Liquor Control Commission of the Michigan Department of Commerce, and the data on distilled spirit sales were obtained from reports published by the Distilled Spirits Council of the United States. Wine sales were not included in the time-series modeling because monthly data are required for this analysis and such data were not available. Furthermore, studies have repeatedly found that beer is the beverage of choice for alcohol-impaired drivers. The following tables show the monthly sales of beer and distilled spirits used in the analysis for Michigan for the years 1978 to 1995.

Beer (barrels)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
78	444847	525519	670838	596423	710383	730920	743468	694479	580148	400950	579697	614663
79	568409	525359	603918	541188	652657	675961	646082	656299	546961	584893	535393	489673
80	478317	502567	547184	581488	672806	697644	692826	644583	578479	553537	495863	493751
81	478837	495390	569588	600296	645753	705977	719272	636036	573957	497510	480804	497561
82	500491	488934	557628	633699	646143	729707	656598	604931	555513	547650	520929	483734
83	462365	484064	575841	612727	635593	601969	683633	728428	609782	558054	518496	429519
84	461401	462460	604817	580958	631011	655120	691770	668087	516256	577723	490959	448902
85	479329	460926	538286	620349	694818	649023	702760	579268	535981	559006	495133	445645
86	497650	474027	595185	647780	671687	620271	651418	628174	570948	565139	514165	496189
87	489880	509793	553907	606946	639363	732615	732634	613724	551699	528302	512606	465251
88	509330	522262	571351	590129	634405	668027	694217	654091	564179	537852	507407	470813
89	486635	486818	617549	551376	643038	663895	608225	646008	556880	555426	529241	454836
90	475033	421584	502742	494333	518054	537110	552839	589263	480013	506706	530741	470737
91	461821	447087	539528	568268	686142	678689	720821	651551	579952	582185	491083	465601
92	469669	482623	593251	611753	633130	658204	619320	548869	581766	530684	541373	486083
93	448314	468009	564057	582006	621005	647066	636855	663575	577733	542707	559487	483421
94	415141	478927	557184	546940	641336	683998	617911	660454	526931	516744	557790	486115
95	447398	460255	552542	582890	634754	675319	618085	656339	540870	529387	501712	426014

Spirits (gallons)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
78	1043517	1088820	1585457	1360429	1266908	1690320	1296561	1280002	1615287	1433344	1593340	2655445
79	1011078	1150371	1544688	1317911	1315533	1695030	1400533	1279241	1648028	1479314	1609575	2546365
80	1095461	1179415	1599415	1324387	1298006	1683113	1402852	1274732	1756949	1373092	1549924	2444551
81	1128625	1150773	1522021	1326464	1261157	1647205	1356672	1261928	1805300	1239024	1494053	2317260
82	1166365	1122398	1509417	1256126	1244997	1632616	1307417	1261036	1849848	1067895	1468250	2261179
83	1093655	1117673	1455977	1212393	1232980	1617705	1234635	1225101	1856087	969831	1459302	2406405
84	1055452	1134840	1447287	1188321	1193851	1576091	1259779	1225127	1864037	1276453	1473424	2299679
85	1014925	1119257	1454280	1196069	1230044	1587246	1290733	1265006	2064315	1056054	1335829	2144599
86	1012028	1026644	1373828	1117366	1199239	1539484	1235738	1199509	1632176	1113375	1406786	2130866
87	1005675	1026544	1348263	1102653	1145998	1446137	1154958	1115016	1578935	988195	1273360	2018165
88	965593	960502	1260605	1060388	1086573	1421708	1138014	1093060	1654168	1155715	1252144	1929098
89	973091	931011	1252593	1091128	1026183	1384183	1093588	1068839	1340858	1102256	1216979	1873395
90	954783	922139	1193089	1026617	1048470	1376414	1111926	1090757	1326926	1096610	1169676	2093593
91	721842	881557	1166701	977384	1035075	1293394	1066563	1048880	1339089	989138	1142345	1773084
92	791375	883098	1142644	956145	1020570	1267042	1063744	1047227	1398808	886442	1367603	1684138
93	866433	921005	1294183	1022967	716129	1122890	970004	971344	1136754	1016559	1053308	1578044
94	811659	860431	1101524	924597	958750	1211922	986913	989244	1174190	958204	1052654	1606478
95	770907	840509	1071677	892665	960300	1222323	984375	963583	1168970	952077	1081212	1600758

Vehicle Miles of Travel

Information on vehicle miles of travel in Michigan was obtained from the Michigan Department of Transportation. The available data consisted of annual VMT for state trunkline roads, county primary roads, county local roads, city major streets, and city local streets for the years from 1987 to 1995. Only total statewide VMT was available for the years 1978 to 1986. The following procedure was used to obtain the monthly estimates of VMT required for ARIMA modeling.

First, the average values for the proportions of VMT attributable to state trunkline, county primary, county local, city major, and city local roads were calculated from the data for the years 1987 to 1995 and applied to the years 1978 to 1986. This gave annual values of VMT for the five classes of roads considered.

The next step involved estimating monthly distributions from the annual values of VMT by road class. Many studies of variation of traffic volumes have identified distinct patterns of seasonal variation on most rural roads and no strong seasonal variation patterns on most urban streets. A typical pattern of the variation in travel on rural roads by month was obtained from the Institute of Transportation Engineers, *Transportation and Traffic Engineering Handbook,* second edition, Prentice Hall, Inc.: Englewood Cliffs, N.J., 1982, page 249. This distribution is shown in the following table:

Typical Distribution of Rural VMT by Month (%)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6.45	6.36	7.94	8.11	8.90	9.15	9.79	9.94	8.83	8.80	8.02	7.72

We decided to apply these rates to the VMT on rural roads and to divide the annual VMT on urban roads by 12. However, the road classifications available to us were jurisdictional and did not clearly distinguish rural from urban roads. Obviously, urban major streets and urban local streets are urban. State trunkline roads can be in either urban or rural areas, but most of their mileage is in rural areas. County primary and local roads are predominately rural. Therefore, we applied the rural monthly distribution to the VMT for state trunkline and the county roads. The annual VMT for urban major and local streets was divided by 12 to obtain the monthly values. Finally, the monthly rural and urban VMT values were added to give the required total monthly VMT values required for modeling. These values are shown below.

VMT (in billions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
78	4.56	4.51	5.4	5.49	5.93	6.07	6.43	6.52	5.89	5.88	5.44	5.27
79	4.39	4.34	5.2	5.29	5.71	5.85	6.19	6.28	5.68	5.66	5.24	5.08
80	4.16	4.12	4.92	5.01	5.41	5.54	5.87	5.95	5.38	5.36	4.96	4.81
81	4.2	4.15	4.96	5.05	5.46	5.59	5.92	5.99	5.42	5.41	5.01	4.85
82	4.15	4.1	4.91	4.99	5.4	5.52	5.85	5.93	5.36	5.35	4.95	4.8
83	4.3	4.26	5.09	5.18	5.6	5.73	6.07	6.15	5.56	5.55	5.13	4.98
84	4.45	4.4	5.26	5.35	5.78	5.92	6.27	6.35	5.75	5.73	5.3	5.14
85	4.63	4.58	5.48	5.57	6.02	6.16	6.53	6.61	5.98	5.97	5.52	5.35
86	4.78	4.73	5.65	5.75	6.22	6.36	6.74	6.83	6.17	6.16	5.7	5.52
87	4.95	4.9	5.86	5.96	6.44	6.59	6.98	7.07	6.4	6.38	5.91	5.72
88	5.26	5.2	6.22	6.33	6.84	7	7.42	7.51	6.8	6.78	6.28	6.08
89	5.41	5.35	6.4	6.51	7.03	7.2	7.63	7.72	6.99	6.97	6.45	6.25
90	5.49	5.43	6.5	6.62	7.15	7.32	7.75	7.86	7.1	7.08	6.55	6.35
91	5.54	5.48	6.56	6.67	7.21	7.38	7.82	7.92	7.17	7.15	6.61	6.41
92	5.68	5.62	6.72	6.84	7.39	7.56	8.01	8.11	7.34	7.32	6.78	6.57
93	5.8	5.74	6.86	6.98	7.54	7.72	8.18	8.28	7.49	7.47	6.92	6.7
94	5.77	5.71	6.82	6.94	7.5	7.68	8.13	8.23	7.45	7.43	6.88	6.67
95	5.81	5.74	6.86	6.98	7.54	7.72	8.18	8.28	7.49	7.47	6.92	6.71

Clearly, the monthly VMT is an estimate. However, it is better than the alternative which was simply to divide the annual VMT by 12, and which would not capture any of the seasonal effects of travel that are known to exist and should be included in any time-series modeling of this phenomenon.