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FEMALE INVOLVEMENT IN FATAL CRASHES: INCREASINGLY RISKIER OR INCREASINGLY EXPOSED?

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Abstract

Men have long held the lead in motor-vehicle crashes. However, recent research from a variety of countries indicates that women are closing the gap. The relative increase in females involved in crashes has been associated with an increase in crash exposure. But is it simply that there are more women driving that is causing this increase? Or are there other mediating factors? The main goal of this research effort was to shed some light on this controversy. We found evidence that most of the observed increase in female drivers' fatalities was due to a parallel increase in female driving exposure but that some groups of female drivers (mainly underage female drivers) have become more vulnerable to some risk-taking driving behaviors than others.

Keywords

female drivers; crash exposure; risky driving; underage; fatal crashes

1. INTRODUCTION

Men have long held the lead in motor-vehicle crashes (MVCs). However, recent research from a variety of countries (e.g., Australia, New Zealand, Finland, and the United Kingdom) indicates that women are closing the gap (Attewell, 1998; Hill and Maclay, 1997; Laapotti et al., 2001), particularly young female drivers (Wylie, 1995). The relative increase in females involved in crashes has been associated with an increase in crash exposure (Bergdahl, 1999; Mayhew et al., 2003b; Wylie, 1995). Indeed, women's evolving role in society during the past decades has contributed to the increase in their personal use of vehicles. But is it simply that there are more women driving that is causing this increase? Or are there other mediating factors? For instance, studies in Europe have found that, although females have a greater safety orientation than males, young female drivers have more problems in vehicle handling and in mastering traffic situations (Laapotti et al., 2001; Laapotti et al., 2003). Laapotti and Keskinen (1998) reported that female drivers may be more prone than male drivers to lose control of their vehicles on slippery roads. Also, generational changes in attitudes toward risk and/or driving skills might be contributing to this rise. Studies in New Zealand suggest that female

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drivers have become more risk inclined over time, so their behavior now more closely matches that of the greater risk-taking driving behavior of men (e.g., Wylie, 1995). Road conditions also may affect female drivers differently than male drivers.

Although international reports call attention to the increasing vulnerability of female drivers to fatal and nonfatal injuries, our knowledge about this risk for U.S. women is sparse and fragmented. In a recent news report (CNN), the National Highway Traffic Safety Administration (NHTSA) reported that the percentage of young U.S. female drivers involved in fatal crashes has grown faster than the rates for males. Specifically, women represented 28% of the young drivers killed in 2003 compared with 25% in 1993, a 12% relative increase (Williams and Shabanova, 2003). Some state-based studies offer insight to this finding. For instance, data from Michigan show that the rate of aggressive, risky driving, and speed-related collisions among female drivers (particularly young women) is increasing (Kostyniuk et al., 1996; Waller et al., 2001). An Internet-based survey of Ohio drivers reported that middle-aged women caught in summer traffic with children in the vehicle were more likely to drive aggressively than their male counterparts (Progressive Insurance, 2000). Further, some U.S. research efforts focused on older women suggested that they may be increasingly vulnerable to crash-related injuries (Kelley Baker et al., 2003).

Yet, besides these isolated efforts, very little is known about the risk female drivers are facing. Is such a risk caused solely by an increase in driving exposure, as it was postulated? In 2003, Mayhew et al. (2003a) used the Fatality Analysis Reporting System (FARS) to study this issue. The authors reported that although the overall prevalence of female drivers in fatal crashes increased between 1975 and 1998 when compared to that of males, such relative increase disappeared when adjusted by the number of licensed drivers. Using the number of licensed drivers to correct for driving exposure presents some limitations, however. Driver’s license data come from state files that may not include unlicensed or revoked drivers who are at high risk for crash involvement and includes individuals who have licenses principally for identification but do not own or have access to a vehicle, a limitation prevalent among extreme age groups. Perhaps more important, a recent report by the Insurance Institute for Highway Safety (IIHS, 2006, p. 6) questions the reliability of licensure data: *“…big year-to-year fluctuations in the licensure data that aren’t explained by population changes, law changes, or any other logical factor. The fluctuations are worst for the youngest drivers.”* Another common method of normalizing crash fatality data has been the estimated vehicle miles traveled (VMT) for each relevant group (e.g., Braver, 2001). Unfortunately, the VMT method also has its limitations. Although state and national totals can be estimated from relatively objective sources (e.g., gasoline tax receipts), estimates for age, gender, and ethnic subgroups must come from infrequent self-report surveys. Also, the VMT method does not provide for exposure to risks related to the quality of roads or vehicles or to the seasonal weather or urban/rural traffic conditions, a severe problem for trend analyses. Furthermore, the VMT approach does not provide separate estimates for the miles driven at different BACs (blood alcohol concentrations) or other driving conditions, making the use of VMT for comparisons across subgroups likely to be biased. Not surprisingly, Voas et al. (2007) have recently shown that the use of suboptimal normalizing measures of crash exposure, such as driving licensure or VMT, may yield biased results when these measures are applied to comparisons among driver subgroups. Finding an appropriate measure to normalize drivers’ subgroups is relevant to this study, for there is even less knowledge about how the vulnerability of underage female drivers is affected by current trends in driving exposure and risk-related driving.

In this study, we further explore the evolution of the vulnerability of female drivers to fatal crashes over time. More specifically, this study has three aims. First, we investigated recent trends in the involvement of female drivers in fatal crashes. Special emphasis was put on addressing the hypothesis that the observed increase in the involvement of female drivers in crashes is due to their increasingly riskier driving, and not on their increased driving exposure. A second objective of this study was to evaluate the same hypothesis introduced before but to apply it only to underage female drivers, a group suspected of being increasingly prone to risky driving. Third, we evaluated the role that alcohol plays in such trends. In particular, we were interested in evaluating whether female drivers have become increasingly involved in alcohol-related crashes over time. Knowing if the risk female drivers are facing originates simply on increasing driving exposure or on alternative factors, such as changes in attitudes toward risk, would help researchers and policymakers design appropriate measures to reduce the vulnerability of females to MVCs.

2. METHODS

2.1. Data

Data for this study were obtained from the 1982–2006 FARS, which is a record system for fatal crashes (defined as a crash on a public roadway causing a death within 30 days of the event). FARS provides detailed information about the fatally injured drivers' gender, age, level of alcohol consumption, and maneuvering skills. FARS also contains information about the number of vehicles involved in the crash. The dataset provides a large representative source of information that allows us to confidently make inferences at the national level, as well as on changing trends over time.

There were 1,433,014 drivers in the 1982–2006 FARS file. Of these drivers, we were interested only in those with gender information who were driving passenger cars, minivans, or SUVs. Of the 891,593 drivers of those vehicles, 885,747 had information on their gender. About 66% of them were males (n=584,386) and 34% were females (n=301,361). To evaluate trends affecting the likelihood of female involvement in fatal crashes, we needed correct identification of crash responsibility. Although FARS contains information that could be used for such identification (e.g., information on the maneuverings incurred by the drivers prior to the crash, as well as on the road and weather conditions at the time of the crash), assigning crash responsibility in multivehicle crashes when police reports are not available is problematic. Thus, to ensure a proper identification of crash responsibility, we considered only drivers who were involved in single-vehicle crashes (with no involvement by pedestrians or other road users). We assumed that these drivers bore the sole responsibility for the crash, a criterion commonly used by researchers to assign crash responsibility (e.g., Williams and Shabanova, 2003).

BAC measures were used to identify female involvement in alcohol-related crashes. Actual BAC measures are present in the FARS, but for only a fraction of the drivers. For those with no actual measure available, the FARS provides imputed BAC measures developed using a multiple imputation technique by Subramanian (2002). This technique replaces each missing BAC in the file with 10 imputations. The 10 imputed BACs, with the nonmissing BACs, are analyzed by standard statistical techniques yielding 10 outcomes that are used to account for the additional uncertainty attributable to the missing data. We applied these imputed variables to our evaluation. FARS variables were used to identify female involvement in crashes associated to the following non-alcohol- related risk conditions: improper maneuvering, speeding, and seatbelt nonuse. We used FARS Driver Condition Factor (DR_CF1 - DR_CF4) variables to assign an improper maneuvering or speeding condition to each driver in the file. Depending on the crash conditions, FARS officials assign a condition number to indicate the condition (or lack of condition). The presence of an improper maneuvering or speeding identifier in any of the four "driver condition" variables was enough to be considered indicative of the condition. For seatbelt nonuse, we relied on variables aut_rest (from 1982 to 1990) and rest_use (from 1991 to 2006). Table 1 describes how these variables were used to allocate drivers into these conditions.

2.2. Reference Variables and Driving Exposure

Central to this study was evaluation of trends in the involvement of female drivers in crashes, both with and without taking driving exposure into account. As previously stated, two of the commonest used measures of driving exposure in traffic research are the number of licensed drivers and VMT (e.g., Braver, 2001). Unfortunately, both of such measures have severe limitations, particularly for comparisons among drivers' subgroups.

To address some of these limitations, an alternative measure of exposure has been recently suggested for the analysis of alcohol-related crashes: the crash incidence ratio (CIR). Introduced and applied by this research team to the evaluation of alcohol-related traffic laws (Tippetts et al., 2005; Voas et al., 2000, 2002, 2003, 2007), the CIR can be defined as the ratio of the percentage of drivers showing some trait of interest (e.g., females) among all drivers in a specific subgroup (e.g., in a certain year) compared to the percentage who do not have the trait of interest (i.e., male drivers) in the same subgroup (year). Voas et al. (2007) showed that, when compared against a certain benchmark (i.e., the year 1982), the CIR becomes identical to the quasi-induced exposure technique known as the relative accident involvement ratio (RAIR) (Aldridge et al., 1999; Stamatiadis and Deacon, 1995; Stamatiadis et al., 1999). Equation 1 shows the CIR/RAIR for evaluating the relative involvement of female drivers in fatal crashes for the year i, with respect to the same relative involvement in the year 1982.

$$\mathrm{CIR/RAIR_i} = \frac{(\#\ \text{female drivers killed in year i})/(\#\ \text{male drivers killed in year i})}{(\#\ \text{female drivers killed in1982})/(\#\ \text{male drivers killed in1982})} \qquad \text{Eq(1)}$$

By applying the CIR/RAIR to this study, we explicitly made male involvement in fatal crashes the comparison reference against which to compare female involvement. By accounting for some driving similarities within gender and age groups (i.e., by assuming that all underage drivers in a certain location—rural, urban, etc.—follow relatively similar driving patterns), the CIR can control for some of the limitations present in other normative measures and could be a less-biased measure of crash exposure than either the licensure number or VMT (Voas et al., 2007).

The CIR/RAIR obtained from equation 1 can be viewed as the odds that a female driver (compared to a male driver) would be killed in an MVC in the year ith, relative to a similar likelihood for the year 1982. For instance, in equation 1, a CIR/RAIR for the year 2006 with a value of 2 (i.e., $\mathrm{CIR/RAIR_{2006}}=2$) would indicate that, compared to male drivers, the odds that a female driver would be killed in an MVC in the year 2006 doubled that for the year 1982. From equation 1 also comes that the CIR/RAIR for the year 1982 is always 1 (i.e., $\mathrm{CIR/RAIR_{1982}}=1$).

Trend studies face problems when data-collection procedures and/or variable definitions shift over time. Another advantage of the CIR/RAIR for this study is that it eliminates much of the bias that could arise from such problems. By pairing the driving of females in a year with that of males in the same year and dividing the former by the latter (see equation 1), the CIR/RAIR cancels some of the data-related bias.

2.3. Analyses

A limitation of the CIR/RAIR for this study is that the index does not fully adjust for differences in driving exposure between males and females. As long as the amount of driving differs between women and men, it would not be cancelled in equation 1. However, the CIR/RAIR allowed us to evaluate the evolution of the involvement of female drivers in fatal crashes by testing how such evolution departed from comparable male drivers. To do so, we first estimated the overall index for each year ($\mathrm{CIR/RAIR^{overall}}$) and graph its evolution. The resulting curve depicts how, compared to males, the odds of female involvement in all types of single-vehicle crashes evolve over time. Next, for each year in the file, we estimated the CIR/RAIR for the risk-related driving conditions under study (improper maneuvering, speeding, drinking and driving, and seatbelt nonuse) and graph their evolution over time. Then we compared these curves and tested if those for the risk-related driving conditions departed significantly from that for the overall CIR/RAIR.

An example may help clarify the strategy we followed. Assume that the $CIR/RAIR^{overall}$ shows a constant growth over time. Then we would conclude that the odds of female involvement in all single-vehicle fatal crashes have been increasing over time. Assume that we estimate CIR/RAIR for speeding and observe that, for the 2000–2006 period, the CIR/RAIR for speeding was significantly higher than the CIR/RAIR for all crashes:

$$\mathrm{CIR/RAIR}^{\mathrm{speeding}}{}_{00-06} > \mathrm{CIR/RAIR}^{\mathrm{overall}}{}_{00-06}.$$

Then we would conclude that for the last 7 years, the odds of female involvement in speeding-related single-vehicle fatal crashes were much higher than the overall odds that female drivers faced at that time. In other words, we would conclude that the overall odds of female involvement in these crashes had increased over time but that the female drivers' odds for speeding-related crashes had increased even more.

To perform such a comparison between curves, we modeled the evolution of the CIR/RAIR curves as growth curves. A flat, steady curve around the value of 1 (i.e., $CIR/RAIR_{1982}$, the value of any CIR/RAIR for the year 1982) would denote no change in the odds of female driver involvement in the trait of interest (i.e., driving condition) over time. Growth curves for the CIR/RAIR were modeled as a function of year, $year^2$, driving condition, and year by driving condition interaction. The term "$year^2$" was included to capture the curvilinear nature of the growth curves. Of particular importance to us was the significance of the time (year) by the driving condition interaction. If statistically significant, such interaction would indicate that the shapes of the curves under study and the odds they represent would differ over time. We used the SAS procedure PROC MIXED for these analyses.

3. RESULTS

Figure 1 shows the evolution of the number of drivers killed in single-vehicle crashes by gender. As expected, the number of fatalities among male drivers involved in single-vehicle crashes is much larger than that for female drivers. Also as expected, Figure 1 shows that the total number of fatal crashes in which male and female drivers are involved tend to follow an upward curve, reflecting the constant incorporation of new drivers to American roads. However, the annual number of male fatalities in this type of crash decreased until the early 1990s, when it resumed its growth. To some extent, the shape of this curve could be explained by the association between single-vehicle crashes and drinking and driving, particularly at nighttime (Heeren et al., 1985). Impaired driving and the prevalence of alcohol-related crashes in the country were declining for almost 30 years until the early 1990s, when such a decline stalled (e.g., Stewart et al., 2004). Figure 1 shows the number of male drivers killed with a BAC≥.08 following precisely such a pattern of early decrease and then stalling. It is very likely that the initial decline in alcohol-related crashes translated into a decline in the number of single-vehicle crashes. Once the reduction in impaired driving leveled off, the number of single-vehicle crashes resumed its growth. In an attempt to find more evidence about the association between the decline in impaired driving and the evolution of the number of male drivers shown in Figure 1, we re-estimated that curve but for daytime single-vehicle crashes only (i.e., between 6 a.m. and 6 p.m.), when the prevalence of impaired driving is minimal compared to nighttime driving.

Although not shown because of space limitations, the “dip” in the curve for male drivers shown in Figure 1 almost disappeared when such a curve was based on daytime crashes only.

Interestingly, both the curve showing the annual number of female fatalities and the curve showing female involvement in BAC≥.08 in Figure 1, albeit lower than those for males, do not show the “dip” in the curves for male drivers. This result indicates that the role of alcohol on the occurrence of single-vehicle crashes is much less significant among female drivers than among male drivers.

An alternative and illustrative way to display the curves shown in Figure 1 is to make them relative to the year 1982, as Voas and Hause (1987) did in their study of nighttime crashes. Figure 2 shows how the curves in Figure 1 evolve from their initial 1982 value and that the number of males involved in BAC≥.08 crashes has decreased from its initial 1982 value down to .63 times that value in the early 1990s, but it has stalled since. Further, the total number of male drivers involved in single-vehicle crashes, despite an early dip, has returned to the 1982 counts and beyond.

Perhaps the most illustrative aspect of Figure 2 involves sober drivers, females in particular. Figure 2 shows clearly that while the number of BAC≥.08 fatal crashes has decreased or stalled since 1982 for both male and female drivers, the number of “sober” (BAC=.00) fatal crashes has continuously grown for both of them, but such a growth was larger for female drivers (p<.001) than for male drivers (the curve for “sober female drivers” tops all the others in Figure 2).

Comparisons between the involvement of female and male drivers in fatal single-vehicle crashes are further shown in Figure 3, which depicts the evolution of the CIR/RAIR for the same groups of drivers shown in Figure 1 and Figure 2. As explained in the previous section, our analytical strategy looked first at estimating the evolution of the overall CIR/RAIR for each year ($CIR/RAIR^{overall}$) and then comparing the resultant curve with that for the risk-related driving conditions under study (improper maneuvering, speeding, drinking and driving, and seatbelt nonuse). Figure 3 shows that $CIR/RAIR^{overall}$, the odds (compared to males) of female involvement in single-vehicle fatal crashes each year sharply increased until the mid-1990s, when they were more than 1.6 times those of 1982. This sharp increase coincides with all reports showing an increased involvement of female drivers in crashes. Since then, however, the overall odds of female involvement reversed the trend and started to decline slightly, although the 2006 crashes remained about 1.4 times that of 1982.

Figure 3, when comparing the curves of the risk-related driving conditions against the overall $CIR/RAIR^{overall}$, reveals two types of CIR/RAIR curves. One group of curves includes those for improper maneuvering, and speeding. At the 1% alpha significance criterion (i.e., p≤.01), the shape of these curves (i.e., their year by driving condition interaction term) did not differ significantly from that for $CIR/RAIR^{overall}$. The second group includes the CIR/RAIR for the drinking-and-driving and the seatbelt nonuse crash conditions: $CIR/RAIR^{BAC>.00}$, $CIR/RAIR^{BAC\geq.08}$, and $CIR/RAIR^{seatbelt}$, respectively. Also under the same 1% alpha criterion, this second group of curves was statistically different (flatter) than for the $CIR/RAIR^{overall}$ and for the first group. In other words, under this criterion, the odds of female involvement in single-vehicle fatal crashes involving speeding or improper maneuvering have increased over time, but not more than the overall increase in crash involvement of female drivers during that period. On the other hand, the odds of female involvement in alcohol-related or seatbelt nonuse single-vehicle fatal crashes increased less than those for the other types of crashes.

At the 5% alpha significance criterion (i.e., p≤.05) however, the shape of all driving condition curves was statistically different (i.e., at this significance level, the shape of all curves were found significantly different from that for $CIR/RAIR^{overall}$). When we re-run our analysis, including a dummy (1,0) variable to account for the observed change in the mid-1990s (i.e., a value of 0 indicated the 1982–1992 period and a value of 1, the 1993–2006 period), we obtained a 1% significance of the interaction term for BAC>.00, BAC≥.08, and seatbelt nonuse, but the other two driving conditions were nonsignificant (*p* values of .12 for each of them).

Next, we explored if the odds of female involvement vary by age group, with special focus on underage drivers. Figure 4 displays the $CIR/RAIR^{overall}$ curve (also shown in Figure 3) and $CIR/RAIR^{15–20}$, $CIR/RAIR^{21–24}$, and $CIR/RAIR^{25+}$, the curves for drivers aged 15 to 20, 21 to 24, and 25 and older. Figure 4 shows that the curve for drivers aged 25 and older closely follows the $CIR/RAIR^{overall}$ curve. This was expected as most drivers in the file fall in that age group. For the younger drivers, the picture is different. For those aged 21 to 24, the $CIR/RAIR^{21–24}$ begins to level off after 1990. The $CIR/RAIR^{15–20}$ curve keeps growing until 1996, when it levels off at a higher value. Statistical tests concur with this visual evaluation: interaction terms associated to these curves indicate that their shape is significantly different from that of the $CIR/RAIR^{25}$ and overall curves ($p<.001$ for the general model; $p<.05$ for the above-described model with the dummy (1,0) variable to account for the observed change in the mid-1990s). Relevant to this study is the finding that since the 1990s, the odds of underage female involvement in single-vehicle fatal crashes was significantly higher than the overall increase in crash involvement of female drivers of all ages during that period (i.e., the main effect for $CIR/RAIR^{15–20}$ after the 1990s was significantly higher ($p<.01$) than that for the other groups).

The relatively high vulnerability to crash risk by underage female drivers suggested in Figure 4 induced us to look more closely at this group. We therefore repeated the analysis shown in Figure 3, but for underage drivers only. The resulting picture, depicted in Figure 5, is not much different than the one shown in Figure 3, except the curves in Figure 5 reach higher CIR/RAIR values. Statistical tests for the curves in Figure 5 also yield similar results to those applied to test the curves in Figure 3. Whereas the shape of the improper maneuvering and speeding curves were not statistically different from that for $CIR/RAIR^{overall}$, the BAC and seatbelt nonuse curves were significantly different, in particular after the mid-1990s ($p>.01$).

4. DISCUSSION

The main goal of our research was to shed some light on the controversy surrounding the observed increase in the involvement of female drivers in fatal crashes, with special emphasis on detangling the role of driving exposure from driving risk. Previous research efforts provided some evidence suggesting that the main reason for the observed increase in female fatalities over time was a parallel increase in driving exposure, but the evidence was inconclusive and the picture was unclear. In this effort, we tried an alternative analytical strategy to investigate the same dilemma. The results were also inconclusive, but we believe the resulting picture is less blurred.

This study has confirmed once more that the participation of females in fatal MVCs has increased over time. In agreement with previous reports, our study also suggests that most of this increase is caused by an increase in driving exposure rather than by changes in attitudes toward risk and/or behavior. Our evidence also shows that the prevalence of “improper maneuvering” or “speeding” among female driver fatalities in MVCs has increased over time paralleling that for males; that the prevalence of alcohol-related and seatbelt nonuse crashes among female drivers have grown at a smaller pace than that for “improper maneuvering” or “speeding.”; and that underage females have recently become a highly vulnerable group of drivers, for the odds of underage female drivers being killed in single-vehicle crashes are significantly higher than for other age groups. We therefore conclude that the evidence does not support the hypothesis of women becoming over time more risk-taking drivers than men.

The evolution of the prevalence of risky-driving behaviors among females was not uniform, however, as some of these behaviors became more prevalent over time than did others and some female groups became more vulnerable to risky driving than did others.

In summary, our study confirmed that the observed increase in female involvement in fatal crashes is largely due to a parallel increase in female driving exposure, but also points out that there are some groups of female drivers (young women in particular) who have become more vulnerable to some risk-taking driving behaviors than others. A clearer identification and understanding of these groups and their vulnerabilities is necessary for the development of effective countermeasures.

This study is not free of limitations. First, this study is based only on crash fatalities. Our decision to rely only on fatalities was based on the availability, richness, and reliability of the FARS, but the extrapolation of this study's findings to nonfatal crashes and property-damage-only crashes may not be valid. As was mentioned, although the CIR/RAIR-based strategy we applied does eliminate the limitations associated with the adoption of driving licensure normalizing measures, it does not fully adjust for driving exposure. Nevertheless, we have provided researchers with a new angle on a problem that is analytically difficult to tackle.

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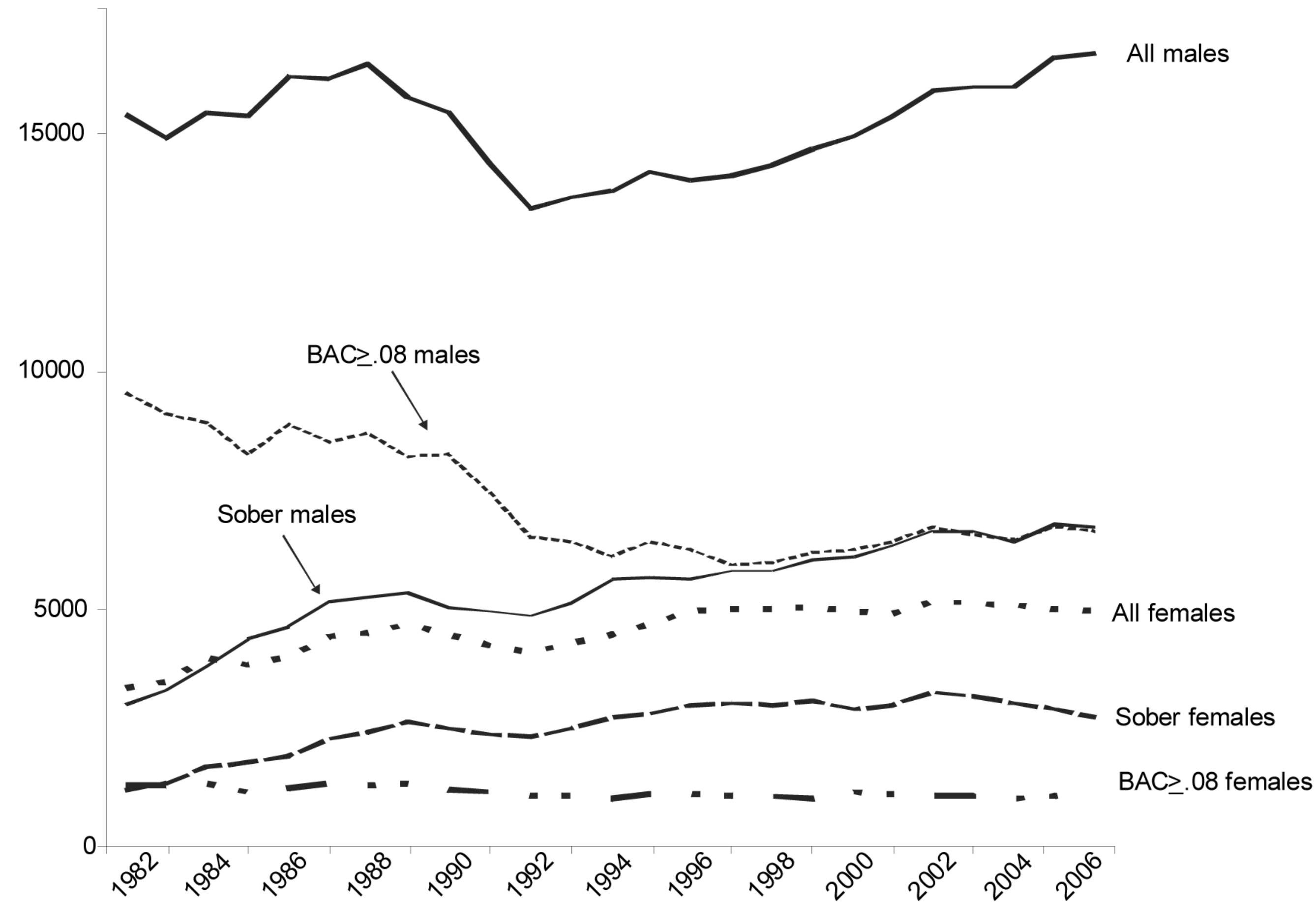

Figure 1.

Number of drivers killed in single-vehicle crashes by alcohol involvement and gender, 1982–2006

Source: Computed from FARS datasets (downloaded from ftp://ftp.nhtsa.dot.gov/FARS/). "Sober" denotes BAC = .00. Drivers with .00<BAC<.08 are not included in the figure. Therefore, "sober" and BAC≥.08 drivers do not add up to "all."

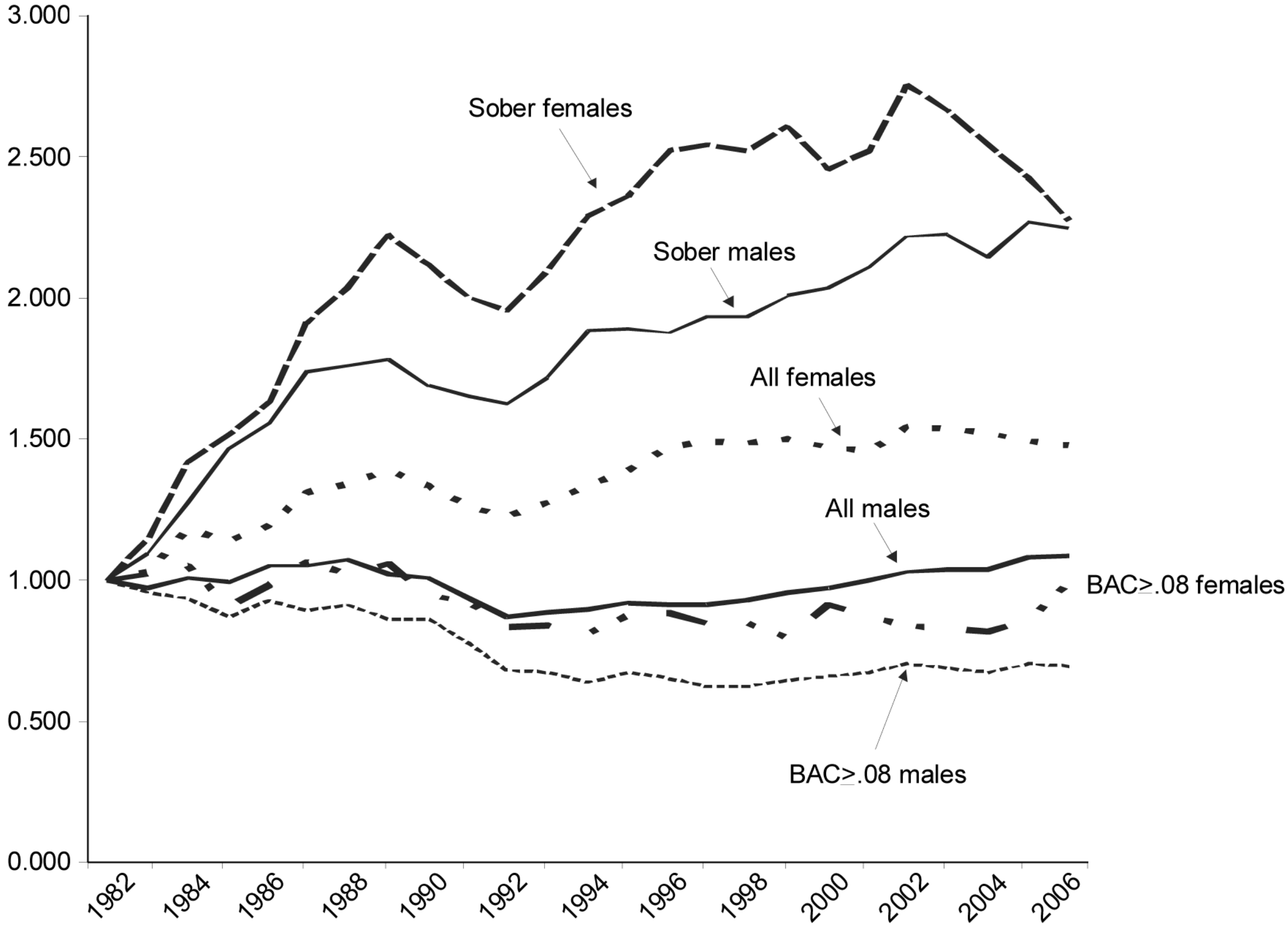

Figure 2.
Evolution of the ratio of the annual number of drivers killed in single-vehicle crashes in 1982 by alcohol involvement and gender, 1982–2006
Source: Computed from FARS datasets (downloaded from ftp://ftp.nhtsa.dot.gov/FARS/). “Sober” denotes BAC = .00.

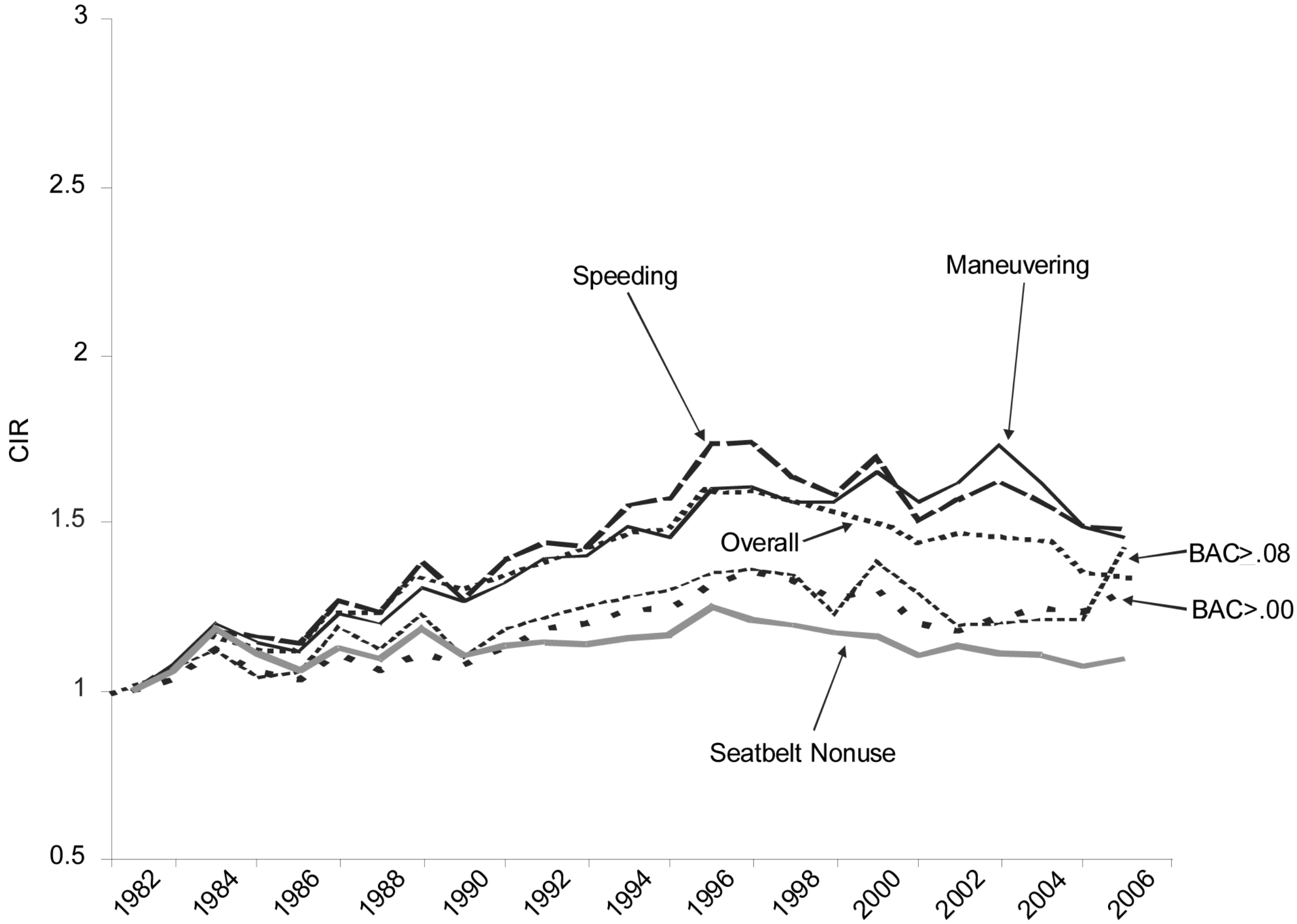

Figure 3.
Evolution of the annual CIR/RAIR statistic representing the odds of female drivers involvement in fatal single-vehicle crashes by type of crash, 1982–2006
Source: Computed from FARS datasets (downloaded from ftp://ftp.nhtsa.dot.gov/FARS/). "Overall" includes all drivers and all type of driving conditions. "BAC>.00" and "BAC ≥.08" denote drivers with positive BACs and BACs greater than or equal to .08, respectively. "Speeding," "Maneuvering," and "Seatbelt Nonuse" conditions are defined in the text and in Table 1.

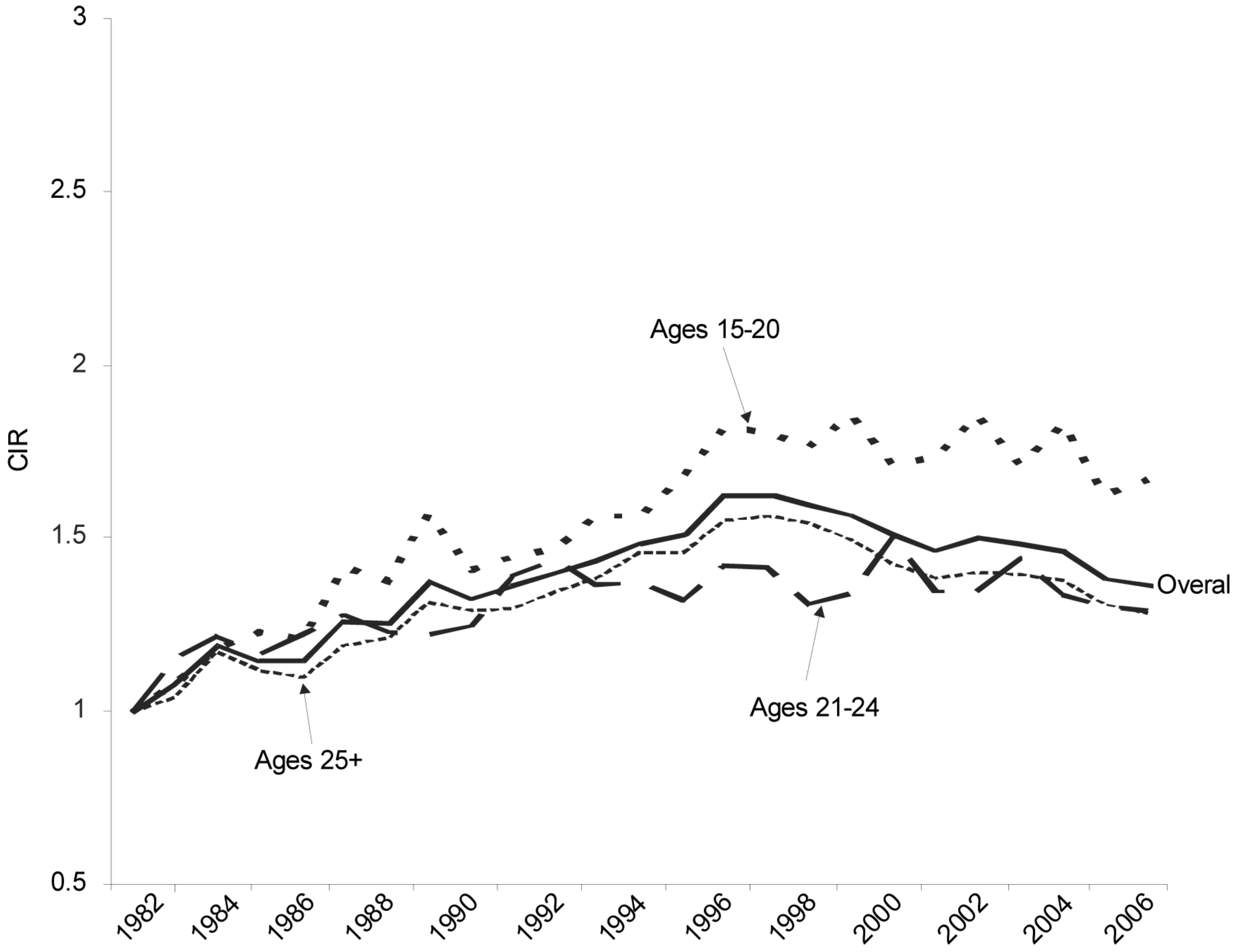

Figure 4.

Evolution of the annual CIR/RAIR statistic representing the odds of female drivers being involved in fatal single-vehicle crashes by age group, 1982–2006

Source: Computed from FARS datasets (downloaded from ftp://ftp.nhtsa.dot.gov/FARS/). "Overall" includes all drivers and all types of driving conditions. Ages 15–20, 21–24, and 25 + denote underage drivers, drivers aged 21–24, and drivers aged 25 and older, respectively.

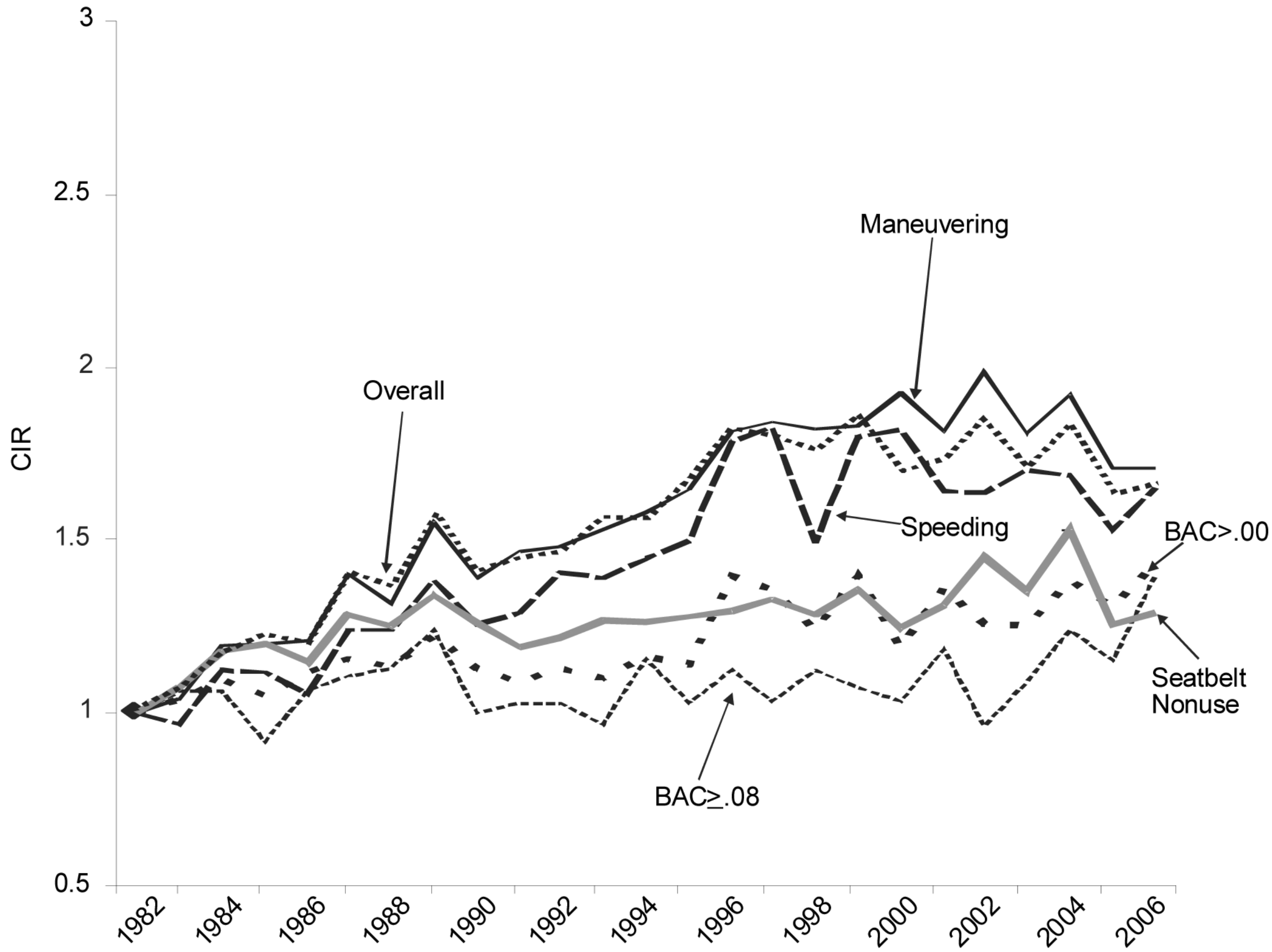

Figure 5.

Evolution of the annual CIR/RAIR statistic representing the odds of underage female drivers being involved in fatal single-vehicle crashes by type of crash, 1982–2006

Source: Computed from FARS datasets (downloaded from ftp://ftp.nhtsa.dot.gov/FARS/). “Overall” includes all drivers and all type of driving conditions. “BAC>.00” and “BAC ≥.08” denote drivers with positive BACs and BACs greater than or equal to .08, respectively. “Speeding,” “Maneuvering,” and “Seatbelt Nonuse” conditions are defined in the text and in Table 1.

Table 1

FARS variables used to create three driving condition

Condition	Year	FARS Variable	Criteria for Inclusion	Reference Level
Seatbelt	1991–2006	Rest_use(1)	1=Shoulder Belt; 3=Lap & Shoulder Belt(2)	0=None Used/Not Applicable(3)
	1982–1990	Aut_rest(1)	1=Automatic Belt in Use	2=Automatic Belt Not in Use
Maneuvering	1982–2006	DR_CF1, DR_CF2, DR_CF3, or DR_CF4 (since 1997) (4)	26 to 37: (26 – Following Improperly; 27 - Improper or Erratic Lane Changing; 28 - Failure to Keep in Proper Lane or Running off Road; 28 - Failure to Keep in Proper Lane (*since* 2000); 29 - Illegal Driving on Road Shoulder, in Ditch, or Sidewalk, or on Median; 30 - Making Improper Entry to or Exit from Trafficway; 31 - Starting or Backing Improperly; 32 - Opening Vehicle Closure into Moving Traffic or Vehicle Is in Motion; 33 - Passing Where Prohibited by Posted Signs, Pavement Markings, Hill or Curve, or School Bus Displaying Warning Not to Pass; 34 - Passing on Wrong Side; 35 - Passing with Insufficient Distance or Inadequate Visibility or Failing to Yield to Overtaking Vehicle; 36 - Operating the Vehicle in an Erratic, Reckless, Careless or Negligent Manner or Operating at Erratic or Suddenly Changing Speeds) 47 to 48 (47 - Making Right Turn from Left-Turn Lane or Making Left Turn from Right-Turn Lane; 48 - Making Improper Turn) 52: (Operator Inexperience)	0=None
Speeding	1982–2006	DR_CF1, DR_CF2, DR_CF3, or DR_CF4 (since 1997)	44 (44 Driving too Fast for Conditions or in Excess of Posted Speed Limit) 46 (Operating at Erratic or Suddenly Changing Speeds (until 1994))	0=None

(1) Until 1990, safety belt use was recorded in variable *aut_rest*. From 1991 to 2006, variable *rest_use* was used to describe a larger variety of safety devices (e.g., including use of helmets or airbags).

(2) Safety levels used in this study are those (1) relevant to the sample (e.g., helmets and airbags are not included), and (2) those who clearly indicated a shoulder belt use (e.g., "Lap belt only," "Type Unknown," or "Used Improperly" levels were also excluded).

(3) Level 0 for variable Rest-use has been defined slightly differently over time: "None Used - Vehicle Occupant/Not Applicable - Nonmotorist" (1991–1993), "None Used - Vehicle Occupant; Not Applicable" (1994–2004), and "None Used/Not Applicable – Not a Motor Vehicle Occupant" (2005–2006).

(4) The "FARS variable" column indicates the FARS variables used to assign each driver to each "condition." Each driver may have assigned up to four "driver conditions," each indicated separately in variables DR_CF1 to DR_CF4 (if less than 4 conditions are needed, the remaining variables are set as missing). Depending on the crash conditions, FARS officials are supposed to select a condition number to indicate the proper condition. There is a myriad of such condition levels (up to 99). The column "criteria for inclusion" indicates the condition levels used to identify the conditions under study. The presence of any of these criteria levels in any of the four "driver condition" variables was used as to indicate the condition. The reference level was always "0," indicating no special driver condition.