

Car crashes rank among the leading causes of death in the United States.



Prevalence of Motor Vehicle Crashes Involving Drowsy Drivers, United States, 2009 – 2013

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Title

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Abstract

Although official government statistics suggest that drowsy driving only contributes to approximately 1-3% of motor vehicle crashes each year in the United States, results of in-depth studies suggest that the true prevalence is likely much higher. A previous study by the AAA Foundation for Traffic Safety found that 7% of all crashes in which a vehicle was towed from the scene, 13% of crashes in which a person was hospitalized, and 17% of fatal crashes involved a drowsy driver in years 1999 – 2008.

The current study updates that study with data from years 2009 – 2013. Data from a representative sample of 14,268 crashes in which a vehicle was towed from the scene were examined. Driver drowsiness was assessed by trained investigators. Multiple imputation was used to estimate the proportion of drivers who were drowsy among those whose drowsiness status investigators were unable to ascertain.

Results showed that an estimated 6% of all crashes in which a vehicle was towed from the scene, 7% of crashes in which a person received treatment for injuries sustained in the crash, 13% of crashes in which a person was hospitalized, and 21% of crashes in which a person was killed involved a drowsy driver. If these proportions are applied to all reported crashes nationwide, results suggest that an average of 328,000 crashes annually, including 109,000 crashes that result in injuries and 6,400 fatal crashes, involve a drowsy driver.

Introduction

According to the National Highway Traffic Safety Administration (NHTSA), approximately 1.4% of all motor vehicle crashes in the United States, 2.2% of those that resulted in injuries, and 2.5% of all fatal crashes in years 2005 – 2009 involved a drowsy driver, and those crashes resulted in a total of 5,021 deaths over those years (NHTSA, 2011).

However, the official government statistics are widely regarded as substantial underestimates of the true magnitude of the problem. The statistics reported by the NHTSA are based on data compiled from reports completed by police officers investigating the scenes of motor vehicle crashes. However, unlike impairment by alcohol, impairment by sleepiness, drowsiness, or fatigue does not leave behind physical evidence, and it may be difficult or impossible for the police to ascertain in the event that a driver is reluctant to admit to the police that he or she had fallen asleep, if the driver does not realize or remember that his or her performance was impaired due to fatigue, or if the driver is incapacitated or deceased and thus unable to convey information regarding his level of alertness prior to the crash. This inherent limitation is further compounded by the design of the forms that police officers complete when investigating crashes, which in many cases obfuscate the distinction between whether a driver was known not to have been asleep or fatigued versus whether a driver's level of alertness or fatigue was unknown. The absence of this distinction precludes the use of standard statistical methods such as multiple imputation to estimate the proportion of drivers whose alertness or drowsiness could not be ascertained in the field who were likely to have been drowsy (Tefft, 2012).

The purpose of this study was to estimate the proportion of motor vehicle crashes in the United States that involved drowsy drivers in years 2009 – 2013, using data from a representative sample of crashes in which driver drowsiness was assessed by trained crash investigators.

Methods

Data were analyzed from a representative sample of 21,292 crashes that occurred in the United States in years 2009 – 2013 in which at least one passenger car, pickup truck, van, minivan, or sport utility vehicle was towed from the scene and investigated as a part of the NHTSA's National Automotive Sampling System Crashworthiness Data System (NASS CDS) data collection system (NHTSA, 2013a).

In NASS CDS, trained crash investigators assessed drivers' pre-crash attention to driving on the basis of interviews with the driver and/ or other vehicle occupants as well as by examining reports completed by police officers who also investigated the crash (NHTSA, 2013b). A driver's attention could be coded as attentive, looked but did not see, distracted (the data identifies several specific distractions), sleepy or asleep (hereafter referred to as *drowsy*), and unknown. Because cases in which investigators could not determine the driver's attentiveness are explicitly distinguished from crashes in which the driver was known to have been attentive, it is possible to use the method of multiple imputation (Rubin, 1987) to estimate the proportion of drivers of unknown attention status who were likely to have been drowsy.

Multiple imputation was performed following the methods described in the previous AAA Foundation study (Tefft, 2012), with the following modification: Beginning in 2009, several data elements used in the imputation of driver drowsiness in the previous study—most importantly the maximum severity of injury sustained by any occupant involved in the crash—were not collected in a substantially greater proportion of cases than in previous years due to changes in the NASS CDS data collection protocol. Imputation models failed to converge when crashes of unknown severity were included. To make imputation feasible, crashes in which the maximum severity of injury sustained by any involved occupant was unknown (7,024 crashes which involved 10,822 drivers) were excluded. Analyses reported here were based on the remaining 14,268 crashes which involved a total of 25,528 drivers.

Data were weighted to yield estimates generalizable to all police-reported crashes in which a vehicle was towed from the scene nationwide over the study period. All statistics other than raw numbers of cases examined are based on weighted data. Reported confidence intervals account for both the design of the NASS CDS sample and the variance introduced through the multiple imputation of missing values. All analyses were conducted using Stata statistical software version 13.1 (StataCorp LP, College Station, Texas).

Results

Of the 25,528 drivers included in the analysis, 35% were coded as attentive just prior to crashing, 5% were coded as “looked but did not see,” 8% were coded as distracted, and 2% were coded as drowsy; the driver’s pre-crash attention status was coded as unknown for 51% of drivers. Viewed from the level of the crash, 3% of crashes involved at least one driver coded as drowsy, 33% of crashes involved no drowsy drivers and no drivers of unknown attentiveness, and 64% involved no drivers coded as drowsy but at least one driver whose attentiveness was unknown.

When missing values of driver attentiveness were imputed, an estimated 3.5% of the drivers whose attentiveness was originally coded as unknown were drowsy. Combining cases in which drowsiness was known and cases in which missing values of driver attentiveness were imputed, an estimated 3.3% (95% Confidence Interval [CI]: 2.1% – 4.6%) of all crash-involved drivers were drowsy.

The proportion of crash-involved drivers who were drowsy varied significantly by crash severity: while an estimated 3% (95% CI: 1% – 5%) of drivers involved in crashes that resulted in no injuries were drowsy, 4% of all drivers involved in crashes that resulted in injuries (95% CI: 3% – 5%), 8% (95% CI: 6% – 11%) of drivers involved in crashes that resulted in a person being admitted to a hospital, and 15% (95% CI: 9% – 20%) of drivers involved in fatal crashes were drowsy.

When aggregated to the level of the crash, an estimated 6% (95% CI: 4% – 8%) of all crashes, 7% (95% CI: 5% – 8%) of crashes that result in a person receiving treatment for injuries, 13% (95% CI: 9% – 17%) of all crashes that resulted in a person being hospitalized due to injuries sustained in the crash, and 21% (95% CI: 13% – 28%) of all fatal crashes involved a drowsy driver (Figure 1).

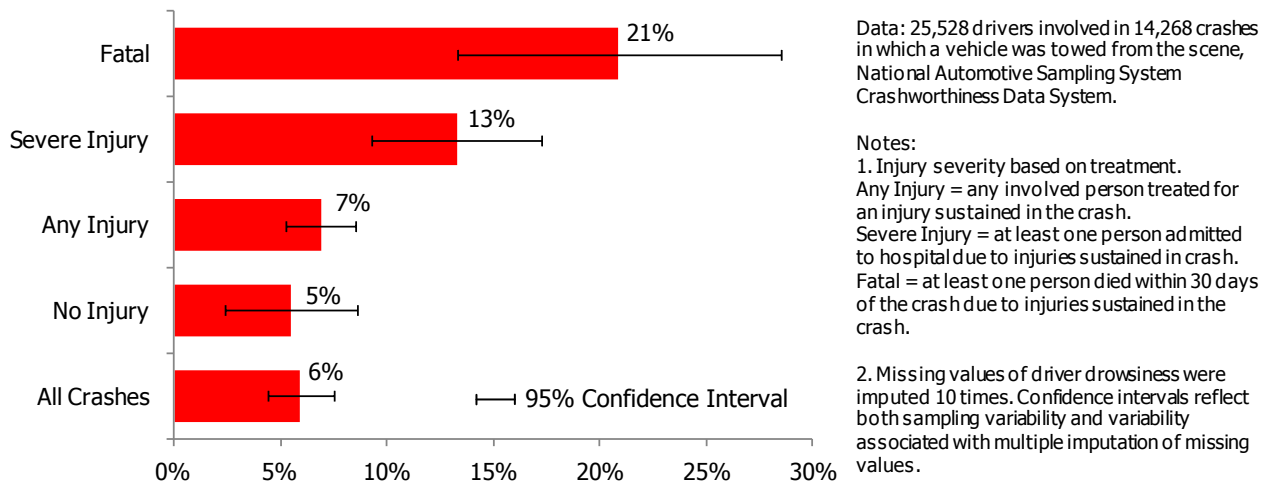


Figure 1. Proportion of crashes that involved a drowsy driver, overall and by maximum injury severity in crash, United States, 2009 – 2013.

Discussion

This study estimates that as many as 6% of all motor vehicle crashes in which a vehicle was towed from the scene, 7% of crashes in which a person was treated for injuries sustained in the crash, 13% of those that that resulted in hospital admission, and 21% of fatal crashes involved a drowsy driver.

Relation to other research

While these results imply a much greater prevalence of drowsy driving than the official statistics published by the NHTSA, experts have widely regarded official statistics as the “tip of the iceberg” (Stutts et al., 2005) due to the many difficulties and limitations inherent in relying on crash-involved drivers realizing, remembering, and willfully reporting to a police officer that he or she had fallen asleep or was fatigued. A driver who realizes that he or she was asleep or fatigued may not volunteer that information to a police officer, a driver who was not actually asleep may not realize that his or her ability to attend and respond appropriately to the driving task was impaired by fatigue, and research has shown that a person needs to have been asleep for a substantial length of time before he or she is likely to even realize upon waking up that he or she had indeed been asleep (Gastaut & Broughton, 1965). In-depth studies of the prevalence of driver drowsiness in motor vehicle crashes have consistently found drowsy driving to be involved a much greater proportion of crashes than reported by the NHTSA (2011) and generally agree well with the results of the current study.

Masten et al. (2006) used data from police-reported crashes in the state of North Carolina in which drivers were explicitly coded as drowsy or as not drowsy to develop a model to predict the probability of drowsiness among crash-involved drivers, applied the model to

national data on fatal crashes that occurred in the United States in years 2001 – 2003, and estimated that 15% of drivers involved in fatal crashes were drowsy, which the authors referred to as a conservative estimate.

Klauer et al. (2006) instrumented a sample of 109 vehicles with in-vehicle cameras and other sophisticated data collection equipment to examine crashes and near-crashes that occurred over a period of 12-13 months. By examining pre-crash video for clear evidence of drowsiness such as slack muscle tone in the face and prolonged eyelid closures, researchers concluded that approximately 22-24% of crashes and near-crashes involved moderate to severe drowsiness.

The NHTSA's National Motor Vehicle Crash Causation Survey (NHTSA, 2008) collected in-depth data on a representative sample of 5,470 crashes to which emergency medical services responders were dispatched in years 2005 – 2007. Only crashes that occurred between the hours of 6 AM and 11:59 PM were investigated. Trained investigators interviewed crash-involved drivers regarding the drivers' recent and overall sleep schedule, work schedule, medications used, and other factors possibly relevant to driver fatigue. In these data, 1.6% of crash-involved drivers were determined to have actually been asleep at the time of the crash, an additional 5.5% were determined to have been fatigued, and no determination of the presence or absence of fatigue was possible for 28% of drivers (unpublished analysis by author). Given that crashes between the hours of midnight and 5:59 AM were not investigated, and that no determination of the presence or absence of fatigue could be made for 28% of the drivers, the estimate that approximately 7% of all drivers involved in crashes were asleep or fatigued is likely an underestimate of the true prevalence of driver drowsiness and fatigue in crashes.

In a previous study by the AAA Foundation for Traffic Safety, Tefft (2012) estimated the proportion of crashes that involved a drowsy driver in years 1999 – 2008 using the same method used in the current study. In that study, an estimated 7% of all crashes, 13% of crashes that resulted in hospitalization, and 17% of fatal crashes were estimated to have involved a drowsy driver. Although the proportion of fatal crashes estimated to have involved a drowsy driver was slightly higher in the current study than in the previous study, both contained substantial sampling variability and uncertainty introduced by the multiple imputation of missing values, the estimates from the previous and current study are well within one another's 95% confidence intervals, and both the previous and current study estimated that 13% of drivers involved in crashes resulting in hospitalization, i.e., among the most severe of the non-fatal crashes, involved a drowsy driver. Thus, while the current study suggests that the proportion of crashes that involve a drowsy driver has not declined since the time of the previous study, it does not provide significant evidence that it has increased, either.

Limitations

While information on driver drowsiness reported in the data analyzed for this study was assessed by trained investigators, it is very difficult to ascertain whether or not a driver was actually drowsy. As noted previously, some drivers may not realize or remember that they had been asleep or that their performance was impaired by fatigue, and some who were aware that drowsiness contributed to their crash may not have been willing to admit this to investigators. Alternatively, if viewed as a more socially acceptable explanation for

crashing than an alternative (e.g., distraction due to use of an electronic device or otherwise voluntarily focusing one's attention elsewhere), a driver who was not actually drowsy might claim to have been drowsy. While the method of multiple imputation allows for valid estimation of the proportion of drivers who were drowsy given the relationship between drowsiness and other variables in cases when drowsiness is known, it cannot correct for errors present in the original data (i.e., incorrect coding of drowsiness by investigators). However, it is noteworthy that in a study with very rigorous ascertainment of drivers' drowsiness, Klauer et al. (2006) reported an even higher prevalence of drowsiness in crashes and near-crashes than the current study estimated.

A substantial number of crashes—33% of the total crashes in the original database—were excluded from the analysis due to missing data on injury severity, which was critical to the imputation of missing data on driver drowsiness. While it is theoretically possible that the prevalence of drowsiness was higher or lower in those crashes than in the crashes that were included, this seems unlikely. These crashes were omitted due matters of NASS CDS data collection protocol that have no plausible relationship to driver drowsiness. Also, the results of the current study were very similar to those of a previous study with a substantially larger sample and in which far fewer cases were excluded (Tefft, 2012).

This study only examined crashes in which at least one passenger vehicle was towed from the scene; crashes that involved only a motorcycle or a heavy truck but no passenger vehicle, and crashes that involved passenger vehicles but none were towed, were not included in the study. According to the National Highway Traffic Safety Administration's General Estimates System (a representative sample of all police reported crashes) and Fatality Analysis Reporting System (a census of all fatal crashes), respectively, there was an average of 2,228,000 crashes each year in years 2009 – 2012 in which a passenger vehicle was towed from the scene, 975,000 of which resulted in injuries and 23,800 of which were fatal (final national data from 2013 are not yet available). Applying the results of the current study only to those crashes in which a passenger vehicle was towed would suggest that approximately 134,000 crashes each year in which a passenger vehicle is towed from the scene, including 68,000 injury crashes and 4,998 fatal crashes, involved a drowsy driver. If the results are generalizable to all crashes including those in which no passenger vehicle is towed—an annual average of 5,460,000 total police-reported crashes including 1,556,000 injury crashes and 30,456 fatal crashes (NHTSA, 2014)—this would imply that approximately 328,000 police-reported crashes each year, including 109,000 that result in injuries and 6,400 fatal crashes, involve a drowsy driver. Note that the exclusion of crashes in which no passenger vehicle was towed was not due to any hypothesized relationship between a vehicle being towed and a driver being drowsy; this was simply a function of the scope of the investigations included in NHTSA's NASS CDS database which the current study analyzed.

Finally, this study did not investigate the cause of the crashes that were investigated. While results show that 6% of all crashes and 21% of fatal crashes involved a drowsy driver, it is possible that other factors besides drowsiness—on the part of the drowsy driver or another driver involved in the crash—may have contributed to some of the crashes.

Conclusion

Official government statistics suggest that 1.4% of all crashes, 2.2% of crashes that result in injuries, and 2.5% of fatal crashes involve a drowsy driver (NHTSA, 2011). However, the results of this study and several other studies suggest that the true prevalence is much higher. This study estimates that as many as 6% of all crashes in which a passenger vehicle is towed from the scene, 7% of crashes that result in any injuries, 13% of crashes that result in severe injuries requiring hospitalization, and 21% of fatal crashes involve a drowsy driver. Applying these estimates, conservatively, to all crashes nationwide in which a passenger is towed from the scene would indicate that an average of 134,000 crashes each year in which a passenger vehicle is towed, including 68,000 that result in injuries and 4,998 fatal crashes, involve a drowsy driver. If the results of the current study are generalizable to all crashes, this would imply that approximately 328,000 police-reported crashes each year, including 109,000 that result in injuries and 6,400 fatal crashes, involve a drowsy driver.

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