

Countermeasures to driver fatigue: a review of public awareness campaigns and legal approaches

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The relationship between fatigue and road crashes has received increased attention over the past 15 years.^{1,5} Figures stating the extent of fatigue as a contributor generally range from 10 to 40%.⁶⁻⁹ Estimates in the higher end of this range are usually for fatal fatigue-related crashes. While some researchers have suggested that the overall figure is lower (e.g. 1.6%,¹⁰ 5-15%¹¹), there is evidence to suggest that such figures underestimate the contribution of fatigue based on generally accepted definitions.¹² In Australia, 16.6% of fatal crashes in 1998 involved driver fatigue.¹³ A crash is generally assessed as being fatigue-related if the driver was described by police as being asleep, drowsy or fatigued and/or if the vehicle's path suggested a loss of concentration of the driver due to fatigue.⁷ Given the worldwide contribution of road traffic crashes to death and injury (1.2 million in 1998¹⁴), and World Health Organization (WHO) projections of 2.3 million by 2020, the United Nations has predicted¹⁵ that the problem will escalate to a "global public health crisis".

The 10-40% contribution rate of fatigue to crash risk is comparable with that of alcohol intoxication. The literature suggests that alcohol intoxication contributes to 5% of all crashes,¹⁶ 20% of all serious injury crashes,¹⁶ and between 31% and 40% of all fatal crashes.¹⁶⁻¹⁷ Additional research has confirmed that fatigue and alcohol risk are broadly comparable.¹⁸⁻²³ Governments throughout the world have spent considerable resources educating the public regarding the risks associated with drink-driving.¹⁴ However, relatively little effort has

been given to raising awareness on the consequences of fatigue-related impairment.

From a management perspective, fatigue may be more complex and difficult to address, as alcohol has legal frameworks in place in the form of limits for blood alcohol concentration (e.g. 0.02%: Norway, Sweden; 0.05%: Australia, Germany, Spain, France, Greece, Italy; 0.08%: New Zealand, UK, Ireland, Switzerland; 0.08/0.10%: US^{24,25}). Laws have only very recently begun to be passed for fatigue in relation to driving. For example, 'Maggie's Law', which became effective in New Jersey in August 2003, allows prosecutors to charge drivers involved in a fatal crash with vehicular homicide if there is evidence that it was caused by sleepiness. Fatigue is specifically defined in this law as more than 24 hours of continuous sleep deprivation.²⁶

Research shows that the only way to minimise fatigue-related crashes, other than to avoid driving, is to obtain sufficient restorative sleep and avoid periods of prolonged wakefulness.²⁷⁻²⁹ A study by Arnold and colleagues (1997³⁰) revealed that individuals who obtained less than six hours of sleep were twice as likely to be involved in a dangerous event while driving. To date, the development of effective countermeasures for fatigued driving has taken several directions: public awareness campaigns; legal approaches; environmental measures; roadside initiatives; and in-vehicle technologies.

These countermeasures can be divided into those aiming to reduce the likelihood of fatigue-related driving, and those aiming to reduce the consequences of driving while

Abstract

Objective: Driver fatigue accounts for 10-40% of road crashes and is a critical area for public health. As other major road safety issues are more successfully managed, driver fatigue becomes proportionately more important. Both public awareness and legal developments have been slow to reach the same levels as for other road safety risks. The aim of this article is to review countermeasures for non-commercial drivers that are designed to reduce the likelihood of fatigue-related crashes through education and legislation.

Methods: This review outlines information from a wide variety of sources including governments, road safety groups and the scientific literature. Educational and legislative approaches are discussed in terms of both their effectiveness and the associated implications for public health.

Conclusions: Areas for improvement in education include personalising the risk to drivers and developing simple metrics for the self-assessment of fatigue. Legal implications should be more clearly defined and specific laws are needed to more effectively prosecute fatigued drivers who cause crashes. Additional research is needed to further investigate the efficacy of available countermeasures.

Implications: Increasingly, road traffic injury is being discussed more broadly as a public health issue. However, the specific issue of driver fatigue still receives less attention than other main causes of road crashes, despite making a significant and comparable contribution to crash rates. Countries such as Australia and New Zealand have a responsibility to counter driver fatigue, as well as other causes of road crashes, and to further pursue improvements for the benefit of public health.

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fatigued. It is probable that the positive impact of multiple countermeasures is additive, or even multiplicative, but in order to review them systematically on their merits they are presented individually in sequence. Details of possible inter-relationships between countermeasures discussed in this article are outlined in the discussion section.

The specific countermeasures addressed in this review are those that focus on reducing the likelihood of fatigue-related driving. The paper also aims to define their basic role for non-commercial drivers. Furthermore, it discusses details of existing initiatives in a number of State and international jurisdictions, possible future directions, and implications for public health. A separate article will review the remaining countermeasures.

Public awareness and education campaigns

Awareness and education campaigns have been effective, to varying degrees, in addressing road safety issues. The most notable of these have targeted drink-driving, speed, and seatbelt use.¹⁴ The premise of such campaigns is to: a) raise awareness of the problem; b) educate the audience on actions they can take; and c) develop social norms to effect a change in behaviour.

To develop appropriate programs for driver fatigue the current knowledge, as well as perceptions and beliefs of the general population, must first be determined. The reason for this is that, to our knowledge, there is no generally agreed report of these details. Importantly, all drivers have the ability to recognise when they are feeling sleepy.³¹⁻³³ Despite this, however, many choose to keep driving in dangerous circumstances. Reasons for continuing driving are many and varied. Examples include: a) poor understanding of fatigue-related crash risk (inaccurate knowledge); b) underestimating the speed of transition between sleepiness and sleep (incorrect perception); c) no history of fatigue-related incidents (belief based on experience); d) choosing to ignore the warning signs (risk taking); e) pressure to reach destination (motivation); and f) no perceived threat of penalty.^{34,35}

In an attempt to direct campaigns towards addressing such factors, several specific aspects should be considered.³⁶ Most importantly, the demographics of the target populations and strategic 'voice' of the campaign(s) need to be determined.³⁷ Ideally, the populations that are experiencing the highest level of fatigue-related crashes should be statistically determined. These groups, with the exception of commercial operations, are likely to include: a) males aged between 16 and 24 years;³⁸ b) shiftworkers;^{12,39} c) individuals with sleep disorders;⁴⁰⁻⁴² d) holiday makers;⁴² e) people with young children;⁴³ and f) specific professionals (e.g. surgeons, emergency workers⁴⁴). It is important to recognise that each of these specific groups may benefit from different messages or approaches to education.

To determine the strategic 'voice' of the campaign, the desired reaction from the audience must be decided. Consideration should therefore be given to whether the individual will be emotionally affected by the given message, or discover a new knowledge

regarding the message on a conceptual level. Emotive approaches portray images that individuals can relate to on a personal level (e.g. a fatal crash scene caused by a tired driver). Knowledge-based approaches assume that the audience has an awareness of, and/or a capacity to identify with, fatigue as a risk. Possible themes include:

- Educating the community that driving when fatigued is a risk equal to driving drunk.^{18,23}
- Tactical use of driver rotation, caffeine and napping.⁴⁵
- Encouraging drivers to consider fatigue-related driving risks as a personal responsibility.⁴⁶
- Educating the community on minimum sleep requirements and fatigue warning signs.⁴⁷⁻⁴⁹
- Challenging existing beliefs about personal ability to cope with fatigue,^{49,50} including gender-specific differences.⁵¹
- Targeting specific populations with direct education (e.g. learner driver schools, sleep disorder clinics, timed television advertising).

Global campaign trends

The use of campaigns aimed at non-commercial drivers is growing internationally. Some examples are listed below.

The United States *Drive Alert – Arrive Alive* national campaign has used a combination of media, ranging from national publications, newspaper articles and television programs.⁵² The British Government regularly targets fatigue as part of its annual national *Think!* Campaign.⁵³ This campaign is structured as a comprehensive road safety initiative, targeting aspects such as drink-driving, speed, seatbelts, child road safety, mobile phone use and fatigue.⁵⁴ Australia has been active in using awareness campaigns to educate the public about the dangers of driver fatigue. Media has included: brochures, posters, television and radio commercials, newspaper columns, information cards, state transport websites, and full-page newspaper/magazine advertisements.

A nationally distributed brochure, *Fatigue: The Hidden Killer*, is available in Australia by request from the Australian Transport Safety Bureau, and is also provided to hotels, motoring organisations and community road safety groups. Numerous state transport authorities have also developed brochures for safe country driving and related topics such as foods that may assist in maintaining alertness.⁵⁵⁻⁵⁷ One Victorian television campaign focused on napping, stating that "a 15-minute nap could save your life!" to reinforce its power nap message. This campaign has also used billboards and full-page magazine and newspaper notices.⁵⁵ Western Australia has also committed substantial efforts to television campaigns.⁵⁵ One particular television commercial shown throughout Western Australia also uses an emotive response. A driver is shown to be fighting sleep, repeating "I can make it". After a crash, an ambulance officer is then seen telling a police officer that "the driver didn't make it". Three 15-second commercials have also been created, each providing a 'solution' to help combat fatigue. The first suggests a 15-minute nap, the second a stop for coffee, and the third suggests sharing the drive.

New Zealand has a well-developed range of publicity that takes a direct focus on driver fatigue.⁵⁸ One approach involves the distribution of a fatigue-related fact sheet from driver reviver stops and to callers at the Land Transport Safety Authority. In addition, local road safety co-ordinators are involved in fatigue projects using local advertising – generally conveyed via local radio stations, billboards, and community newspapers. Other international jurisdictions have also demonstrated a commitment to educational initiatives focusing on driver fatigue. These include South Africa,⁵⁹ France⁵⁴ and Germany,⁵⁴ and have typically included leaflets and billboard campaigns.

Numerous studies into the effectiveness of road safety campaigns have shown the need for increased public knowledge of personal responsibility.⁴⁶ In addition, improved effectiveness may be gained from better dissemination of clear information relating to: traffic offences; enforcement tactics; likelihood of apprehension; and associated penalties. There are, however, relatively few thorough evaluations of campaign implementations and this is an area where further research is required.

Legal and judicial initiatives: monitoring and enforcing against driver fatigue

Studies of road safety campaigns indicate that the benefits of education are reduced without the inclusion of facts relating to potential physical and legal consequences.⁴⁶ Indeed, studies^{37,60} have indicated that even where impairment due to sleep loss or sleep disorders is acknowledged by individuals, they are only likely to stop driving if there is a perceived threat of penalty. The perception of penalty can be created by the use of quantitative pro-active tools, as has been the case with breathalysers to deter driving under the influence of alcohol. Unfortunately, in the authors' opinions, none of the technologies developed for fatigue detection have such potential at this point in time.^{61,62} The main reason for this is that there are significant within- and between-individual differences seen in the outputs of such technologies, which have not been adequately investigated. This is true of both in-cab monitoring technologies and roadside performance impairment assessment technologies. Therefore, it is necessary, at this point in time, to use improved crash investigation, licensing processes, public education and also countermeasures that reduce the consequences of fatigue-related crashes.

Crash investigation

Laboratory studies using driving simulators^{32,33} and field studies using questionnaires^{9,63} have lent further credence to the fact that fatigue impairment is a major contributing factor to crashes. Qualitative evidence supports this via admissions by commercial and non-commercial drivers who have reportedly driven while drowsy and/or fallen asleep at the wheel.⁹

As awareness of driver fatigue increases, investigators are slowly being trained to determine the likelihood that fatigue was a contributing factor to a crash. This is another essential step towards a broadly acceptable enforcement strategy for managing the

problem.¹³ Such efforts will improve the quality of data, which will in turn lead to the development and evaluation of more effective countermeasures.⁶⁴ It should be cautioned, however, that training improvements must not only be in the detection of drowsiness but in all potential factors contributing to a crash, including, for example, various forms of awake inattention such as mobile phone usage.⁶⁵

Studies of crash data show that fatigue-related events are typified by certain characteristics, defined in a set of criteria used by Horne and Reyner.⁶ These include:

1. Breathalyser alcohol levels below the legal driving limit.
2. The vehicle either ran off the road or into the back of another vehicle.
3. No signs of the brakes being applied beforehand (i.e. no skid marks).
4. No mechanical defect in the vehicle, no tyre blow-out.
5. Good weather and clear visibility.
6. Elimination of speeding and driving too close to the vehicle in front.

Similar criteria have been used in other studies^{11,66} and have found comparable results. Importantly, investigators must be aware of potential interactions of fatigue with alcohol (and other drugs). Traditionally, crashes in which illegal blood-alcohol concentrations (BAC) were detected had alcohol intoxication identified as the major cause. Research has recently shown, however, that fatigue and alcohol interact, even at legal levels, resulting in greater impairment to driving than caused by fatigue or alcohol alone.⁶⁷ This is a key area that requires further research to inform crash investigation. We therefore support research into methods of quantifying fatigue in the same way as alcohol.²¹

Laws concerning fatigue in transport are broadly inconsistent⁶⁸ and especially so for non-commercial drivers. Typically, authorities will attempt to bring prosecutions against drivers who fall asleep at the wheel with charges of "dangerous driving" or "driving without due care and attention".⁶⁸ Many defences contest that while a driver is asleep, he/she cannot be held responsible for "dangerous driving" simply because they are effectively unconscious and therefore not voluntarily driving dangerously. However, it is also argued that in falling asleep, a driver will typically (unless suffering from certain sleep disorders) experience a state of increasing sleepiness.^{32,33} The main issue now is whether drivers are aware that a) this increasing sleepiness will eventually lead to falling asleep, and b) their driving will be impaired to a significant level. We support the proposal to create an offence of fatigued driving.⁶⁸

One of the major success factors in addressing road safety issues is the perception of being caught breaking the law. Indeed, evaluations of fatigue awareness campaigns in Australia indicate that laws and enforcement increase the efficacy of programs.¹⁴ However, at present there is no meaningful reproach for motorists who drive when tired, except in rare cases. To date, such cases have generally involved commercial vehicles and fatalities. Referring to the coroner's report of the Bunker's truck crash⁵ involving six fatalities, fatigue was cited as one of the key causes

of the crash. In this case, the driver was held responsible. However, it must be noted that there is also contrary evidence as illustrated by the decision in the Jimenez case.⁶⁹ This finding stated that a person is no longer legally responsible after they have fallen asleep.

Case study: Selby, North Yorkshire, UK

On 28 February 2001, a UK express passenger train crashed near Selby, North Yorkshire, at approximately 0612 hours. Ten passengers were killed and more than 70 injured. The train had been travelling at about 125mph, and became derailed before colliding with an oncoming freight train. The crash was caused when the driver of a Land Rover ran down a motorway embankment, coming to a stop on the railway line. The driver had not slept at all the previous night. It was concluded that he fell asleep at the wheel, and he was convicted of 10 charges of death by dangerous driving. He was sentenced to five years in jail.⁷⁰

It should be remembered that although in certain cases drivers may claim not to have fallen asleep at the wheel due to insurance or legal reasons, there are also physiological reasons why they may not remember having done so.⁷¹ This area is one that requires further investigation.^{32,33}

Licensing and 'fitness to drive'

Sleep disorders also pose a difficult challenge for driver licensing bodies.^{72,73} Although commercial drivers and some company personnel are subject to medical fitness testing that covers their impacts, this is unlikely to be so for non-commercial drivers. In addition, general guidelines may not be sufficient given that some medical professionals argue that every case needs to be treated individually.⁷¹ In some jurisdictions, medical practitioners may be obliged to inform local licensing authorities if a patient is considered unfit to drive.^{74,75}

Another issue that is being increasingly investigated is the response of drivers to treatment of sleep disorders, and the resulting implications for fitness to drive. For example, one study that investigated obstructive sleep apnoea syndrome (OSAS) showed that simulated driving performance improved after only a few days of treatment.⁷⁶ Surprisingly, improvements were sustained for up to a week after treatment was withdrawn. This latter finding is contrary to earlier reports showing minor residual benefits after treatment withdrawal, and a return of daytime sleepiness and reactions to untreated levels after a single night without treatment.⁷⁷ Further research is needed to understand how fitness to drive is affected during cessation of treatment, and what the time course of benefit is. The investigation of these issues is of major practical, clinical, economic and public health importance, particularly since OSAS patients are known to use treatment intermittently.⁷⁷ Current AustRoads fitness to drive guidelines do not answer these questions, and there is therefore scope for some improvement.²⁵

Discussion

Previous efforts to reduce road crash risk have been effective to varying degrees. Objective improvements following the implementation of countermeasures have only been investigated in a limited number of studies. There are, however, lessons to be learned, especially from studies using pre- and post-implementation evaluation structure. If such methodological templates can be used more frequently in future study designs, then reductions in risk may occur at a faster pace than by using other, as yet untested, methods. This approach is therefore not only likely to have high impact, but might also have high cost efficacy.

Based on previous research, there is evidence that awareness campaigns could benefit from being coupled with legal and judicial initiatives.⁴⁶ Therefore, approaches might include a number of inclusions: For example:

- Creating communication between local, national and international transport authorities as well as developing legal and judicial approaches for the reduction of fatigue crash risk.
- More formal identification of fatigue as a risk, e.g. being tired is like being drunk.
- Emotional stimulation of the consequences of fatigue, e.g. if you fall asleep and kill someone, you are personally responsible, and therefore criminally liable.
- Techniques to promote self-awareness of fatigue and also to identify fatigue in others, e.g. if you cross a rumble strip more than twice within 10 minutes then you need to take a break.
- Practical approaches to assist drivers and passengers to minimise driver fatigue by obtaining adequate sleep and maximising the use of other preventive strategies, e.g. you will know when you are tired, but you will not know when you are going to fall asleep.
- Evaluation programs to collect and interpret data for the international road transport community on actual efficacy of specific strategies.

Although road safety is becoming increasingly discussed as a public health issue, rather than a transportation issue,^{14,78} the focus is still primarily on speeding, alcohol intoxication and not wearing seatbelts. While the authors fully support the inclusion of road safety as a public health issue, we believe that driver fatigue must be a more prominent factor, particularly as it is now listed among the most common causes of road crashes.¹⁴ Despite increased awareness in some jurisdictions, the WHO fails to mention fatigue in action plans along with speed, alcohol, seatbelts and helmets in terms of enforcement.¹⁵

We support the proposal that driving while fatigued should be punishable by law⁴⁸ and that research should focus on the development of roadside measures to quantify fatigue at the individual level. Further research is also needed to fully understand who is most at risk from fatigue-related crashes in order to better direct effective education campaigns to the appropriate target populations. Countries such as Australia and New Zealand are well placed to aid the global community in developing effective countermeasures through research, education and legislation.

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