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Drowsy driving prevention: A National Sleep Foundation position statement and call to action

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ABSTRACT

Drowsy driving is a prevalent form of impaired driving at the intersection of sleep health and public safety. While drowsiness has been implicated in up to 21% of motor vehicle crash fatalities, drowsy driving is largely preventable, primarily by allowing for adequate sleep opportunity and obtaining sufficient healthy sleep. National Sleep Foundation calls for targeted actions from a broad range of community members to improve public sleep health and road safety. Combating drowsy driving requires a comprehensive and coordinated approach across drivers, educators, government policy makers, healthcare professionals, industry, labor representatives, employers, and law enforcement. Actions that can prevent drowsy driving will improve the health and safety of the nation.

Introduction

Drowsy driving is impaired driving. While specific definitions may vary, drowsy driving can be conceptualized as operating a motor vehicle while being too sleepy to stay alert. It is a dangerous and widespread risk on US roads, estimated to be a common behavior by over 150 million Americans, with 3% of drowsy drivers reporting that they drive drowsy at least weekly.[11,38] Data from the AAA Foundation for Traffic Safety and other studies implicate drowsiness in 21% of all motor vehicle crashes resulting in death and 13% of motor vehicle crashes resulting in hospitalizations—totaling more than 300,000 police-reported crashes, 100,000 injuries, and 6400 deaths in the US each year.[43] Drowsy driving is often identified as the "fourth D" among drunk, drugged, and distracted causes of risky driving.[11,27] Drowsy driving is often underrecognized compared to other forms of impaired driving because, unlike alcohol or drug use, drowsiness leaves no physical evidence. While acknowledging drowsy driving can be caused or exacerbated by factors such as sedating medications and substances, medical conditions and illness, and engagement in repetitive behaviors, National Sleep Foundation (NSF) focuses on the predominant and most preventable cause of drowsy driving: an insufficient amount of quality sleep to maintain alertness while operating a motor vehicle.

National Sleep Foundation's mission is to improve the health and well-being of the public through sleep education and advocacy. Given the significant impact of drowsy driving on public health and safety, NSF has sustained advocacy efforts and public education about the dangers of drowsy driving and ways to prevent it since its founding in 1990 and has formally developed and produced Drowsy Driving Prevention Week since 2007. In 2016, NSF published a landmark expert consensus guideline establishing that individuals

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Table 1
Warning signs, risk factors, and at-risk groups for drowsy driving

Warning signs:	Risk factors:	At-risk groups:
1. Difficulty focusing thoughts, starting to daydream, wandering eyes. 2. Having trouble remembering the last few miles driven. 3. Missing an exit or ignoring traffic signs. 4. Yawning repeatedly or rubbing your eyes. 5. Nodding off or finding it hard to keep your head up. 6. Drifting from your lane, tailgating, hitting a shoulder rumble strip, driving too slowly. 7. Feeling restless and irritable, or becoming aggravated with common annoyances such as sitting in traffic.	1. Lack of sufficient quality sleep. Most adults need 7-9 h of sleep per night and most teens need 8-10 h per night to maximize alertness. 2. Use of substances or medications that cause drowsiness. 3. Driving long hours without breaks, especially during the body's natural alertness dips in the early afternoon and between midnight and 6 a.m. 4. Undiagnosed, untreated, or under-treated medical conditions, especially sleep disorders associated with daytime sleepiness, such as obstructive sleep apnea (OSA), insomnia, or narcolepsy.	1. Young drivers. Males under 25 years old are at highest risk overall. 2. Commercial drivers. Long-haul drivers are at high risk. 3. Shift workers and people with variable or long work hours. Working the night shift can increase the risk of drowsy driving by nearly six times. Rotating-shift workers and people working more than 60 h a week need to be particularly careful. 4. People with undiagnosed or untreated sleep disorders. Untreated obstructive sleep apnea increases the risk of falling asleep at the wheel by seven times. 5. Business travelers. These workers spend long hours driving or may be jet-lagged from a previous trip.

with 2 hours of sleep or less in the preceding 24 hours are categorically too sleep deprived to operate a motor vehicle safely, and that most healthy drivers would likely be impaired with only 3-5 hours of sleep.[9] Previous studies have demonstrated that sleeping only 4-5 hours in a 24-hour period increases crash risk equivalent to risk associated with a blood alcohol concentration (BAC) of 0.05 (federal legal limit is 0.08), and getting less than 4 hours of sleep increases crash risk as much as a BAC of roughly 0.12.[44] Further, driving for prolonged hours is also associated with deteriorated driving performance, thereby increasing risk of crashes.[31] Table 1 highlights risk factors, warning signs, and at-risk groups associated with drowsy driving.

Each year, to complement the best available crash, morbidity, and fatality data from US federal transportation traffic safety sources, NSF conducts representative, population-level research to gather data on Americans' attitudes and behaviors about drowsy driving and their sleep health. Previous NSF surveys have established drowsy driving is prevalent across the lifespan, with unique findings that 16% of teen drivers and 60% of adult drivers report they have ever driven drowsy, despite 95% of teens and 97% of adults also reporting drowsy driving is extremely or very risky.[12,28] Moreover, adult drivers who consistently get the NSF-recommended 7-9 hours of sleep per night, were less likely to drive drowsy.[11] Taken together, the results of these NSF surveys reveal a concerning, broad public mindset that minimizes the risks and consequences of drowsy driving compared to other forms of impaired driving while also highlighting specific targets for population-level education and behavior change.

Positions

The National Sleep Foundation convened an expert panel to advise on potential recommendations to address known causes and risk factors for drowsy driving and improve road safety. These recommendations were then internally reviewed and vetted by NSF and adopted based on NSF priorities and expertise, as the leading voice in public sleep health. It should be noted that the work of this panel does not represent a formal consensus effort, nor do the positions of NSF represent the views of any organization from which the members of the expert panel were employed. The National Sleep Foundation calls for specific actions from a broad range of the population:

Recommendations for everyone

1. Prioritize sufficient, quality sleep.
2. Recognize signs of drowsiness and stop driving if you feel drowsy.
3. Avoid driving with less than 5 hours of sleep the previous night.
4. Reschedule plans, pull over, assign a designated driver, or use a rideshare or taxi service to avoid driving while drowsy.
5. Schedule regular stops on long trips—every 100 miles or two hours.
6. Plan long trips with a companion, someone who can watch for warning signs of drowsiness and who can also help drive if needed.
7. Say or do something if you or someone you know has not obtained sufficient sleep to drive safely.

Rationale for everyone recommendations

The most predominant and preventable cause of drowsy driving is not getting enough of the quality sleep needed to safely operate a motor vehicle. Individuals are generally not fit to drive safely if they have obtained less than 5 hours of sleep the previous night.[10,44,9] Prioritizing sleep and adopting healthy sleep habits is essential so individuals can get enough of the quality sleep they need. When feeling drowsy behind the wheel, it is common for individuals to report using ineffective methods thought to help improve alertness, such as lowering the windows, increasing the volume of music, or eating a snack.[48] However, when a driver is sleep deprived and experiencing signs of drowsiness, it is imperative that they avoid driving by rescheduling plans or assigning a designated driver, rather than relying on ineffective methods that do not target the main cause of drowsy driving—insufficient quality sleep. Other "secondary" interventions, including caffeine or pulling over to take a nap, may be utilized in situations where it is not feasible to avoid driving altogether.

Recommendations for public health, educational, and government organizations

1. *Educational imperatives:* Prioritize drowsy driving prevention as a goal in the health and transportation safety agenda. Reinforce that drowsy driving is impaired driving through public service campaigns and educational initiatives in health and safety. Incorporate drowsy driving education and prevention skills into driver education programs, including how to mitigate risk through obtaining adequate sleep, recognizing signs of drowsiness and fatigue, and taking appropriate actions when feeling drowsy (eg, pulling over to nap). Educate health and safety officials and healthcare providers about the association of certain medical conditions, medication use, and lifestyle with risks for drowsy driving.
2. *Focused outreach:* Reach populations with the highest risk for fatigue-related crashes, such as males between the ages of 16 to 24 years, workers with non-standard work hours and shifts, individuals with sleep disorders, people with young children, and at-risk professionals (eg, long-haul truck drivers, nurses, physicians, first-responders and emergency workers) with tailored educational materials and training programs.

3. *Physical interventions:* Install and program signage along high-ways and major roads with calls to sleep first for alert driving, take breaks when tired, and with warnings about the dangers and consequences of drowsy driving. Incorporate rumble strips on roadways to help decrease run-off crashes. Ensure highways have adequate and safe rest areas for drivers to use when feeling drowsy.

4. *Technology:* Support and promote science-backed innovation for use in vehicles and with drivers to help detect signs of drowsiness, promote alertness, and curtail driving while impaired by drowsiness.

5. *Policy:* Establish clear definitions of drowsy driving and recognition of drowsy driving as impaired driving, pathways for legislation, and criteria and expectations for law enforcement similar to other forms of impaired driving like drunk, drugged, or distracted driving. Regularly evaluate and adjust policies, programs, and practices for effectiveness. Provide adequate training and technologies to help law enforcement and other agencies in roadside evaluations and incident investigations of driver impairment due to drowsiness. Ensure all crash reporting forms include an option to indicate drowsy driving as a possible cause. Pass laws relevant to promoting sleep health and safety, such as establishing permanent standard time and age-appropriate school start times for teens, both of which can reduce the risks associated with drowsy driving.

Rationale for public health, educational, and government organizations recommendations

Public health and transportation agencies must recognize drowsy driving as a substantial form of impaired driving and support countermeasures and policies that can help to reduce the burden of drowsy driving plus contribute to Safer People, Safer Roads, and Safer Vehicles.[47] For example, one of the objectives identified by Healthy People 2030 for both sleep and transportation is to "reduce the rate of motor vehicle crashes due to drowsy driving".[29] A review of public awareness campaigns and law enforcement approaches to counter driver fatigue recommended groups experiencing the greatest risk for drowsy and fatigue-related crashes who would likely benefit the most from awareness and education campaigns include: "a) males aged between 16 and 24 years, b) shift workers, c) individuals with sleep disorders, d) people on vacation, e) people with young children, and f) specific professionals (eg, surgeons, first-responders and healthcare workers)".[13] Among commercial operations, long-haul truck drivers are also at higher risk for driver sleepiness and crash risk due to work patterns, compensation structures and models, and lifestyles.[24] Educational materials, training on risk mitigation, or campaigns for high-risk drivers and their circle of influencers (ie, healthcare providers, employers, friends, and families), such as the NIOSH training for shift workers [8] can be effective for behavioral change. For example, one study which investigated an educational intervention in young adults found that the intervention group was more likely to report they would not continue driving due to tiredness after a simulated drive.[1]

Safety features in road infrastructure, such as the use of center-line and shoulder rumble strips are effective in reducing crashes of all types, including a 36.8% reduction in head-on collisions.[17,33] While initial hits of rumble strips by drowsy drivers do increase alertness, repeated hits of rumble strips do not appear to have the same effect, demonstrating that this countermeasure is temporary as it does not remove the driver from the road.[50] Also, the extent to which they prevent drowsy driving crashes needs evaluation.[4] Another infrastructure approach is the use of signage; however, careful implementation of such an approach is necessary, as signage can lead to decreased attention to road hazards, particularly for young drivers.[32] An innovative combination of rest areas and a drowsy

driving advisory system, consisting of roadside signage implemented before interstate exits or rest areas, successfully reduced drowsy driving crashes by 49%.[35] Another infrastructure approach which may help to reduce drowsy driving crashes, particularly for commercial vehicle drivers, is access to frequent and safe rest areas. One case-control study found crashes involving drowsiness/fatigue where a commercial vehicle driver was at-fault were twice as likely to occur on roads with no rest area or truck stop within 20 miles of the crash site.[6] In South Korea, another evaluation of the effects of supplemental rest areas found they reduced freeway crashes caused by drowsy driving by 14%.[21]

One policy-based intervention that may help to reduce drowsy driving crashes for young drivers is laws for graduated driver licensing. State graduated driver licensing requirements for beginning drivers, specifically nighttime restrictions that restrict driving after 10 pm, are effective in reducing crashes among young people, a population at increased risk for drowsy driving.[45] Regarding the effects of early school start times, studies have demonstrated that delaying school start times by even 30 minutes corresponded to increased sleep duration in teens, as well as fewer motor vehicle crashes, better mental health, and better academic performance.[51] Another opportunity to reduce risk is removing daylight saving time and establishing permanent standard time. Risk of motor vehicle crashes increases during the transition from standard time to daylight saving time in the spring, with fatal motor vehicle crash risk increasing by 6%.[14,37] Eliminating daylight saving time in favor of permanent standard time may contribute to a decreased risk of motor vehicle crashes by limiting the disruptive effects of clock change and reducing chronic circadian misalignment.[14]

Recommendations for employers

1. Educate workforces about the dangers and consequences of drowsy driving and the importance of sleep for alert driving.
2. Emphasize drowsy driving prevention for commutes to and from work, as well as relevant on-the-job vehicle and equipment operation.
3. Promote fatigue management programs for industries that rely on at-risk activities known to reduce opportunities for healthy sleep, such as non-traditional work schedules (ie, shift work, long work hours), motor carriage and long-distance driving (eg, trucks and buses), and other safety-critical transportation operations.
4. When rotating shifts are used, employ a clockwise rotation (ie, morning to afternoon to evening).
5. Provide adequate time between shifts to allow for sufficient sleep and an appropriate space for post-work naps.

Rationale for employer recommendations

Drowsy driving can also be attributed to several work-related factors, such as shift work, long work hours, and commute times. Approximately thirty percent of US civilian jobs in 2016 required driving a vehicle, including passenger vehicles (eg, automobile, bus) or some other type of vehicle (eg, tractor-trailer, construction vehicle).[7] In addition to driving as part of their jobs, almost 124 million people in the US routinely drove or carpooled to and from work in 2022.[46] Compared to working regular daytime schedules when people are naturally more alert, working at night can cause misalignment with circadian "lows," and place shift workers at greater risk of shorter and impaired sleep, increased drowsiness, degraded driving performance, and subsequent crash and injury.[22,30,34,41] A study using the 2008 National Sleep Foundation's Sleep in America poll showed shift workers were 3 times more likely than day workers to drive while drowsy (OR 3.05, 95% CI: 1.48-6.29).[42] Further, the number of hours an individual works can affect their risk of driving drowsy. A survey of US workers found that compared

to those who reported working 31-40 hours per week, the risk for driving while drowsy increased 73% for those who worked 41-50 hours per week (OR 1.73, 95% CI: 1.04-2.89) and almost tripled for those who worked more than 50 hours per week (OR 2.91, 95% CI: 1.70-4.96).[42] Similarly, medical interns (ie, resident physicians) who worked unusually long shifts (≥24 hours) were more than twice as likely to report a motor vehicle crash, compared to those who worked a standard shift.[2,25] In the oil and gas extraction industry, long daily commutes were linked to feeling very drowsy while driving at work,[16] and were a contributing factor to fatal work-related crashes.[36]

Fatigue management policies and programs play an important role in helping employers prevent work-related drowsy driving. Reviews of fatigue training and sleep education have reported promising results in encouraging workers to adopt healthier behaviors to improve sleep and reduce fatigue.[18,3] The National Transportation Safety Board's investigation reports most frequently recommend the use of scheduling policies and practices as a countermeasure for the prevention of fatigue-related transportation incidents.[26] Specific to work-related driving, a study examining fleet safety practices among 70 companies from a range of industries found companies who implemented fatigue management (specifically fatigue training for new hires, medical screening for fatigue, and restrictions on night driving) reported significantly lower crash-related injuries per million miles as compared with companies that did not implement each of these practices.[49] Implementation of Fatigue Risk Management Systems (FRMS), a risk-based, multi-level approach to fatigue management is a more comprehensive approach being adopted by employers with already established safety management systems.[15,19,23,52] A systematic review of FRMS effectiveness found that while evaluations of entire FRMS are limited, improvements in safety and fatigue metrics are evident for individual FRMS components.[40]

Recommendations for the automotive manufacturing and technology industries

1. Integrate drowsy driving detection and mitigation systems and other essential driver assistance and safety technologies across vehicles to democratize access by automotive consumers.
2. Ensure that new technologies are scientifically validated and real-world effectiveness is quantified.
3. Support innovation among emerging mobility alternatives, such as rideshare solutions and autonomous platforms.

Rationale for the automotive manufacturing and technology industry recommendations

The development of effective driver monitoring systems (DMS) offers innovative auto technology that could detect impaired driving whether drunk, drugged, distracted, or drowsy. For example, the Honoring Abbas Family Legacy to Terminate Drunk Driving Act of 2021 (HALT) requires the inclusion of built-in technology to help prevent drunk driving, paving the way for industry-produced technologies to be added to motor vehicles that aim to prevent impaired driving. Complemented by advanced driver assistance systems (ADAS) that manage speed, lane keeping, automatic emergency braking, and more, new technologies have the potential to reduce impaired driving risks and enhance road safety. For example, sensor-based DMS and in-vehicle DMS systems have been shown to reduce risky driving behaviors and aid in the early detection of drowsiness.[20,5,53] DMS systems must be scientifically validated and acceptable to drivers to ensure their effectiveness and provided across vehicle platforms and models so that innovative safety technology benefits all road users.[39,52] Adding industry-produced and scientifically validated DMS and ADAS systems can help prevent all forms of impaired driving and improve public safety and health.

Recommendations for funding agencies and organizations

1. Fund and support research to better quantify the health, safety, economic, and societal burdens of drowsy driving as a form of impaired driving.
2. Fund and support research aimed at promoting the implementation of drowsy driving mitigation approaches.
3. Support efforts to identify social determinants, disparities, or disproportionate effects of drowsy driving on historically underserved communities.
4. Broaden funding to all relevant organizations with stated interests to better understand and mitigate the risks of drowsy driving, including sharing and implementation of best practices.

Rationale for funding agencies and organizations recommendations

Despite widespread recognition of the risks of drowsy driving, a large percentage of teen and adult drivers report having engaged in this behavior.[28] Funding agencies are in the position to support science and research that will increase public awareness and concern for drowsy driving and identify additional at-risk groups that can benefit from tailored interventions.

Conclusion

Drowsy driving is impaired driving, representing a considerable and known risk to the public health and safety of millions of drivers and passengers on US roads and beyond. Drowsy driving is preventable through changes in attitudes, actions, policies, and cultural beliefs that move individuals to prioritize and pursue healthy sleep and choose alternatives to driving while sleep deprived or fatigued. Understanding the potentially catastrophic consequences of drowsy driving and taking proactive measures, both individually and as a society, can help reduce the number of drowsy driving-related crashes. As public awareness increases and support broadens for interventions that reduce drowsy driving, public health and safety advocates will need to assess the impact of campaigns and programming on drowsy driving attitudes and behaviors. Moreover, technological advances are needed to accurately detect driver drowsiness in vehicles and on the roadside, and to supply reliable data and clear criteria for future legislation. Combating drowsy driving requires a comprehensive approach that involves drivers, educators, government, healthcare professionals, industry, labor representatives, employers, and law enforcement. To this end, funding organizations will need to continue supporting ventures aimed at investigating and reducing drowsy driving. Beginning with healthy sleep, it is possible to reduce the risks of drowsy driving, improve road safety, and ultimately save lives.

Author contributions

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Disclosures

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