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Abstract

This report examines the relationship between the blood alcohol concentrations (BACs) of young drivers 16 to 20 years old and a comparison group (drivers 21 to 34) involved in fatal crashes and the following factors: restraint use, previous driving while intoxicated (DWI) conviction, driver license status, number of vehicles involved in the crash, speed limit, vehicle type, number of vehicle occupants, driver gender, time of day, day of week, holiday period, season, rural/urban status, and region of the country. Using NHTSA's Fatality Analysis Reporting System (FARS) data, we examine the relationship between BACs and the above-listed factors first with an exploratory data analysis, presenting percentages based on the two most recent years of available FARS data (2008-2009), and then by an ordinal logistic regression analysis, using 2000-2009 FARS data.

While both age groups had 5.0 percent of their drivers with BACs of .01 to .07 grams per deciliter, the percentage of drivers with BACs of .08 to .14 g/dL was slightly higher among drivers 21 to 34 (10.5%) versus drivers 16 to 20 (8.1%); by comparison, the percentage of drivers with BACs of .15 g/dL or higher was more than twice as high among drivers 21 to 34 years old (23.4%) versus drivers 16 to 20 (10.1%). Among drivers 16 to 20, 76.8 percent had BACs of .00, compared to 61.1 percent of drivers 21 to 34.

Among drivers with positive BACs, 60 percent of the drivers 21 to 34 years old had BACs of .15 or higher, compared to only 43 percent of drivers 16 to 20.

Ordinal logistic regression analysis demonstrated the partial effect of each factor on BAC while adjusting for the presence of all other variables in the model. This method of analysis demonstrated that the most significant factors for predicting the driver BAC level were restraint use, previous DWI status, and the time of day. Specifically, unrestrained drivers, drivers with DWI convictions recorded within three years of the crash, and drivers at night were likely to have BAC values in higher BAC categories than drivers not fitting this profile.

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Executive Summary

This report examines factors contributing to the impaired driving of young drivers in fatal crashes, focusing on drivers in the 16- to 20-year-old age group. Given that these drivers are uniformly subject to the minimum legal drinking age (MLDA) of 21, the National Highway Traffic Safety Administration is keenly interested in preventing their impairment. This analysis explores and then models the relationship between the blood alcohol concentration (BAC) of young drivers 16 to 20 and a comparison group of drivers 21 to 34 years old involved in fatal crashes and the following factors about the crash, as reported to NHTSA's Fatality Analysis Reporting System (FARS) in data years 2000 to 2009: restraint use, previous DWI conviction, driver licenses status, number of vehicles involved in the crash, estimated vehicle speed, vehicle type, number of vehicle occupants, driver gender, time of day, day of week, holiday period, season, rural/urban status, and region of the country. This report models the probability that a young driver in a fatal crash has a BAC in one of the following categories: .00 g/dL, .01-.07g/dL, .08-.14 g/dL, and .15 g/dL or higher. The analysis reveals that the factors most strongly contributing to predicting the driver BAC category were restraint use, previous DWI status, and the time of day (nighttime/daytime).

Exploratory Data Analysis

All results and interpretations in this report apply only to the population of passenger vehicle drivers involved in fatal crashes. While FARS data for the entire period 2000 to 2009 was examined for this report, the exploratory data analysis section displays results for the two most recent years of available data (2008 and 2009); the percentages below reflect the combination of these two years of FARS data.

While both age groups had 5.0 percent of their drivers with BACs of .01-.07, the percentage of drivers with BACs of .08 to .14 was slightly higher among drivers 21 to 34 (10.5%) versus drivers 16 to 20 (8.1%); by comparison, the percentage of drivers with BACs of .15 or higher was more than twice as high among drivers 21 to 34 (23.4%) versus drivers 16 to 20 (10.1%). Among drivers 16 to 20, 76.8 percent had BACs of .00, compared to 61.1 percent of drivers 21 to 34. *(Page 6)*

Among drivers with positive BACs, 60 percent of the drivers 21 to 34 had BACs of .15 or higher, compared to only 43 percent of drivers 16 to 20.

Many factors in fatal crashes are correlated with the BAC levels of the driver in these crashes. Unrestrained drivers 21 to 34 were over 2.5 times more likely to be alcohol-impaired than restrained drivers of that age range. Unrestrained drivers 16 to 20 were over 3 times as likely to be alcohol-impaired than restrained drivers of that age range. *(Page 7)*

With BACs of .00, drivers 16 to 20 were 67 percent restrained, yet their restraint use dropped 49 percentage points to 28 percent when the BAC level was .15 or higher. Similarly, drivers 21 to 34 with zero BACs were 71 percent restrained, yet their restraint use dropped 39 percentage points to 32 percent when the BAC level was .15 or higher.

FARS records all prior convictions (including prior DWI convictions) that occurred within the previous three years from the date of the crash. Drivers with a previous DWI conviction were far more likely to be alcohol-impaired than drivers with no previous DWI conviction. Over 45 percent of drivers 21 to 34 with previous DWI convictions had BACs of .15 or higher; among drivers 21 to 34 without previous DWI convictions, only 22 percent had BACs of .15 or higher. By comparison, 30 percent of drivers 16 to 20 with previous DWI convictions had BACs of .15 or higher, and 10 percent with no previous DWI convictions had BACs of .15 or higher. *(Page 10)*

Drivers with invalid driver licenses were far more likely to be alcohol-impaired than drivers with valid driver licenses. Over half of drivers 21 to 34 with invalid driver licenses had BACs of .08 or higher, while among drivers 21 to 34 with valid driver licenses, 30 percent had BACs of .08 or higher. Thirty-two percent of drivers 16 to 20 with invalid driver licenses had BACs .08 or higher, which was twice as high as the 16 percent of the drivers in this age group with valid driver licenses. *(Page 11)*

Speeding drivers were far more likely to be alcohol-impaired than non-speeding drivers. Fifty-six percent of speeding drivers 21 to 34 and 30 percent of speeding drivers 16 to 20 had BACs of .08 or higher. By comparison, only 26 percent of non-speeding drivers 21 to 34 and 12.5 percent of non-speeding drivers 16 to 20 had BACs of .08 or higher. *(Page 13)*

Among drivers 16 to 20, the proportion of passenger car, sport utility vehicle (SUV), and pickup truck drivers who had BACs of .15 or higher ranged from 9 to 12 percent, while only 3.6 percent of van drivers had BACs of .15 or higher. The percentage of 21 to 34 passenger car, SUV, and pickup drivers with BACs of .15 or higher was 23 to 26 percent, which was roughly twice as high as the percentage of van drivers (12.6%) of 21 to 34. *(Page 15)*

When the driver was "not alone" in the vehicle, he/she was more likely to have had BACs of .01 to .07 than drivers who were "alone." Similarly, drivers who were "not alone" were also more likely to have BACs of .08 to .14 than were drivers who were "alone." The pattern changed among drivers with BACs of .15 or higher, as these drivers within the highest BAC category were more likely to be "alone" than "not alone." Among drivers in fatal crashes with positive BACs, the driver who was "alone" was likely to have consumed more alcohol than the driver who was "not alone." *(Page 16)*

Male drivers were roughly twice as likely as female drivers to have BACs of .08 or higher. This trend occurred among drivers 16 to 20 as well as drivers 21 to 34. *(Page 18)*

Among drivers 16 to 20, drivers in nighttime crashes were about 3 times as likely to have BACs of .01 to .07 as drivers in daytime crashes, while drivers in nighttime crashes were about 4 times as likely as drivers in daytime crashes to have BACs of .08 to .14, and drivers in nighttime crashes were nearly 5 times as likely as drivers in daytime crashes to have BACs of .15 or higher. For drivers 21 to 34, drivers in nighttime crashes were over 2 times as likely to have BACs of .01 to .07 as drivers in daytime crashes, drivers in nighttime crashes were over 3 times as likely to have BACs of .08 to .14 as drivers in daytime crashes, and drivers in nighttime crashes were over 4 times as likely as drivers in daytime crashes to have BACs of .15 or higher. *(Page 19)*

During weekends, nearly 45 percent of drivers 21 to 34 had BACs of .08 or higher, compared to 25.2 percent of drivers during weekdays. Drivers 16 to 20 were twice as likely to have had BACs of .08 or higher during the weekend (24.9%) as compared to the weekdays (12.5%). *(Page 21)*

Ordinal Logistic Regression Analysis

The ordinal logistic regression analysis, using FARS data from 2000 through 2009, examined young driver alcohol use through both odds ratios and probability distributions *(Page 27)*. This portion of the analysis demonstrated that restraint use, previous DWI status, and driving at night were the factors most significantly accounting for an elevated driver BAC value. Unrestrained drivers had odds 3.2 times greater than restrained drivers to be in the next higher-level BAC category. A driver with a DWI conviction in the three years prior to the crash had odds 2.31 times greater to be in the next higher-level BAC category than a driver who had no prior DWI convictions. Those involved in nighttime crashes had odds 5.03 times greater to be in the next higher-level BAC category than those involved in daytime crashes. The ordinal logistic regression model demonstrated that high-risk behavior is strongly associated with high BAC values. This result is especially important to those in the traffic safety community engaged in efforts to identify and interdict such behavior.

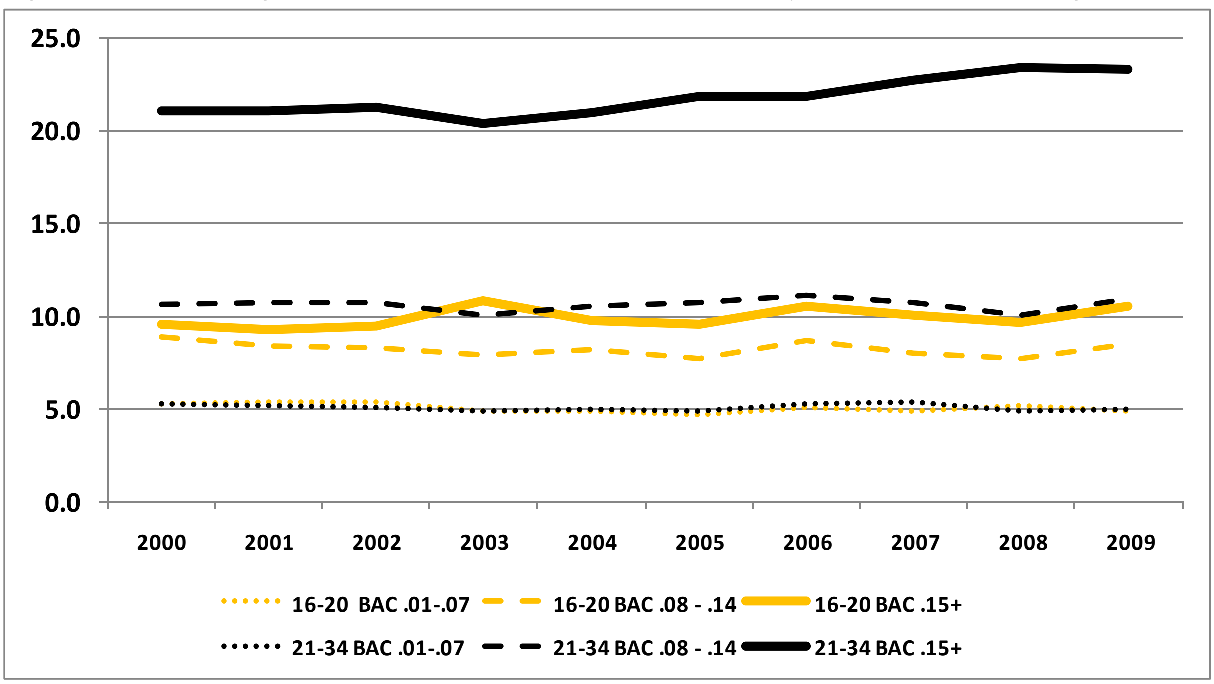
Background and Introduction

For several decades, much work had been done to examine the alcohol-impaired-driving behavior of drivers 21 and older, and to work to reduce alcohol-impaired driving among those drivers who have reached the minimum legal drinking age (MLDA). This report focuses on drivers 16 to 20 to determine what factors are strongly associated with their BAC levels at the time of the fatal crashes. To help put the alcohol-impaired driving of people 16 to 20 into perspective, this report compares the crash data for two separate age groups of drivers: 16 to 20 and 21 to 34.

Figure 1 below shows the trend of BAC levels of drivers 16 to 20 and 21 to 34 in fatal crashes from 2000 through 2009. As the legend in Figure 1 displays, the three black lines represent the three different BAC levels of drivers 21 to 34, and the three orange lines show the equivalent for drivers 16 to 20. The one black solid line and the one orange solid line represent the highest BAC category of .15 or higher for 21 to 34 and 16 to 20, respectively.

Figure 1 shows how consistent the percentage distribution of 16 to 20 and 21 to 34 driver BAC levels has been over the 10-year-period from 2000 through 2009. The two dotted lines for BAC .01 to .07 g/dL (see left side of the legend) are almost identical, showing that the percentage of drivers with BACs of .01 to .07 is roughly 5 percent for both age groups. The two dashed lines for BAC .08 to .14 (see middle third of the legend) are consistently separated by about 2 to 3 percentage points, with around 10 or 11 percent of the 21- to 34-year-old age group and around 8 or 9 percent of the 16- to 20-year-old age group at this .08 to .14 BAC level. The two thick solid lines for BAC .15 or higher (see right side of legend) are separated by the largest amount. While around 10 percent of the drivers 16 to 20 have had BACs of .15 or higher, the percentage of 21- to 34-year-old drivers with BACs of .15 or higher (see top black line in Figure 1) has risen over time, from a low of 20.4 percent in 2003 to above 23 percent in 2008 and 2009.

Figure 1: Percentage Distribution of Driver BAC Level, by Year and Driver Age



NHTSA considers a fatality occurring in a crash involving a driver with a BAC of .08 or higher an alcohol-impaired driving fatality.

Since the late 1980s, the MLDA in the United States has been 21. In addition, zero tolerance laws have been enacted in all States. The zero tolerance law makes it illegal for people under the age of 21 to operate motor vehicles with any detectable amount of alcohol in their systems (e.g., with BACs of .02 or more).

The proportion of alcohol-impaired driving fatalities decreased from 48 percent in 1982 to 32 percent in 1995. Since 1995, this percentage has shown minimal change, remaining between 30 and 32 percent every year.

In 1982, 21,113 alcohol-impaired-driving fatalities occurred, and the rate in 1982 for alcohol-impaired-driving fatalities was 1.32 per 100 million VMT. The number of alcohol-impaired-driving fatalities, at 10,839 in 2009, has been nearly cut in half since 1982, while the fatality rate per VMT has dropped 73 percent, from 1.32 in 1982 to 0.36 in 2009.

Most of this improvement occurred from the early 1980s up through the mid-1990s. The alcohol-impaired fatality rate (per 100 million VMT) dropped substantially from 1.32 in 1982, to 0.98 in 1987, to 0.63 in 1992. By the mid-1990s, the rate was below 0.50, and it hovered there from 1997 through 2006, with 12,500 to 13,500 alcohol-impaired-driving fatalities each year. That rate dropped to 0.43 in 2007, 0.39 in 2008, and is at 0.36 as of 2009, with a trend that parallels the large overall decline in the number of motor vehicle fatalities in the last few years.

Methodology

This report uses crash data from 2000 to 2009 from NHTSA's Fatality Analysis Reporting System (FARS) to examine the relationship between the BAC of passenger vehicle drivers split into two age groups, 16 to 20 and 21 to 34, and the following factors: restraint use, previous DWI conviction, driver license status, number of vehicles involved in the crash, estimated vehicle speed, vehicle type, number of vehicle occupants, driver gender, time of day, day of week, holiday period, season, rural/urban status, and region of the country. This report defines passenger vehicles as cars, vans, SUVs, and pickups. In addition to a presentation of individual variable charts and tables, we present a model that estimates the relationship between driver BAC and the independent variables, adjusting for the presence of all variables included in the model. The individual charts and tables are produced using 2008-2009 data, to show the most recent trends, and the model used 10 years of data (2000-2009). It is important for the reader to understand that this report uses only data from the population of fatal crashes, not crashes at all levels of injury severity. The results derived from the population of fatal crashes would not necessarily be the same as a model based on the population of all drivers (whether involved in crashes or not).

Most alcohol-impaired driving research classifies a driver as alcohol-impaired when the driver BAC is measured to be at least .08 g/dL. In this report, we use four categories of BAC as follows: (1) .00 g/dL, (2) .01 to .07 g/dL, (3) .08 to .14 g/dL, and (4) .15 g/dL and greater. The units for BAC values (g/dL) will not be displayed throughout the main body of the report. We chose .00 because it is illegal *per se* (in and of itself) for drivers under the age of 21 to operate a motor vehicle with any detectable amount of alcohol in their system. We chose .08 because it is illegal *per se* for a driver 21 or older to operate a motor vehicle at this BAC level in every State in the United States. We chose .01 to .07 to capture the range of BACs between these two *per se* levels. We chose .15 and greater because many jurisdictions have established a separate "high BAC" offense, and .15 is the most common high BAC level in the United States (the median for positive BAC drivers involved in fatal crashes is .15 g/dL).

Estimates of alcohol-impaired-driving fatalities are generated using BAC values both directly reported to FARS and BAC values imputed when they are not reported. It is important to note that the term *alcohol-impaired* does not indicate that a particular crash or a fatality was caused by alcohol impairment.

The exploratory data analysis examines each of the above-listed variables in relation to driver BAC, without respect to other variables. The ordinal logistic regression analysis combines all of the above variables to estimate the partial effect of each variable on predicting the BAC category for each crash. Since regression analysis estimates the partial effects of selected independent variables on the dependent variable (BAC), not all of the original variables considered in the exploratory data analysis were statistically significant at the alpha=.05 level. Also, given that we had both directly reported and multiply imputed values for BAC, this report employed a special technique to derive the estimated regression coefficients. The combined estimated coefficients were derived using the SAS software procedure MIanalyze, which averages the estimates across the number of imputations. Unreported BAC values in the FARS database have 10 imputed values and thus SAS procedure MIanalyze performed 10 separate logistic regression analyses and then averaged the respective coefficients into a single final model, representative of the array of 10 imputed BAC values.

Exploratory Data Analysis

*Note: This **Exploratory Data Analysis** (EDA) section provides tables of BAC distribution, stratified by categories of each variable (e.g., restraint use). These tables only examine one variable at a time, and do not adjust for the presence of other variables. For an estimation of the impact of many variables on BAC distribution, after adjusting for other variables in the model, see the **Ordinal Logistic Regression Analysis** section that begins on page 27.*

Overall Distribution of BAC Level, by Driver Age

While FARS data for the entire period from 2000 through 2009 was examined while producing this EDA section of the report, the EDA section displays results for the two most recent years of available data (2008 and 2009). Among passenger vehicle drivers age 16 to 20, 7,441 had BACs of .00, 489 had BACs of .01 to .07, 784 had BACs of .08 to .14, and 976 had BACs of .15 or higher. Among drivers 21 to 34, 13,840 had BACs of .00, 1,129 had BACs of .01 to .07, 2,379 had BACs of .08 to .14, and 5,294 had BACs of .15 or higher. These counts are produced using FARS 2008 and 2009 data.

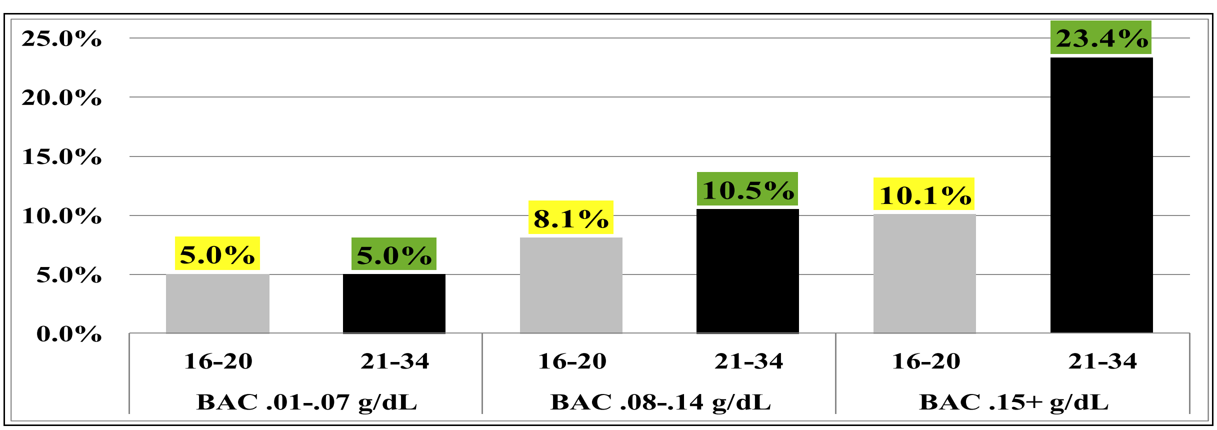
Variable definitions, as necessary, are provided at the beginning of the section describing the tabular results for that variable. For example, the definitions of daytime/nighttime, holiday/non-holiday, summer/non-summer, and speeding-related (yes/no) are included in the corresponding results section.

Figure 2 below shows a percentage distribution of driver BAC level for drivers in fatal crashes, for 16 to 20 (percentages shown in yellow) and 21 to 34 (percentages shown in green). The percentages for each age range sum to 100 percent, as the y-axis represents the percentage of the total drivers for that age range. For example, Figure 2 shows that 61.1 percent of drivers had BACs of .00, while the three 21-to-34 bars (with green percentages shown above bars) show that 5.0 percent of drivers had BACs of .01 to .07, 10.5 percent of drivers had BACs of .08 to .14, and 23.4 percent had BACs of .15 or higher. (Note: 61.1 + 5.0 + 10.5 + 23.4 = 100).

Among drivers 16 to 20, 76.8 percent (in yellow in table above chart) had BACs of .00, compared to 61.1 percent (in green in table above chart) of drivers 21 to 34. While both age groups had 5.0 percent of their drivers with BACs of .01 to .07, the percentage of drivers with BACs of .08 to .14 was slightly higher among drivers 21 to 34 (10.5%) versus drivers 16 to 20 (8.1%); by comparison, the percentage of drivers with BACs of .15 or higher was more than twice as high among drivers 21 to 34 (23.4%) versus drivers 16 to 20 (10.1%).

Figure 2: Percentage Distribution of Driver BAC Level, by Driver Age

BAC .00	16-20	76.8%
	21-34	61.1%



Restraint Use

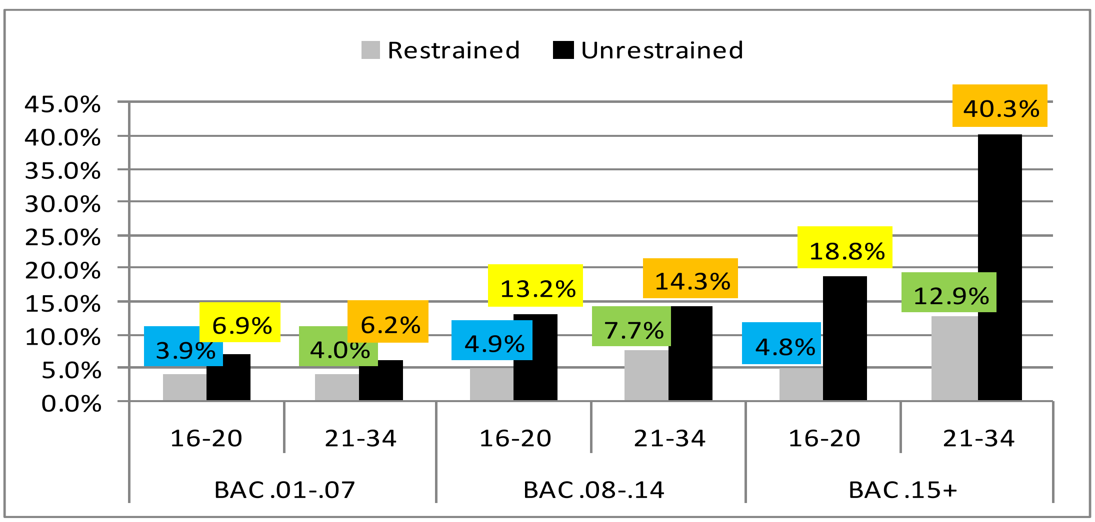
In fatal crashes, unrestrained drivers 21 to 34 were over 2.5 times as likely to be alcohol-impaired than restrained drivers of that age range. Unrestrained drivers 16 to 20 were over 3 times as likely to be alcohol-impaired than restrained drivers of that age range.

This section focuses on the relationship in fatal crashes between restraint use and driver BAC. Figure 1 shows a percent distribution of driver BAC level, among four categories of drivers age (16 to 20 and 21 to 34) and restraint use (restrained and unrestrained). The percentages of these four categories of drivers are shown in blue, green, yellow, and orange.

In Figure 3, the percentages for each age/restraint use category sum to 100 percent, as the y-axis represents the percentage of the total drivers for that age range and restraint use category. For example, Figure 3 shows that 86.4 percent of restrained drivers 16 to 20 had BACs of .00, while the three "restrained/16 to 20" bars in the chart show that 3.9 percent of restrained drivers had BACs of .01 to .07, 4.9 percent of restrained drivers had BACs of .08 to .14, and 4.8 percent of restrained drivers had BACs of .15 or higher. (Note: 86.4 + 3.9 + 4.9 + 4.8 = 100). The "restrained/16 to 20" numbers in this example are displayed in blue in Figure 3.

Figure 3: Percentage Distribution of Driver BAC Level, by Restraint Use and Driver Age

BAC .00	**Restrained**	16-20	86.4%
		21-34	75.4%
	Unrestrained	16-20	61.1%
		21-34	39.2%



Note: For each of the four age/restraint use color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

When combining the percentages from the BAC .08 - .14 bars with those from the BAC .15 or higher bars, Figure 3 shows that 54.6 percent (14.3 + 40.3, see orange percentages) of unrestrained drivers 21 to 34 had BACs of .08 or higher, while only 20.6 percent (7.7 + 12.9, see green percentages) of restrained drivers 21 to 34 had BACs of .08 or higher. Thus unrestrained drivers 21 to 34 were over 2.5 times as likely to be alcohol-impaired (defined as BAC of .08 or greater) than restrained drivers of that age range.

Among drivers 16 to 20, 32.0 percent (13.2 + 18.8, see yellow percentages) of unrestrained drivers have BACs of .08 or higher, while only 9.7 percent (4.9 + 4.8, see blue percentages) of restrained drivers 16 to

20 have BACs of .08 or higher. This shows that unrestrained drivers 16 to 20 were over 3 times as likely to be alcohol-impaired than restrained drivers of that age range.

Among restrained drivers 16 to 20, 86.4 percent had BACs of .00, compared to 75.4 percent of restrained drivers 21 to 34. While both age groups had about 4 percent of their restrained drivers with BACs of .01-.07, the percentage of restrained drivers with BACs of .08-.14 was over 50 percent higher among drivers 21 to 34 (7.7%) versus drivers 16 to 20 (4.9%); by comparison, the percentage of restrained drivers with BACs of .15 or higher was over 150 percent higher among drivers 21 to 34 (12.9%) versus drivers 16 to 20 (4.8%).

Among unrestrained drivers 16 to 20, 61.1 percent had BACs of .00, compared to only 39.2 percent of unrestrained drivers 21 to 34. For both age groups, 6 to 7 percent of their unrestrained drivers had BACs of .01 to .07, and 13 to 14 percent of their unrestrained drivers had BACs of 08 to .14; however, among unrestrained drivers, the percentage of drivers with BACs of .15 or higher was more than twice as high among drivers 21 to 34 (40.3%) versus drivers 16 to 20 (18.8%).

The same data on restraint use and BAC that is displayed in Figure 3 was used to produce Figure 4, which shows the percentage of drivers restrained, by driver age and BAC. The columns in Figure 4 each represent a percentage of restraint use. For example, among drivers 16 to 20 with BACs of .00, 67 percent were restrained.

Figure 4: Percentage of Drivers Restrained in Fatal Crashes, by Driver Age and BAC

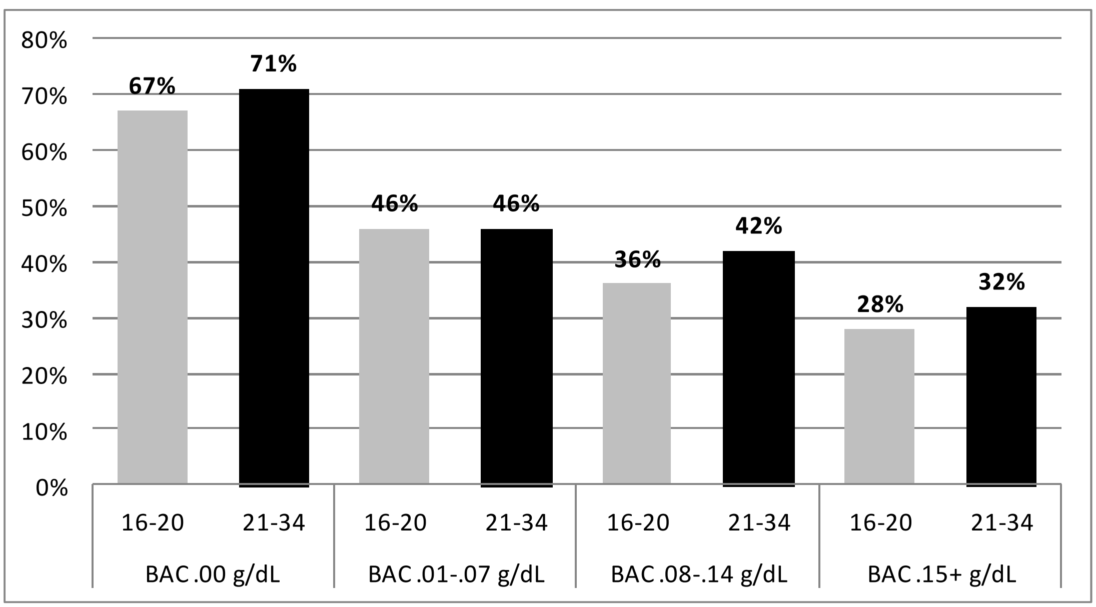


Figure 4 shows that for both age groups, driver restraint use declines as their BAC level increases. The drop in restraint use is steepest as the driver BAC increases from .00 to .01 to .07, yet continues to drop significantly for each higher category of BAC.

With BACs of .00, drivers 16 to 20 were restrained 67 percent of the time, yet their restraint use dropped 39 percentage points to 28 percent when the BAC level was .15 or higher. Similarly, drivers 21 to 34 with zero BACs were restrained 71 percent of the time, yet their restraint use dropped 39 percentage points to 32 percent when the BAC level was .15 or higher.

Previous DWIs (within 3 years from the date of the crash)

In fatal crashes, drivers with previous DWI convictions were far more likely to be alcohol-impaired than drivers with no previous DWI convictions. Over 45 percent of drivers 21 to 34 with previous DWI convictions had BACs of .15 or higher; among drivers 21 to 34 without previous DWI conviction, only 22 percent had BACs of .15 or higher. By comparison, 30 percent of drivers 16 to 20 with previous DWI convictions had BACs of .15 or higher, and 10 percent with no previous DWI conviction had BACs of .15 or higher.

Figure 5 below shows the percentage distribution of BAC levels of drivers in fatal crashes, stratified according to whether the driver had no previous DWI conviction (see gray bars) or did have a previous DWI conviction (see black bars). As expected, the BACs of drivers with previous DWI was much higher than the BACs of drivers with no previous DWI. This data on fatal crashes shows that drivers being convicted of DWI do not reduce their alcohol consumption to levels similar to drivers with no previous DWI conviction, but rather still have BAC levels well above drivers with no previous DWI conviction.

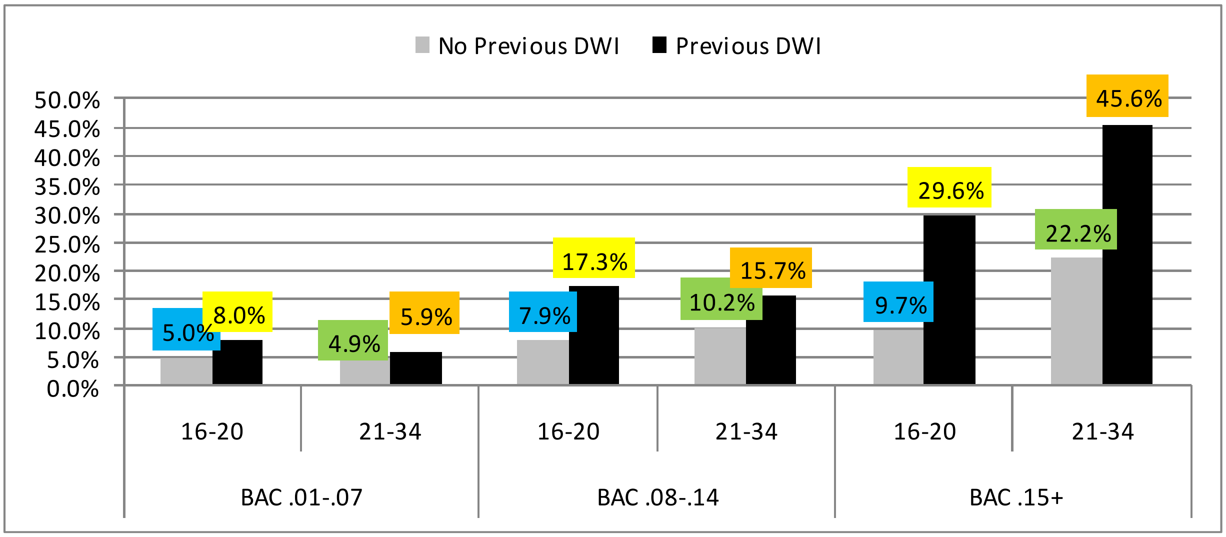
Among drivers 21 to 34, only 32.8 percent of drivers with previous DWI convictions had BACs of zero in the fatal crash, compared to 45.1 percent of drivers 16 to 20 with previous DWI conviction. Drivers with no previous DWI conviction were much more likely to have BACs of .00, both among drivers 16 to 20 (77.3%) and drivers 21 to 34 (62.7%).

Figure 5 shows that 45.6 percent of drivers 21 to 34 with a previous DWI conviction had BACs of .15 or higher, and another 15.7 percent of drivers 21 to 34 with a previous DWI conviction had BACs of .08 to .14. Among drivers 16 to 20 with a previous DWI conviction, 29.6 percent had BACs of .15 or higher, and another 17.3 percent had BACs of .08 to .14.

The BAC levels of drivers with no previous DWI were much lower. Drivers 21 to 34 with no previous DWI were less than half as likely (22.2%) to have BACs of .15 or higher, compared to the same age drivers with a previous DWI (45.6%); drivers 16 to 20 with no previous DWI were one-third as likely (9.7%) to have BACs of .15 or higher, compared to the same age drivers with a previous DWI (29.6%).

Figure 5: Percentage Distribution of Driver BAC Level, by DWI Conviction and Driver Age

BAC .00	No Previous DWI	16-20	77.3%
		21-34	62.7%
	Previous DWI	16-20	45.1%
		21-34	32.8%



Note: For each of the four age/DWI color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

<u>Driver License Status</u>

In fatal crashes, drivers with invalid driver licenses were far more likely to be alcohol-impaired than drivers with valid driver licenses. Over half of drivers 21 to 34 with invalid driver licenses had BACs of .08 or higher, while among drivers 21 to 34 with valid driver licenses, 30 percent had BACs of .08 or higher. Thirty-two percent of drivers 16 to 20 with invalid driver licenses had BACs .08 or higher, which was twice as high as the 16 percent of the drivers in this age group with valid driver licenses.

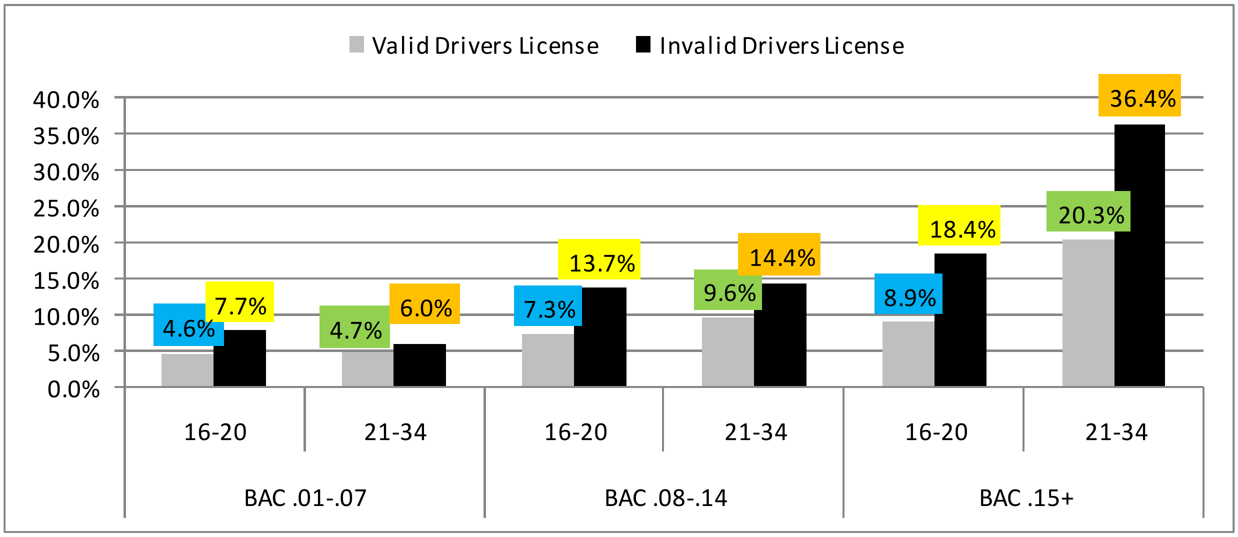
Figure 6 shows that with valid driver licenses, nearly 80 percent of drivers 16 to 20 and almost two-thirds of 21 to 34-year-old drivers in a fatal crash had BACs of .00. Among drivers with invalid driver licenses, only 60 percent of 16-20-year-olds and only 43 percent of 21 to 34-year-old drivers had a zero BAC.

For all positive BAC levels shown in Figure 6, the proportion of drivers with invalid driver licenses was higher than the proportion of drivers with valid driver licenses. The difference increased as the BAC level increased. Among drivers 21 to 34, 6.0 percent of those with invalid licenses had BACs .01 to .07, while 4.7 percent of those with valid licenses had BACs of .01 to .07; in this same age group, 36.4 percent of those with invalid licenses had BACs .15 or higher, which is far higher than the 20.3 percent of those with valid licenses who had BACs .15 or higher.

Among those with invalid licenses, drivers 21 to 34 (36.4%) were nearly twice as likely as drivers 16 to 20 (18.4%) to have BACs .15 or higher, yet these 21 to 34-year-old drivers (14.4%) were not much more likely than 16-20-year-old drivers (13.7%) to have BACs .08 - .14. This pattern can be seen in the bar chart in Figure 6 below by comparing percentages displayed in orange with percentages displayed in yellow, at the two highest BAC levels.

Figure 6: Percentage Distribution of Driver BAC Level, by Driver Licenses Status and Driver Age

BAC .00	Valid Drivers License	16-20	79.2%
		21-34	65.4%
	Invalid Drivers License	16-20	60.3%
		21-34	43.2%



Note: For each age/BAC color category (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

<u>Crash Type (Single-Vehicle Versus Multivehicle)</u>

In fatal crashes, drivers in single-vehicle (SV) crashes were far more likely to be alcohol-impaired than drivers in multivehicle (MV) crashes. The majority of drivers 21 to 34 in SV crashes had BACs of .08 or higher, while among drivers 16 to 20 in an SV crash, nearly 30 percent had BACs of .08 or higher. The percentage of drivers 16 to 34 who were alcohol-impaired was about 3 times higher in SV crashes compared to MV crashes. As the BAC level of the driver rose, the relative risk of being in an SV crash versus being in an MV crash increased.

The percentage of drivers with BACs of .00 varied greatly between SV fatal crashes and MV fatal crashes. Figure 7 shows that in MV fatal crashes, almost 90 percent of drivers 16 to 20 and over three-quarters of 21- to 34-year-old drivers had BACs of .00. Drivers in SV crashes were much less likely to have BACs of .00. In SV fatal crashes, only 64 percent of 16- to 20-year-olds and only 43 percent of 21- to 34-year-old drivers had zero BACs.

For all positive BAC levels shown in Figure 7, the proportion of drivers in SV crashes was substantially higher than the proportion of drivers in MV crashes, showing that drivers in SV fatal crashes were more likely to have consumed alcohol prior to the crashes.

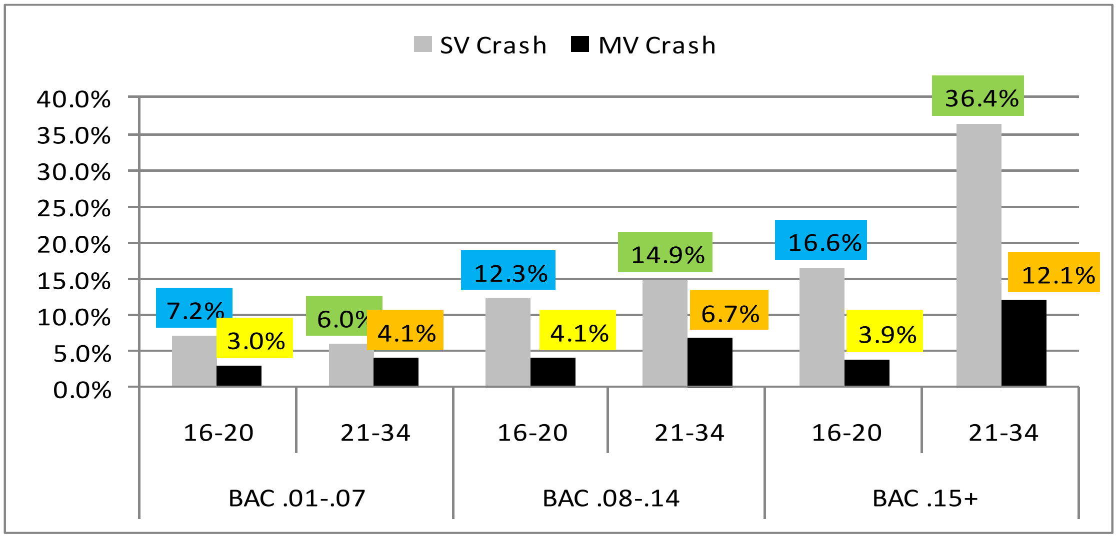
Among the 57.3 percent of drivers 21 to 34 in SV crashes with positive BACs, 36.4 percent had BACs of .15 or higher, 14.9 percent had BACs of .08 to .14, and only 6.0 percent had BACs of .01 to .07. These percentages are shown in green above the appropriate columns in Figure 7 below. The BAC distribution for 21- to 34-year-olds was much lower for MV crashes (see orange), with only 12.1 percent with BACs of .15 or higher, 6.7 percent with BACs of .08 to .14, and only 4.1 percent with BACs of .01 to .07. As the BAC increased, the relative risk of being in an SV crash versus an MV crash increased.

Figure 7 shows that similar comparisons can be made when looking at age 16 to 20 SV crash data (see blue) and MV crash data (see yellow). For each positive BAC level among crashes of 16- to 20-year-olds, the percentage of SV crashes at that alcohol level was higher than the percentage of MV crashes. A total of 28.9 percent (16.6 + 12.3, shown in blue) of SV crashes of 16- to 20-year-olds had BACs of .08 or higher, compared to only 8.0 percent (3.9 + 4.1, shown in yellow) of MV crashes of the same age group.

As with crashes of 21- to 34-year-olds, as the BAC increased in the 16 to 20 age group's fatal crashes, the relative risk of being in an SV crash versus an MV crash increased. For drivers 16 to 20 in fatal crashes, 7.2 percent in SV crashes had BACs of .01 to .07, compared to 3.0 percent in MV crashes, for a relative risk of 2.4 (7.2%/3.0%). For drivers 16 to 20 with BACs of .08 to .14, the relative risk of SV crashes versus MV crashes rose to 3.0 (12.3%/4.1%), and for BAC of .15 or higher, the relative risk was 4.3 (16.6%/3.9%).

Figure 7: Percentage Distribution of Driver BAC Level, by Crash Type and Driver Age

BAC .00	Single-Vehicle Crash	16-20	64.0%
		21-34	42.7%
	Multivehicle Crash	16-20	89.0%
		21-34	77.1%



Note: For each of the four age/crash type color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

Speeding

In fatal crashes, speeding drivers were far more likely to be alcohol-impaired than non-speeding drivers. Fifty-six percent of speeding drivers 21 to 34 and 30 percent of speeding drivers 16 to 20 had BACs of .08 or higher. By comparison, only 26 percent of non-speeding drivers 21 to 34 and 12.5 percent of non-speeding drivers 16 to 20 had BACs of .08 or higher.

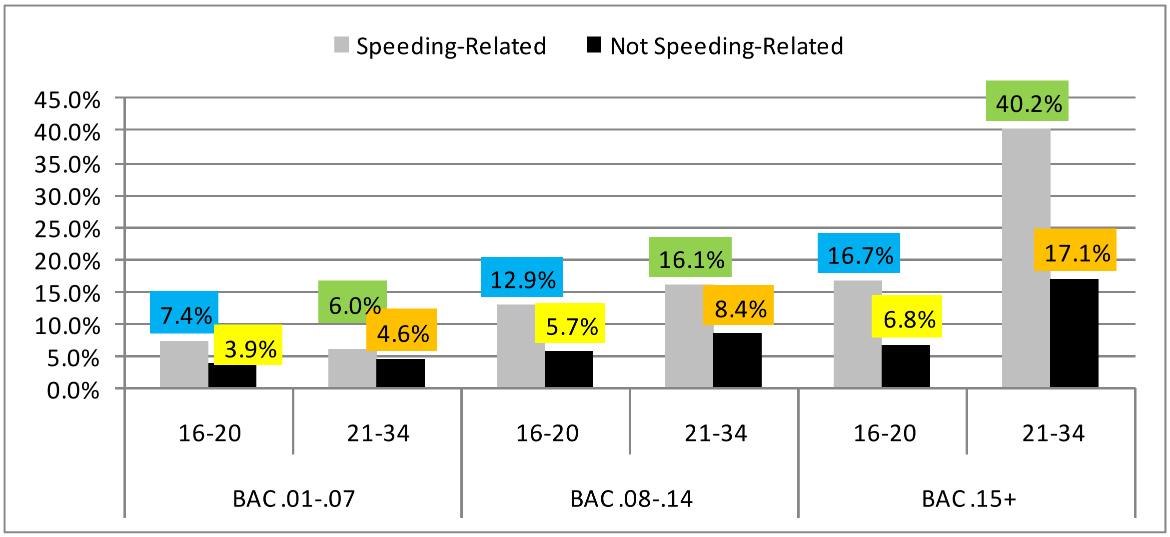
NHTSA considers a crash to be speeding-related if a driver was charged with a speeding-related offense or if an officer indicated that racing, driving too fast for conditions, or exceeding the posted speed limit was a contributing factor in the crash.

The percentage of drivers with BACs of .00 varied greatly between speeding and non-speeding drivers. Figure 8 shows that 83.6 percent of non-speeding drivers 16 to 20 and 69.9 percent of non-speeding 21- to 34-year-old drivers had BACs of .00. Speeding drivers were much less likely to have BACs of .00. For speeding drivers, only 62.9 percent of 16- to 20-year-olds and only 37.7 percent of 21- to 34-year-old drivers had zero BACs.

The proportion of speeding drivers was higher than the proportion of non-speeding drivers for all positive BAC levels, as shown in Figure 8. Among speeding drivers 21 to 34, 40.2 percent had BACs of .15 or higher, as shown in green in Figure 7 below. Non-speeding drivers 21 to 34 were less than half as likely (17.1%, see orange) as speeding drivers 21 to 34 to have BACs of .15 or higher. While 16.7 percent (shown in blue) of speeding drivers 16 to 20 had BACs of .15 or higher, only 6.8 percent (shown in yellow) of non-speeding drivers 16 to 20 had that high level of BAC.

Figure 8: Percentage Distribution of Driver BAC Level, by Speeding Status and Driver Age

BAC .00	**Speeding**	16-20	62.9%
		21-34	37.7%
	Non-Speeding	16-20	83.6%
		21-34	69.9%



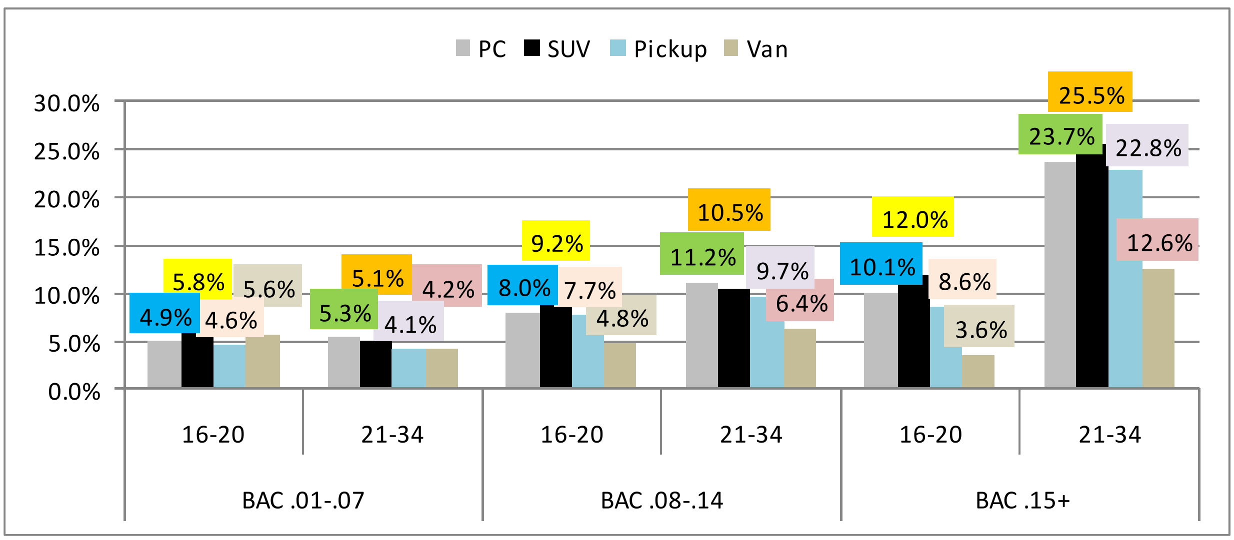
Note: For each of the four age/speeding color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

Vehicle Type

In fatal crashes, for all eight age/vehicle type groups, the percentage of drivers with BACs of .01 to .07 varied little, ranging from 4.1 percent to 5.8 percent. Drivers of vans were the least likely to fall into the BAC range of .08 to .14; drivers of passenger cars (PC), SUVs and pickups were all more likely to have BACs of .08-.14. The greatest variation across vehicle types was seen in the BAC level of .15 or higher. Among drivers 16 to 20, 9 to 12 percent of PC, SUV, and pickup drivers had BACs of .15 or higher, while only 3.6 percent of van drivers had BACs of .15 or higher. The percentage of 21 to 34 PC, SUV, and pickup drivers with BACs of .15 or higher was 23 to 26 percent, which was roughly twice as high as the percentage of van drivers (12.6%) of 21 to 34.

Figure 9: Percentage Distribution of Driver BAC Level, by Vehicle Type and Driver Age

BAC .00	**Passenger Car**	16-20	77.0%
		21-34	59.8%
	SUV	16-20	73.1%
		21-34	59.0%
	Pickup	16-20	79.1%
		21-34	63.4%
	Van	16-20	86.0%
		21-34	76.8%



Note: For each of the eight age/vehicle type color categories (for example, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent. The percentages in the above chart are shown in eight colors, for the eight age/vehicle body type categories.

Driver Alone Versus Driver Not Alone

In fatal crashes, the probability that a driver had a BAC of .00 was not related to whether or not the driver was driving in the vehicle alone ("Driver Alone") or with another passenger ("Driver Not Alone"). When the driver was "not alone," he/she was more likely to have had a BAC of .01 to .07 than drivers who were "alone." Similarly, drivers who were "not alone" were also more likely to have BACs of .08 to .14 than were drivers who were "alone."

The pattern changed among drivers with BACs of .15 or higher. These drivers within the highest BAC category were more likely to be "alone" than "not alone." This data shows that among drivers in fatal crashes with positive BACs, the driver who was "alone" was likely to have consumed more alcohol than the driver who was "not alone."

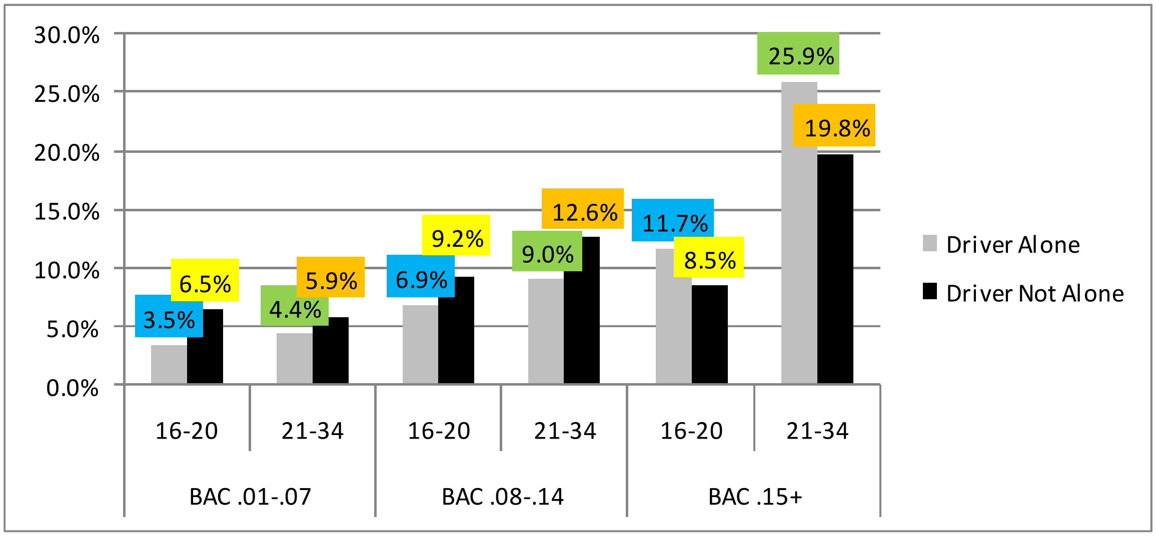
The percentage of drivers with BACs of .00 varied slightly between "driver alone" fatal crashes and fatal crashes where the driver was "not alone." Figure 10 shows that in crashes where the driver was "not alone," 75.7 percent of drivers 16 to 20 and 61.7 percent of 21- to 34-year-old drivers had BACs of .00. Drivers in fatal crashes where they were driving alone were similarly likely to have BACs of .00; 77.9 percent of 16- to 20-year-olds driving alone and 60.7 percent of 21- to 34-year-olds driving alone had zero BACs.

Among drivers "not alone," 18.5 percent (12.6 + 5.9) of drivers 21 to 34 had BACs of .01 up to .14, compared to 13.4 percent (9.0 + 4.4) of drivers "not alone" fatalities (see Figure 10). For drivers 16 to 20 "not alone," 15.7 percent (9.2 + 6.5) had positive BACs of less than .15, while 10.4 percent (6.9 + 3.5) of drivers " alone" had positive BACs of less than .15. These numbers show that among fatal crashes where the driver BAC was from .01 up to .14, the driver was more likely to be with one or more passengers in the vehicle, rather than driving alone.

This pattern changes when the driver BAC was .15 or higher. Among crashes where the driver was "not alone," 19.8 percent of 21- to 34-year-old driver fatalities had positive BACs of .15 or higher, compared to 25.9 percent of drivers "not alone." For drivers 16 to 20 "not alone," 8.5 percent had positive BACs of .15 or higher, while 11.7 percent of drivers "alone" in this age group had positive BACs of .15 or higher. These numbers show that among crashes where the driver was driving alone, the driver was more likely to have BACs of .15 or higher compared to crashes where the driver was not alone.

Figure 10: Percentage Distribution of Driver BAC Level, by Occupant Level and Driver Age

BAC .00	**Driver Alone**	16-20	77.9%
		21-34	60.7%
	Driver Not Alone	16-20	75.7%
		21-34	61.7%



Note: For each of the four age/ "driver alone versus not alone" color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

Gender

In fatal crashes, male drivers were roughly twice as likely as female drivers to have BACs of .08 or higher. This trend occurred among drivers 16 to 20 and drivers 21 to 34. While 21.5 percent of male drivers 16 to 20 had BACs of .08 or higher, only 10.8 percent of female drivers in that age range had BACs of .08 or higher. Similarly, 39.5 percent of male drivers 21 to 34 had BACs of .08 or higher compared to 20.3 percent of female drivers in that age range.

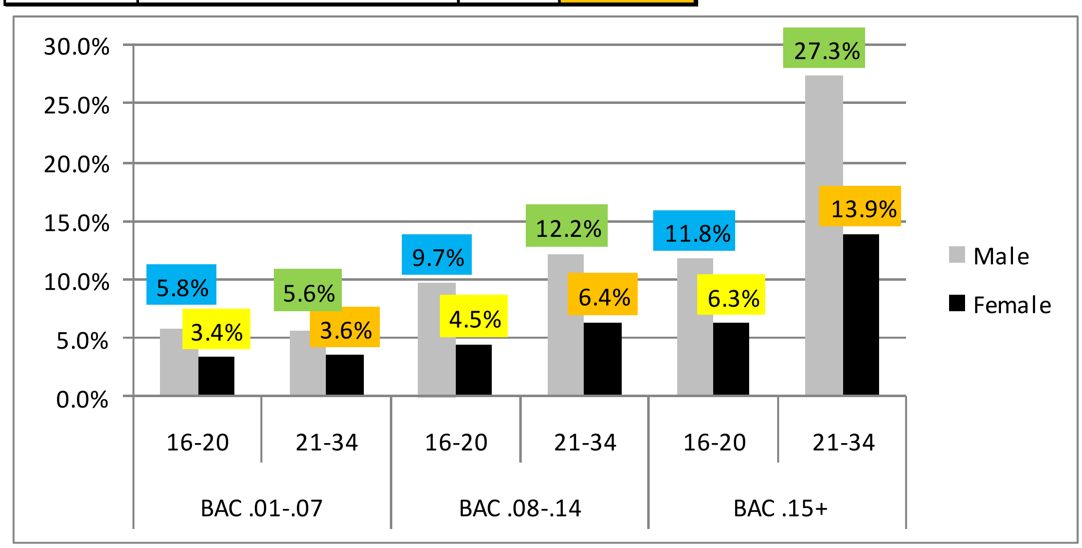
The percentage of drivers with BACs of .00 varied greatly across gender. Figure 11 shows that among males, 72.6 percent of drivers 16 to 20 and 54.9 percent of 21 to 34-year-old drivers in fatal crashes had BACs of .00. Female drivers were much more likely to have BACs of .00, as 85.8 percent of 16- to 20-year-old female drivers and 76.2 percent of 21- to 34-year-old female drivers had zero BACs.

For the BAC .15 or higher level, the proportion of male drivers was roughly twice the proportion of female drivers. Among male drivers 21 to 34, 27.3 percent had BACs of .15 or higher, as shown in green in Figure 11 below. Female drivers 21 to 34 were about half as likely (13.9 percent, see orange) as male drivers 21 to 34 to have BACs of .15 or higher. While 11.8 percent (shown in blue) of male drivers 16 to 20 had BACs of .15 or higher, only 6.3 percent (shown in yellow) of female drivers 16 to 20 had that high level of BACs.

For both age groups, the percentage of male drivers with BACs of .08 to .14 was about twice as high as the percentage of female drivers. This parallels the trend seen in the BAC .15 or higher crashes. Males were slightly more than 1.5 times as likely as females to have to have BACs of .01 to .07.

Figure 11: Percentage Distribution of Driver BAC Level, by Gender and Driver Age

BAC .00	**Male**	16-20	72.6%
		21-34	54.9%
	Female	16-20	85.8%
		21-34	76.2%



Note: For each of the four age/gender color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

Night Versus Day

In fatal crashes involving alcohol, as the BAC level in the crash increased, the odds the fatality in the crash occurred at night increased, for both drivers 16 to 20 and drivers 21 to 34. Among drivers 16 to 20, drivers in nighttime crashes were about 3 times as likely to have BACs of .01 to .07 as drivers in daytime crashes, while drivers in nighttime crashes were about 4 times as likely as drivers in daytime crashes to have BACs of .08 to .14, and drivers in nighttime crashes were nearly 5 times as likely as drivers in daytime crashes to have BACs of .15 or higher.

For drivers 21 to 34, drivers in nighttime crashes were over 2 times as likely to have BACs of .01 to .07 as drivers in daytime crashes, drivers in nighttime crashes were over 3 times as likely to have BACs of .08 to .14 as drivers in daytime crashes, and drivers in nighttime crashes were over 4 times as likely as drivers in daytime crashes to have BACs of .15 or higher.

A crash occurring between 6 p.m. and 5:59 a.m. is defined to have occurred at night, while crashes from 6 a.m. to 5:59 p.m. are categorized as daytime crashes.

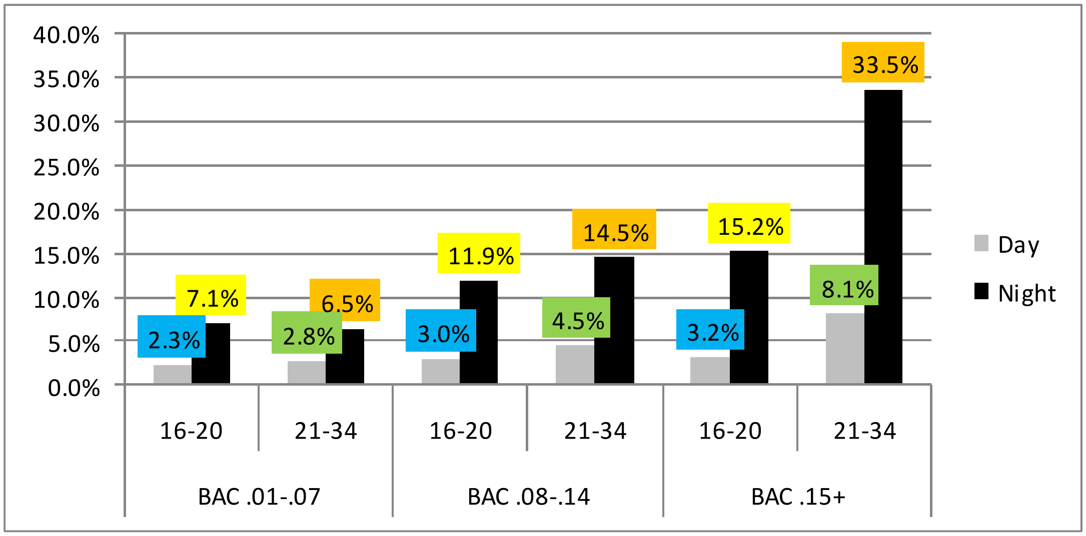
A significant increase in BAC levels is seen in nighttime crashes compared to daytime crashes. Among drivers in nighttime fatal crashes, less than half (45.5%) of drivers 21 to 34 had BACs of .00, and less than two-thirds (65.8) of drivers 16 to 20 had BACs of .00. Among drivers in daytime fatal crashes, a very high proportion of drivers 16 to 20 (91.4%) and drivers 21 to 34 (84.6%) had BACs of .00, as shown in Figure 12.

When combining the percentages from the BAC .08- .14 bars with the BAC .15 or higher bars, Figure 12 shows that 48.0 percent (14.5 + 33.5, see orange percentages) of nighttime drivers of 21 to 34 had BACs of .08 or higher, while only 12.6 percent (4.5 + 8.1, see green percentages) of daytime drivers of 21 to 34 had BACs of .08 or higher. Thus nighttime drivers 21 to 34 were about 4 times as likely to be alcohol-impaired as daytime drivers.

By comparison, 27.1 percent (11.9 + 15.2, see yellow percentages) of nighttime drivers of 16 to 20 had BACs of .08 or higher, while only 6.2 percent (3.0 + 3.2), see blue percentages) of daytime drivers of 16 to 20 had BACs of .08 or higher. This shows that nighttime drivers 16 to 20 were over 4 times as likely to be alcohol-impaired than daytime drivers of that age range.

Figure 12: Percentage Distribution of Driver BAC Level, by Time of Day and Driver Age

BAC .00	Day	16-20	91.4%
		21-34	84.6%
	Night	16-20	65.8%
		21-34	45.5%



Note: For each of the four age/ day-night color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

Weekday Versus Weekend

In fatal crashes, a much higher percent of drivers on the weekend were at BACs of .08 or higher, for both drivers 16 to 20 and drivers 21 to 34, compared to drivers on weekdays. Nearly 45 percent of weekend drivers 21 to 34 had BACs of .08 or higher, compared to 25.2 percent of weekday drivers. Drivers 16 to 20 were twice as likely to have had BACs of .08 or higher on the weekend (24.9%) compared to the weekday (12.5%).

NHTSA defines a crash that occurs from Friday at 6 p.m. to Monday at 5:59 a.m. to be a "weekend" crash. All other crashes are defined as "weekday" crashes.

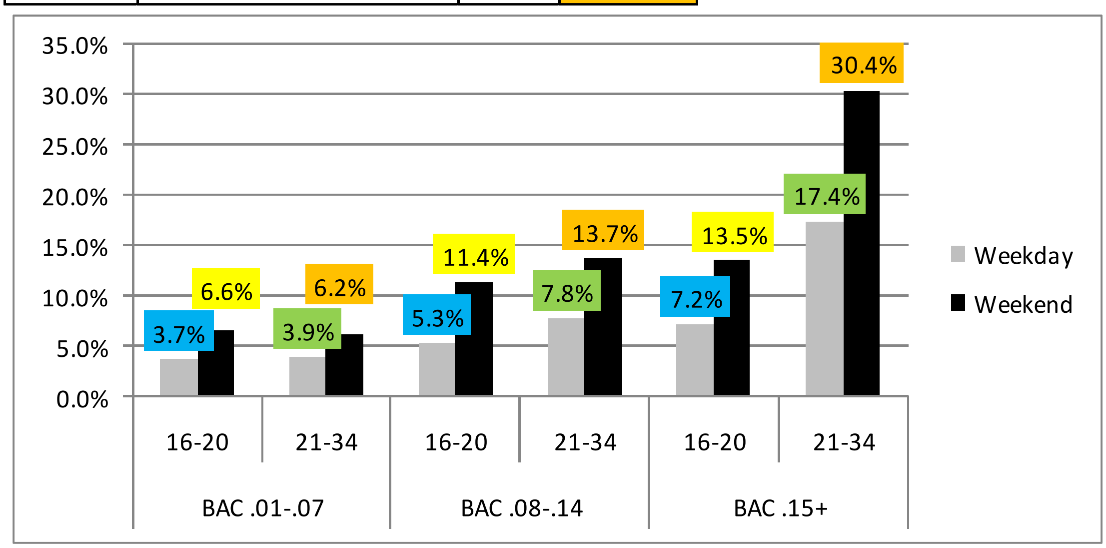
Among fatal crashes on the weekend, about half (49.7%) of drivers 21 to 34 had BACs of .00, and about two-thirds (68.5%) of drivers 16 to 20 had BACs of .00. This is shown below in Figure 13. During weekdays, 83.8 percent of drivers 16 to 20 and 70.9 percent of drivers 21 to 34 had BACs of .00.

The bar chart displayed in Figure 13 shows that for all six age-BAC categories with positive BACs (i.e., 21 to 34 and BAC .08 to .14), the percentage of weekend drivers was roughly 1.5 to 2 times the percentage of weekday drivers.

For the three BAC categories of .01 to .07, .08 to .14, as well as .15 or higher, the odds of a weekend driver having that positive BAC level, versus a weekday driver having that same positive BAC level, were higher for drivers 16 to 20 compared to drivers 21 to 34. For example, drivers 16 to 20 were 1.9 times as likely (13.5%//7.2 percent = 1.9) in a weekend crash to have BACs of .15 or higher, compared to a weekday crash; similarly, drivers 21 to 34 were 1.7 times as likely (30.4%/17.4 percent = 1.7) in a weekend crash to have BACs of .15 or higher, compared to a weekday crash.

Figure 13: Percentage Distribution of Driver BAC Level, by Day of Week and Driver Age

BAC .00	**Weekday**	16-20	83.8%
		21-34	70.9%
	Weekend	16-20	68.5%
		21-34	49.7%



Note: For each of the four age/ day of week color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

Holiday Versus Non-Holiday

In fatal crashes, the percentage of drivers during major holiday periods that were at BACs of .08 or higher was higher than the corresponding percent of non-holiday drivers, for both age categories. Forty-three percent of holiday drivers 21 to 34 had BACs of .08 or higher, compared to 33 percent of non-holiday drivers 21 to 34. Drivers 16 to 20 were also more likely to have had BACs of .08 or higher on a holiday (23%) compared to a non-holiday (18%).

The NHTSA definition of legal holiday is as follows. The six major holiday periods included in this section are New Year's Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving, and Christmas. The length of the legal holiday period depends on the day of the week which the holiday falls, as shown below:

- If the holiday falls on Monday, the holiday period is from 6 p.m. Friday to 5:59 a.m. Tuesday.
- If the holiday falls on Tuesday, the holiday period is from 6 p.m. Friday to 5:59 a.m. Wednesday.
- If the holiday falls on Wednesday, the holiday period is from 6 p.m. Tuesday to 5:59 a.m. Thursday.
- If the holiday falls on Thursday, the holiday period is from 6 p.m. Wednesday to 5:59 a.m. Monday.
- If the holiday falls on Friday, the holiday period is from 6 p.m. Thursday to 5:59 a.m. Monday.

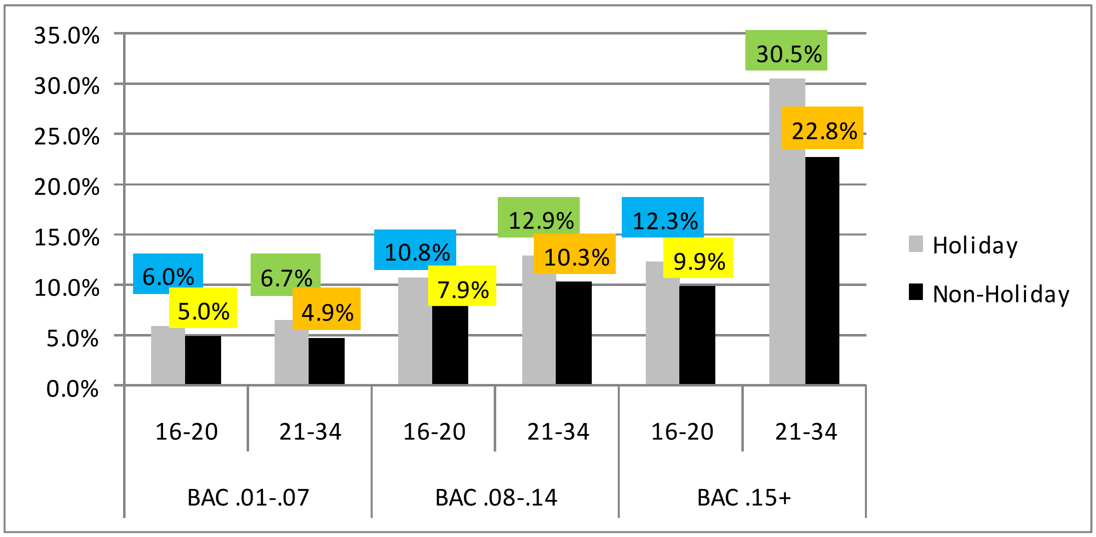
For each of the years in this report, Memorial Day and Labor Day include three whole days, since they begin on Monday. The length of the other holidays varies.

Figure 14 shows that on a holiday, 50.0 percent of drivers 21 to 34 and 71.0 percent of 16- to 20-year-old drivers in a fatal crash had BACs of .00. In fatal crashes on days that were not on a holiday, 62.0 percent of 21- to 34-year-old drivers and 77.2 percent of 16- to 20-year-old drivers had a zero BAC. These differences between holiday and non-holiday percentages of BAC .00 levels, of 6.2 percent for drivers 16 to 20 (6.2 = 77.2 – 71.0) and 12.0 percent for drivers 21 to 34 (12.0 = 62.0 – 50.0), show that the increased percent of positive BAC levels on holidays versus non-holidays is larger among drivers 21 to 34 than among drivers 16 to 20.

For all positive BAC levels shown in Figure 14, the proportion of holiday drivers at that BAC level was higher than the proportion of non-holiday drivers. The difference was largest among drivers 21 to 34 at the BAC level of .15 or higher. Among drivers 21 to 34, 30.5 percent of those during holiday periods had BACs .15 or higher, versus 22.8 percent of those on non-holiday periods having BACs of .15 or higher. The difference between holiday and non-holiday periods was smaller among the other five age-BAC categories, as shown in Figure 14.

Figure 14: Percentage Distribution of Driver BAC Level, by Holiday Status and Driver Age

BAC .00	Holiday	16-20	71.0%
		21-34	50.0%
	Non-Holiday	16-20	77.2%
		21-34	62.0%



Note: For each of the four age/holiday color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

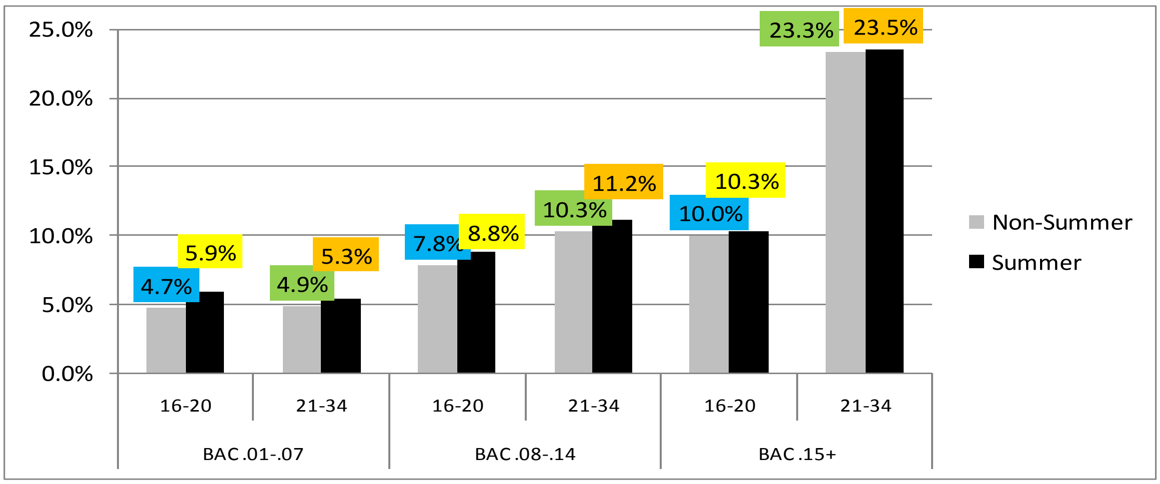
Summer Versus Non-Summer

In fatal crashes, for both drivers 16 to 20 and drivers 21 to 34, the BAC level in the summer months was not significantly different from the non-summer months. The slight increase in BAC in summer months, compared to non-summer months, was larger for 16- to 20-year-old drivers than for 21- to 34-year-old drivers, and was larger for the lower BAC levels of .01 to .07 and .08 to .14, compared to the highest level BAC of .15 or higher.

June, July, and August are coded as summer months. The other nine months are coded as non-summer months. Figure 15 below displays the similarity between summer and non-summer months.

Figure 15: Percentage Distribution of Driver BAC Level, by Season and Driver Age

BAC .00	**Non-Summer**	16-20	77.4%
		21-34	61.5%
	Summer	16-20	75.1%
		21-34	60.0%



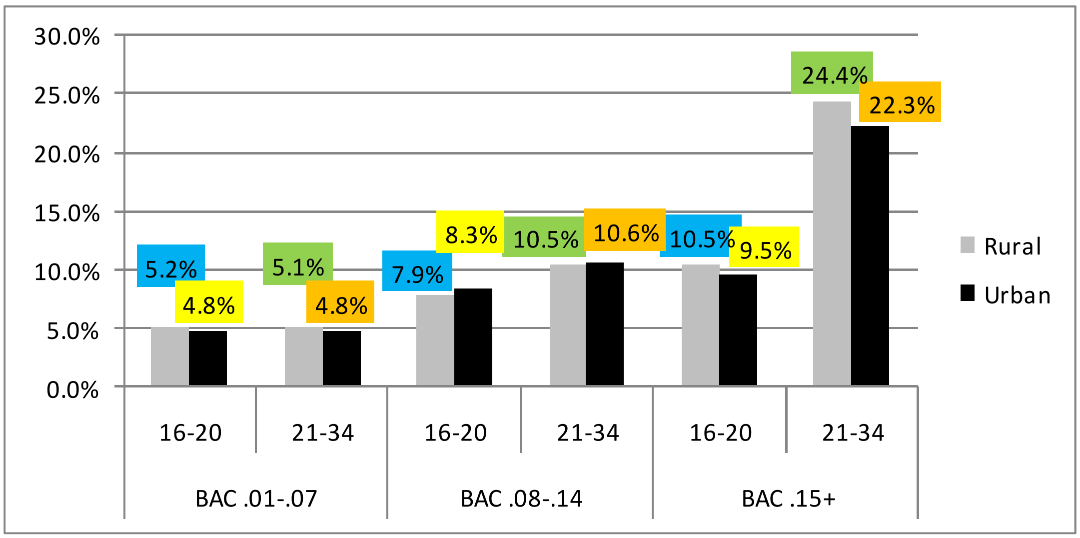
Note: For each of the four age/season color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

Land Use (Rural Versus Urban)

In fatal crashes, for drivers 16 to 20 and drivers 21 to 34, the BAC level in rural crashes was not significantly different from urban crashes. Drivers in rural areas were slightly more likely to have BACs of .15 or higher, while the percentage of drivers with BACs of .01 to .07, or .08 to .14, was nearly identical when comparing rural crashes to urban crashes. Results are displayed below.

Figure 16: Percentage Distribution of Driver BAC Level, by Rural/Urban Status and Driver Age

BAC .00	**Rural**	16-20	76.4%
		21-34	60.0%
	Urban	16-20	77.3%
		21-34	62.3%



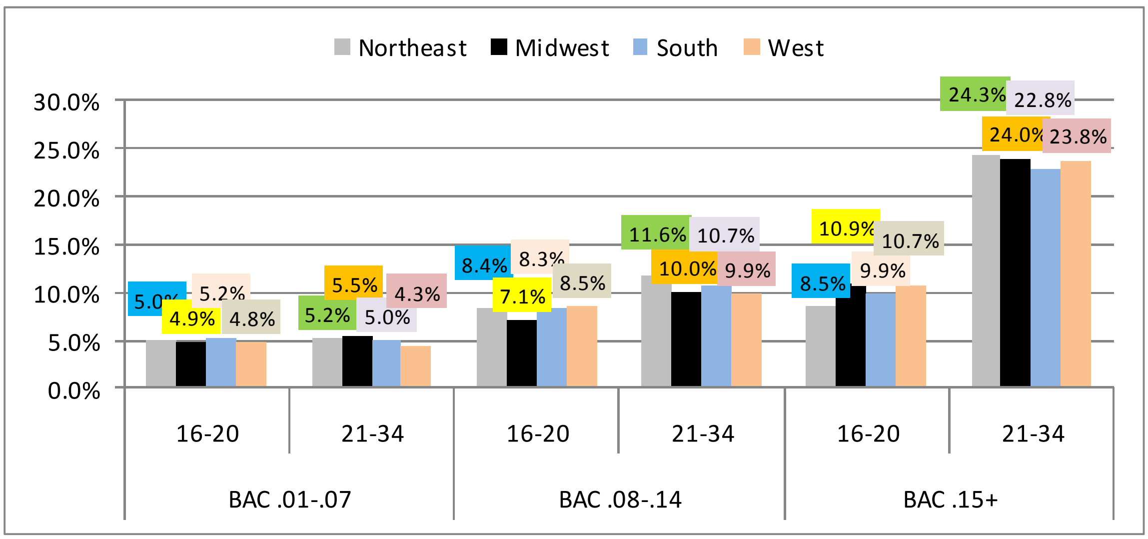
Note: For each of the four age/ rural-urban color categories (blue, green, yellow, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent.

Region of the Country

In fatal crashes, for drivers 16 to 20 and drivers 21 to 34, the BAC level did not vary significantly between the four regions of the country (Northeast, Midwest, South, and West). Results are displayed below.

Figure 17: Percentage Distribution of Driver BAC Level, by Region and Driver Age

BAC .00	**Northeast**	16-20	78.1%
		21-34	58.9%
	Midwest	16-20	77.2%
		21-34	60.5%
	South	16-20	76.6%
		21-34	61.0%
	West	16-20	76.0%
		21-34	62.0%



Note: For each of the eight age/region color categories (for example, orange), the sum of the four percentages (BAC .00, BAC .01-.07, BAC .08-.14, and BAC .15+) is 100 percent. The percentages in the above chart are shown in eight colors, for the eight age/region categories.

The States that constitute the above four regions are grouped as follows:

Northeast: Connecticut, Massachusetts, Maine, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

Midwest: Iowa, Kansas, Illinois, Indiana, Michigan, Minnesota, Missouri, North Dakota, Nebraska, Ohio, South Dakota, Wisconsin

South : Alabama, Arkansas, the District of Columbia, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia

West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, New Mexico, Nevada, Oregon, Washington, Washington, Wyoming

Ordinal Logistic Regression Analysis

This section specifies and estimates an ordinal logistic regression model to explore the relationship between the driver BAC category in fatal crashes and various factors described below. The goal of the exploratory data analysis was to identify candidate variables for the ordinal logistic regression analysis. The ordinal logistic regression analysis combined variables from the exploratory data analysis to estimate the partial effect of each variable on predicting the BAC category for each driver. Since regression analysis estimates the partial effects of selected independent variables on the dependent variable (BAC), not all of the original variables considered in the exploratory data analysis were statistically significant at the alpha=.05 level. Also, given that we had both directly reported and multiply imputed values for BAC, this report employed a special technique to derive the estimated regression coefficients. The combined estimated coefficients were derived using the SAS software procedure MIanalyze, which averages the estimates across the number of imputations. Unreported BAC values in the FARS database have 10 imputed values and thus SAS procedure MIanalyze performed 10 separate logistic regression analyses and then averaged the respective coefficients into a single final model, representative of the array of 10 imputed BAC values. The model uses FARS data from 2000 through 2009. While the exploratory data analysis portion of this report presents tables with FARS data from the two most recent years available, 2008 and 2009, an exploratory data analysis was also performed using FARS data from 2000 through 2009 in order to help in preparing this model.

Tables 1 and 2 present the odds ratios and the parameter estimates, respectively. The various levels of the categorical variables used in the analysis and their reference categories (in parentheses) are listed next:

Dependent Variable

Driver BAC in four ordered levels: (.00, .01 to .07, .08 to .14, .15 or higher)
This variable incorporates values derived from the process of multiple imputation.

Independent Variables

- **Restraint use:** Restrained, Unrestrained, Unknown restraint use (reference category: Restrained)
- **Age Group**: 16 to 20, 21 to 34 (reference category: 21 to 34)
- **Previous DWI conviction (within three years from the date of the crash):** Previous DWI, No previous DWI (reference category: no previous DWI conviction)
- **Driver License Status:** Valid driver license, Invalid driver license (reference category: Valid driver license)
- **Speeding:** Speeding involved, No speeding involved (reference category: Speeding involved)
- **Number of Occupants:** Driver alone, Driver not alone (reference category: Driver not alone)
- **Driver Sex:** Male, Female (reference category: Female)
- **Time of Day:** Day, Night (reference category: Day)
- **Day of Week:** Weekday, Weekend (reference category: Weekday)

The preceding variables were significant at the alpha=0.05 level. Not all of the variables presented in the tabulations before were found significant in this portion of the analysis. This difference exists because the logistic regression estimates the *partial effect* of each variable on the blood alcohol concentration level, holding the other variables constant.

Table 1: Odds Ratio Estimates			
Effect	**OR est.**	**L95***	**U95***
Restraint Use: Restraint Not Used Versus Restraint Used	3.2046	3.1333	3.2773
Restraint Use: Restraint Use Unknown Versus Restraint Used	1.9036	1.8352	1.9743
Age Group: Young Drivers 16 to 20 Versus Comparison Age Group 21 to 34	0.4269	0.4168	0.437
DWI Status: Previous DWI Versus No Previous DWI	2.3108	2.2006	2.4265
Driver Licenses Status: Invalid Driver Licenses Versus Valid Driver Licenses	1.8574	1.8092	1.9069
Speeding: No Speed Involved Versus Speed Involved	0.4346	0.4251	0.4444
Number of Occupants: Driver Not Alone Versus Driver Alone	0.844	0.8266	0.8622
Driver Sex: Male Versus Female	1.6853	1.643	1.7287
Time of Day: Night Versus Day	5.0386	4.9154	5.1645
Day of Week: Weekend Versus Weekday	1.6595	1.6245	1.6953
** The L95 and U95 values are the lower and upper bounds of the odds ratio 95% confidence interval*			

The odds ratios in Table 1 compare the odds that a driver in a particular independent variable non-reference category had BACs in a category one level higher, with the odds that a driver from the independent variable reference category had BACs category one level higher. The BAC categories are ordered from .00 (lowest category), .01 to .07, .08 to .14, and .15 or higher (highest category). The reference categories for each independent variable are listed in the bullets prior to Table 1.

For example, Table 1 shows that the odds of a male driver (the non-reference category) being in the next higher-level BAC category are about 1.69 times the odds of the female driver (the reference category) being in the next higher-level BAC category, holding all other factors in the model constant. On a percentage basis this translates to 1.69 – 1.0 = .69 → 69% greater odds. This 69 percent increase in odds can be applied to any one of the following three possible BAC category shifts: (1) going from the BAC category of .00 up to .01 to .07, or (2) going from BACs of .01 to .07 up to .08 to .14, or (3) going from the BAC category of .08 to .14 up to .15 or higher.

Another example from this table shows that the odds of being in the next higher-level BAC category can *decrease* when moving away from the reference category. The odds of a driver who is not speeding (the non-reference category) being in the next higher-level BAC category are approximately 0.43 times the odds of the speeding driver (the reference category) being in the next higher-level BAC category, holding all other factors in the model constant. On a percentage basis this odds ratio of 0.43 translates to .43 – 1.0 = -.57 → 57% smaller odds.

<u>Interpretation of Odds Ratios</u>
These examples show that odds ratios greater than 1.0 indicate an increased likelihood for a particular outcome, while odds ratios equal to one indicate no change in the likelihood for a particular outcome, and odds ratios less than one indicate a decreased likelihood for a particular outcome.

Furthermore, this model assumes that the odds ratio of moving from a lower BAC category to the next higher BAC category within the dependent variable is constant. For example, the odds ratio of 3.20 for unrestrained versus restrained shows that the odds of the unrestrained driver (to move to the next higher BAC category) are 3.20 times greater than for a restrained driver, holding other factors constant. This odds ratio is constant for movements from one BAC level to the next higher category, such as going from the.01 to .07 category up to the.08 to .14 category, or going from the .08 to .14 category up to the .15 or higher category.

All interpretations of odds ratios are applicable only to the domain of drivers involved in fatal crashes.

<u>Restraint Use</u>
The odds ratios for the restraint use variable show that an unrestrained driver's odds of being in the next higher-level BAC category are 3.20 times a restrained driver's odds of being in the next higher level BAC, holding other factors constant. Also, drivers with unknown restraint use have odds of being in the next higher-level BAC category that are 1.90 times greater than restrained drivers. The odds ratios for the restraint use variable indicate that drivers who are unrestrained and those with unknown restraint use are more likely to be in a higher BAC category than restrained drivers.

<u>Age Group</u>
Drivers in the 16 to 20 age group had an odds ratio of .43, indicating that their odds of being in the next higher-level BAC category were 57% less than drivers in the 21 to 34 age group.

<u>Previous DWIs (within 3 years from the date of the crash)</u>
Drivers with a previous DWI had odds 2.31 times greater of being in the next higher-level BAC category than did drivers without a DWI conviction.

<u>Driver License Status</u>
The odds of a driver with invalid licenses being in the next higher BAC level are approximately 86% greater than for drivers with valid licenses.

<u>Speeding</u>
In crashes where no speeding occurred, the odds of a driver being in the next higher BAC category were 57 percent less than for crashes where speeding was a crash-related factor.

<u>Number of Occupants</u>
In vehicles where the driver was not alone, the odds of that driver being in the next higher BAC category were 16 percent less than for drivers who had other occupants in the vehicle.

<u>Driver Sex</u>
Male drivers had 69 percent greater odds of being in the next higher-level BAC category than did than female drivers.

<u>Time of Day</u>
The odds of drivers in nighttime crashes being in the next higher level BAC category were 5 times higher than drivers in daytime crashes.

<u>Day of Week</u>
The odds of drivers in weekend crashes being in the next higher level BAC category were 66 percent higher than drivers in weekday crashes.

Table 2 shows the parameter estimates from the logistic regression analysis. The parameter estimates show that the factors with the greatest influence on the predicted BAC category are: restraint use (unrestrained versus restrained), age group (age group 16 to 20 versus age group 21 to 34), and time of day (night versus day).

Table 2: Ordinal Logistic Regression Analysis Parameter Estimates					
Parameter	**d.f.**	**est.**	**s.e.**	**Wald Chi-Square**	**p-value**
Intercept: .01<=BAC<=.07	1	-2.2134	0.0192	13254.2140	<.0001
Intercept: .08<=BAC<=.14	1	-2.4571	0.0194	16046.8070	<.0001
Intercept: BAC>.15	1	-2.9669	0.0198	22474.8800	<.0001
Restraint Use: Unrestrained vs. Restrained	1	1.1645	0.0114	10351.8870	<.0001
Restraint Use: Unknown vs. Restrained	1	0.6437	0.0186	1194.6580	<.0001
Age Group: Drivers 16-20 vs. Drivers 21-34	1	-0.8514	0.0122	4860.7850	<.0001
DWI Status: Previous DWI vs. No Previous DWI	1	0.8376	0.0249	1130.0590	<.0001
License Status: Invalid vs. Valid	1	0.6191	0.0134	2131.0000	<.0001
Speeding: No Speeding Involved vs. Speeding Involved	1	-0.8333	0.0114	5372.5860	<.0001
Number of Occupants: Driver Not Alone vs. Driver Alone	1	-0.1695	0.0108	245.6720	<.0001
Gender: Male vs. Female	1	0.5219	0.0130	1620.3740	<.0001
Time of Day: Night vs. Day	1	1.6171	0.0126	16453.2570	<.0001
Day of Week: Weekend vs. Weekday	1	0.5066	0.0109	2163.1800	<.0001

An important note about the parameter estimates is that they provide the basis for the odds ratios presented earlier. The derivation of the odds ratios from the parameter estimates has the general form:

$$e^{\beta_i} = Odds\ Ratio\ (\beta_i)$$

where β_i refers to a specific parameter estimate. A specific example, showing the derivation of the odds ratio for restraint use (unrestrained versus restrained) follows:

$$e^{1.1645} = 3.2046$$

Thus, when the parameter estimate for restraint use (1.1645) is exponentiated it equals the odds ratio for that particular category, 3.2046.

Risk Profile Examples

In order to further illustrate the model described above through both the odds ratios and the parameter estimates, the following probability example is listed. For the purpose of this analysis, we define both high and low risk profiles for both the young driver group (16-20) and the comparison age group (21 to 34). The high risk profile is defined as: unrestrained, DWI (in the last three years), invalid licenses, speeding, driver alone, male, night time, and weekend. The low-risk profile is defined as: restrained, no DWI (in the last three years), valid licenses, no speeding, driver not alone, female, day time, and weekday. Table 3 displays both driver risk profiles, as well as the number of drivers in each. This example was constructed to demonstrate the correlation between driver behavior and blood alcohol concentration. For each risk profile, we show the coded values of the independent variables and the number of drivers exhibiting these characteristics. For each observation in each of the two risk profiles, the model has computed the probability that the observed (known) BAC category is the same as the BAC category predicted by the model.

Table 3: Risk Profile Examples				
Factor	**High-Risk Drivers**		**Low-Risk Drivers**	
Restraint Use	none	none	used	used
Age Group	**16-20**	**21-34**	**16-20**	**21-34**
DWI	previous	previous	none	none
License Status	invalid	invalid	valid	valid
Speeding	yes	yes	no	no
Occupants	alone	alone	not alone	not alone
Sex	male	male	female	female
Time of Day	night	night	day	day
Day of Week	weekend	weekend	weekday	weekday
Number of Observations	**1,080**	**7,050**	**50,610**	**118,080**

Table 4 shows the distribution of BAC across each age group within each risk profile. For example, 79.62 percent of the drivers in the 21 to 34 age group in the high-risk profile had BACs value greater than or equal to.15 g/dL. Conversely, Table 4 shows that 97.72 percent of the drivers in the 16 to 20 age group in the low-risk profile had a zero BAC.

Table 4: BAC Distribution by Age Group and Risk Profile				
BAC Category	**Driver Risk Profile**			
	High-Risk		**Low-Risk**	
	16-20	**21-34**	**16-20**	**21-34**
.00 g/dL	6.39%	7.57%	97.72%	96.31%
.01-.07 g/dL	0.28%	3.28%	0.67%	0.87%
.08-.14 g/dL	8.33%	9.53%	0.54%	1.00%
.15+ g/dL	85.00%	79.62%	1.07%	1.83%
All	100.00%	100.00%	100.00%	100.00%

On the next page, Figures 18 and 19 show the distributions of the probabilities that the observed (known) BAC values equal the model-predicted BAC values, broken down by risk profile (high and low risk drivers) and age group (16 to 20 and 21 to 34). For Figure 18, the distributions of the probability that the observed BAC values equaled the model-predicted BAC values for the low risk profile ranged from .0078 to .0166 (age group 16 to 20) and from .0188 to .0386 (age group 21 to 34); these low probabilities (of around 1 to 2 percent for 16 to 20 and 2 to 4 percent for 21 to 34) show that it is more difficult for the model to correctly predict the BAC category for drivers in the low-risk profile. Conversely in Figure 19, the distributions of the probability of observed BAC values for the high risk profile ranged from .807 to .903 (age group 16 to 20) and from .91 to .96 (age group 21 to 34); these high probabilities demonstrate that the model is successful in predicting the BAC values for drivers in the high-risk profile. Further evidence of this is shown in Figures 20 and 21. These figures show the distribution of the BAC values for the low- and high-risk profiles drivers by age group. For each age group in the low-risk profile, it is clear that the majority of the drivers in each age group had BAC of zero. However, in the high-risk profile, the majority of the drivers in each age group had BACs greater than .15 g/dL. The conclusion that we draw from this is that higher risk behavior is strongly associated with higher levels of alcohol consumption, while lower risk behavior is not as strongly associated with higher levels of alcohol consumption.

Figure 18: Low-Risk Profile Probability Distributions, by Age Group

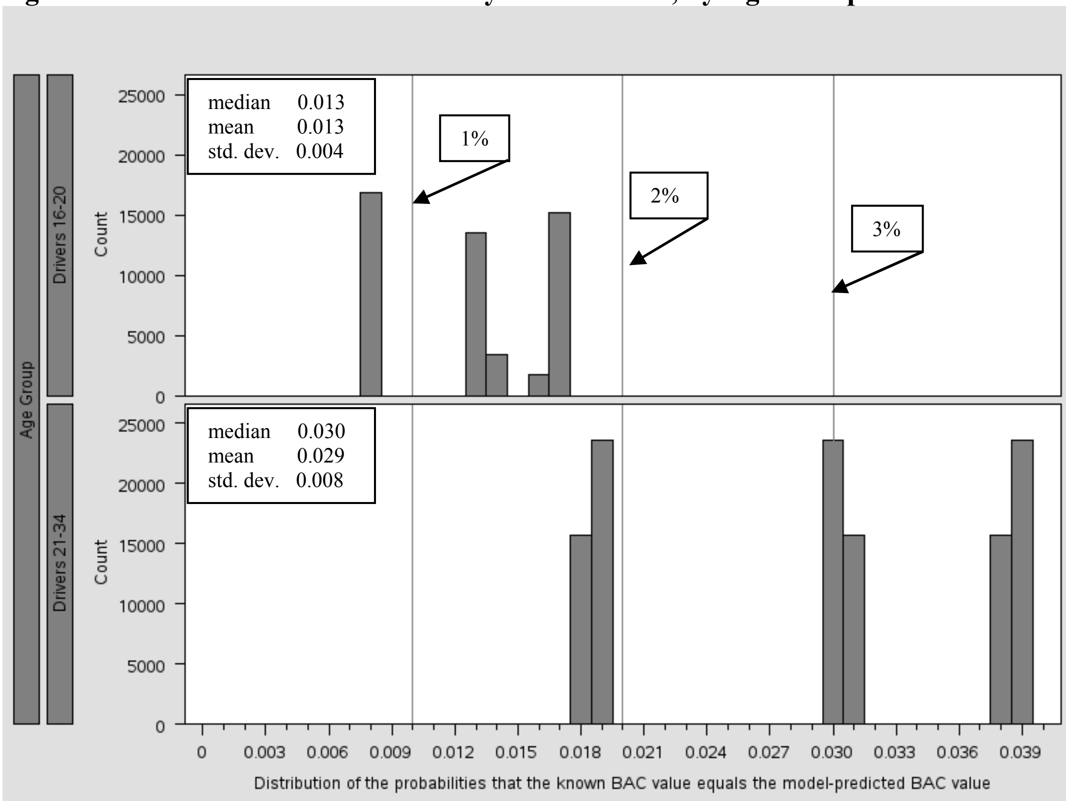


Figure 19: High-Risk Profile Probability Distributions, by Age Group

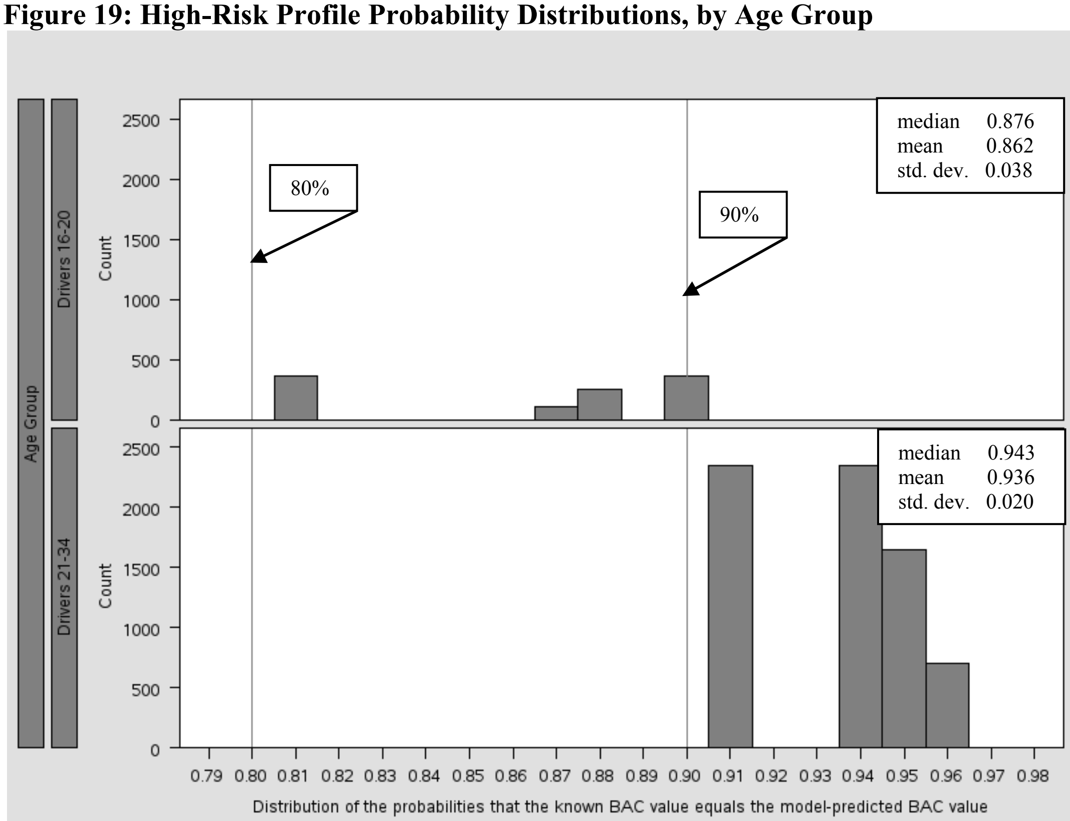


Figure 20: Low-Risk Driver BAC Distribution, by Age Group

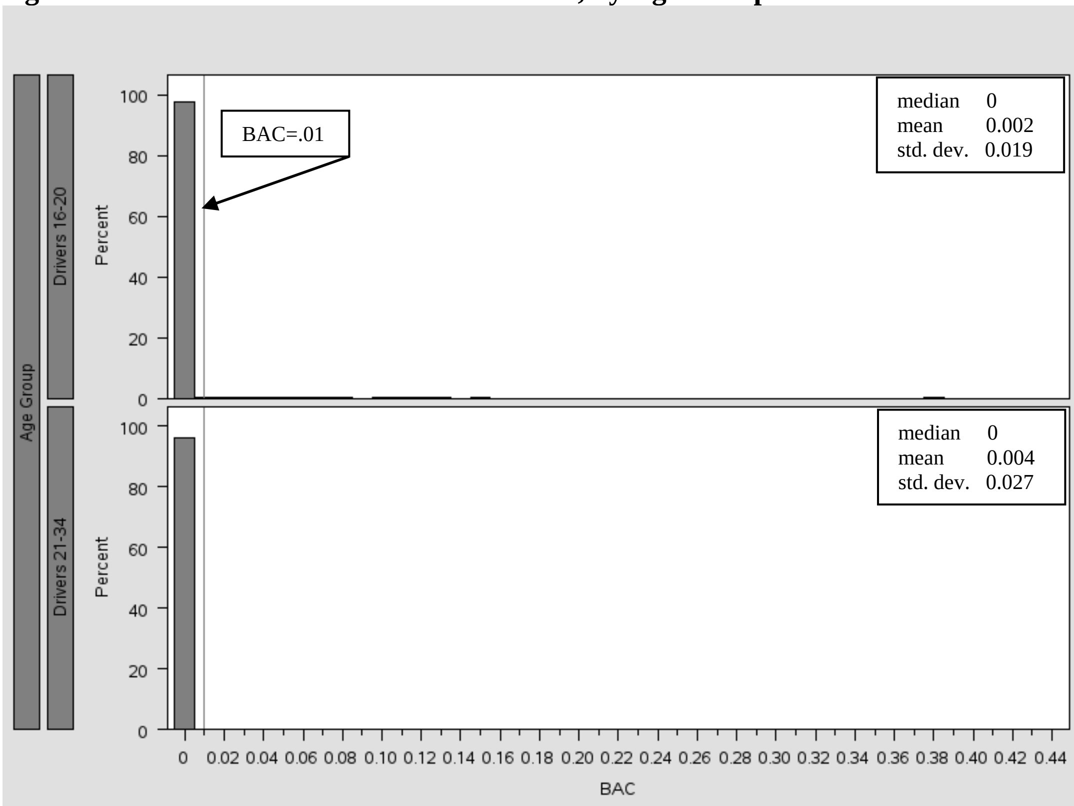
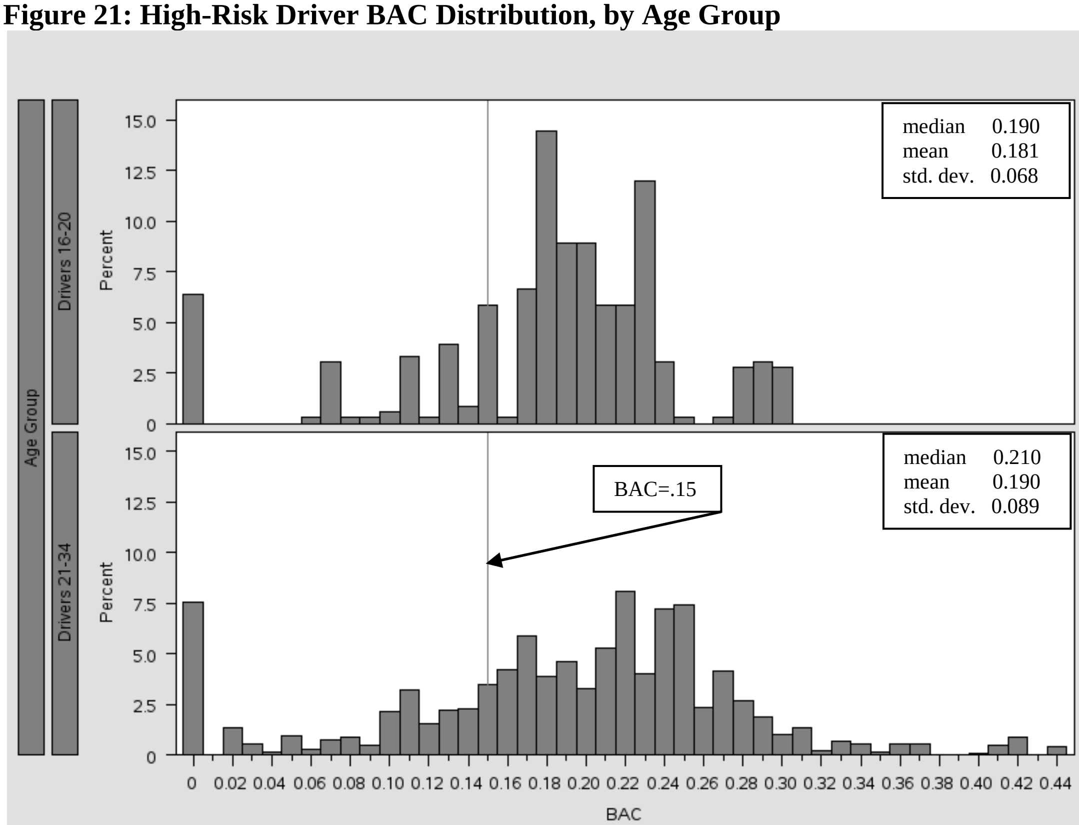


Figure 21: High-Risk Driver BAC Distribution, by Age Group



The ordinal logistic regression analysis examined young driver alcohol use through both odds ratios and probability distributions. The odds ratios (derived from the parameter estimates) showed how the

The ordinal logistic regression analysis examined young driver alcohol use through both odds ratios and probability distributions. The odds ratios (derived from the parameter estimates) showed how the differences between levels of the independent variables affected the BAC outcome. This portion of the analysis demonstrated that restraint use, previous DWI status, and driving at night were the factors most significantly accounting for an elevated driver BAC value. Unrestrained drivers had odds 3.20 times greater than restrained drivers to be in the next higher-level BAC category. Drivers with a DWI conviction in the last three years had odds 2.31 times greater than non-DWI convicted drivers to be in the next higher level BAC category. Those driving at night had odds 5.03 times greater than daytime drivers to be in the next higher level BAC category than daytime drivers. Furthermore, defining risk profiles for drivers demonstrated that the model's predictive ability is greatest for drivers exhibiting high-risk behavior. Drivers designated as high-risk: unrestrained, previous DWI, invalid driver licenses, speeding, nighttime driving and weekend driving were those most likely to have the model's predicted BAC value and the known BAC value in agreement. Both of these analytical tools quantified the relationship between the relevant driver factors and BAC, adjusting the effect of each individual variable for the presence of all the other variables in the model.

Conclusion

This report examines factors contributing to the impaired driving of young drivers in fatal crashes, focusing on drivers in the 16 to 20 age group. This analysis explores the BAC of young drivers (16 to 20), as well as a comparison group (drivers 21 to 34), and then models the relationship between the BAC and many other crash factors. This report models the probability that a young driver in a fatal crash has BACs in one of the following categories: .00 g/dL, .01-.07 g/dL, .08-.14 g/dL, and .15 g/dL or higher.

The exploratory data analysis showed that in fatal crashes, drivers with the following characteristics were more likely to have higher BACs than drivers not displaying these characteristics: unrestrained, with a prior DWI conviction within three years of the crashes, with invalid driver licenses, involved in single-vehicle crashes, in a speeding-related crashes, male, driving at night, and driving on the weekend.

While exploratory data analysis looked at many other variables, the ordinal logistic regression used only a subset of the original variables for the final model: restraint use, age group, DWI (within the last three years), driver licenses status, speeding, number of vehicle occupants, driver sex, time of day, and day of week. Each of these variables was significant at the alpha=.05 level. The variables that contributed most to predicting the correct BAC category for drivers were: restraint use (unrestrained), previous DWI (occurring within three years of the crash), and time of day (night driving). Young drivers (16 to 20) were less likely to have a higher BAC value than the comparison group (21 to 34), other factors held constant. Finally, the ordinal logistic regression model demonstrated that high risk behavior is strongly associated with high BAC values. This result is especially important to those in the greater traffic safety community engaged in efforts to identify and interdict such behavior.

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