



Acute Sleep Deprivation and Risk of Motor Vehicle Crash Involvement

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through research
and education

December 2016



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Sleep deprivation has been shown to:

- Slow reactions to stimuli
- Decrease accuracy of responses
- Lead to long lapses in attention

Previous studies have shown that the effects of sleep deprivation on attention and performance are greater during the early morning hours

Previous research by the AAA Foundation found that drowsy driving is involved in as many as:

- 7% of all crashes where a vehicle was towed
- 13% of all crashes resulting in hospital admission
- 21% of all fatal crashes

However, there is little scientific research on the relationship between *specific amounts of sleep deprivation* and *crash risk* amongst the general driving population.

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

November 2014



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Asleep at the Wheel: The Prevalence and Impact of Drowsy Driving.

November, 2010



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Experts recommend that healthy adults should sleep for 7-9 hours daily; (and more for teens and young adults, people experiencing illness, and people recovering from sleep debt)^{1,2}

Surveys by the Bureau of Labor Statistics³ show that in a typical 24-hour period, **18%** of adults sleep for less than 7 hours, including:

- **1.3%** who sleep less than 4 hours
- **0.3%** who sleep for less than 2 hours

Surveys by the Centers for Disease Control & Prevention⁴ report that **35%** of adults reported usually sleeping **less than 7** hours daily, including

- **12%** reported commonly sleeping **less than 5** hours daily

1. Hirshkowitz M et al. 2015. National Sleep Foundation's updated sleep duration recommendations: final report. *Sleep Health*, 1(4): 233-243.

2. Watson NF et al. (2015). Recommended amount of sleep for a healthy adult: A joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society. *Sleep*. 38(6): 843-844.

3. American Time Use Survey. 2015. American Time Use Survey—2003-2014 Microdata files. Washington, DC: Bureau of Labor Statistics.

4. Liu Y, Wheaton AG, Chapman DP, Cunningham TJ, Lu H, Croft JB. 2016. Prevalence of healthy sleep duration among adults — United States, 2014. *MMWR Morbidity and Mortality Weekly Report*.



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This new study is the first study to analyze the relationship between acute sleep deprivation and the risk of crash involvement in a representative sample of the general driving population



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Data were from a statistically representative sample of crashes that:

- Occurred between July 2005 and December 2007, 6 AM - 11:59 PM
- Involved at least one car, pickup truck, van, minivan, or SUV that was towed from the scene
- Resulted in emergency medical services dispatch
- Were subject to in-depth on-scene multidisciplinary investigations by specially trained investigators independent of law enforcement (for a previous project by the U.S. Department of Transportation)

Investigations included data on:

- Factors that contributed to the crash, such as:
 - Errors committed by the drivers (e.g., failed to brake in time)
 - Vehicle mechanical failures (e.g., tire blowout)
 - Environmental conditions (e.g., wind blows car out of lane)
- Drivers' sleep
 - Total amount of sleep in 24-hour period before the crash
 - Usual daily amount of sleep
 - Recent changes in sleep schedule
- Numerous other factors related to driver, vehicle, road

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Compared amount of sleep in the 24 hours before the crash among drivers who contributed to the crash by means of some unsafe action, inaction, or error vs. other drivers who did not contribute to the crashes

Key Assumption

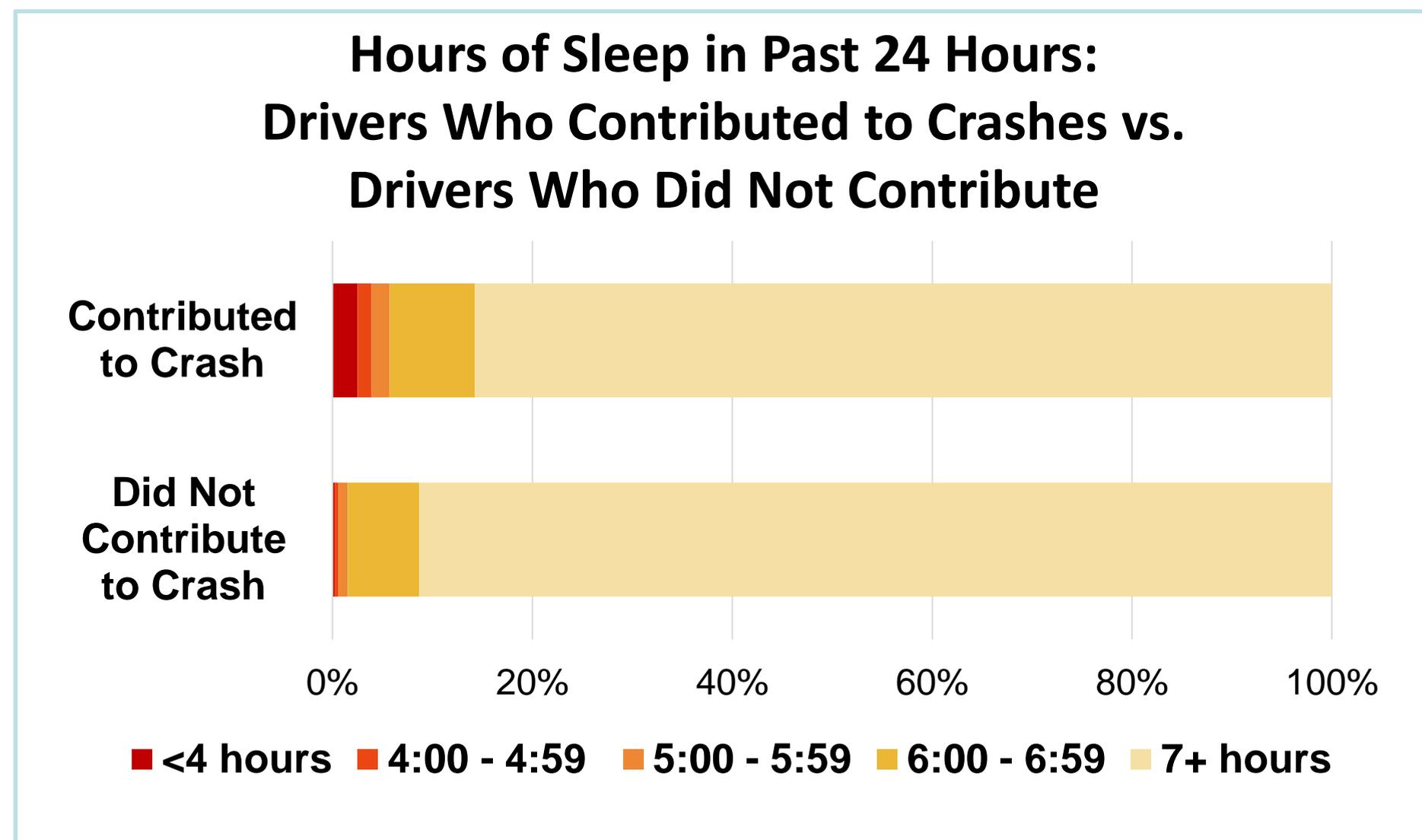
- Drivers who were *involved* in crashes *but did not contribute to the crashes* through their own actions or errors represent a sample of all drivers on the road at the times and places where crashes occurred
 - Therefore, sleep reported by these drivers provides an estimate of sleep among all drivers on the road
 - Therefore, differences in sleep among drivers who contributed to crashes vs. drivers who did not contribute to crashes provides an estimate of the relationship between sleep and rate of crash involvement

Used multivariable logistic regression model to control for other factors that might be related to sleep and/or crash risk (driver age, time of day, crash location, & recent changes in sleep schedule)



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- The majority of drivers in both groups reported at least 7 hours of sleep in the 24 hours before the crash, BUT
- Drivers who contributed to crashes were significantly more likely to report less than 7 hours of sleep
- Drivers who contributed to crashes were more than 10x as likely as non-contributing drivers to have slept for less than 4 hours



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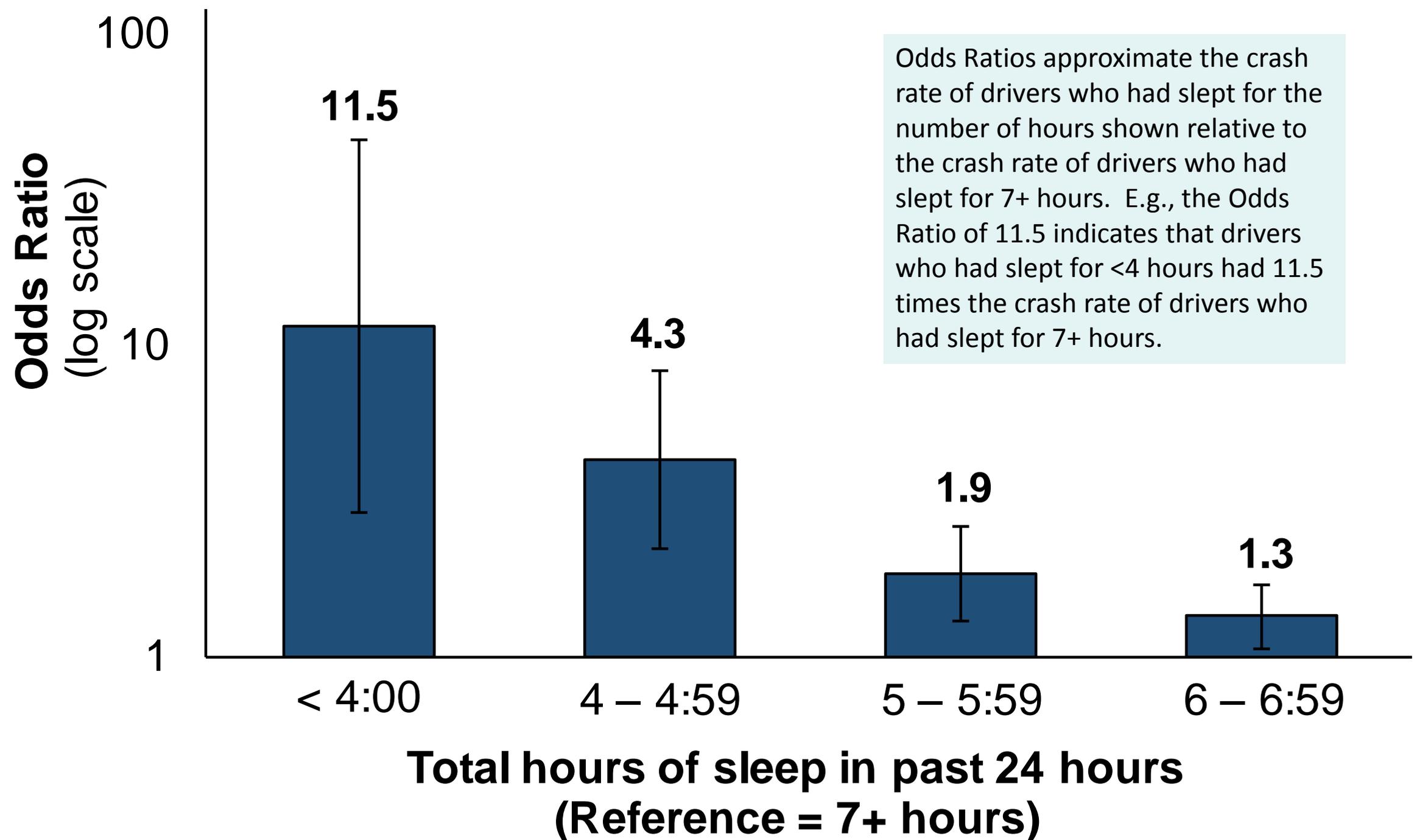
After adjustment for other factors, drivers who had slept for less than 7 hours in the 24 hours before the crash were significantly more likely to have contributed to crashes in which they were involved

Because of the study design, this indicates that drivers who had slept for less than 7 hours had significantly higher crash rates than drivers who had slept for 7 hours or more.

- Drivers who had slept for less than 4 hours in the 24 hours before the crash had 11.5 times the odds of having contributed to the crash compared to drivers who had slept for 7+ hours



Odds Ratios for Contribution to Crash in Relation to Sleep in Past 24 Hours



Odds Ratios shown above are adjusted for driver age, time of day of crash, crash location (intersection vs. non-intersection) and recent changes in the driver's sleep schedule.

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Analysis of drivers' usual amount of sleep and sleep in the past 24 hours relative to their usual amount found:

- Drivers who usually slept for 4-5 hours per night had 5.4 times the crash rate of drivers who usually slept for 7+ hours
- Drivers who slept for more than 1 hour less than usual in the past 24 hours had significantly increased crash rates, independent of how much they usually slept
- Drivers who slept for 4+ hours less than usual had 10.2 times the crash rate of drivers who slept for their usual amount or more



Limitations of this study include:

- Data on sleep was self-reported (drivers might over-report or under-report sleep)
- Could not adjust for effects of alcohol or drugs due to data limitations
- There was no available data on crashes that occurred between midnight and 6 AM (not included in the original federal study that collected the data analyzed for this new study)
 - Other studies suggest that the prevalence of drowsy drivers on the road is greatest during the overnight and early morning hours¹, and that the impairing effects of sleep deprivation are also greatest during the early morning hours², suggesting that under certain conditions the true risk of sleep deprivation may be even greater than the current study estimates

1. Tefft BC. 2012. Prevalence of motor vehicle crashes involving drowsy drivers, United States, 1999-2008. *Accident Analysis & Prevention*, 45(1): 180-186.

2. Lim J, Dinges DF. 2008. Sleep deprivation and vigilant attention. *Annals of the New York Academy of Sciences*, 1129: 305-322.

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A National Sleep Foundation consensus working group concluded that individuals who have slept 2 hours or less within a 24-hour period “are not fit to operate a motor vehicle”¹

- The results of this current study generally support that recommendation, and suggest that drivers who have slept for less than 4 or 5 hours in the past 24 hours are likely to be substantially impaired

Comparison of this study’s results to previous National Highway Traffic Safety Administration research on the crash risk associated with alcohol^{2,3} indicates:

- The crash risk associated with driving after having slept for only 4-5 hours is similar to the crash risk associated with driving with a BAC of 0.08 (the legal limit in all U.S. states)
- The crash risk associated with driving after having slept for less than 4 hours is similar to the crash risk associated with driving with a BAC between 0.12 - 0.15

1. Czeisler CA et al. 2016. Sleep-deprived motor vehicle operators are unfit to drive: a multidisciplinary expert consensus statement on drowsy driving. *Sleep Health*, 2(2): 94-99.

2. Compton RP, Berning A. 2015. Drug and Alcohol Crash Risk. Report No. DOT HS 812 117. Washington, DC: United States Department of Transportation.

3. Blomberg RD, Peck RC, Moskowitz H, Burns M, Fiorentino D. 2005. Crash Risk of Alcohol Involved Driving: A Case-Control Study. Final Report. Stamford, CT: Dunlap and Associates, Inc.

