Review of effectiveness of laws limiting blood alcohol concentration levels to reduce alcohol-related road injuries and deaths

Centre for Public Health Excellence NICE

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Executive summary

The review aimed to assess how effective the blood alcohol concentration (BAC) laws are at reducing road traffic injuries and deaths. It also assessed the potential impact of lowering the BAC limit from 0.08[1] to 0.05.

The review examined:

- drink-driving patterns and the associated risk of being injured or killed in a road traffic accident
- how BAC limits and related legislative measures have changed drink-drinking behaviour and helped reduce alcohol-related road traffic injuries and deaths
- models estimating the potential impact of lowering the BAC limit from 0.08 to 0.05 in England and Wales
- lessons from other countries on using BAC laws as part of overall alcohol control and road safety policies.

A conceptual framework was used to show how, in theory, a law limiting drivers' BAC levels could lead to changes in how much drivers drink and the number of alcohol-related road traffic injuries and deaths. The review of evidence tested these theoretical links and the robustness of the underlying assumptions.

The review was conducted in accordance with the methods outlined in NICE's 'Methods for development of NICE public health guidance (second edition, 2009)' available from www.nice.org.uk/phmethods

Quality of the evidence

The evidence comes primarily from the US, Australia, New Zealand and other European countries (mostly Scandinavia) and it is difficult to determine how applicable the findings are to the UK. There are marked historical, institutional,

[1] This review draws on a wide range of studies that used a variety of units to define BAC levels -such as milligrams of alcohol per 100 millilitres of blood (50mg/100ml or 80mg/100ml). In this review report we have not sought to standardised the terminology, but in summary sections the shorthand of 0.05 or 0.08 is used.

social and cultural differences between countries, as well as different political and policy priorities in relation to traffic safety, alcohol consumption and drink-driving.

Any evaluation of the effectiveness of BAC laws and related measures has certain limitations. In part, this is due to the complex nature of such interventions. It is also due to the methodological difficulties involved in conducting rigorous evaluations of the impact of legislative measures on a population. As a result, it is difficult to attribute precisely reductions in alcohol-related injuries and deaths to changes in BAC limits.

The quality of studies is also variable. The best available evidence is provided by time series studies and multivariate regression analyses that have sought to control for confounding factors. (These factors include underlying trends in alcohol consumption and economic and social changes, as well as other alcohol control and road safety policies.)

Findings of the review

The main findings of the review are presented below.

Drink-driving and the risk of a road traffic accident

There is strong evidence that someone's ability to drive is affected if they have any alcohol in their blood. Drivers with a BAC of between 0.02 and 0.05 have at least a three times greater risk of dying in a vehicle crash. This risk increases to at least six times with a BAC between 0.05 and 0.08, and to 11 times with a BAC between 0.08 and 0.10.

Studies consistently demonstrate that the risk of having an accident increases exponentially as more alcohol is consumed.

Younger drivers are particularly at risk of crashing whenever they have consumed alcohol – whatever their BAC level – because they are less experienced drivers, are immature and have a lower tolerance to the effects of alcohol than older people.

Younger drivers may also be predisposed to risk-taking – regardless of whether or not they have drunk alcohol.

Effectiveness of BAC laws

Overall, there is sufficiently strong evidence to indicate that lowering the legal BAC limit for drivers does help reduce road traffic injuries and deaths in certain contexts.

A number of studies indicate that lowering the BAC limit from 0.10 to 0.08 reduces road traffic injuries and fatalities, although the scale of effect varies. They include high quality review evidence (Shults et al. 2001 [++[2]]). The effect is independent of other control measures (in particular, administrative licence suspension).

Other studies indicate that reducing the BAC limit from 0.08 to 0.05 is effective. In what is the most recent and relevant high quality study, the adoption of a 0.05 BAC driving limit reduced alcohol-related driving death rates by 11.5% among young people aged 18–25 (Albalate 2006 [++]). It also reduced driving fatalities among men of all ages by 5.7%, and among men in urban areas there was a 9.2% reduction. The analysis, which covered 15 European countries, took account of a large number of factors which could have affected the results, including related policies and enforcement: minimum legal driving age, points-based licensing and random checks.

There were no significant reductions in deaths or injuries among the population as a whole when other concurrent policies and infrastructure quality were taken into account.

The lowering of the BAC limit from 0.08 to 0.05 also led to a significant reduction in fatal accidents in Australia, specifically, an 18% reduction in Queensland and 8% reduction in New South Wales (Henstridge et al. 2004 [+]).

[2] Code for quality rating of the study: ++ high, + good, - weak

There is insufficient evidence to judge what level of effect might be sustained by lowering the BAC limit, although certain studies indicate that there could be positive, long-term gains. Two high quality evaluations (Albalate 2006; Eisenberg 2003 [both ++]) report that the full effect may be achieved at years 2 or 3, and up to 6 or 7 years later.

The effects of the 0.05 law in Europe were evident after 2 years and increased over time – with the greatest impact occurring in between 3 and 7 years (Albalate 2006).

Other European-based studies that have examined the effect of lowering the BAC limit to 0.05 have certain methodological weaknesses and the findings show some inconsistencies.

Public awareness and enforcement of BAC laws

There is sufficiently strong evidence to indicate that publicity and visible, rapid enforcement is needed if BAC laws are to be effective. Drivers need to be aware of – and understand – the law. They also need to believe they are likely to be detected and punished for breaking the law.

Sobriety checkpoints (random and selective breath testing) can help reduce road traffic injuries and deaths, according to two high-quality reviews (Peek-Asa 1999; Shults et al. 2001 [both ++]). In addition, random breath testing (RBT) had an immediate, substantial and permanent impact on accidents in three out of the four states studied in an Australian study (Henstridge et al. 1997 [+]). A further study showed that sobriety checkpoints in US states helped enforce the 0.08 law (Tippetts et al. 2005 [+]).High quality review evidence also shows that mass-media campaigns can reduce alcohol-impaired driving and alcohol-related crashes (Elder et al. 2004 [++]).

The effects of the 0.05 BAC law in Austria and Netherlands were attributed in part to publicity and enforcement measures (Bartl and Esberger 2002; Mathijssen 2005 [both -]).

A European review of enforcement measures (Makinen et al 2002) showed that countries fulfilling most of the following criteria have the lowest drink driving figures:

- Long tradition in drink driving enforcement including low legal limits
- Relatively high objective risk of detection (as measured by proportion of drivers tested)
- Mass media supporting enforcement.

BAC laws and changes in drink-driving behaviour

There is sufficiently strong evidence to indicate that lowering the BAC limit changes the drink-driving behaviour of drivers at all BAC levels.

The BAC law appears to act as a general deterrent and the beneficial effects are not just restricted to the drivers at the BAC levels involved.

Five studies (included in a systematic review) showed that the introduction of a 0.08 BAC legal limit reduced the number of alcohol-related deaths involving drivers with a BAC of 0.10 or higher (Shults et al. 2001 [++]).

Another study showed that it had a differential impact according to age, with the highest reductions in deaths among younger drivers (14% reduction among 18–20 years, 9.7% among 21–24 years and 6.7% among those aged 25 and older) (Dee 2001 [++]).

Other studies have shown that reducing BAC limits to 0.05 or lower has an impact on drivers who drink heavily. For example, in 1991 when the BAC limit was lowered from 0.08 to 0.05 in the Australian Capital Territory, it reduced the incidence of drink-driving with a BAC well above the original 0.08 limit (Brooks and Zaal 1993).

In addition, analysis of six roadside surveys conducted between 1987 and 1997 in Adelaide, South Australia, found that the percentage of people driving

at night with a BAC at or above 0.01, 0.05 and 0.08 decreased at an almost uniform rate (Kloeden and McLean 1997).

Although these studies show reductions in drink driving among those with high BAC levels the precise mechanisms that influence their willingness and capacity to change their drink-driving behaviour is unclear.

A pan-European study reported that the 0.05 BAC limit had a statistically significant effect on younger drivers, men, and men in urban areas (Albalate 2006 [++]).

An evaluation of administrative licence suspensions (ALS) combined with BAC laws found that women and older drivers demonstrated a higher degree of compliance (Kaplan and Prato 2007 [+]). Analyses of differences in terms of car occupancy showed that if drivers were alone in the vehicle they were less influenced by the BAC limit. The authors suggest that drivers are more likely to comply with the law when there is at least one other person in the vehicle.

Administrative licence suspension or revocation (ALS/R)

There is sufficiently strong evidence from good and high quality studies to show that administrative licence suspension can help reduce road traffic injuries and deaths.

This effect pre-supposes that a BAC limit is in place.

According to one study, such a policy (with immediate sanction) can reduce the likelihood of being involved in a fatal, alcohol-related crash by 5%. It affected drivers at all BAC levels. Laws mandating licence suspension penalties after conviction had little effect, and did not appear to be an effective deterrent (Wagenaar and Maldonado-Molina 2007 [+]).

Another study (Villaveces et al. 2003 [+]) showed that administrative licence revocation laws were associated with a 5% reduction in overall mortality and a 5% reduction in alcohol-related crash fatalities. A further study reported that

administrative licence revocation was associated with an 8.6% and 10.6% reduction in alcohol-related fatal accidents (Kaplan and Prato 2006 [+]).

A model of the effect of ALR legislation, taking into account variables for the business cycle, mileage travelled and demographic characteristics, also showed significant reductions in alcohol-related crash fatalities (Freeman 2007 [++]). However, administrative licence revocation usually has a BAC limit as a criterion, so the author says the results should be 'properly interpreted as a partial effect conditioned on the existence of a BAC law'.

Young drivers: zero tolerance laws and graduated licensing schemes

There is sufficiently strong evidence to indicate that zero tolerance laws and graduated licensing can help reduce alcohol-related injuries and deaths.

Zero tolerance laws and graduated licensing schemes can help reduce alcohol-related injuries and deaths. One systematic review reported a 9–24% reduction in crash fatalities, while another reported reductions in the range of 11–33% (Shults et al. 2001; Zwerling and Jones 2001 [both ++]).

Additional evidence is provided by primary evaluation studies of high or good quality. The age groups covered by these laws is specific to the jurisdiction (typically under 21 in the US, under 18 in Australia and lower in certain other cases such as in New Zealand with a minimum legal age for driving of 15 years).

One study found that zero tolerance laws, combined with administrative licence revocation, led to a 4.5% reduction in fatal crashes among young drivers (Eisenberg 2003 [++]). Another showed that zero tolerance laws reduced the proportion of deaths among underage drink-drivers by 24.4% (Voas et al. 2003 [+]). A further study linked zero tolerance laws to a 12% reduction in alcohol-related fatalities and a 4% reduction in overall crash fatalities (Villacaves et al. 2000 [+]).

Three US studies showed that zero tolerance laws changed the pattern of alcohol consumption and the drink-driving behaviour of young people overall.

In one, it led to a 19% reduction in the number of young people (aged under 21) driving after drinking any alcohol – and a 23% reduction in the number driving after five or more drinks (Wagenaar et al [+]). The law did not effect overall drinking or binge drinking participation. In a second study zero tolerance, combined with graduated licensing laws, reduced heavy episodic drinking and led to a shift to becoming a 'light' drinker among those aged under 21 (Carpenter 2004 [+]).

The third study showed that zero tolerance laws reduced drinking and driving among college students (aged under 21). The main response was to refrain from driving after drinking, with the greatest effect made by those who reported drinking away from home (Liang and Huang 2008 [+]).

Good quality evidence shows that graduated driver licensing restrictions help reduce crashes among young drivers. A systematic review conducted by Hartling et al. (2004 [++]) reported a general reduction for all types of crash. Among those aged 16, there was, on average, a 31% reduction in alcohol-related incidents during the first year (the rate ranged from 26-41%). Reductions in injury crash rates were similar (median 28%, range 4-43%).

A study of the impact of graduated driver licence restrictions on young drivers in New Zealand showed that crashes involving those on a restricted licence were less likely to have occurred at night – and less likely to have involved passengers. In addition, the driver was less likely to have been suspected of drinking alcohol, compared with crashes involving a driver licensed under the old system (Begg et al. 2001 [+]).

Modelling the impact of a 0.05 BAC limit

A range of estimates were produced for the number of alcohol-related driving casualties that would be avoided in England and Wales from introducing a 0.05 BAC limit, according to different assumptions.

Assuming the policy produces the same relative effect on the BAC distribution as observed in Australia, 144 deaths and 2929 injuries were estimated to be avoidable.

Assuming the policy produces the same relative effect on accidents as observed in other European countries, 77-168 deaths and 3611-15832 injuries were estimated to be avoidable.

A model was developed, using the best evidence identified during the systematic review, to estimate what impact lowering the BAC limit to 0.05 would have on the number of alcohol-related deaths and injuries.

A number of estimates were made, based on an extrapolation of the effect of lowering the BAC limit from 0.08 to 0.05 in other countries. The predictions also take into account the ongoing shift in the distribution of blood-alcohol concentration levels in the driving population (that is, the amount that people are drinking before driving). Given the many uncertainties related to the data and the assumptions used in the modelling, the figures should be interpreted with considerable caution.

There was limited evidence on the pattern of drink-driving in the UK, as measured by BAC levels among the driving population. There was also a lack of UK evidence on how reducing the legal limit might change drink-driving behaviour and the associated risk of casualties, particularly among those drinking above the current 0.08 BAC limit. Consequently, unknown parameters had to be calibrated or estimated from the international literature.

International lessons

It is generally accepted that reducing the legal BAC driving limit is an effective drink-driving deterrent and there is a clear trend, especially in Europe, towards introducing a 0.05 limit.

Other interventions that are being introduced to support this policy include lower BAC limits for young, learner, probationary and professional drivers (sometimes called ‘zero tolerance’), and a range of enforcement measures, particularly random breath testing but also alcohol ignition interlock devices and more consistent and intensive enforcement in general.

European citizens (including drivers) appear to support drink-driving policies already in force, as well as proposals to extend them. The same is true of UK citizens. However, UK citizens are less likely than other Europeans to know what the legal BAC limit is, and are among the least likely to have had their BAC level checked. In common with drivers in other countries which do not have systematic random breath testing, UK drivers are likely to think that they will never be checked.

Summary statement

Overall, the evidence indicates that lowering the UK BAC limit from 0.08 to 0.05 is likely to reduce the number of alcohol-related deaths and injuries.

It could have an impact on the drink-driving behaviour of everyone who drinks alcohol – including those who tend to drink well above the current limit before driving. However, the effect of lowering the BAC limit (in terms of scale and sustainability) is likely to be dependent on increasing the public's awareness and understanding of BAC limits and rigour of enforcement strategies. Currently, the actual – and perceived – risk of being detected and sanctioned for drink-driving (in the context of the BAC 0.08 limit) is low, and therefore does not act as a sufficiently strong deterrent.

The effect is also likely to be dependent on the precise combination of measures (including sanctions) targeting specific groups of drink-drivers, particularly those who drink and drive persistently above the limit.

Specific additional measures used in combination with a lower BAC limit are likely to enhance the effect. Administrative licence suspensions have proved an effective deterrent as they are employed immediately after the offence. Zero tolerance laws and graduated licensing systems for young drivers have also proved effective.

This review is based on a rigorous review of the best available evidence. However much of this evidence is from the USA, Australia, and other European countries. The precise impact of these measures in the UK is

uncertain, given differences in the context. Nevertheless the review findings provide an important basis for informing government policy on drink-driving.

Contents

1 Introduction

The Department for Transport has asked NICE to help strengthen the evidence base on the effectiveness of measures for improving road safety, and specifically measures on limiting blood alcohol concentration (BAC) levels for reducing road traffic injuries and deaths.

BAC levels can be expressed in various ways. Using the UK's legal BAC limit as an example, these are as: milligrams of alcohol per 100 millilitres of blood (80mg/100ml); grammes of alcohol per 100 millilitres of blood (0.08g/100ml); and grammes of alcohol per litre of blood (0.8g/litre). (In the USA, decilitre is sometimes used instead of 100 millilitres: e.g. 0.08g/dl.) Often, the BAC level is expressed as a percentage (e.g. 0.08% instead of 0.08g/100ml) or in the shorthand forms 80, 0.08, or 0.8. This report draws on a wide range of reviews and studies, whose authors have used this variety of ways of describing BAC levels. We have not standardised the terminology in sections which report or summarise the findings of this literature (sections 3–6 and 8). However, we have standardised it in the other sections, using the form 0.08. (For an explanation of other terms used in this report, see the glossary on page 162.)

1.1 Aims and objectives

- To assess the evidence on the effectiveness of laws limiting blood alcohol concentration levels in reducing road traffic injuries and deaths, and implications for changing the blood alcohol concentration limit for England.
- To review international policies on measures to reduce blood alcohol concentration levels and their relevance and applicability to the UK context; including issues relating to implementation and enforcement.
- To advise on the relative effectiveness of options for reducing blood alcohol concentration levels and related road traffic injuries and deaths, based on modelling techniques.

1.2 Background: policy position

The government's current policy on drink-driving is set out in its 2000 strategy for road safety, 'Tomorrow's roads – safer for everyone' (Department of the Environment, Transport and the Regions 2000). Within the theme of 'safer drivers', the strategy made a commitment to introduce new measures to reduce drink-driving. These included tougher penalties for 'high-risk offenders', a scheme for courts to send drink-drivers on rehabilitation courses, continuation of high-profile publicity campaigns, targeted breath testing in locations where drinking may be more likely to take place, and enabling evidence from roadside breath tests to be admissible as evidence in court.

The strategy set targets for 2010 of reducing from a 1994–8 baseline the numbers of people overall and of children killed or seriously injured in road accidents, and the 'slight casualty' rate. Statistics for 2008 show that the overall target for 2010 has been met and the targets for children and the slight casualty rate exceeded, despite a growth in traffic of 16% (Department for Transport 2009). For drinking and driving they show that:

- In 2008, it was estimated that 13,020 reported casualties (6% of all road casualties) occurred when someone was driving while over the legal alcohol limit.
- The provisional number of people estimated to have been killed in drink-drive accidents was 430 in 2008 (17% of all road fatalities), an increase of 20 fatalities compared to 2007.
- The provisional number of killed or seriously injured (KSI) drink drive casualties in 2008 was 2060, less than a quarter of the 1980 level and 5% below the 2007 level.
- Provisional figures for the number of slight drink drive casualties in 2008 fell 7% since 2007, from 11,850 to 10,970.

The strategy deferred a decision on proposals to lower the legal BAC limit from 0.08 to 0.05 so that account could be taken of policy initiatives by the European Commission. In its second 3-year review of the strategy, the government placed the priority of improving enforcement of the current limit

ahead of a change to the BAC limit, but promised to keep the case for reduction under review (Department for Transport 2007).

Policies on drink-driving need to be seen in the context of the government's broader policies on alcohol control, as set out in 2007 in 'Safe, sensible, social' (Department of Health 2007). This also focuses on a minority of drinkers, defined as those who cause the most harm to themselves, their communities and their families: young people aged under 18 who drink alcohol; binge drinkers aged 18–24, a minority of whom are responsible for the majority of alcohol-related crime and disorder; and drinkers who are causing harm to their health. 'Safe, sensible, social' thus echoes, and places in a wider context, policy proposals on drink-driving.

The present BAC limit for drivers of 0.08 has been backed by enforcement, penalties and publicity. The penalty for exceeding the legal alcohol limit or being unfit to drive through drink is a mandatory minimum disqualification of 12 months. Offenders may also be fined up to £5000 and sent to prison for up to 6 months. A minimum 3-year disqualification is imposed for a second offence within 10 years.

1.3 Policy review questions

The specific review questions were as follows:

Risk of road traffic injuries and deaths relating to blood alcohol levels

- What is the best estimate of the relationship between the level of alcohol in the blood and the risk of a crash? Is it possible to combine data from current studies meaningfully? How is risk segmented across different population groups (for example, age, sex) or by time of day? Is it possible to derive a multivariate model to predict risk?
- By mode and role (for example, driver, passenger), what is the population attributable risk of alcohol in terms of a) injuries b) fatalities in the following BAC bands in the UK today: 0, 1–19, 20–49, 50–79, 80–99,100–149,150–199, 200+? What is the best estimate of the number of road deaths attributable to alcohol overall?

- What are the personal and lifestyle characteristics of people who crash their cars while under the influence of alcohol? How are they different from other drivers, particularly those who commit their offences while considerably over the prescribed limit?

International policy measures on limits for blood alcohol levels to reduce road traffic injuries and deaths

- All other things being equal, if the limit was lowered to 0.05 (or 0.02), what is the most likely impact of this in England, given what we know about the experience of having done this in other countries? What are the likely changes in people's behaviour given the current system of enforcement in the UK? How would different segments of society respond to the lowering of the limit?
- What evidence is there that the introduction of a new, lower limit would affect the behaviour of drivers who currently cause fatalities while well over the current limit?
- What has been the impact of different control or enforcement measures in different countries? Are there any consistent messages that might be transferrable to a UK setting?
- What have been the consequences of policies that have directly addressed younger drivers?
- What is the evidence of any potential adverse or unintended consequences of introducing a lower limit?

Appraisal of options for reducing blood alcohol levels

- If there is no change in the current limit, what is the likely impact of introducing random testing in the UK and doing more tests?

References

Department for Transport (2007) Second review of the government's road safety strategy. London: Department for Transport.

Department for Transport (2009) Reported road casualties Great Britain: 2008. Annual report. London: Department for Transport.

Department of Health/Home Office (2007) Safe, sensible, social: The next steps in the national alcohol strategy. London: Department of Health.

Department of the Environment, Transport and the Regions (2000) Tomorrow's roads – safer for everyone. London: Department of the Environment, Transport and the Regions.

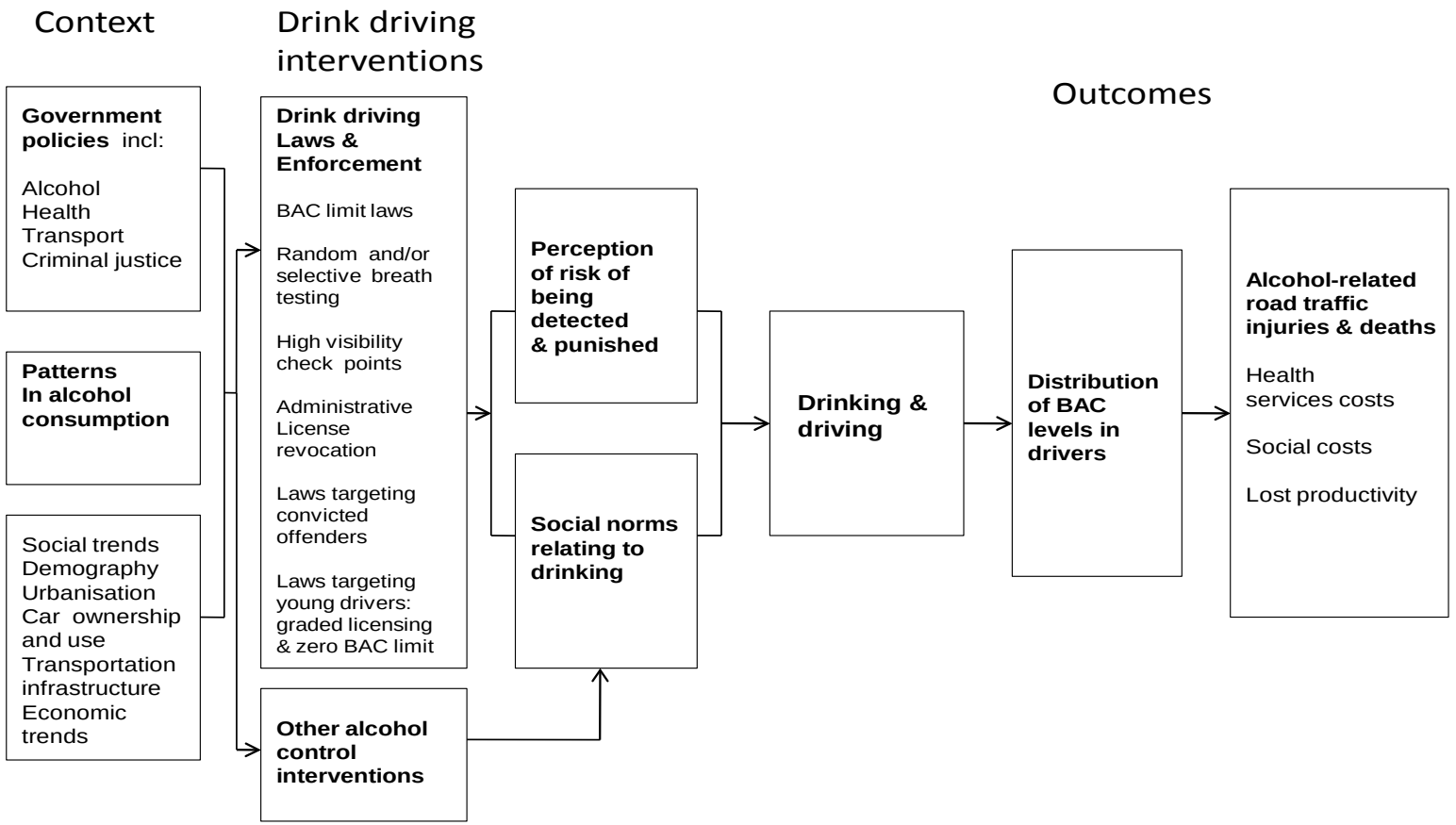
2 Review approach and methodology

The review was conducted in line with NICE methods for review of public health programmes and interventions (NICE 2009).

2.1 Conceptual framework

The conceptual framework has guided the review process. It sets out the rationale for why the intervention – that is, the reduction in the legal limit of BAC for driving (from 0.08 g/dl to 0.05 g/dl) – could work. It defines the conceptual links between the law for 0.05 g/dl, changes in drink driving and long-term health outcomes (as measured by alcohol-related road injuries and deaths).

Logic model: Laws limit blood alcohol concentration level of drivers



These links are based on a set of assumptions about the links between drink-driving interventions, individual drink-driving behaviours, including alcohol consumption, and resulting involvement in accidents. These assumptions are set out below:

Assumptions

- Alcohol consumption impairs driving functions: drivers' risk of injury and death increases with blood alcohol concentrations at and above 0.02g/dl.

- Drink-drivers will tend to comply with a prescribed limit by reducing their intake of alcohol before driving, thereby lowering their risk of being involved in a crash, and being injured or killed.

- Drivers' reduced alcohol consumption is dependent on their awareness and understanding of the prescribed limit, their perception of risk of being detected and punished for violating the law, and their responsiveness to social norms around driving behaviour.

- Enforcement measures that are well-publicised, enforced and sustained are therefore vital in increasing drivers' perception of risk of detection.

- Any new law imposing a lower prescribed limit, with the necessary enforcement measures will also influence social norms regarding drinking and driving, strengthening the view that drinking and driving is socially unacceptable.

- Young drivers have a higher risk of being involved in a crash, and being injured and killed as the influence of alcohol is compounded by inexperience and also propensity for risk taking behaviour.

- Consequently specific targeted measures may be required including a lower limit for BAC.

These assumptions draw on both theoretical and empirical evidence. This review aims to consider this evidence and test the robustness of the above assumptions.

Policy and research have drawn on ‘deterrence’ theory in particular to help understand and explain how policy measures could influence patterns of drink drinking (Homel 1988). A distinction is made between specific and general deterrence. Specific deterrence occurs when a drink driver is apprehended and punished and consequently is deterred from future drink driving. General deterrence results from the perception that there is a high risk of detection and punishment for drink driving.

Effectiveness of measures is dependent on whether they deter drivers from drinking and driving because of the risk and threat of being detected and punished. This is not only related to the nature of the legal sanction, but also individual factors, including assessment of risk, fear of disapproval, shame and embarrassment, and certain personality traits such as risk-taking propensity and levels of impulsivity. Such factors mean that legal sanctions are likely to have a differential deterrent effect.

A key question is the extent to which legal sanctions affect the behaviour of a ‘hard core’ of drivers who may continue to drink and drive regardless of level of sanctions.

This conceptual model helps assess and interpret the evidence on effectiveness. It helps also to identify the gaps in the evidence.

In particular the model identifies the range of contextual factors that influence drink driving behaviours and road traffic injuries and deaths. The precise mix of traffic safety and alcohol control policies are distinct to each country or state. Evaluation of the impact of BAC laws needs to take account of this policy context as well as other factors, including wider economic and social trends. Assessment of the relevance and applicability of policy measures to the UK from elsewhere must consider variation in contexts.

Approach to evidence reviews and impact evaluation

The approach comprised the following five components:

- Summary review of studies on the relative risks of road traffic injuries and deaths relating to blood alcohol concentration (BAC) levels.

- A systematic review of the effectiveness of drink-driving laws reducing the legal limits of BAC levels in reducing alcohol-related road traffic injuries and deaths covering:
    - review-level evidence: that is, systematic reviews of studies of evaluations for drink-driving laws and related measures
    - primary evaluations of drink-driving laws.

- Impact evaluation based on a modelling approach for estimating the effect of different legal limits of blood alcohol levels on alcohol-related road traffic injuries and deaths (modelling project undertaken by the School of Health and Related Research, Sheffield University).

- A comparative analysis of the effectiveness of international policies on limits on BAC levels in reducing road traffic injuries and deaths, and implications for measures in England.

The aim was to define and assess the current body of knowledge of most relevance to the research questions. The combination of components was intended to build on existing review work. In particular it aimed to consider more recent evidence regarding experience of lowering BAC limits to 0.05g/dl or lower where available (that is, to examine evidence of most relevance to the UK context).

The review is therefore not exhaustive or fully comprehensive. Existing review work provided a platform for the review. This included a number of narrative reviews (Anderson 2008; Chamberlain and Solomon 2002; Fell and Voas 2006; Howat et al. 2004; Mann et al. 2001). These narrative reviews provided valuable reference sources (although they were not fully appraised as they did not meet the inclusion criteria).

Literature search

The search strategy was designed and undertaken by NICE Technical Team and Information Services to support all the above reviews. The search involved two phases:

- Scoping searches to identify policy documents and guidance relating to national and international approaches to reducing drink-driving, and including associated research, review and evaluation material

- Systematic literature searches to identify systematic reviews, epidemiological studies and other studies relating to risks relating to drinking and driving, and primary evaluation studies.

The data bases and websites and policy sources that were searched are listed below.

Search sources			
Databases	Systematic review sources	Sources of international policy guidance and documentation	
ASSIA British Nursing Index Centre for Reviews and Dissemination databases (DARE, HTA, NHS EED) Cinahl Cochrane Library (CDSR, CENTRAL, DARE, HTA, NHS EED) Embase ERIC HMIC MEDLINE MEDLINE in Process PsycInfo Social Care Online Social Policy and Practice Social Science Citation Index Sociological Abstracts Transport	Aggressive Research Intelligence Facility (ARIF) Bandolier Campbell Library of Systematic Reviews Cochrane Database of Systematic Reviews Cochrane Drugs and Alcohol Group Cochrane Injuries Group DARE (CRD and Cochrane) HTA (CRD and Cochrane) NHS EED (CRD and Cochrane) National Institute for Health Research (NIHR) Health Technology Assessment Programme	Agency for Healthcare Research and Quality (AHRQ) Alcohol Advisory Council of New Zealand Alcohol Concern Alcohol and Education Research Council Association of Public Health Observatories British Medical Association Canadian Medical Association Infobase Clinical Evidence Clinical Knowledge Summaries Department for Transport Department of Health Drugscope European Commission European Legal Database on Drugs European Road Safety Observatory European Transport Safety Council Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI Centre) Faculty of Public Health Guidelines International Network (GIN) Global Information System on Alcohol and Health (GISAH) Global Road Safety Partnership Health Development Agency Health Protection	National Health and Medical Research Council (Australia) National Highway Traffic Safety Administration (US) National Institute for Health and Clinical Excellence NHS Information Centre National Institute on Alcohol Abuse and Alcoholism (US) National Institute on Alcohol Abuse and Alcoholism – Alcohol Policy Information System NLH International Guidelines NLH Mental Health Specialist Library NLH National Library of Guidelines Specialist Library NLH National Library for Public Health Specialist Library New Zealand Guidelines Group New Zealand Ministry of Health North West Public Health Observatory OpenSigle Parliamentary Advisory Council for Transport Safety Royal Society for the Prevention of Accidents SAMHSA's National Clearinghouse for Alcohol and Drug

		Agency The Home Office Information about Drugs and Alcohol (IDA) Institute of Alcohol Studies International Centre for Alcohol Policies International Harm Reduction Association: International Harm Reduction Intute Joseph Rowntree Foundation King's Fund National Guidelines Clearinghouse	Information The Scottish Government SIGN Transport Research Laboratory TRIP database Welsh Assembly Government World Health Organisation: Alcohol World Health Organisation: Violence and Injury Prevention and Disability WHOLIS - World Health Organization library database

The search strategy used for MEDLINE is provided as an example and is set out in appendix A. The subject headings used in this strategy were adapted accordingly for the searches conducted in the databases.

Inclusion and exclusion criteria for evidence reviews

Studies were eligible for inclusion if they were concerned with:

- Epidemiological consequences of alcohol consumption relating to driving impairment; relative risks of road traffic injuries and deaths relating to blood alcohol concentration (BAC) levels.

- Drink-driving policy interventions:
    - laws prescribing limits for blood alcohol concentration for driving
    - penalties including licence suspension, fines and jail sentencing
    - enforcement including random breath testing/sobriety checks

  - laws targeting younger drivers, including minimum legal age for drinking alcohol, lower BAC limits (zero tolerance), graduated licensing schemes.

- Outcomes:
  - road traffic accidents, injuries and deaths relating to alcohol
  - measurement of BAC levels among drivers
  - self-reported measures of drink driving behaviour.

- Study design:
  - epidemiological studies and other types of studies on risks of drinking and driving
  - systematic reviews including meta analyses
  - primary evaluations of drink-driving laws.

Studies were excluded as follows:

- secondary or tertiary prevention measures for drink-driving (including individual-based treatment measures and schemes)
- measures relating to prevention of driving under the influence of drugs and alcohol
- studies published in any other language than English
- studies carried out in developing countries
- review studies published before 1990
- studies of primary evaluations published before 1995 (except studies identified by experts relating to 0.05 g/dl BAC laws).

Screening and data extraction strategy

The screening of potential studies and documents was based on the above criteria. The initial screening of the search results involved assessment of titles and abstracts by two reviewers independently, and then full texts. Differences about inclusion were resolved through discussion, with a third reviewer providing advice when necessary. The studies and papers were

categorised according to type of study or material: policy, review level, primary evaluation, epidemiological and risk studies.

Certain material although relevant, did not meet the inclusion criteria. For example, as noted above a number of narrative reviews were not systematic reviews. This material was used as background documentation to assist interpretation of evidence as appropriate as well as a means to identify primary studies and other relevant work. Studies were often reported in multiple papers, including conference papers and discussion papers. The reviewers attempted to prioritise the most recent paper published in a peer review journal. Relevant papers were also identified by academics (providing advice to the project).

The international policy search identified documentation from:

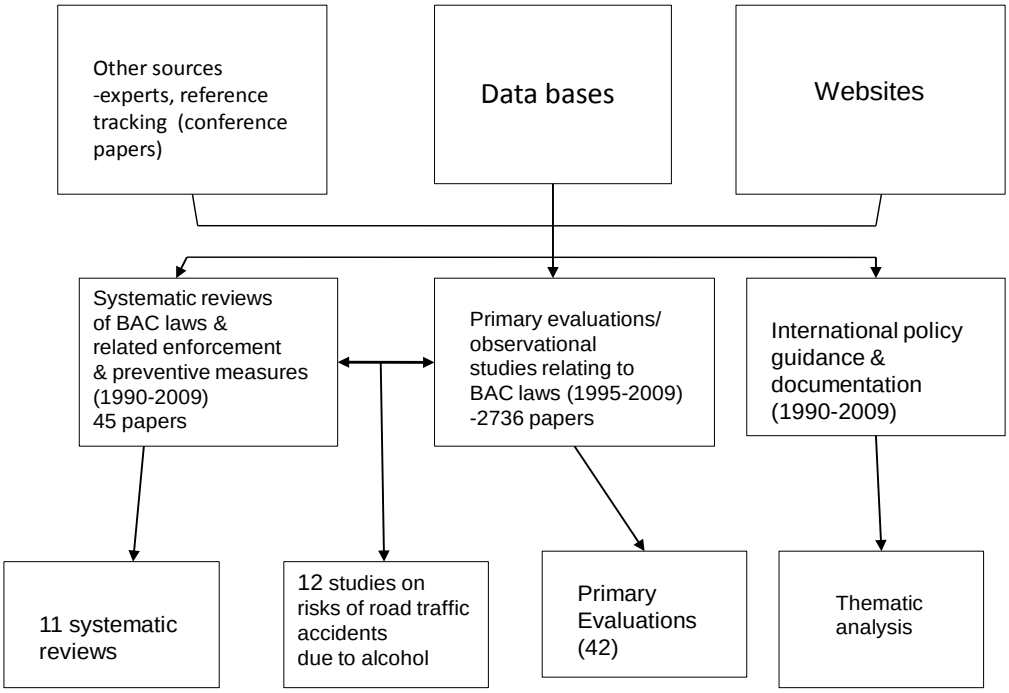
- national governments (mainly the UK, the USA, Canada, New Zealand, and Australia) and the executive agencies, advisory bodies, and research and evidence bodies connected to them
- supra-national and international bodies such as the European Commission and WHO
- national and international non-governmental organisations (NGOs), including organisations of concerned professionals
- academic and independent researchers and policy analysts.

Analysis and synthesis of the policy documentation was based on a thematic approach (described in section 7).

The comparative analysis provided a basis for testing the assumptions in the conceptual framework regarding the ‘context’ for effective intervention; and also for identifying lessons relevant in reviewing UK policy on BAC limits.

The documentation was used to analyse international experience relevant to informing any change of policy in England.

Summary of search strategy



Quality appraisal strategy

The quality of the systematic reviews and primary evaluations was assessed according to the schemes set out in tables below. These criteria were informed by NICE methods, and those used by the Cochrane collaboration for public health interventions((Cochrane Collaboration 2007).

Quality assessment criteria for reviews

1	Clear and appropriate focused question
2	Description of review methodology
3	Sufficiently rigorous search strategy
4	Appraisal of study quality taken into account
5	Sufficient similarities between studies to make combing them reasonable
6	Overall assessment: approach sufficient to minimise bias/account taken of any likely direction of bias
7	Types of evaluative studies specified
8	Relevance of findings to key questions

Quality assessment criteria for primary evaluation studies	
Interrupted time series/controlled interrupted time series	
1	Protection against secular changes
2	Appropriate analysis: use of ARIMA models OR time series regression models
3	Nature of intervention effect pre-specified or rational explanation given
4	Data collection – protection from bias
5	Data completeness
6	Objective outcome assessment (blinded or variables objective)
7	Reliability of primary outcomes
Randomised controlled trials, controlled trials, controlled before and after studies	
1	Concealment of allocation (RCTs, CT only)
2	Similarity to baseline outcomes
3	Similarity to other baseline characteristics (CBA)
4	Protection against contamination
5	Follow up of participants (not applied to population cross sections)
6	Objective assessment of outcomes (blinding or variables objective)
7	Reliability of primary outcome measures

Each study was rated according to the extent to which the quality criteria were met as outlined below. The data extraction forms and quality rating for each study are shown in appendix C.

Quality rating	Definition
++ High	All or most of the checklist criteria have been fulfilled. Where the criteria have not been fulfilled the conclusions are very unlikely to alter.
+ Good	Some of the checklist criteria have been fulfilled, where they have not been fulfilled, or not adequately described, the conclusions are unlikelyto alter.
– Weak	Few or no checklist criteria have been fulfilled and the conclusions are likely or very likely to alter.

Synthesis

Overall interpretation and synthesis of the evidence took account of the following:

- overall quantity and quality of the evidence
- degree of consistency of findings, particularly regarding the nature of the effect
- applicability of the findings to the UK context.

This synthesis was presented in a narrative form, including evidence statements. Evidence statements summarise the overall strength (quality, quantity and consistency) of the evidence. The degree of overall strength is defined taking account of the quality ratings of reviews and primary evaluation. The table below defines what constitutes the different levels of evidence statements for the purposes of this review.

Evidence statements terminology	
Rating of strength of evidence	Quality, quantity and consistency of evidence of reviews/studies
Strong evidence	There are at least two high quality systematic reviews (++), and/or at least four high quality primary evaluations (++); and/or six good quality primary evaluations The overall weight of the evidence is in a consistent direction
Sufficiently strong evidence	There is at least one high or good quality systematic review (++), and/or at least two high quality primary evaluations and/or three good quality primary evaluations The weight of the evidence is, on balance, in a consistent direction; among high/good quality studies there may be some degree of variability
Weak evidence	There are no high or good quality systematic reviews; there are a small number of good or weak primary evaluations There are inconsistencies in the evidence
Inconsistent evidence	A further comment may be required on the degree of variability in direction of effect/outcomes; and level of agreement/disagreement
No evidence	There is no high or good quality evidence, within the scope (study design/sources of studies) included in the review

References

Andersen P (2008) Reducing drinking and driving in Europe. Report written on behalf of the Institute of Alcohol Studies. Belgium: European Commission

Chamberlain E, Solomon R (2002) The case for a 0.05% criminal law blood alcohol concentration limit for driving. Injury Prevention 8: (Supplement iii17)

Cochrane Collaboration (2007) Systematic reviews of health promotion and public health interventions guidelines version 2 [online]. Available from http://ph.cochrane.org/sites/ph.cochrane.org/files/uploads/Guidelines%20HP_PH%20reviews.pdf

Fell JC, Voas RB (2006) The effectiveness of reducing illegal blood alcohol concentration (BAC) limits for driving: evidence for lowering the limit to .05 BAC. Journal of Safety Research 37 (3): 233–43

Homel R (1988) Policing and punishing the drinking driver: a study of general and specific deterrence. New York: Springer-Verlag

Howat P, Sleet D, Elder R et al. (2004) Preventing alcohol-related traffic injury: a health promotion approach. Traffic Injury Prevention 5 (3): 208–19

Mann RE, Macdonald S, Stoduto G et al. (2001) The effects of introducing or lowering legal per se blood alcohol limits for driving: an international review. Accident Analysis and Prevention 33 (5): 569–83

NICE (2009) Methods for development of public health guidance. London: NICE

3 Epidemiology: alcohol-related risks of road traffic injuries and death

This section reports the summary review of studies on the relative risks of road traffic injuries and deaths relating to blood alcohol concentration (BAC) levels. The increased relative risks at an individual level and attributable risk at a population level provide the underpinning epidemiological rationale for interventions that limit the alcohol consumption of drivers.

A total of 12 studies were identified which investigated the relationship between BAC levels and the risk of road traffic injury and death. Most of the studies are non-UK based and span four decades including Borkenstein's Grand Rapids study conducted in the early 1960s. The studies identified varied in terms of their design, methodology and models used for estimating the relative risk of alcohol-related crashes, injuries and deaths.

Maycock (1997) describes the various sources of data available in the UK that can be used to determine prevalence of drink driving and risk of road traffic injury and death, and their strengths and weaknesses. In particular, road side surveys are conducted in the main during late night/early morning ('drinking hours'). As such the survey data can be only representative of patterns of drink driving during this period. Such surveys do not provide an estimate of prevalence of drink driving over 24 hours; and capture in full the pattern of drink driving in the population.

Of the 12 studies, only one reported findings from the UK (Maycock 1997); the remaining 11 studies were from the USA (6), Australia (2) and New Zealand (3). The 12 studies are categorised into the following three groups with some studies overlapping between the three groups:

3.1 Epidemiological studies

Of the 12 studies identified, four were categorised as epidemiological studies (Brooks and Zaal 1993; Hingson and Winter 2003; Kloeden and McLean 1997; Maycock, 1997). These four papers reviewed various sources of drink-

driving data including national statistics, coroners data, prosecution data, random breath testing and surveys to identify trends relating to drinking and driving including the characteristics of drinking drivers (for example, age, gender occupational group), and drinking and driving by time of day, day of week and month of year.

3.2 Laboratory studies

Two studies conducted in the USA (Moskowitz and Fiorentino 2000; Moskowitz et. al. 2000) investigated the effects of varying levels of alcohol on driving-related skills within a laboratory setting. In the first study Moskowitz and Fiorentino (2000) reviewed 112 studies on the effects of low doses of alcohol and driving-related skills, while in the second study Moskowitz et. al. (2000) examined the effects of alcohol on driving skills at BAC of 0.00% to 0.10% in a sample of 168 subjects assigned to age, gender and drinking practices groups.

3.3 Estimation of relative-risk studies

A third group of studies reports estimates on the relative risk of being involved in an accident where risk is estimated in relation to a number of different variables including age, gender, time of day, number of passengers (Allsop 1966; Keall et al. 2004; Keall et al. 2005; Keall and Frith 2005; Maycock 1997; Peck et al. 2008; Zador et al. 2000). Reporting on studies conducted in the UK, USA and Australia the authors make use of various data sources including case-control data.

Maycock (1997) in his review of drinking and driving in the UK calculates the relative risk of being involved in a drink-drive accident as the number of drink-drive accidents per 1000 injury accidents. Thus the relative risk by age (both sexes combined) is estimated as the number of drivers in a particular age group who failed a breath test after an accident divided by the total number of accident involvements for that age group (Department of Transport 1994).

Three studies conducted in New Zealand (Keall et al. 2004; Keall et al. 2005; Keall and Frith 2005) sought to produce estimates of the relative risk of being

involved in a crash analysing a number of variables. One study (Keall et al. 2004) investigated the influence of carrying passengers on driver risk and also estimated driver risk by age and BAC level while controlling for any such passenger effects. A further aim of the study was to estimate passenger effects on driver risk while controlling for the effects of alcohol and age for driving trips at a time of night and days of the week when the vast majority of travel in New Zealand is associated with socialising. A second study by Keall et al. (2005) sought to tease out the risk associated with driving at night and the risk associated with inherently night time factors, from the risk associated with alcohol. In a third study by Keall and Frith (2005), the authors present a method for estimating the risk of driver involvement in injury crashes for case-control data where control drivers have reliable measures of BAC and other driver characteristics but crash-involved drivers do not have BAC measures.

In the USA, a paper by Allsop (1966) provides a summary and additional analysis of the Borkenstein et al. (1963) study in Grand Rapids, Michigan, which investigated the effects of alcohol on driving skill and accident involvement. Zador et al. (2000) also in the USA, sought to re-examine and refine estimates for alcohol-related risk of driver involvement in fatal crashes by age and gender as a function of BAC. A third US study by Peck et al. (2008) re-analyses data collected by Bloomberg et al. (2005) to investigate how the two variables of age and BAC interrelate to influence crash risk.

3.4 Summary of epidemiological studies

Trends in crash deaths and injuries

While the data is historical, the Maycock study (1997) is one of the few sources of UK data on the BAC distribution in the population. Data for the period 1984–90 for the UK indicates that accidents of all severities involving drinking and driving have been declining at considerably higher rates than have accidents in general. For the same period there has been an overall decline in the proportion of fatalities for which BAC is known which were over the legal limit. However, the BAC distribution for UK drivers killed in accidents while over the legal limit has remained much the same over the 10 year period

1984–94, with the significant exception that the fatalities involving drivers over five times the legal limit 10 years ago have virtually disappeared in the most recent period. In the USA, similar trends concerning traffic deaths involving alcohol declined markedly from the early 1980s to 1996 but that in the 6 years since then the downward trend has abated and alcohol-related traffic deaths have actually increased.

The main findings of the studies on patterns of alcohol-related drink-drive injuries and fatalities are shown in the tables below.

UK trends in drink-driving (Maycock 1997)

- In the UK reductions in fatal, serious and slight drink-drive accidents from 1984–94 have been declining at a considerably higher rate than have accidents in general.
- Reductions in fatal, serious and slight drink-drive accidents from 1984–94 are reported as 7.9%, 10.2% and 5.8% respectively.
- The equivalent rates for all fatal and serious accidents over the same period are 5.6 per cent and 5.8 per cent respectively, indicating that accidents of all severities involving drinking and driving have been declining at considerably higher rates than have accidents in general.
- The distribution of women who are involved in fatal accidents in the UK as drink-drivers for the period 1990–94 is very similar to that of men.
- In the UK, coroners' data for the period 1990–94 show that the age distributions of male and female drink-drivers involved in all injury accidents and in fatalities are very similar.
- In the UK for the period 1984–94 there has been an overall decline in the proportion of all fatalities for which blood alcohol concentration is known which were over the legal limit. This overall decline however conceals that while car driver and motorcyclist fatalities have been declining over the decade, accidents involving pedestrians have not.
- The BAC distribution for UK drivers killed in accidents while over the legal limit has remained much the same over the 10 year period 1984–94, with the significant exception that the fatalities involving drivers over five times the legal limit 10 years ago, have virtually disappeared in the most recent period.
- In the UK the hourly pattern of drinking and driving show the expected high incidence of drinking and driving between the hours of 22.00h and 02.00h.

USA (Hingson & Winter 2003) **and Australian** (Brooks & Zaal 1993) **trends in drink driving**
• In the USA alcohol-related fatality has declined markedly from the early 1980s to 1996 while accidents not involving alcohol, have increased 43% in the same period. • Traffic deaths involving people with BAC up to 0.08g/dl had the smallest proportional decline (19%) while traffic deaths among people with BAC of 0.08 g/dl and higher declined 35% and those with BAC of 0.15 g/dl and higher declined 37%. • Since 1982 declines in USA alcohol-related traffic deaths have not varied much by gender. However, the proportion of male drivers involved in alcohol-related crashes has declined by 37% whereas the number of female drivers in alcohol-related fatal crashes for the same period had only declined by 22%. • Young people aged 16–20 in the USA had the greatest decline (56%) in alcohol-related traffic deaths since 1982. • In the USA drivers between the ages of 16 and 20, and especially those aged 21 to 45 are more likely to be involved in alcohol-related fatal crashes at a rate that is out of proportion to their percentage of the population. • In Australia a reduction in the maximum permitted legal BAC from 0.08g/dl to 0.05g/dl led to a reduction in drink-driving at BAC levels well above the original 0.08g/dl limit.

Trends in alcohol distribution among drink-drivers

The accident trends reported by both Maycock (1997) and Hingson and Winter (2003) have arisen from an actual reduction in the amount of drinking and driving taking place as evidenced from the trends in breath-test results over the same period of time for those drivers involved in accidents. The US study (Hingson & Winter 2003) reports that traffic deaths involving people with a BAC of up to 0.08g/dl had the smallest proportional decline (19%) while traffic deaths among people with a BAC of 0.08g/dl and higher declined 35% and those with a BAC of 0.15g/dl and higher declined 37%. A similar trend has been reported in Australia where studies have reported a substantial drop in the incidence of high RBT readings above 0.10g/dl in 1991 compared to 1990, following a reduction in the maximum permitted legal BAC from 0.08 to

0.05g/dl. This decrease occurred mainly at BAC levels above 0.15g/dl and was particularly pronounced at levels above 0.20g/dl.

Characteristics of drink-drivers

Occupational groups

In the UK the distribution of occupational groups found among those prosecuted for drink-drive offences reported considerably more from lower social groups (DE).

Gender

Analysis of UK roadside survey data indicate that of those detected driving after drinking some alcohol, 74% were men, and of those over the limit 89% were men and of those prosecuted 93% were men (Maycock 1997). However, the proportion of drink-drivers who are male is falling slightly and for the years 1990–94 the annual reduction in positive breath tests for male drivers has averaged 8.3% while the comparable reduction for women is only 2.2%. These differential trends have had the effect of increasing the proportion of drink-drivers who are female from 9.8% in 1990 to 12.4% in 1994. A similar trend has been witnessed in Australia leading to the two groups having similar levels of drink-driving over the years.

Age

UK data reveals that the peak age for being involved in an accident while over the limit occurs in the 20–24 age group and declines with age for older drivers. A number of data sources show that heavier drinkers tend to be older than those whose BAC is nearer to the legal limit. Significant differences exist between the age distribution of male and female drivers who have failed a breath test. There are a higher proportion of older women in the population of offenders than is the case for men, and those women who are considered ‘high risk offenders’ are on average 6–7 years older than their male counterparts.

Drinking and driving law enforcement

Prosecution data *(1990-1992 sample of police files)*

In the UK 39% of drink-drive offenders are considered as ‘high risk offenders’ of which just over 7% were women. The prosecution data are weighted towards the heavier drinker with 92–93% of those prosecuted being male and considerably more in occupational group DE (42%).

Problem drinkers and drink-driving

A US study (based on a national survey of self reported drink driving behaviour among adults over 16 years) reported that overall 21% of the driving-age public reported driving a vehicle within 2 hours of consuming alcoholic beverages and about 10% of these trips were driven at BAC of 0.08g/dl or higher (NHTSA 2000). Consistent with fatality data, males were much more likely to report driving after drinking than females. Also in the USA, evidence about the relationship between alcohol dependence and alcohol-related crashes reveals that 13% of respondents were diagnosed as having been alcohol-dependent at some point in their lives and represented 65% of those who had ever been in a motor vehicle crash because of having too much to drink.

UK characteristics of drink-drivers (Maycock 1997)

- UK data collected from roadside surveys (1988–90 data) reveal that among drivers who were over the legal alcohol limit there were a higher proportion of drivers in occupational groups C2 (skilled manual workers) and DE (semi-skilled, unskilled workers and the unemployed) - 40% and 20% respectively – than would be expected in the population as a whole.
- In the UK roadside survey, data show that 13.3% of male drivers stopped in the survey had been drinking to some extent (BrAC >3 ug/100 ml) about twice the proportion of women (6.8%).
- In the UK there are significant differences between the age distribution of male and female drivers who have failed a breath test. A higher proportion of older women in the population are offenders than is the case for men. Women considered as 'high-risk offenders' are on average about 6–7 years older than their male counterparts.
- Heavier drinkers tend to be older than those whose BAC is nearer to the legal limit. Prosecution data (1990-1992) reveal that the peak age for drivers just over the legal limit occurs about the 23–24 age group, while for drivers over 2.5 times the legal limit, the peak age is about 29–30.
- In the UK driving population as a whole, 85% of drivers surveyed were driving with little or no alcohol in their blood. The proportion of drivers over the legal limit averaged just under 1.5% of drink-drivers surveyed during the heaviest drinking periods of the week.

USA and Australian characteristics of drink-drivers

- Drivers in fatal crashes in the USA who had positive BAC were more likely than other drivers in fatal crashes to have had their driver's licence suspended (Hingson & Winter 2003)
- Two studies in the USA report that the higher the BAC of a driver in a fatal crash, the greater the likelihood that the crash involved only one vehicle (Borkenstein 1963, Hingson & Winter 2003).
- In the USA survey data revealed that fatally injured drivers with BAC of 0.15g/dl or higher, relative to zero-BAC drivers, were much more likely to have been classified by informants as 'problem drinkers' (31%compared to 1%) (Hingson & Winter 2003)
- In Australia drink-driving continues to be primarily a late night activity, especially at the higher BAC levels and that the difference between drink-driving from 22:00 h to 23:00 h. and later at night, have tended to become more pronounced over time (Kloeden & McLean 1997).

Summary of laboratory studies

In the USA, Moskowitz and Fiorentino (2000) conducted a review of 112 studies, which examined the effects of low doses of alcohol on driving-related skills. Focusing on experimental measures of skills performance on driving-related behaviour, the authors examined 13 categories of driving-related behaviours.

A second US study by Moskowitz et al. (2000) conducted a controlled experimental laboratory study which sought to examine the effects of alcohol on driving skills at a BAC of 0.00% to 0.10% in a sample of 168 subjects assigned to age, gender and drinking practices. The study was designed to determine the BAC at which impairment of specific experimental tasks occur and the interaction of age, gender and drinking practices with BAC on the magnitude of impairment.

In the first review conducted by Moskowitz and Fiorentino (2000) into the effects of low doses of BAC on driving-related behaviour, the authors adopt two approaches to reviewing the literature. In the first instance, the authors present the data for impairment across all behavioural areas. Each study was

counted once at the lowest BAC for which impairment was found. Based on this approach, the authors found that overall impairment (based on 109 of the 112 studies reviewed) was reported by 27% of studies by 0.039 g/dl, 47% by 0.049 g/dl, and 92% by 0.079.

The second approach adopted by the authors was based on all 112 studies and focused on specific behavioural areas of more numerous behavioural tests across BAC. The results of this second approach indicate that impairment of driving-related skills begins with any departure from zero BAC as in some cases impairment was reported at a BAC as low as 0.009 g/dl. By the time subjects reach a BAC of 0.030 g/dl the number of impaired behavioural areas is greater than the number not impaired, and that by 0.05 g/dl, the majority of studies have reported impairment by alcohol. By a BAC of 0.08 g/dl, 94% of the studies reviewed reported impairment.

Moskowitz and Fiorentino (2000) note that the results of the behavioural response areas include areas which are on the one hand insensitive to the effects of alcohol and on the other scarcely representative of the demands of driving. While behavioural areas differ in their relative sensitivity to the impairing effects of alcohol the authors note that with the exceptions of critical flicker fusion and simple reaction time, all driving-related skills exhibited impairment by 0.07 g/dl in more than 50% of tests. The authors acknowledge that discrepancies in test results reflect a lack of standardisation in test methods and that failure to find alcohol impairment at low BAC may be attributable to the use of tasks, which are not sensitive to behavioural changes caused by alcohol. When studies only involving driving (in simulators and on the road) simulated piloting, divided attention and vigilance are examined, 73% of the test results exhibited impairment by 0.039 g/dl. When tracking and drowsiness are included, 65% of the tests performed by 0.039 g/dl showed impairment. Virtually all subjects tested in the studies reviewed exhibited impairment on critical driving measure by the time they reached 0.080 g/dl. Possible differences in degree of alcohol impairment as a function of differences in age, gender and drinking practices were not reported in this review.

A second US laboratory study conducted by Moskowtiz et al. (2000) had two major objectives. Firstly, the authors sought to determine the level of BAC at which driving-related impairment appeared for the majority of subjects in a representative sample of the population and secondly, to determine and to what degree driving-related impairment by alcohol was differentially affected by differences in age, gender and drinking practices. The authors report that alcohol significantly impaired performance on some measures at all examined levels of BAC, from 0.02% (the lowest level tested) to 0.10% (the highest level tested) with the magnitude of impairment increasing with increasing BAC. Differences in the magnitude of alcohol impairment between categories of age, gender and drinking practices were small, inconsistent in direction and did not reach statistical significance. The authors concluded that significant differences may have emerged if a wider range of subject characteristics and levels of BAC had been tested. In addition, BACs over 0.10% were not tested and the sample did not include subjects under age 19 years and over 70 years, or very light or very heavy drinkers. A major conclusion of this study is that by 0.04% BAC, all measures of impairment that are statistically significant are in the direction of degraded performance.

Laboratory studies
• Results from laboratory studies indicate that impairment of driving-related skills begins with any departure from zero BAC and that by 0.05g/dl, the majority of studies have reported impairment by alcohol (Moskowitz & Fiorentiono 2000). • By BAC of 0.08 g/dl, 94% of the studies reviewed reported impairment. • Moskowitz et al. (2000) reported that by 0.04% BAC, all measures of impairment that are statistically significant are in the direction of degraded performance. • Moskowitz et al. (2000) reported that differences in the magnitude of alcohol impairment between categories of age, gender and drinking practices were small, inconsistent in direction and did not reach statistical significance.

Summary of relative risk studies

The relative risk of being involved in an accident has been investigated in a number of studies where risk is estimated in relation to a number of different variables including age, gender, time of day, number of passengers (Allsop 1966; Keall et al. 2004; Keall et al. 2005; Keall and Frith 2005; Maycock 1997; Peck et al. 2008; Zador et al. 2000). There are relatively few case-control studies of driver crash risk associated with BAC and of the seven studies reported below, five used case-control data (Allsop 1966; Keall et al. 2004; Keall et al. 2005; Keall and Frith 2005; Peck et al. 2008) while the Maycock (1997) and Zador et al. (2000) studies were sampled by roadside surveys but not matched to cases by crash location.

In the UK, Maycock (1997) produced estimates of the relative risk of being involved in a drink-drive accident and fatal accident as a function of BAC. Maycock (1997) calculates the relative risk of being involved in a drink-drive accident as the number of drink-drive accidents per 1000 injury accidents. Using this approach, the relative risk by age (both sexes combined) is estimated as the number of drivers in a particular age group who failed a breath test after an accident divided by the total number of accident involvement for that age group (Department of Transport 1994). Maycock

(1997) points out that using injury accidents as a measure of exposure to risk (as opposed to year of age) has the effect of reducing variation between the age groups, particularly the first two age groups (17–19 years and 20–24 years). According to Maycock (1997), the difference between these two groups is smaller in terms of relative risk, due to the fact that although the younger drivers have higher accident liabilities, there are fewer of them and they drive fewer miles annually than their older counterparts. Over age 40, a driver's risk of involvement in accidents in general, declines with age, though not nearly as rapidly as the distribution of drink-drive accidents by year of age. This is presumably because older drivers drive fewer miles and have lower accident liabilities than younger drivers, but have relatively more accidents involving alcohol than the numbers by year of age would suggest. Based on these estimates, the relative risk of drivers in the 20–24 age group being involved in a drink-drive accident is just under three drink-driver accidents per 1000 injury accidents and the corresponding figure for the 60–70 age group is 0.8 (a ratio of slightly under 4).

Three case-control studies conducted in New Zealand (Keall et al.,2004; Keall et al. 2005; Keall and Frith 2005) sought to produce estimates of the relative risk of being involved in a crash using a number of different variables. To estimate the effect of alcohol, driver's age and the influence of passengers carried, on the risk of driver fatal injury in New Zealand, Keall et al. (2004) used data collected at randomly selected roadside sites and combined this with data on fatally injured drivers in crashes occurring on the same weekdays and times, at locations matched by the size of the nearest town for the years 1995–2000.

A second study by Keall et al. (2005) sought to tease out the risk associated with driving at night from the risk associated with alcohol, and risk associated with inherently night time factors. Control data were obtained from the New Zealand travel survey from mid–1997 to mid–1998 by interviewing in person, 14,000 people from 7000 randomly sampled households. Case data were derived from information on 23,912 injury crash-involved drivers in 1997 and 1998, classified by location into road types. In a third paper by Keall and Frith

(2005), the authors presented a method for estimating the risk of driver involvement in injury crashes for case-control data where control drivers have reliable measures of BAC and other driver characteristics but crash-involved drivers do not have BAC measures. Control data were obtained from random breath testing measurements between 1996 and 2000, and in 2002. Case data were derived from all crash reports for injury crashes occurring between 21:30 h. and 2:30 h on Friday and Saturday nights for the years 1996–2002.

In the USA, Allsop (1966) reports on some re-analyses he carried out on the Grand Rapids, Michigan study conducted by Borkenstein et al. (1964) in the early 1960s. Conducting a case-control study, Borkenstein et al. (1964) compared the BAC of drivers involved in a random sample of all crashes in Grand Rapids with a control group of drivers selected from the city's traffic at the same locations and times as the crashes.

Zador et al. (2000) also in the USA, sought to re-examine and refine estimates for alcohol-related risk of driver involvement in fatal crashes by combining crash data from the Fatality Analysis Reporting System (FARS) with exposure data from the 1996 'National roadside survey of drivers'. Logistic regression was used to estimate age and gender-specific relative risk of fatal crash involvement as a function of the BAC for drivers involved in a fatal crash and for drivers fatally injured in a crash.

A third US study by Peck et al. (2008) presents a re-analysis of the case-control data collected by Bloomberg et al. (2005) from two study sites, Long Beach, California and Fort Lauderdale, Florida during 1996–1998. Using four different age groupings (under 21, 21–25, 26–54 and 55+), Peck and colleagues investigated how the two variables of age and alcohol interrelate to influence crash risk. The authors conducted analysis in which BAC levels were first set at 0–0.23+g/dl and then collapsed the extreme BAC values into a single open-ended interval of 0–.08+g/dl. The purpose of collapsing the extreme values into a single open-ended interval (.08g/dl and above) was to re-evaluate the significance and magnitude of the age x BAC interaction using

data that are less subject to the small Ns and empty cells at a BAC beyond .08g/dl.

Relative risk and BAC levels

Age and BAC levels

In the UK, Maycock (1997) reports the 1990–94 BAC distribution for the age groups 17–24, 25–34 and 35 and over. The proportion of fatalities with BAC less than half the legal limit (less than 40 mg/100 ml) for these age groups for this period are respectively 75.2%, 66% and 83.4%. So, in relation to fatalities, the age grouping in which the highest proportion of drivers have been killed, with a BAC over half the legal limit is the age group 25–34 When comparing these figures for the period 1980–84, the proportion of fatalities with BAC less than half the legal limit (less than 40 mg/100 ml) were 53.3%, 43.4% and 67.7% for the three age groups quoted above. These figures are considerably lower than for the 1990–94 period. Overall the analysis indicates that the numbers of drivers exceeding four times the legal limit have been drastically reduced, but that the shape of the distribution below this level has changed little.

Allsop (1966) in the USA re-analysed and confirmed the Borkenstein et al. (1964) finding that the increase in accident risk resulting from high alcohol levels is greater for young and older drivers than for middle-aged drivers.

In the USA, Peck et al. (2008) investigated the two variables of age and BAC as risk factors in traffic accident causation. Relative risk is presented as the simple odds of crash involvement of each positive BAC group (number with crashes/number in control) compared to odds of crash involvement of zero-level BAC group. The relative risk is calculated as the ratio of the two odds (crash odds of each positive BAC group/crash odds of zero-level BAC group).

According to Peck et al. (2008) almost 50% of drivers under 21 were involved in a crash. From their analysis, they report on the strong relationship between BAC and crash risk in the under—21 age group as the only group showing relative risks above 1.0 at all BAC levels above zero. At very elevated BAC,

the authors report that drivers under 21 years with a BAC of .23+ are predicted to have an almost 3500–fold increase in crash risk whereas the other three age groups (21-25, 26-54 and 55+) exhibit relative risks ranging from 36 to 45. Within-age relative risk curves for values ranging from 0–0.23+ were computed for narrow BAC bands (10 mg/100 ml) and results indicate that the relative risks for drivers under 21 were more elevated at all levels of BAC, even as low as .01. The other three age groups included in the model exhibited small non-significant risk reductions until level of BAC reached .05, at which point all show a directional increase in crash risk compared to zero BAC drivers. The authors note however that while other studies (Zador et al. 2000) have reported relative-risk increases of similar magnitude for young drivers there may be some instability in the interaction parameter of the model at high levels of BAC due to sparseness of data as the sample size for cells becomes very small, particularly for control subjects.

Reporting on the model in which all levels of BAC above .08 were capped at .08+, Peck et al. (2008) report that crash risk is elevated at all positive BAC and rises more steeply for under 21 age groups compared to older drivers. At BACs of .08 and above, the relative risks approach 40.0 for drivers under 21.

Accident-involved drivers and BAC levels

In the UK, Maycock (1997) explored the distribution of alcohol in drivers using a number of data sources to estimate relative risk. In order to test the assumption that the distribution of BrAC obtained in the roadside surveys for drivers who are drinking and driving is reasonably representative of a full 24 hour distribution, coroner's data is used as the only readily available data that provides alcohol distributions for different times of day.

The estimates obtained by Maycock (1997) demonstrate that relative risk increases exponentially with the level of alcohol in the blood and that the average risk of being involved in an accident at alcohol levels of half the legal limit, the legal limit and twice the legal limit are respectively 2.4, 5.6 and 31 times the risk encountered by a driver who has not been drinking.

In the USA, Allsop (1966) carried out some re-analysis of the Grand Rapids, Michigan study and confirmed that the Grand Rapids study positively showed that the risk of being involved in an accident at BAC levels above 80 mg/100 ml is higher than at alcohol levels below 10 mg/100 ml and the risk increases rapidly as the highest levels are reached. Allsop (1966) concluded however that there are insufficient data to show positively whether the accident risk at alcohol levels of between 10 and 50 mg/100 ml differs from that at alcohol levels below 10 mg/100 ml.

Fatal accidents and BAC levels

In the UK, Maycock (1997) estimated the relative risk of being involved in a fatal accident as a function of BAC in a similar way to that described above for accident-involved drivers. In this case, the roadside survey distribution (up to the 81–95 ug/100 ml BrAC category) has been compared with the corresponding ranges of BAC for coroners data extracted for periods corresponding to those used in the roadside survey. A comparison of the BrAC distribution observed in the UK roadside surveys with a BAC distribution in driver fatalities over the same period shows that the relative risk of being involved in a fatal accident increases exponentially with the level of alcohol in the body, but at a rate which is more rapid than is the case for injury accidents (Maycock 1997).

Using case–control data, Keall et al. (2004) in New Zealand employed two methods to estimate driver risk of fatal injury, a logistic regression model and crude risk ratio. A number of explanatory variables and their interactions were available to be used in the model and included: BAC, driver gender, driver age (15–19, 20–24, 25–19 and 30+), 'time of night' (before or after midnight), and 'number of passengers' (0, 1 and 2+). As their corresponding estimated coefficients were nearly identical, the age groups 25–29 and 20–24 were combined, which had negligible effect on the fit of the other parameters. Only statistically significant terms were retained in the model, which were identified as age, BAC and 'number of passengers'.

Keall et al. (2004) reported that the driver risk of fatal injury for all three age groups analysed (15–19, 20–29 and 30+), indicate that risk increases exponentially up to about 200 mg/dl and then less exponentially thereafter. For teenage drivers and drivers in their 20s the risks are higher than for drivers aged 30+. According to the estimates produced by the final model, teenagers have over five times the risk of drivers aged 30+ at all BAC levels modelled (less than 200 mg/dl) and drivers in their 20s have three times the risk of drivers aged 30+.

Fatal single-vehicle crashes and BAC levels

In the USA, Zador et al. (2000) sought to re-examine and refine estimates for alcohol-related relative risk of driver involvement in fatal crashes by age (16–20, 21–34, 35+) and gender as a function of BAC using six driver groups. The authors report that the relative risk of receiving a fatal injury in a single-vehicle crash increases steadily with increasing BAC for both men and women in every age group with one exception. Among all male and female drivers, except those in the 16–20 age group, the relative risk of receiving a fatal injury is lower for drivers with a positive BAC under 0.02% than for drivers with 0.0%. When comparing the 16–20 age group however, the comparable relative risk was substantially increased even at this low positive BAC, by 55% among men and 35% among women. For driver fatalities in single-vehicle crashes with a BAC in the range of 0.08% and 0.10% (mid-point 0.9%) relative-risk estimates ranged from a low of 11.4 for drivers aged 35 and over, to a high of 51.9 for male drivers under 21 years.

The patterns of results for involvement in fatal crashes and for fatalities in single-vehicle crashes were somewhat different, especially for women (Zador 2008). First, although relative risk still decreased with increasing age among both men and women, the comparable decreases by age were less pronounced for driver involvement in all crashes than for fatalities in single-vehicle crashes. For women in the age groups 21–34 and 35 and over, the relative risk of being involved in a fatal crash exceeded the relative risk of a fatal injury in a single-vehicle crash.

In general, controlling for age, relative risk increased faster for men than women, and controlling for gender, it increased faster for drivers aged 16-20 and slowest for drivers 35 and over. In addition, in every comparison, relative risk increased faster with increasing BAC for fatally injured drivers than for driver involvement in fatal crashes.

Method for estimating relative risk for crash-involved drivers with missing BAC

Keall and Frith (2005) present a method for estimating the risk of driver involvement in injury crashes for case-control data where control drivers have reliable measures of BAC and other driver characteristics but crash-involved drivers do not have BAC measures. The method of deriving relative risks from the data is based on the simple assumption that the expected number of crashes (crash-involved drivers) is proportional to the number of controls (drivers stopped at the roadside) multiplied by risk. Using New Zealand data, the estimates of relative risk of night-time driver by age group and BAC involvement in injury crashes were statistically significant as the approximate 95%confidence interval (CI) do not include the value one. The authors applied the estimation method to data from the Grand Rapids study, which resulted in a risk curve with identical slope to that calculated using the New Zealand data. The authors conclude that there appears to be a reasonable correspondence between the risks estimated by Hurst et al. (1994) in their re-analyses of the Grand Rapids data and based on the complete data and the risk curve estimated using the method proposed which ignored the BAC information for cases. They caution however that the 15 driver groups used from tables of the report by Borkenstein et al. (1964) study are almost certainly too few to allow a reasonably accurate estimate of the slope of the risk curve. The estimated risk curve varied considerably when certain groups were excluded from the analysis indicating an unacceptably high variance for the proposed estimator with so few groups. The authors concluded that the method described has the potential to generate risk estimates associated with alcohol (and other factors) where cases have missing data although the estimates must be regarded as provisional until further research is carried out on the estimation method.

Relative risk and time of day

Keall et al. (2004) reported that there is only suggestive evidence that travelling in the 2 hours after midnight may incur more of a risk than the 2 hours before.

Relative risk and gender

Keall et al. (2004) reported that a model for gender provided only suggestive evidence of higher fatal injury risks for males per driving trip. Zador et al. (2008) reported surprise that for the 16–20 age group women had lower relative risk than men at every BAC. For a BAC of 0.02% and over this lower relative risk was roughly comparable to relative risk among adult drivers aged 21 to 34. Peck et al. (2008) reported that relative-risk differences by gender are unremarkable – male and female have almost identical gender-specific relative-risk curves.

Relative risk and presence of passengers

The risk associated with number of passengers as presented by Keall et al. (2004) is contrary to other research which shows that the presence of passengers overall has a beneficial influence on the safety of drivers aged 30 and over. The estimates provided by Keall et al. (2004) show an increase risk for drivers (both when they are sober and with a positive BAC) when carrying two or more passengers compared to carrying a single passenger. The effect is multiplicative having a net larger impact on younger drivers and drivers who have consumed any alcohol; driving solo is associated with an almost double risk relative to carrying a single passenger. This difference may be due to the different relationships between drivers and passengers on Friday and Saturday nights. Teenage drink-drivers who are carrying two or more passengers have the highest risk as identified by the model.

Relative risk and driving at night

Reporting on the overall effect of alcohol use on male drivers' risk by road type for weekend nights during the summer holiday season, Keall et al. (2005) reported that in terms of the change in risk by road type, high volume roads (divided state highways and motorways) were the least affected by the

elimination of drink-driving. However, for males driving on lower volume roads, eliminating all drink-driving would approximately halve the overall risk (and hence all the number of crash involvements, if driving patterns remained the same) of the youngest drivers but would have virtually no overall effect on the oldest drivers, as there are few older drink-drivers on the road at these times. The data however cannot tell us how much of this change in risk is due to a few drivers driving with high BAC levels, or many drivers driving with low levels; what is represented is an average change for the driver group and driving situation. The risk of a crash at night relative to risk during the day (excluding risk associated with drinking and driving) was shown to decrease with age. Excluding any effects of alcohol, young people aged 15–19 on a major urban road during the weekend have a 75% increased crash risk at night relative to the same situation during the day. Roads lighted at night were associated with a 20% estimated reduction in risk at night compared to daytime, compared to roads not lighted at night.

UK relative-risk results

- The relative risk of drivers in the 20–24 age group being involved in a drink-drive accident is just under three drink-driver accidents per 1000 injury accidents and the corresponding figure for the 60–70 age group is 0.8 (a ratio of slightly under 4).
- The proportion of fatalities with BAC less than half the legal limit (less than 40 mg/100 ml) for the age groups 17–24, 25–34 and 35+ for the period 1990–94 are respectively 75.2%, 66.0% and 83.4%. When compared to the 1980–84 period the figures are 53.3%, 43.4% and 67.7% . Overall, analysis indicates that the numbers of drivers exceeding four times the legal limit have been drastically reduced, but that the shape of the distribution below this level has changed little.
- Relative risk increases exponentially with the level of alcohol in the blood and the average risk of being involved in an accident at alcohol levels of half the legal limit, the legal limit and twice the legal limit are respectively 2.4, 5.6 and 31 times the risk encountered by a driver who has not been drinking.
- The relative risk of being involved in a fatal accident increases exponentially with the level of alcohol in the body, but at a rate which is more rapid than is the case for injury accidents (Maycock 1997).

USA and Australian relative-risk results

- Peck et al. (2008) reported on the strong relationship between BAC and crash risk in the under-21 age group as the only group showing relative risks above 1.0 at all BAC levels above zero.
- At very elevated levels of BAC, the authors reported that drivers under 21 years with a BAC of .23+ are predicted to have an almost 3500-fold increase in crash risk whereas the other three age groups exhibit relative risks ranging from 36 to 45 (Peck et al. [2008]).
- Allsop (1966) confirmed that the Grand Rapids study positively showed that the risk of being involved in an accident at BAC levels above 80 mg/100 ml is higher than at alcohol levels below 10 mg/100 ml and the risk increases rapidly as the highest levels are reached.
- Borkenstein (1963) reported that drivers at blood alcohol levels 10–49 mg/100 ml drive better at this alcohol level than they do on the average in the complete absence of alcohol, and also better than drivers who drink only enough to attain the 0.01–0.049% alcohol level. But this estimate is questioned by Allsop (1966).
- Re-analysis by Allsop (1966) reported insufficient data from the Grand Rapids study to show positively whether the accident risk at alcohol levels of between 10 and 50 mg/100 ml differs from that at alcohol levels below 10 mg/100 ml.
- Keall et al. (2004) reported that the driver risk of fatal injury for all three age groups analysed indicate that risk increases exponentially up to about 200 mg/dl and then less exponentially thereafter.
- Teenagers have over five times the risk of drivers aged 30+ at all BAC levels modelled (less than 200 mg/dl) and drivers in their 20s have three times the risk of drivers aged 30+ (Keall et al. 2004).
- Among all male and female drivers, except those in the 16–20 age group, the relative risk of receiving a fatal injury is lower for drivers with a positive BAC under 0.02% than for drivers with 0.0%.
- When comparing the 16–20 age group the comparable relative risk was substantially increased even at this low positive BAC, by 55% among men and 35% among women.
- For driver fatalities in single-vehicle crashes with a BAC in the range of 0.08% and 0.10% (mid-point 0.9%) relative-risk estimates ranged from a low of 11.4 for drivers aged 35 and over, to a high of 51.9 for male drivers under 21 years.
- There is only suggestive evidence that travelling in the 2 hours after midnight may incur more of a risk than the 2 hours before.
- The relative risks for gender provide only suggestive evidence for

higher fatal injury for males per driving trip.

- The risk associated with passengers carried presented by Keall et al. (2004) is contrary to other research. In the present study the estimates provided show an increase risk for such drivers (both when they are sober and with positive BAC) carrying two or more passengers compared to carrying a single passenger.
- New Zealand data reveal that excluding any effects of alcohol, young people aged 15–19 on a major urban road during the weekend have a 75% increased crash risk at night relative to the same situation during the day.

References

Allsop R (1966) Alcohol and road accidents. Report 6. Road Research Laboratory. England: Ministry of Transport.

Brooks C, Zaal D (1993) Effects of a reduced alcohol limit for driving. Australia: Federal Office of Road Safety

Hingson R, Winter M (2003) Epidemiology and consequences of drinking and driving. Alcohol Research & Health27 (1): 63–78

Hingson R, Winter M (2003) Epidemiology and consequences of drinking and driving. Alcohol Research & Health 27 (1): 63-78

Keall MD, Frith WJ (2005) A method for estimating crash risk associated with driver BAC. Transportation Research Part e Logistics and Transportation Review 41 (5): 409–20

Keall MD, Frith WJ, Patterson TL (2005) The contribution of alcohol to night time crash risk and other risks of night driving. Accident Analysis & Prevention 37 (5): 816–24

Keall MD, Frith WJ, Patterson TL (2004) The influence of alcohol, age and number of passengers on the night- time risk of driver fatal injury in New Zealand. Accident Analysis and Prevention 36 (1): 49–61

Kloeden C, McLean A (1997) Night time drink driving in Adelaide. 1987–1997. Australia: University of Adelaide

Maycock G (1997) Drinking and driving in GB: a review. Report 232. Crowthorne: Transport Research Laboratory

Moskowitz H, Florentino D (2000) A review of the literature on the effects of low doses of alcohol on driving-related skills. Washington: US Department of Transportation

Moskowitz H, Burns M, Fiorentino D et al. (2000) Driver characteristics and impairment at various BACS. Washington: US Department of Transportation

National Highway Traffic Safety Administration. (2000) Relative risk of fatal crash involvement by BAC, age and gender. Washington: US Department of Transportation

Peck RC, Gebers MA, Voas RB et al. (2008) The relationship between blood alcohol concentration (BAC), age, and crash risk. Journal of Safety Research 39 (3): 311–19

Zador PL, Krawchuk SA, Voas RB (2000) Alcohol-related relative risk of driver fatalities and driver involvement in fatal crashes in relation to driver age and gender: an update using 1996 data. Journal of Studies on Alcohol 61 (3): 387–95

Zador PL, Krawchuk SA, Voas RB (2000) Relative risk of fatal crash involvement by BAC, age and gender. Journal of Studies on Alcohol 61,387-395

4 Review of effectiveness of BAC laws and related measures

This section reports the findings of the review of existing systematic reviews.

A total of 11 systematic reviews were identified that examined the effectiveness of laws limiting blood alcohol concentration (BAC), and other preventative measures on reducing road traffic injuries and deaths. The table below summarises the quality assessment and findings of the 11 systematic reviews.

One study by Shults et al. (2001) undertook a series of systematic reviews of evidence regarding interventions to reduce alcohol-impaired driving. These were conducted as the basis for the recommendations of the USA Task Force on Community Prevention Services. The reviews were undertaken in line with the systematic review methods used by the Task Force (Guide to community preventive services (community guide)' described elsewhere in detail (Briss et al. 2000; Zara et al. 2001).

There were four interventions relevant to this review and these included: use of 0.08 BAC laws, lower BAC laws for young or inexperienced drivers, minimum legal drinking age laws and sobriety checkpoints. The findings are presented separately. The Schults et al. (2001) paper was the only systematic review of the effect of 0.08 BAC laws.

Three of the reviews reported on the effectiveness of sobriety checkpoints and/or random breath testing (Goss et al. 2008; Peek-Asa 1999; Shults et al. 2001). Five of the reviews examined the effectiveness of drink-driving laws aimed at young people (Hartling et al. 2004; Shults et al 2001; Wagenaar and Toomey 2002; Zwerling and Jones 1999). One review (Dinh-Zarr et al. 2004) examined the effectiveness of interventions for preventing injuries in problem drinkers (including drink-driving). The remaining three examined a broad range of drink-driving interventions including: the effectiveness of designated

drivers (Ditter et al. 2005); mass-media campaigns (Elder 2004); and alcohol ignition interlock programmes (Willis-Lybrand and Bellamy 2004).

4.1 Quality assessment of systematic review evidence

Overall the quality of the reviews identified was good. All 11 reviews addressed an appropriate and focused question, and adequate descriptions of the methodology of each review was reported.

(It is important to note that although the quality of the 11 systematic reviews was assessed as high, the quality of the primary evaluation studies included in many of the reviews was variable.)

The reviews assessed primary evaluation studies that in the main employed non experimental or observational study designs, such as an ecological design in which the intervention of interest (for example, minimum legal drinking age laws) is applied across an entire population (Hingson 2001). These types of studies have inherent methodological weaknesses. They are especially vulnerable to the influence of a range of confounding factors and therefore there are difficulties in attributing the specific effect to the intervention.

There are also difficulties in measuring the best outcome variable such as blood alcohol concentration (BAC) data and therefore many of the studies included in the reviews used proxy measures such as the number of crashes during high-risk time periods. The use of proxy measures are a potential source of bias.

Dinh-Zarr et al. (2004) and Willis et al. (2004) identified randomised controlled trials (RCTs) for inclusion in their reviews but do not undertake any pooled analysis as for the most part this would have involved combining markedly heterogeneous groups of participants, interventions and outcomes which can produce inappropriate and misleading conclusions.

Reviews of interventions aimed at reducing road traffic alcohol-related deaths and injuries				
Authors	**Interventions**	**Type of review**	**Quality**	**Findings/comment**
	0.08 BAC laws	Systematic review (SR)		
Shults et al. (2001)	0.08 BAC laws	SR	++	Post-law reduction in % change in alcohol-related fatalities: 7% decrease (inter quartile range –15% to 4%) Difficult to separate the effect of .08 BAC laws from that of administrative licence revocation laws
Sobriety breath testing				
Peek-Asa (1999)	Random alcohol screening on reducing motor vehicle crash injuries	SR	++	All studies showed decrease in fatalities & injuries. Alcohol-related fatalities showed greatest decreases (8–71%)
Shults et al. (2001)	Random breath testing (RBT) checkpoints Selective breath testing (USA) checkpoints	SR	++	Consistent decrease crash outcomes for SBT checkpoints (20–24% decrease) & RBT checkpoints (16–22% decrease) SBT and RBT checkpoints are effective in preventing alcohol-impaired driving, alcohol-related crashes and associated fatal and non-fatal injuries
Goss et al. (2008)	Increased police patrols for preventing alcohol-impaired driving	SR	++	Most studies found that increased police patrols reduced traffic crashes and fatalities
Young drivers				
Shults et al. (2001)	Lower BAC laws (0.02) for young or inexperienced drivers	SR	++	All studies reported post law reduction in crashes. Fatal crashes (three studies): 24%, 17%, 9% Lower BAC laws are effective in

				reducing alcohol-related crashes among young or inexperienced drivers
Zwerling and Jones (1999)	Low blood alcohol concentration laws for younger drivers	SR	++	All six studies included in the review showed a reduction in the chosen outcome measure following implementation of the BAC law (although reductions were not statistically significant for three studies). The reductions in outcome ranged from 4% to 33% with a cluster of parameter estimates just under 20%. One study evaluated laws with differing levels of BAC and found a dose-response effect: In states with zero BAC there was a 22% reduction in single vehicle fatalities. In states with 0.02% BAC the reduction averaged 17% In states with 0.04% to 0.06% BAC laws the reduction was only 7%
Wagenaar and Toomey (2002)	Minimum drinking age laws	SR	++	The authors located 57 published studies that assessed the effects of changes in the legal minimum drinking age on indicators of driving after drinking and traffic crashes. In the 57 studies a total of 102 outcome measures were analysed and over half (51%) showed a statistically significant inverse relationship between legal drinking age and crashes. That is, as the legal age was lowered, the number of crashes increased, and as the legal age was raised, the number of crashes decreased. Of all the analyses that reported significant effects, 98% found higher drinking ages associated with

				lower rates of traffic crashes
Shults et al. (2001)	Minimum legal drinking age (MLDA) laws	SR	++	33 studies qualified for review. USA, Canada, Australian-based. Assessed effect of changes in the MLDA from 18 to 21 years or vice versa. Changes in the MLDA results in changes of roughly 10% to 16% in alcohol-related crash outcomes for the targeted age groups, decreasing when the MLDA is raised and increasing when it is lowered. The authors state generalisability to other countries may be limited in patterns of alcohol consumption and driving among young people aged 18 to 20
Hartling et al. (2004)	Graduated driver licensing (GDL) for reducing motor vehicle crashes among young drivers	SR	++	Overall, the evidence indicates that GDL is effective in reducing crash rates of teenage drivers although the magnitude of the reduction is unclear. For young people aged 16 the median decrease in overall crash rates per population in the first year was 31% (range 26–41%). Data on alcohol-related crashes are presented for four jurisdictions with zero tolerance for BAC. For young people aged 16, two studies report per population reductions of 16% and 38% for the first year post-GDL
Related preventive measures				
Ditter et al. (2005)	Designated driver programmes for reducing alcohol-impaired driving	SR	++	In this review types of designated driver programmes were evaluated: • Population-based campaigns to promote the concept and use of designated drivers. • Incentive programmes based in drinking establishments to encourage people to act as

				designated drivers. Only one population-based study was identified and survey results indicate a 13% increase in respondents 'always' selecting a designated driver but no significant change in alcohol-impaired driving or riding with an alcohol-impaired driver. Eight incentive programmes were identified and seven of these evaluated the number of patrons who identified themselves as designated drivers before and after programmes were implemented, with a mean increase of 0.9 designated drivers per night. Authors conclude that there is insufficient evidence to determine the effectiveness of designated driver programmes for reducing alcohol-impaired driving and alcohol-related crashes
Dinh-Zarr et al. (2004)	Interventions for preventing injuries in problem drinkers	SR	++	Completed trials comparing interventions for problem drinking to no intervention reported reductions in injury-related outcomes (reductions ranged from 27% to 65%) although the authors point out that as few of the trials were sufficiently large to assess effects on injuries, the individual effect estimates were generally imprecise. Data on the effect of interventions on motor vehicle crashes and on injuries following motor vehicle crashes does not establish that reductions in unintentional injuries are due to decreases in driving while impaired by alcohol
Elder et al. (2004)	Mass-media campaigns for reducing drinking and	SR	++	A total of eight studies met the quality criteria for inclusion in this review. The studies were classified according to whether

	driving and alcohol-related crashes			their themes focused primarily on the legal or the social and health consequences of drinking and driving. The median decrease in crashes across all studies and all levels of crash severity that estimated the effects of the campaigns was 13% (the inter-quartile range: 6% to 14%). Two studies that used roadside BAC test results as outcome measures showed substantial decreases in the proportion of drivers with BAC levels of 0.05g/dl and 0.08 g/dl.
Willis-Lybrand and Bellamy (2004)	Alcohol ignition interlock programmes for reducing drink-driving recidivism	SR	++	The authors report that recidivism was lower in the RCT intervention group while the device was still installed in the vehicle (rr 0.36 [95% CI 0.21 to 0.63]) but that the benefit disappeared once the device was removed (rr 1.33 [95% CI 0.72 to 2.46]). In addition, the authors examined the results when the interlock and post-interlock periods are combined and conclude that the effectiveness of the interlock period is severely reduced as a result. Controlled trials support this conclusion, with a general trend – in both first time and repeat offenders – towards lower recidivism rates when the interlock device is installed. Neither the RCT nor the controlled trials provide evidence for any effectiveness of the programmes continuing once the device has been removed.

4.2 Systematic review of 0.08 BAC law

The Shults et al. (2001) review identified nine studies that met the inclusion criteria; all were US-based.

Quality assessment criteria

In the Shults et al. (2001) review, four of the studies were time series, and five were before-and-after studies with concurrent comparison groups. The outcome measures were: fatal injury crashes, and fatal and non-fatal injury crashes. Particular methodological weaknesses included small sample sizes and failure to take account of related policy measures.

Findings

The median post-law percentage change in alcohol-related motor vehicle fatalities was -7% (inter-quartile range -15% to -4%). Results were generally consistent in direction and size across the studies.

Five of the nine studies measured fatalities involving drivers with BACs of 0.10 g/dl or higher and reported post-law reductions for most studies. The review authors point out that these findings indicate that the behaviour of 'hard core' drink-drivers as well as 'social drinkers' were effected by the lowering of the BAC limit.

The review states in conclusion that 'according to the Community guide's rules of evidence, available studies provide strong evidence that 0.08g/dl BAC laws are effective in reducing alcohol-related crash fatalities'.

4.3 Systematic reviews of sobriety checkpoints and policing

Three reviews were identified that examined the effectiveness of random breath testing and increased police patrols that targeted alcohol-impaired driving (Goss et al. 2008; Peek-Asa 1999; Shults el al. 2001). The review by Peek-Asa (1999) covered two types of random alcohol screening. The two schemes involved vehicles being stopped regardless of suspicion of alcohol use, but schemes varied with respect to breath testing. In the first instance,

cars were stopped and administered random breath tests at checkpoints by roving units, regardless of suspicion of alcohol use. In the second instance, sobriety checkpoints were in operation and cars were stopped randomly; but a breath alcohol test was administered only if the use of alcohol was suspected.

Similarly Shults et al. (2001) reviewed two types of sobriety checkpoints: random breath testing checkpoints where all drivers stopped are given breath tests for BAC (European and Australian approach); and selective breath testing checkpoints where police must have reason to suspect the driver stopped at a checkpoint has been drinking before a breath test can be demanded (US model) (the Peek-Asa definition of sobriety checkpoint).

Goss et al. (2008) aimed to assess the effects on injuries and crashes of increased police patrols that target alcohol-impaired driving.

Quality assessment criteria

Studies were included in the Peek-Asa (1999) review if they used an objectively measured outcome and had a control group and/or comparison period, and also included enough raw data for drawing conclusions. Studies had to include at least one of the following measurable outcomes: motor vehicle crashes, injuries, or fatalities; alcohol-related motor vehicle crashes, injuries or fatalities such as night-time or single vehicle events. Fourteen studies met the inclusion criteria (7 US based, 7 Australian). No randomised controlled studies were available. Studies were grouped and compared based on the type of outcome measures used. Confidence intervals were calculated where possible.

In the Shults et al. (2001) review 23 studies met the qualifying criteria: 11 of the studies examined selective breath testing (all US based) while the remaining 12 examined random breath testing (11 Australian, 1 based in France). Almost all were based on time series analyses with or without concurrent comparison groups. Outcome measurement included: fatal injury crashes, fatal and non-fatal crashes, other crashes, total crashes, drivers with BAC greater than 0.08g/dl.

Goss et al. (2008) included randomised controlled trials (RCTs), controlled trials (CTs), controlled before-and-after (CBA), interrupted time series (ITS) and controlled interrupted time series (CITS) studies identified before 2006. Alcohol-related traffic crashes and injuries and fatalities were the primary outcomes. A total of 32 studies met the inclusion criteria and of these, 91% were conducted in the USA. Australia, Ireland and New Zealand were also study sites. Following assessment, 21 of the studies were rated as not adequate on at least one of the quality assessment criteria.

Findings

Peek-Asa (1999) reported that all studies with one exception showed that the implementation of random screening was followed by a period of reduced fatalities, injuries, and/or alcohol-related fatalities and injuries. Decreases were larger among studies measuring alcohol-related outcomes than those measuring total outcomes. The greatest decreases were for random screening programmes implemented in a ‘blitz’ approach for less than 1 year in a small area.

Shults et al. (2001) reported that both selective breath testing and random breath testing checkpoints consistently resulted in decreased crashes. For selective breath testing, fatal injury crashes decreased 26% and 20%, for the two studies using this outcome. For random breath testing the median change for fatal injury crashes (six studies) was a 22% decrease. The authors state that although the random breath testing checkpoints have greater sensitivity in detecting drink-drivers than selective breath testing checkpoints the review found no evidence that their effectiveness for reducing alcohol-related crashes differed. They also state that improvements in technology (passive alcohol sensors) are likely to increase the sensitivity in detecting drink-drivers at selective breath testing checkpoints.

Goss et al. (2008) concluded that studies evaluating increased police patrol programmes were generally consistent in reporting reductions in traffic crashes and fatalities. However, given the methodological limitations, the

evidence could not firmly establish that police patrols reduced traffic crashes, fatalities and injuries.

4.4 Legislative measures targeting young drivers

‘Zero tolerance’ and low BAC laws for young drivers

Two reviews were identified which examined the effectiveness of low BAC laws aimed at young people. Shults et al. (2001) reviewed the effect of lower BAC laws for young or inexperienced drivers. Zwerling and Jones (1999) sought to identify studies which aimed to determine whether low BAC laws among younger drivers reduced motor vehicle accidents. The studies included in these reviews were conducted in the US and states in Australia. In the US, lower BAC laws were typically applied to all drivers younger than the minimum legal drinking age of 21 years. By 1998 all 50 states had enacted lower BAC laws. The zero tolerance BAC law was applied to all first time drivers (first year) in the Australian studies and young drivers under 18 years.

Quality assessment criteria

In the Shults et al. (2001) review, six studies met the qualifying criteria regarding study design and outcomes reported. Study designs included; time series with or without concurrent comparison group, or before-and-after with concurrent comparison group. Outcomes reported were fatal injury crashes, fatal and non-fatal injury crashes or ‘had been drinking’ crashes. Four of these studies were US-based and two were conducted in Australia.

Zwerling and Jones (1999) identified six studies (USA and Australia) which aimed to determine whether low BAC laws among younger drivers reduced motor vehicle accidents. To be included in the review, studies had to include data on one of the selected objectively measured outcomes and include a control or comparison group. In addition, studies had to meet methodological quality criteria devised by the authors for each type of study design. The types of outcomes examined were limited to changes in rates of all motor vehicle crashes, crashes involving injury, and fatal crashes. As all six studies were of an ecological design (two interrupted time series and four pre/post studies) a

pooled analysis of the data was not performed. Instead, the authors sought to measure the magnitude of effect by comparing all the pre/post studies by reanalysing the data to compare a target population (of an age likely to be impacted by the law) with a control population (of an age unlikely to be impacted by the law) and present the number of events (injuries or fatalities) that occurred in defined periods before and after the law was implemented.

Findings

Shults et al (2001) reported that all of the six studies reported post-law reductions in crashes. Three studies reported reductions in fatal crashes of 24%, 17% and 9% respectively. Two studies reported declines of 17% and 3.8% in fatal and non-fatal injury crashes. The review authors point out that it was possible for drivers younger than 21 years with a high BAC to receive zero tolerance citations for violating the lower BAC law, while adults with the same BAC would be arrested for the more serious offense of driving under the influence of alcohol. The review concluded that there was sufficient evidence that lower BAC laws were effective in reducing alcohol-related crashes among young or inexperienced drivers.

Likewise Zwerling and Jones (1999) reported that all six studies in their review showed a reduction in the outcome measure after the implementation of the BAC law, although for three of them the reductions were not statistically significant. The reduction in outcomes ranged from 4% to 33% with a cluster of parameter estimates just under 20%. The authors caution however that as the methods for analysing the data varied among the six studies they cannot be compared precisely. When comparing the results of all the pre/post studies for the magnitude of effect the authors reported that all six studies demonstrated a reduction in injuries following implementation of the law and for three of the studies, the 95% confidence interval excluded zero (the null hypothesis). One study evaluated differing levels of BAC and found a dose-response effect with the greatest reduction, 22%, in night-time, single vehicle fatalities in those states with zero BAC laws.

The authors concluded that despite the difficulties of possible historical bias inherent in ecological studies (the outcome results not from the intervention but from other factors) and from difficulties in measuring the best outcome variable (most studies used surrogates for alcohol-related crashes) the studies were strengthened by the inclusion of appropriate controls which helped control for some of the biases discussed above.

4.5 Minimum legal age for drinking

Two reviews examined the effect of changes in the minimum legal drinking age laws with respect to road traffic injuries and deaths (Shults et al. 2001; Wagenaar and Toomey 2002). Wagenaar and Toomey (2002) examined the effects of changes in the minimum legal drinking age laws on youth over the past 4 decades and their impact on the purchase and/or consumption of alcoholic beverages. Shults et al. (2001) assessed the effect of changes in the minimum legal drinking age from 18 to 21 years or vice versa.

Quality assessment criteria

Studies identified by Wagenaar and Toomey (2002) were all of an ecological design and were assessed for methodological quality using a number of key indicators such as longitudinal design, comparison groups and probability sampling. Outcomes of interest included: self-reported drinking, sales figures, fatal crashes, drink-driving crashes and self-reported driving after drinking. The authors located 57 published studies (US) that assessed the effects of changes in the minimum legal drinking age on indicators of driving after drinking and traffic crashes. The authors coded whether the findings were statistically significant and if the results were significant, coded the direction of the relationship between legal age for drinking and a specific outcome measure.

In the review by Shults et al. (2001) 33 studies qualified for inclusion. 27 were conducted in the USA, one in the USA and Canada and four in Australia. Eighteen studies were time series analyses; and 15 were before-and-after studies with a concurrent comparison group.

Findings

Reporting on the effects of drinking age on driving after drinking and traffic accidents, Wagenaar and Toomey (2002) reported that in the 57 studies identified, a total of 102 crash outcome measures were analysed (for example, fatal crashes, drink-driving crashes, self-reported drinking after driving) and 51% found a statistically significant inverse relationship between legal drinking age and crashes. That is, as the legal age was lowered, the number of crashes increased, and as the legal age was raised, the number of crashes decreased. The authors point out however, that the evidence is not entirely consistent as 35% of the analyses found no association between the legal age and indicators of traffic crashes. However, focusing on those studies of higher methodological quality (that is, those that include a longitudinal design, comparison groups and probability sampling) the authors reveal that 58% of these found a significant inverse relationship between legal age and traffic crashes: none found a significant positive relationship. The authors concluded that the magnitude of effects of the age 21 policy may appear small, particularly in studies using weak research designs and having low levels of statistical power but that when applied to an entire population of youth 'result in very large societal benefits'.

The review by Shults et al. (2001) showed that changes in the minimum legal drinking age produced changes of roughly 10% to 16% in alcohol-related crash outcomes for the targeted age groups, decreasing when the minimum legal drinking age is raised and increasing when it is lowered. The authors stated that applicability to other countries might be limited by differences in patterns of alcohol consumption and driving among young people aged 18 to 20. The review concluded that there is strong evidence that a minimum legal drinking age of 21 is effective in preventing alcohol-related crashes and associated injuries.

4.6 Graduated driver licensing schemes

Hartling et al. (2004) examined the effectiveness of graduated driver licensing systems in reducing crash rates of teenage drivers (16-19 years). The quality

of the studies was assessed based on threats to the validity of ecological studies as presented by Hingson (2001) which included: measurement error, control groups, statistical methods, confounders and regression to the mean. The authors also assessed the quality of the graduated driver licensing programme using the 'Classification of licensing systems' from the Insurance Institute for Highway Safety (2000). This identified a number of key elements: delayed full-privilege licensure, extended periods of supervised practice driving, and restrictions during the intermediate stage on night driving, BAC (not applicable in all jurisdictions) and extra passengers.

Quality assessment criteria

The authors identified 13 ecological studies (USA, Canada, New Zealand and Australia) evaluating 12 graduated driver licensing programmes that were implemented between 1979 and 1998 in the USA (7), Canada (3), New Zealand (1) and Australia (1) as relevant for inclusion in the review. Programmes varied in their restrictions during the intermediate stage: eg night curfews (8), limitations of extra passengers (2) and roadway restrictions (1). Based on the above classification scheme, no programme was good, six were acceptable, five were marginal and one was poor.

The primary outcome of interest was overall crash rates of teenage drivers (that is, crashes involving fatalities, injuries and property damage only). Results were not pooled due to substantial heterogeneity between studies. Percentage change was calculated for each year after the intervention, using 1 year prior to the intervention as the baseline rate. Results were presented for all teenage drivers combined and for teenagers aged 16 only.

Typically across the jurisdictions the minimum initial licence age was 16 years and 17 or 18 years for a full licence. New Zealand had a minimum initial licence age of 15 years and a full minimum licence age of 16 years. When comparing results for different denominators and age groups, only within jurisdiction (direct) comparisons were made because there were too many other confounders between studies.

Findings

The authors reported that reductions in crash rates were seen in all jurisdictions and for all crash types. Among young people aged16, the median decrease in per population overall crash rates during the first year of graduated driver licensing was 31% (range 26–41%). Per population injury crash rates were similar (median 28%, range 4–43%). The authors also presented data on alcohol-related crashes in four jurisdictions with zero tolerance for BAC. For young people aged 16, two studies reported per population reductions of 16% and 38% for the first year post-graduated driver licensing. One study noted a lack of substantial change in alcohol-related crashes over the 3 years studied and the author concluded that this was more than likely due to the zero tolerance law that was instituted prior to the study period. Two studies in jurisdictions which did not have a zero tolerance for BAC (BAC levels were set at of 0.02 and 0.03 g/dl) reported data on drivers with a restricted licence experiencing fewer crashes where alcohol involvement was suspected.

The authors point to the preponderance of research in this area as involving an ecological design and there is often limited or no information on how vigorously the laws are enforced at an individual level. The authors advised caution when comparing results across studies, because of the many factors that could influence crash rates and advocate the use of standard methods for evaluating graduated driver licensing. Despite these limitations, the authors conclude that overall the direction of the findings are consistent, indicating that graduated driver licensing is effective in reducing crash rates of teenage drivers, although the magnitude of the reduction is unclear. Also it was not possible from the evidence available to say which aspects of graduated driver licensing programmes had the biggest effect.

In the UK the minimum driving age for a car is 17 years. The potential effect of introducing similar graduated licensing schemes in the UK is unclear given the many differences in contextual factors, including differences in age limits for driving.

4.7 Other preventive measures

Interventions for preventing injuries in problem drinkers

Dinh-Zarr et al. (2004) undertook a systematic review of the effectiveness of randomised controlled trials to assess the effect of interventions for problem drinking on subsequent injury risk and their antecedents.

Quality assessment criteria

Dinh-Zarr et al. (2004) identified several different intervention approaches which were evaluated, the most common being brief counselling by health workers. The authors limited their critique of the quality of the included studies to an assessment of the quality of the allocation concealment process although they were able to determine this criterion accurately in only a small proportion of the trials reviewed. Outcomes of interest included: injuries and injury deaths, or their antecedents (for example, falls, motor vehicle crashes, suicide attempts). A total of 23 eligible studies were identified (USA and other developed countries) of which 22 have been completed and of these 17 have reported results from injury-related outcomes. The authors did not combine the results quantitatively because the interventions, patient populations and outcomes were so diverse.

Findings

The authors reported that in completed trials comparing interventions for problem drinking to no intervention there was a reduction in the outcomes of interest that ranged from 27% to 65%. However, as few trials were sufficiently large to assess effects on injuries, individual effect estimates were generally imprecise. Data were also available from four trials that assessed the effect of interventions on motor vehicle crashes and on injuries following motor vehicle crashes. The evidence from these four trials does not establish that reported reductions in unintentional injuries are due to decreases in driving while impaired by alcohol.

Dinh-Zarr et al. (2004) concluded that the evidence from the studies suggested that interventions aimed at problem drinkers is effective in reducing

injuries and events that lead to injuries although more research is needed to calculate the level of effectiveness accurately and to determine which type of programme works best. The authors also noted the issue of publication bias as an important threat to the validity of systematic reviews.

4.8 Effectiveness of designated drivers

Ditter et al. (2005) conducted a systematic review to assess the evidence of effectiveness of designated driver programmes for reducing alcohol-impaired driving and alcohol-related crashes in the US and other developed countries. The review was conducted according to the methods of the 'Guide to community preventive services (community guide)' described elsewhere in detail (Briss et al. 2000; Zara et al. 2001).

Quality assessment criteria

Nine studies (USA and Australia) that met the inclusion criteria were assessed for suitability of study design and study execution in terms of potential threats to validity; only those studies with ratings of good or fair were included in the review. Two approaches to promoting the use of designated drivers were separately evaluated for the review:

- population-based campaigns to promote the concept and use of designated drivers
- incentive programmes based in drinking establishments to encourage people to act as designated drivers.

The outcomes evaluated were:

- self-reports of frequency of designated driver selection
- observation of self-identified designated drivers in drinking establishments
- self-reports of alcohol-impaired driving and riding with an impaired driver.

Summary effect sizes were calculated for the study outcomes.

Findings

The authors identified one population-based designated driver promotion campaign. A telephone survey evaluating the effectiveness of this campaign indicated a 13% increase in respondents 'always' selecting a designated driver, but no significant change in self-reported alcohol-impaired driving or riding with an alcohol-impaired driver. The study found no positive or negative effects specific to population-based campaigns promoting designated driver use and the review authors concluded that this single available study provides insufficient evidence to determine the effectiveness of population-based campaigns promoting designated driver use.

Eight incentive programme interventions based in drinking establishments were identified. Seven of these evaluated the number of patrons who identified themselves as designated drivers before and after programmes were implemented, with a mean increase of 0.9 designated drivers per night (inter-quartile range: 0.3 to 3.2 designated drivers per night). The eighth study reported a 6% decrease (p less than 0.01) in self-reported driving or riding in a car with an intoxicated driver among respondents exposed to an incentive programme. The authors reported that in all of the studies there was a lack of consistent denominator data making it difficult to judge the magnitude of intervention effects or the extent to which the numbers reported in each study are comparable. In addition, the authors noted that each of the three outcomes evaluated in the studies reviewed had limitations for assessing the potential injury-prevention benefits of designated driver programmes.

The authors concluded that there is insufficient evidence to determine the effectiveness of incentive programmes to promote designated driver use and that more research and evaluation is required to determine their effectiveness.

4.9 Mass-media campaigns

The goal of the review by Elder et al. (2004) was to assess whether, and under what conditions, mass-media campaigns are helpful in preventing alcohol-impaired driving and alcohol-related crashes. The review was

conducted according to the methods of the ‘Guide to community preventive services (community guide)’ described elsewhere in detail (Zara et al. 2001).

Quality assessment criteria

To be included in the review, studies had to meet minimum quality criteria for study design and execution. Crashes and measured blood alcohol concentration (BAC) were chosen as outcome measures. Separate effect estimates were calculated for the chosen outcomes but as most of the studies reviewed used proxy variables for alcohol-related crashes (for example, single-vehicle night-time fatal crashes) the resulting effect estimates are biased towards the null. Nine papers were identified which included 11 studies or study interventions (study arms) which evaluated changes in number of crashes or in blood alcohol test results following the implementation of mass-media campaigns. Of these 11 studies or study arms, eight met the quality criteria for inclusion in the review (USA, New Zealand and Australia).

Studies were classified according to whether their themes focused primarily on the legal consequences or the social and health consequences of drinking and driving. Three of the evaluated campaigns focused on raising public awareness of enforcement activities and of the legal consequences of drinking and driving. In one of the studies, the authors raised concerns about the stability of the results given the short (5 month) period between implementation of the mass-media campaign and the instituting of driving under the influence legislation. In a second study, the authors point to the very small sample sizes obtained for the outcome measures examined.

The remaining five studies evaluated campaigns that highlighted various social and health consequences of alcohol-impaired driving. In one of the studies, the authors point to controversy over both the theoretical basis of the campaign and the appropriateness of its evaluation. Critiques of the evaluation focus on the issue of whether other factors that may have contributed to changes in alcohol-related crashes (sobriety checks and an economic downturn during the period of evaluation) were correctly accounted for in the analysis.

Findings

The authors report that the median decrease in crashes across all studies and all levels of crash severity was 13% (inter-quartile range: 6% to 14%). The median decrease in injury-producing crashes, the most common crash outcome, was 10% (inter-quartile range: 6% to 15%). Two studies that used roadside BAC test results as outcome measures showed substantial decreases in the proportion of drivers with BAC levels of 0.05g/dl and 0.08 g/dl. However the sample of outcomes was small and the resulting estimates unstable. There was no clear difference in the effectiveness of campaigns that used legal deterrence messages and those that used social and health consequences messages.

Overall the authors concluded that the studies reviewed indicated that under some conditions, well-executed mass-media campaigns can contribute to a reduction in alcohol-impaired driving and alcohol-related crashes although none of the studies provide unequivocal evidence for the effectiveness of mass-media campaigns and further research is needed to maximise the effectiveness and efficiency of future programmes. One further bias identified by the authors is the possibility that studies with positive findings are more likely to be published.

4.10 Alcohol ignition schemes

Willis et al. (2004) undertook to systematically assess the effectiveness of ignition interlock programmes on recidivism rates of drink-drivers, by examining rates of recidivism while the interlock device was installed in the vehicle and after removal of the device.

Quality assessment criteria

The authors identified studies conducted in the USA, Canada, Australia and Sweden including one randomised controlled trial (RCT), ten controlled trials and three ongoing trials. The studies were assessed for quality using a modified quality assessment tool that took account of: internal and external validity, selection bias, performance bias, attrition bias and length of follow-up.

The following outcome measures were included: rates of recidivism while the driver is involved in ignition interlock programme; rates of recidivism after the ignition interlock has been removed from the vehicle, and rates of recidivism during the entire study period. The primary analysis for the RCT was meta-analytic methods. The results from the non-RCTs have been considered in the discussion but have not formed a part of the meta-analysis due to differences in methodology and potential biases.

Findings

In the RCT included in this review the authors report that recidivism was lower in the intervention group while the device was still installed in the vehicle: relative risk 0.36 (95% CI 0.21 to 0.63). The benefit disappeared once the device was removed; relative risk 1.33 (95% CI 0.72 to 2.47). The results from the post-lock period severely effect the overall effectiveness of the interlock, when both the interlock and post-interlock periods are combined. In the 13 non-randomised controlled trials, interlock participants again had lower recidivism than the controls. In nine of the trials, the difference between the groups would be regarded as statistically significant (that is, the 95% CI does not include the value 1.0). As in the RCT study however, the positive results are not reflected in the time period after the interlock is removed.

Overall the authors concluded that the ignition interlock reduces recidivism while installed in the vehicle but that the majority of the evidence supports the conclusion that the interlock device has no long-term effects for reducing recidivism in the population of drivers that use them. The authors caution that these results are obtained from one RCT where the effectiveness of the interlock was not evaluated with the less motivated repeat drink-driver and they also raised concerns regarding the low participation rates in the non-randomised trials included in their review.

References

Dinh-Zarr TB, Goss CW, Heitman E et al. (2004) Interventions for preventing injuries in problem drinkers. Cochrane Database of Systematic Reviews (3)

Ditter SM, Elder RW, Shults RA et al. (2005) Effectiveness of designated driver programs for reducing alcohol-impaired driving: a systematic review. American Journal of Preventive Medicine 28 (5 supplement): 280–7

Elder RW, Shults RA, Sleet DA et al. (2004) Effectiveness of mass media campaigns for reducing drinking and driving and alcohol-involved crashes: a systematic review (brief record). American Journal of Preventive Medicine 27 (1): 57–65

Goss C, Van Bramer L, Gliner J et al. (2008) Increased police patrols for preventing alcohol-impaired driving. Cochrane Database of Systematic Reviews (4)

Hartling L, Wiebe N, Russell K et al. (2004) Graduated driver licensing for reducing motor vehicle crashes among young drivers. Cochrane Database of Systematic Reviews (2)

Peek-Asa C (1999) The effect of random alcohol screening in reducing motor vehicle crash injuries (structured abstract). American Journal of Preventive Medicine 16 (1 supplement): 57–67

Shults RA, Elder RW, Sleet DA et al. (2001) Reviews of evidence regarding interventions to reduce alcohol-impaired driving (Brief record). American Journal of Preventive Medicine 21 (4 supplement): 66–88

Wagenaar AC, Toomey TL (2002) Effects of minimum drinking age laws: a review and analyses of the literature from 1960 to 2000. Journal of Studies on Alcohol (supplement 14): 206–25

Willis C, Lybrand S, Bellamy N (2004) Alcohol ignition interlock programmes for reducing drink driving recidivism. Cochrane Database of Systematic Reviews (3)

Zaza S, Carande-Kulis VG, Sleet DA et al. (2001) Methods for conducting systematic reviews of the evidence of effectiveness and economic efficiency of interventions to reduce injuries to motor vehicle occupants. American Journal of Preventive Medicine 21(4 supplement): 23–30

Zwerling C, Jones MP (1999) Evaluation of the effectiveness of low blood alcohol concentration laws for younger drivers (structured abstract). American Journal of Preventive Medicine 16 (1 supplement): 76–80

5 Review of studies of primary evaluations of BAC laws and related legislative measures

This section reports the findings of the review of the primary evaluations of BAC laws and related measures

Table 5.2.1 presents a summary of the studies (1993–2008): the interventions (BAC laws and related measures), study design, quality rating and the main findings.

5.1 Quality of evaluation studies

The approach to assess the study quality is detailed in the methodology section.

The table shows the range of different study designs that were used to evaluate the effects of BAC laws and related measures. The literature in this field clearly acknowledges the methodological challenges involved in evaluating the effectiveness of legislative measures designed to change patterns of drink-driving behaviour and reduce alcohol-related road traffic injuries and deaths. True experimental designs (such as randomised controlled trials) are difficult to apply and interrupted time series and controlled before-and-after are considered to be the strongest and most practical study designs. This means that it is more difficult to attribute the 'effect' such as changes in level of road traffic accident to specific 'interventions' (that is, BAC laws and other measures).

Nevertheless it is possible to determine the strength of the evidence on the overall weight of the evidence (as demonstrated by the degree of consistency and direction of findings across studies).

Primary outcomes

The primary outcomes used in the studies are shown in the table below (Outcome measures). Nearly all studies used a combination of measures. Alcohol-related fatal and non-fatal injuries resulting from alcohol-related vehicle crashes were the prime focus of studies, however a set of proxy

measures were also used (for example single vehicle night-time crashes). A minority of the studies sought to examine alcohol-related injuries and deaths according to different BAC levels.

The variables vary in their robustness as proxies and their use may act as a source of bias, particularly for those proxies with a weaker association with alcohol involvement (such as total crash rates). Their reliability was also dependent on the quality of systems for measuring, recording and reporting that exist in each country/locally for provision of complete and accurate databases. This includes the local police strategy and systems with respect to breath testing and evidential BAC testing for those involved in road traffic accidents.

Outcome measures		
Primary outcomes		**Denominators**
single vehicle night-time fatal crashes		per l00,000 licensed drivers
all fatal crashes		per 100,000 km
all serious injuries crashes		age specific
all traffic crashes		young drivers – under age 21
Alcohol-related:	defined by BAC level	
• fatal crashes	high BAC greater than 0.10	
• serious injuries crashes	any BAC greater than 0.01	
• traffic crashes (injuries and fatalities)		
Comparison measures		
age-specific groups	age groups not included in laws	
daytime fatal crashes		
non-alcohol-related crashes	BAC less than 0.01	
multiple vehicle crashes		

Study design and analytical approaches

There was some degree of inconsistency in the use of terminology by authors to define the evaluation study design and analytical approaches, reflecting the considerable diversity in specifics of design and analytical methods. This in part appears to be related to consideration of the degree of methodological

development; and adoption of evaluation approaches seeking to strengthen the internal validity of study estimates.

The quality of reporting of studies varied; in most cases there was not sufficient detail provided in the papers for a complete quality assessment by reviewers (and quality rating was problematic).

The review included some early studies that were concerned with evaluating the effect of legislative interventions in a single country, US state or small group of states based on a before-and-after comparison, with or without concurrent control areas, that is, areas without laws.

These studies in the main achieved lower quality ratings. The principal weaknesses were lack of clarity regarding the statistical power of the study, the appropriateness of the comparison group or area (including lack of detail on baseline characteristics); and weaknesses in taking account of the effect of other alcohol-related policies and traffic safety measures.

A further group of studies (mainly later) adopted an alternative evaluation approach using more robust time series analyses or other regression-based analyses. These include a number of US studies that were based on the pooled analysis of state-level estimates of the effect of BAC laws. This increased the statistical power of the pooled estimates, while the state-level analyses sought to control for state and time specific factors (using difference in difference/two-way fixed effects methods).

This approach sought to control for the ‘unobservable’ differences across states and time: traffic safety, changes in public attitudes to drink-driving, legislation, enforcement levels, traffic conditions, and alcohol laws.

A small number of studies received a high quality rating (++): applying and extending the above approach. The studies pooled cross state/country estimates and used multivariate regression techniques to test and control for an extended range of potential confounding factors including the effect of other alcohol related policies.

The table below (Control variables) shows the range of factors (possible confounders) which may impact on outcomes that were considered to different degrees across and within analyses.

Control variables	
Traffic safety (for example, highway improvements)	Unemployment
Public attitudes	Income per capita
Legislation	
Enforcement levels	Combinations of above
Traffic conditions	Geographical variation in implementation of BAC laws
Alcohol laws	
Seasonal variations	
Weekend driving patterns	
Vehicle registration and ownership	
Vehicle safety standards	
Alcohol consumption	
Population age trends	
Establishment of lobby groups (for example, Mothers Against Drink Driving)	
Environmental action	

5.2 Primary evaluation studies: findings

0.05 BAC law and lower

European-based studies

Albalate's study (2006) evaluated the transition of European countries (15 former EU countries) from BAC limits of 0.08 to 0.05. This study provided one of the most recent and relevant studies of high quality (++).

The study used European panel-based data (CARE) for 1991–2003. The primary outcome measures used were fatality rates per million residents of each population group or the fatality rate per 100,000 km driven.

The analysis controlled for a large number of potential confounding factors including unemployment, economic growth, transportation and use of vehicles, road infrastructure, and educational backgrounds. In addition the analysis took account of related policies and enforcement measures: minimum legal driving age, points-based licence and random checks.

The results showed that the lowering of the BAC law to 0.05 produced statistically significant benefits, as measured by reductions in total fatality rate per population or the total fatality rate per km driven. However the effectiveness of the law was differentiated according to gender, age and zone. The estimated effect of the 0.05 BAC limit was found not to be statistically significant for the whole population when controlling for other concurrent policies and infrastructure quality. The effects were statistically significant for the age group 18–25 (11.5%), men (5.7%) and for men in urban areas (9.2%).

This was one of few studies that specifically examined how the size of the effect of the adoption of the lower BAC limit on road fatalities changed over time. The effects were evident after 2 years and increased over time with the greatest impact between 3 and 7 years.

The analysis showed that a number of the control variables appeared to have a particularly important association to road fatalities: motorisation (number of

cars per 1000 residents) as a proxy indicator for transport development, and variables relating to the quality and characteristics of road systems. Also the variable ‘secondary education’ acted as a proxy for income (and reflected the positive correlation between income and both alcohol consumption and vehicle use).

No studies have considered how the effect of lowering of the BAC law to 0.05 may be related to the ‘maturity’ of alcohol control policies and progress in reducing alcohol related crashes as discussed in section 7.

The other European-based studies focused on the impact of lowering BAC limits in the individual countries. These were generally studies that adopted a before-and-after study design, and met fewer quality assessment criteria.

A (-) study of the effect of the lowering of the BAC limit from 0.08 to 0.05 in Austria showed a 9.4% decrease in alcohol-related crashes relative to the total number of crashes (Bartl and Esberger 2000). This short-term effect (approx 1 year follow-up) was attributed in part to intense media campaigns and enforcement. In the Netherlands a (-) study (Mathijssen 2005) reported a reduction in the proportion of drivers with an illegal BAC (greater than 0.05) from 15% to 4.5%. This again was attributed in part to police enforcement: random breath testing and associated publicity. In Denmark the adoption of the 0.05 BAC limit appeared to produce changes in drink-driving behaviour. There was a significant decrease in the number of drinks drivers consumed within a 2 hour period before driving. However accident data showed that this self-reported behaviour change was not accompanied by a decrease in proportion of alcohol-related injury accidents (-) (Bernhoft and Behrendorff 2003).

The lowest BAC limit in Europe of 0.02 was adopted by Sweden in 1990. The Norstrom and Laurell (-) study (1997) examined the effect of lowering the BAC limit from 0.05 to 0.02 using time series analysis. The analysis gave estimates of 9.7% reduction in fatal crashes, 11% reduction in single vehicle crashes and 7.5% reduction in all crashes. The authors also examined the changes in the distribution of BAC levels among convicted drink-drivers before and after

the new BAC limit was introduced. The comparison indicated that while drivers with BACs above 0.15 made up 57.1% of all impaired driving offenders in 1987, their proportion declined to 47.4% in 1991. The findings suggested that the lower BAC limit reduced crashes among drivers who were the highest BAC offenders.

This finding was supported by a further (-) study. Borschos (2000) evaluated the effect of the BAC limit for aggravated drink-driving (reduction from 0.15 to 0.10 in 1994) based on time series analyses. The analysis controlled for the effects of alcohol sales and gasoline sales and also included the reduction of the lower BAC limit (0.02) in 1990 as a control variable. It showed a 13% reduction in fatal crashes.

Australian-based studies

Henstridge at al. (+) (1997) conducted a time series analysis of random breath testing and 0.05 BAC laws in four Australian states. The analysis controlled for seasonal effects, weather, economic trends, road use, alcohol consumption and day of the week. It also took account of related policy measures to determine the effects that could be attributable to random breath testing or the lowering of the BAC limit to 0.05.

In Queensland the adoption of the 0.05 BAC limit produced an estimated 14% reduction in serious collisions and 18% reduction in fatal collisions. In New South Wales there was an estimated 7% reduction in serious collisions and 8% reduction in fatal collisions and 11% reduction in single-vehicle night-time collisions.

There are few recent evaluation studies (identified in this review) that considered the differential impact of lowering of the BAC limit to 0.05 on the behaviour of drivers with different BAC levels that is, changes in the distribution of BAC levels in the drink-driving population. Two Australian studies provide some evidence on the population distribution of BAC levels. These studies are based on the well established systems of police random

breath testing and evidential BAC levels of drivers involved in crashes (see also epidemiological studies).

Brooks and Zaal (-) (1993) assessed the effects of lowering of the BAC limit from 0.08 to 0.05 in 1991 in the Australian Capital Territory. Analysis was based on a linear modelling approach and used data from police random breath testing and alcohol tests of drivers involved in crashes for the 12 months prior to and after the 0.05 BAC limit was implemented.

There was a 34% decrease in the proportion of random breath tested drivers with BACs between 0.15 and 0.19 and a 58% decrease in the proportion above 0.20. The evidential breath tests showed a 31% decrease in drivers with BACs above 0.15 and a 46% decrease in drivers above 0.20. The authors argued that the study provided evidence that the lowering of the BAC limit form 0.08 to 0.05 led to a reduction in drink-driving well above the original 0.08 limit. However there were a number of methodological weaknesses relating to sampling, strong seasonal variation, and lack of analysis regarding other potential confounding factors.

Analysis of a series of six roadside surveys 1987 to 1997 in Adelaide metropolitan area, South Australia, provides evidence on how drink-driving behaviours changed across different groups in the population with the lowering of the BAC limit, with comparatively low levels of enforcement through random breath testing (Kloeden and McLean 1997; 1994).

The legal limit for BAC was changed from 0.08 to 0.05 in 1991. Random breath testing was initially introduced in South Australia in 1981, but at a low level. The level of random breath testing was increased significantly (double) in South Australia in 1997 (although the level was not precisely stated). Unrestricted mobile random breath testing only commenced in June 2005.

This study was not an evaluation per se of the effect of the change in the legal blood alcohol limit from 0.08 to 0.05 in 1991, but trend analysis of surveillance data. The six surveys involved breath samples from a representative sample of Adelaide drivers at night (22:00 h to 03:00 h). Analysis of the percentage of

night-time drivers with BACs at or above 0.01, 0.05 and 0.08 showed a rate of decrease that was almost uniform across all three BAC levels. The rate of decrease was more rapid among men than women.

BAC laws, publicity and penalties in Japan

In 1970 Japan introduced a BAC law setting the legal BAC at 0.05. Subsequently in 2002 Japan introduced a further set of measures: the lowering of the legal BAC from 0.05 to 0.03 and increased the penalties for alcohol impaired driving (increased fines, licence points, culpability of bartenders and passengers in addition to arrested drivers).

The introduction of these 2002 changes in alcohol-related policy measures have been the subject of four evaluation studies (identified in this review) (Desapriya 2006 [-]; 2007 [-]; Nagata et al. 2006 [-]; 2008 [-]). Each study has methodological weaknesses which reiterate the difficulties of conducting evaluations of these types of interventions in a single country.

Nagata and colleagues (2008) reported the evaluation of the effect of the combination of these 2002 measures. Time series analysis was conducted using data from national data sets (1998–2004) and examined changes in rates of all traffic injuries, all severe traffic injuries, traffic fatalities, alcohol-related traffic injuries, alcohol-impaired driving severe traffic injuries and alcohol impaired driving traffic fatalities (per 100,000 population, per billion km driven). Segmented regression analyses were conducted to adjust for baseline trends, seasonality and autocorrelation. The results showed a significant and substantial reduction in alcohol-impaired driving traffic problems: fatalities, severe injuries and all injuries. The new law appeared to have an effect over and above the decrease in alcohol-impaired driving traffic fatalities. The authors suggested that the primary effect of the new law was to change the behaviour of people who intended to drive a motor vehicle after drinking, which affected alcohol-impaired driving injuries but not the overall traffic fatality rate.

However the authors highlight a number of important limitations relating to the study (including inconsistency in definition of alcohol-impaired driving with the lowering of the BAC limit, and missing data on blood alcohol levels). Furthermore the analysis did not control for confounders such as other new traffic laws, campaigns and overall alcohol consumption.

Desapriya et al (2006; 2007) examined the impact of the lowering of the BAC limit to 0.03 on teenage drinking and driving in Japan. Both studies reported on time series analyses conducted on data drawn from national databases between 1998 and 2005.These results showed statistically significant decreases in alcohol-related crashes, alcohol-related injuries and single vehicle night-time crashes among young drivers aged 16–19. In comparison, rates of total crashes, injuries and pedestrian fatalities showed a statistically significant decline or increase in the period following the introduction of the new law.

Lowering of BAC limit to 0.08 in the USA

The evaluation of the 0.08 BAC law in the USA provide less direct evidence regarding the impact of BAC laws at the 0.05 limit. However these evaluations are relevant to many questions related to the adoption of the 0.05 BAC limit. These include in particular the timing of effect of BAC laws, differential impact on population groups and the relationship between BAC laws and other alcohol-related policy measures.

The early evaluations of single US states or small number of states were generally methodologically weaker and received a lower quality assessment. The findings of these state-level evaluations of effects of adoption of the 0.08 BAC limit were inconsistent (Hingson et al. 1996 [-]; Hingson et al. 1998 [-], Foss et al. 1998 [-]). Given methodological weaknesses, it was unclear whether the variations in effects were due to actual differences in effects of the law or were the product of different evaluation methods. Studies involving states with small numbers of accidents are likely to have lacked the statistical power necessary to demonstrate a significant effect.

Aspler et al. (1999 [+]) examined the impact of BAC reductions from 0.10 to 0.08 BAC in 11 US states over a 12 year period (approximately). The study, based on use of accident data from the Fatal Accident Report System (FARS), analysed the incident rates of alcohol involvement in fatal crashes (at different BAC levels), and the effect of confounding factors, including administrative licence revocation laws. The study reported seven of the 11 states showed statistically significant reduction in at least one measure of alcohol involvement in fatal crashes for BAC law alone or in conjunction with administrative licence revocation. The authors conclude that 0.08 BAC laws work best in conjunction with other laws especially administrative licence revocations. Although the study was of a good standard, certain factors affect the robustness of the conclusions. In some states the length of time between implementation of BAC and administrative licence revocations was short and relative impacts difficult to discern, and in states with small populations data was more unstable. Other existing laws (including sobriety checkpoints), and pre-existing downward trends in alcohol involvement in fatal crashes and pre-BAC publicity were other possible confounding factors. Subsequent US studies generally adopted alternative evaluation approaches that attempted to address previous weaknesses (and criticisms). Essentially these studies were based on a design that involved pooling estimates of cross section time series covering a larger number of states. Analyses also took account of the effect of a number of potential confounders and other related policy measures.

The (+) study conducted by Bernat et al. (2004) investigating the lowering of the BAC limit from 0.10 to 0.08 over a 6 year period on single-vehicle night-time fatal crashes was associated with a reduction of 5.2% in fatal traffic accidents, after controlling for potential confounders and for the effect of the administrative licence revocation. Furthermore the analysis showed that there was no significant interaction between the BAC law and administrative licence revocation, that is, benefits were not dependent on both measures being in place. Also the effect of the BAC law was not dependent on the baseline

crash rates in states that is, the lowering of the BAC limit could have an impact in states with lower alcohol related crash rates.

Villiaceves et al. (2003 [+]) investigated the relative effect of a number of related policy measures: BAC 0.08 law; zero tolerance law for younger drivers; administrative licence revocation; sobriety checkpoints and mandatory jail convictions for first drink-driving conviction. The results showed a 14% reduction in alcohol-related crash fatalities. Studies conducted by Tippetts et al. (2005 [+]) and Wagenaar (2007 [+]) similarly investigated the effects of a number of related laws; and showed the lowering of the BAC limit to be effective after controlling for other related measures.

Tippetts et al. (2005 [+]) reported that the number of drink-drivers in fatal crashes declined in 16 of the 19 jurisdictions after the 0.08 BAC law was adopted. Nine of the 16 reported reductions were statistically significant. The combined effect size across all 19 locations showed a statistically significant decline of 14.8% in the rate of drink-drivers in fatal crashes. Also the reduction was greater in states that had an administrative licence suspension/revocation law and implemented frequent sobriety checkpoints.

A small number of high quality studies employed multivariate regression analyses that involved extensive modelling for both technical statistical adjustment and policy effects.

Dee (2001 [++]) evaluated the effects of lowering the BAC limit to 0.08 using a panel of annual state-level data on traffic fatalities 1982–98 (17 years from 48 states), drawn from the Fatal Accident Reporting System. Multiple regression was employed based on two-way fixed effects models that controlled for the influence of unobserved factors (such as cultural attitudes towards drink-driving) and the analysis also included a broader set of controls for potentially confounding determinants of traffic safety and for other traffic-related policies.

The results indicated that the adoption of 0.08 BAC laws produced statistically significant reduction in traffic fatality rates of 16.5 %. When controlling for other factors, the BAC law was still effective, generating a statistically

significant reduction of 7.2% in traffic fatality rates. The study showed that failure to control for the influence of other traffic safety policies could lead to highly inflated estimates of the impact of the 0.08 laws. The study also showed that the law had a differential impact according to age, with reductions in fatality rates being highest among younger drivers (14% reduction among young people aged 18–20 , 9.7% among age 21–24 and 6.7% among those 25 and older).

Eisenberg (2003 [++]) evaluated the effectiveness of a number of policies related to drink-driving, including the lowering of the BAC limit to 0.08, and gave particular attention to the pattern of timing on effects. Multivariate regression analysis was used, taking account of state and year fixed effects, and a broad range of related policies. A number of outcome measures were used: total fatal crash rate, alcohol-related fatal crash rate for any and high BAC (high BAC greater than 0.10), weekend/night-time fatal crash rate, weekend/night-time single vehicle fatal crash rate, fatal crash rate for drivers under age 21.

Eisenberg also examined the timing of the effects of the 0.08 BAC limit. The analysis indicated a shift downward in the fatal crash rate prior to policy enactment, followed by a small additional decline up to 6 years with a further substantial decline.

Freeman (2007 [++]) conducted a pooled cross section time series analysis to evaluate the impact of the BAC 0.08 laws, and extended the approach used by Dee and Eisenberg. The study period was 1980 to 2004, incorporating the lowering of the BAC limit by additional states. The analysis also involved correction for serial correlation and event analyses (taking account of ‘endogeniety bias’ that is, the influence of social opinion). It modelled estimates of the effect of control legislation: BAC, administrative licence revocation, graduated driver licensing, seat belt, and speed limit laws, and other controls including variables for the business cycle, mileage travelled, and demographic characteristics. A range of models included the replication of findings by Dee and Eisenberg, but also demonstrated the impact of

correction for serial correlation, and also examined a time lag effect. The results of the extended models, with correction for serial correlation indicated that the strengthening of BAC laws from 0.10 to 0.08 had little or no effect on traffic fatalities. However administrative licence revocation laws showed significant reductions in fatalities. Freeman pointed out that because administrative licence revocations almost always use a BAC limit as a criterion the results are properly interpreted as a partial effect conditioned on the existence of a BAC law.

Canadian 0.08 BAC laws

Work by Ashbridge et al. (2004 [-]) in Ontario, Canada examined the impact of the 0.08% BAC breathalyser law on a sample of licence holders aged 15 years+. Data from national databases (1962–96) were analysed using a controlled time series analysis with auto-regressive integrated moving average (ARIMA model). The primary outcomes were the rate of fatally injured drink-drivers versus rate of fatally injured non-drink drivers. The authors reported the breathalyser law led to a significant decrease in drink-driving fatalities and was associated with an 18% reduction in proportion of drink-driving fatalities in Ontario between1969 and 1996. No effect was reported for non-drink-driving fatalities. The authors concluded that the BAC law had a long-term effect on alcohol-related fatalities. Weaknesses in the study design were no accountability of additional exogenous variables and no separate geographical control.

Related laws and enforcement measures

Administrative licence revocation (suspension)

Administrative licence revocation provides for the suspension of the driving licence of those caught driving above the BAC limit or within a specified BAC level range below the legal limit. In principal licence suspension can operate to deter drink-driving: in terms of threat of a penalty (temporary loss of licence), deterring offending drivers from engaging in further offences, and also providing a rapid response to offending behaviour and experience of the consequences (celerity). The laws provide for immediate administrative

licence suspension on failure to pass an alcohol breath test. However the nature of sanctions (including length of suspension) varies across jurisdictions (see also section 7.5). The potential added effect of such a measure in the UK is uncertain, given the emphasis given to rapid application of criminal sanctions here.

The specific effect of administrative licence revocation/suspension laws was the focus of a small number of studies included in this review. In addition, other studies have evaluated the effect of administrative licence revocation in conjunction with other measures also in review.

Wagenaar and Maldonado-Molina (2007 [+]) evaluated the impact of mandatory pre-conviction and post-conviction drivers licence suspension laws in 46 US states. Time series analyses were conducted involving separate estimations of ARIMA models for each state. The analysis controlled for state-specific factors influencing crashes, and also other alcohol-related measures (BAC limits, mandatory minimum fines, and mandatory jail penalties). The state estimates were pooled for those states where the effect estimates were known not to be contaminated by simultaneous implementation of other major alcohol-related policies.

The results showed the effectiveness of administrative licence suspension laws; there were significant reductions in single vehicle night-time crashes and fatal crashes involving drivers for the different levels of BAC. There was a 5.2% reduction in alcohol-related (BAC greater than 0) fatal crash involvement. The authors state that the law appears to effectively affect both ‘lower-risk’ more moderate drink-drivers as well as ‘high risk’ or heavy or problem drinkers. The laws mandating licence suspension penalties after conviction had little effect, and did not appear to be an effective deterrent. This showed the importance of speed – penalties that are delayed do not have a demonstrable effect on behaviour.

Kaplan and Prato (2007 [+]) evaluated the impact of the lowering of the BAC limit alongside administrative licence revocation laws on alcohol-related crashes in 22 US states, and the differential impact for subgroups. The

analysis showed that the lowering of the BAC limit was associated with a reduction of between 9.2% and 10.7% in alcohol-related fatalities; and administrative licence revocation was associated with a reduction of between 8.6% and 10.6% in alcohol-related fatal accidents.

The study also showed that the behaviour of particular subgroups was consistent with broader literature and theory regarding compliance. Women and older drivers demonstrated a higher degree of compliance that is, greater relative effect. Differences in terms of car occupancy showed that single occupancy vehicles were less influenced by the BAC limit. The authors suggested that law compliance is therefore much higher when more than one occupant is involved and is related to some sense of responsibility for the life of others.

Mann and colleagues (2002 [-]) evaluated the introduction of the administrative licence revocation law in Ontario. The analysis showed that the law was associated with a reduction of 17.3% in the proportion of driver fatalities with a BAC over 0.08. However the analysis was restricted to 13 months following the introduction of the law and therefore sustainability of the effect over time is unclear. Furthermore the effect may have been influenced by levels of enforcement, as well as other alcohol-related policies.

Mann and colleagues (2003 [-]) conducted a further study of the effect of the lower BAC limit and introduction of administrative licence revocation law in Ontario; and specifically as a test of the differential deterrence hypothesis. (This hypothesis postulates that factors other than the legal deterrent will determine drink-driving behaviour. Such factors include an individual's assessment of risk, fear of shame and propensity for risk taking.) The authors used data from 1996 and 1997 Ontario Drug Monitor (monthly cross-sectional survey of adults in Ontario). The analysis included drivers who reported at least some drinking during the last year. The interaction between the administrative licence revocation law and drink-driving groups (drink-drivers versus non-drink-drivers) was examined. The results showed that the mean alcohol consumption of those who reported drink-driving increased

significantly after the administrative licence suspension was introduced, whereas the alcohol consumption of those who did not drive after drinking remained the same.

Mann et al. suggested that this finding is consistent with the predictions of differential deterrence: that light moderate social drinkers are most affected and drop out of the drinking population, while compulsively motivated or hard core offenders are influenced less.

The authors pointed out that the study had a number of methodological weaknesses (including a lack of comparison data from regions without administrative licence suspension and a reliance on self-report measures). Nevertheless the findings helped to understand the characteristics of different groups of drinkers with respect to driving.

Villaveces (2003 [+]) examined the impact of different alcohol-related laws on fatality rates for vehicle crashes and alcohol-related fatal crash rates. The following policies were assessed: 0.08 BAC law, 0.02 BAC law for drivers aged less than 21, administrative licence revocation laws; sobriety checkpoints; and mandatory jail terms after first convictions. Regression models were used to analyse data over a period of 18 years for 51 states (including the District of Columbia). The BAC laws of 0.08 and zero tolerance had associations with a reduction of alcohol-related fatalities: 14% and 12% respectively. The association was weaker for overall crash fatalities: 3% and 4% respectively.

Administrative licence revocation laws were associated with a 5% reduction in overall fatal crashes, and 5% reduction in alcohol-related fatal crashes.

Younger drivers

Zero tolerance laws

The study conducted by Eisenberg (2003 [++]) (described previously) included analysis of the impact of zero tolerance laws. Zero tolerance laws were estimated to influence fatal crashes involving young drivers (under 21 years)

more than those involving all drivers. However the effect was linked to the presence of administrative licence revocation laws. The combined effect was a 4.5% reduction in the fatal crash rate for young drivers (under 21 years). Furthermore the effect appeared to operate well before the year of enactment. This suggested that unobserved changes in attitudes or anti drink-driving campaigns targeting young people could be responsible for policy adoption and observed reduction in fatal crashes.

The Carpenter study (2007 [+]) examined the effect of zero tolerance law and graduated licensing in Ontario in 1994 among young people aged 16–17 years based on analysis of data drawn from the Ontario 'Student drug use survey'. It examined changes in any past year 'alcohol involved driving' and past year drinking participation 1983–2001 for those aged 16–17 and control younger and older age groups. The analysis showed substantial reductions in levels of alcohol-involved driving and drinking participation. However there was little effect after taking account of the pre-existing downward trend, and also changes in outcomes of control groups. Carpenter stated that the lack of effect in Ontario, in comparison to the US study findings of positive impact, could be attributable to cultural differences (sentiment towards drinking and driving).

Carpenter's US-based study (2004 [+]) aimed to determine how the zero tolerance laws affected alcohol-related behaviours: the mechanisms by which the laws reduced road traffic fatalities. Carpenter pointed out that young people may respond by abstaining from alcohol use, drinking more moderately and/or reducing their propensity to drive when having consumed alcohol. Or young people might increase their alcohol consumption, drinking at home, or using public transport.

Carpenter used data from the Behaviour Risk Factor Surveillance System on self-reported alcohol use and drink-driving for 1984 to 2001. The system provided a large sample of over 49,000 individuals less than age 21; and covered all 50 states and the District of Columbia. The study was based on multivariate regression analysis of the variation produced by adoption of zero

tolerance laws across states and time to estimate the effects of zero tolerance laws on alcohol-related behaviours of age group 18–20. The analysis controlled for the macroeconomic conditions, other alcohol policies, state fixed effects, survey year and month effect, and linear state-specific time trends. In addition the age group 22–24 was used as a comparison group who should have not been affected by the laws and to control for unobserved state/year influences. The results indicated that the main effect of zero tolerance laws was to reduce heavy episodic drinking behaviour (as defined by five or more drinks at one sitting) and overall number of drinks consumed in the previous month among underage males by a statistically significant 13%. This was part of a shift in the distribution of drinking among young men from heavy episodic use of alcohol to more moderate light drinking. The results for young women showed laws reduced heavy episodic drinking, but these reductions did not remain after controlling for other measures addressing drinking behaviour.

Wagenaar et al. (2001 [+]) evaluated the effects on drinking and driving of lowered BAC limits for drivers younger than 21 years in 30 US states between 1984 and 1998 (zero tolerance laws that is, 0.02 BAC). The study used the 1984–98 waves of the 'Monitoring the future surveys' for high school seniors (17-18yrs) – a sample of more than 5000. The analysis compared the means of self-reported outcomes of drinking and driving before and after the implementation of the law, controlling for secular trends. The results showed that the frequency of driving after any drinking declined by 19% and the frequency of driving after five or more drinks declined by 23%. However there were no changes in the overall drinking and binge drinking participation.

A (+) study by Liang and Huang (2008) evaluated the effect of zero tolerance laws on young drivers under age 21 on alcohol use and drink-driving behaviours. The aim was to look at how zero tolerance laws affect the decision to drink and binge drink, the location of drinking (at home or away from home) and the decision to drink and drive. Three waves of the College Alcohol Surveys (CAS) were analysed to examine drinking and driving outcomes of those who reported drinking in the previous 30 days. Multivariate regression analysis was conducted, with older college students as the control

group. The analysis controlled for state fixed effects, year fixed effects, demographic variables, living arrangements, school types and other state-level alcohol control policies.

The results showed that the zero tolerance laws were associated with a 26–27% reduction in the probability of drinking and driving among those who reported drinking away from home. Also the zero tolerance laws were associated with an approximately 7% reduction in the probability of drinking away from home. The authors concluded that the primary response to the law was to refrain from driving after drinking, with the greatest effect among those who reported drinking away from home than that among all drinkers regardless of drinking locations (at home or away from home).

Voas et al. (2003 [+]) evaluated the effect of raising the minimum legal drinking age to 21 years from 18 years, and establishing zero tolerance limit for drivers younger than age 21. The analysis took account of differences among the 50 states in various background factors, changes in economic and demographic factors within states over time, and the effects of other related laws. The results showed substantial reductions in alcohol-related fatal crashes were associated with the two laws. The zero tolerance law reduced the proportion of underage drinking drivers (under 21 years) in fatal crashes by 24.4%.

Villacaves et al. (+) study (2003) (also described above) assessed the impact of a number of alcohol-related policies in the USA 1980–1997 including zero tolerance laws on deaths due to alcohol-related crashes. The analysis showed that the zero tolerance law was associated with a 12% reduction in alcohol-related fatalities, and 4% reduction in overall crash fatalities.

As noted in sections 4.4 and 4.6, it is difficult to assess the likely effect of introducing lower BAC limits for younger drivers in the UK given differences in the minimum legal age for driving.

Graduated driver licensing

Begg et al. (2001 [+]) studied the impact on young driver crashes of the three main driving restrictions in the New Zealand graduated driver licensing system: night time curfew, no carrying of young passengers and a blood alcohol limit of 0.03. In New Zealand the minimum age for an initial licence is 15 years and therefore applicability to the UK context may be limited. Nevertheless this is one of the few studies that has examined the relative effect of different components of graduated driver licensing systems. Multivariate regression analysis was used to compare crashes involving a young driver before graduated driver licensing with whose who held a restricted graduated licence and with those who held a full graduated licence for each of the main driving restrictions. The analysis controlled for gender and age, and trends that may have resulted from other interventions over the period.

The results (statistically significant) showed that crashes that involved a driver with a restricted licence were less likely to have occurred at night, less likely to have involved passengers and less likely to have been suspected of involving alcohol, compared with crashes involving a driver licensed under the old system. This indicated that the graduated driver licensing restrictions and in particular the night-time driving curfew contributed to the reduction in young driver crashes since the introduction of the system.

References

Aberg L (1995) Long time effects of a lowered blood alcohol limit in Sweden. Sweden: Uppsala University

Albalate D (2006) Lowering blood alcohol content levels to save lives: the European experience. Journal of Policy Analysis and Management 39

Asbridge M, Mann RE, Flam ZR et al. (2004) The criminalization of impaired driving in Canada: assessing the deterrent impact of Canada's first per se law. Journal of Studies on Alcohol 65 (4): 450–9

Aspler R, Char AR, Harding WM et al. (1999) The effects of .08 BAC laws (DOT HS 808 892). Washington DC:US Department of Transportation, National Highway Traffic Safety Administration

Assum T (2002) Reduced BAC limit in Norway; less drinking and driving. Norway: Nordic Road and Transport Research

Bartl G, Esberger R (2000) Effects of lowering the legal BAC limit in Austria. Proceedings of 15th Conference on Alcohol Drugs and Traffic Safety Stockholm. International Council on Alcohol, Drugs and Traffic Safety.

Begg DJ, Stephenson S, Alsop J et al. (2001) Impact of graduated driver licensing restrictions on crashes involving young drivers in New Zealand. Injury Prevention 7 (4): 292–6

Bernat DH, Dunsmuir WT, Wagenaar AC (2004) Effects of lowering the legal BAC to 0.08 on single-vehicle-nighttime fatal traffic crashes in 19 jurisdictions. Accident Analysis & Prevention 36 (6): 1089–97

Bernhoft IM, Behrensdorff I (2003) Effect of lowering the alcohol limit in Denmark. Accident Analysis and Prevention 35 (4): 515–25

Borschos B (2000) An evaluation of the Swedish drink driving legislation. Paper presented at the International Conference on Alcohol, Drugs and Traffic Safety, Stockholm

Brooks C, Zaal D (1993) Effects of a reduced alcohol limit for driving. Australia: Federal Office of Road Safety

Carpenter C (2006) Did Ontario's zero tolerance & graduated licensing law reduce youth drunk driving? Journal of Policy Analysis and Management 25 (1): 183–95

Carpenter C (2004) How do zero tolerance drunk driving laws work? Journal of Health Economics 23:1, 61-83

Dee TS (2001) Does setting limits save lives? The case of 0.08 BAC laws. Journal of Policy Analysis and Management 20 (1): 111–128

Desapriya E, Shimizu S, Pike I et al. (2007) Impact of lowering the legal blood alcohol concentration limit to 0.03 on male, female and teenage drivers involved in alcohol-related crashes in Japan. International Journal of Injury Control & Safety Promotion 14 (3): 181–7

Desapriya EB, Shimizu S, Pike I et al. (2006) Impact of lowering the legal BAC limit to .03 on teenage drinking and driving related crashes in Japan. Nihon Arukoru Yakubutsu Igakkai Zasshi 41 (6): 513–27

Eisenberg D (2003) Evaluating the effectiveness of policies related to drunk driving. Journal of Policy Analysis and Management 22 (2): 249–74

Foss RD, Stewart JR, Reinfurt DW (2001) Evaluation of the effects of North Carolina's 0.08% BAC law. Accident Analysis & Prevention 33 (4): 507–17

Freeman D (2007) Drunk driving legislation and traffic fatalities: new evidence on BAC 08 laws. Contemporary Economic Policy 25 (3) 293–308

Hingson R, Heeren T, Winter M (1998) Effects of Maine's 0.05% legal blood alcohol level for drivers with DWI convictions. Public Health Reports 113 (5): 440–6

Hingson R, Heeren T, Winter M (2000) Effects of recent 0.08% legal blood alcohol limits on fatal crash involvement. Injury Prevention 6 (2): 109–14

Hingson R, Heeren T, Winter M (1999) Lowering state legal blood alcohol limits to 0.08%: The effect on fatal motor vehicle crashes. Conference proceedings: Combating Impaired Driving in an Era of Diminished Resources and Shifting Priorities Transportation Research Board Committee on Alcohol

Hingson R, Heeren TC, Winter MI (1996) Lowering state blood alcohol limits to 0.08% – the effect on fatal motor vehicle crashes. American Journal of Public Health 86:9, 1297-9

Hingson, R., Sleet, D. (2006). Modifying Alcohol Use to Reduce Motor Vehicle Injury. In A. Gielen D. A. Sleet (Eds.), Injury and Violence Prevention: Behavioral Science Theories and Application. Indianapolis, IN: Josey Bass.

Johnson D, Fell JC (1995) The Impact of lowering the illegal BAC Limit to 0.08 in 5 states in the USA. 39th Annual Proceedings of the Association for the Advancement of Road Safety Research Chicago: Association for the Advancement of Automobile Medicine.

Kaplan S, Prato CG (2007) Impact of BAC limit reduction on different population segments: a Poisson fixed effect analysis. Accident Analysis & Prevention 39 (6): 1146–54

Kloedon C, McClean A (1994) Late night drinking in Adelaide two years after the introduction of the 0.05 limit. Report 2/94. Adelaide: South Australian Department of Transport, Office of Road Safety

Kloeden C, McLean A (1997) Night time drink driving in Adelaide. 1987–1997. Adelaide: Road accident Research Unit, University of Adelaide

Liang L, Huang J (2008) Go out or stay in? The effects of zero tolerance laws on alcohol use and drinking and driving patterns among college students. Health Economics 17 (11): 1261–75

Mann RE, Smart RG, Stoduto G et al. (2002) The early effects of Ontario's administrative driver's licence suspension law on driver fatalities with a BAC > 80 mg%. Canadian Journal of Public Health 93 (3): 176–80

Mann RE, Smart RG, Stoduto G et al. (2003) The effects of drinking-driving laws: a test of the differential deterrence hypothesis. Addiction 98 (11): 1531–6

Mathijssen MP (2005) Drink driving policy and road safety in the Netherlands: a retrospective analysis. Transportation Research (Part E) Logistics and Transportation Review 41 (5): 395–408

McCartt AT, Blackman K, Voas RB (2007) Implementation of Washington State's zero tolerance law: patterns of arrests, dispositions, and recidivism. Traffic Injury Prevention 8 (4): 339–45

McCartt AT, Blackman K, Voas RB (2007) Implementation of Washington State's zero tolerance law: patterns of arrests, dispositions, and recidivism. Traffic Inj Prev 8:4 339-45

Nagata T, Setoguchi S, Hemenway D et al. (2008) Effectiveness of a law to reduce alcohol-impaired driving in Japan. Injury Prevention 14 (1): 19–23

Nagata T, Hemenway D, Perry MJ (2006) The effectiveness of a new law to reduce alcohol-impaired driving in Japan. Japan Medical Association Journal 49: 365–9

Norstrom T (1997) Assessment of the impact of the 0.02% BAC-limit in Sweden. Studies on Crime and Crime Prevention 6 (2): 245–58

Norstron T, Laurell H (1997) Effects of lowering of the legal BAC limit in Sweden. In Mercier-Guyon C ed Alcohol and Drugs and Traffic Safety France 87-94

Tippetts AS, Voas RB, Fell JC et al. (2005) A meta-analysis of .08 BAC laws in 19 jurisdictions in the United States. Accident Analysis & Prevention 37 (1): 149–61

Ulmer RG, Preusser DF, Williams AF et al. (2000) Effect of Florida's graduated licensing program on the crash rate of teenage drivers. Accident Analysis & Prevention 32 (4): 527–532

Villaveces A, Cummings P, Koepsell TD et al. (2003) Association of alcohol-related laws with deaths due to motor vehicle and motorcycle crashes in the United States, 1980–1997. American Journal of Epidemiology 157 (2): 131–40

Voas RB, Tippetts AS, Taylor EP (2001) The Illinois .08 law. An evaluation. Journal of Safety Research 33 (1): 73–80

Voas RB, Tippetts AS, Fell JC (2003) Assessing the effectiveness of minimum legal drinking age and zero tolerance laws in the United States. Accident Analysis & Prevention 35 (4): 579–87

Voas RB, Tippetts AS, Taylor EP (2002) The Illinois .08 law. An evaluation. Journal of Safety Research 33 (1): 73–80

Wagenaar AC, Maldonado-Molina MM (2007) Effects of drivers' license suspension policies on alcohol-related crash involvement: long-term follow-up in forty-six states. Alcoholism: Clinical & Experimental Research 31 (8): 1399–406

Wagenaar AC, Maldonado-Molina MM, Ma L et al. (2007) Effects of legal BAC limits on fatal crash involvement: analyses of 28 states from 1976 through 2002. Journal of Safety Research 38 (5): 493–9

Wagenaar AC, Maldonado-Molina MM, Erickson DJ et al. (2007) General deterrence effects of U.S. statutory DUI fine and jail penalties: long-term follow-up in 32 states. Accident Analysis & Prevention 39 (5): 982–94

Wagenaar AC, O'Malley PM, LaFond C (2001) Lowered legal blood alcohol limits for young drivers: effects on drinking, driving, and driving-after-drinking behaviors in 30 states. American Journal of Public Health 91 (5): 801–4

Wagenaar AC (2004) Reducing drinking-driving among young adults: effects of BAC laws. Alcohol Research & Health 28 (4): 233–4

Table 5.2.1 Evaluation studies of changes in BAC limit laws and related enforcement measures

Author	Setting	Intervention	Study type	Quality	Findings/comment
Albalate (2006)	Europe (former EU 15 countries)	Transition to 0.05 BAC laws 1991–2003	Multivariate regression analysis	++	Reductions in road traffic fatalities only statistically significant when not controlling for related policies and infrastructure quality. i.e. reduction not statistically significant at whole population level BUT Statistically significant reductions for specific groups and areas: Reductions greatest in males and young drivers especially in urban zones
Aberg (1995)	Sweden	Lowering of BAC limit from 0.05 to 0.02	Uncontrolled before-and-after behavioural survey	-	Awareness and support for law, but responders overestimated how much they could drink; no evidence of change in behaviour
Ashbridge et al. (2004)	Canada	0.08 BAC law	Time series analysis	+	Reduction of 18% in the number of fatally injured drinking drivers but no corresponding effect was observed for non-drinking-driver fatalities
Aspler et al. (1999)	USA	0.08 BAClaw	Time series 11 US states	+	Significant reductions in alcohol involved crashes in two to five of 11 states
Assum (2002)	Norway	0.02 BAC law	Uncontrolled before–and-after behavioural	-	No change in percentage of drivers likely to drive with a BAC 0.05; social norms data implied drinking & driving mutually exclusive behaviours

			survey		
Bartl and Esberger (2002)	Austria	0.05 BAC law	Controlled before–and-after comparison	-	No reporting of statistical analysis, percentage increase/decrease only
Begg et al. (2001)	New Zealand	Graduated driver licensing restrictions on young drivers (1987)	Multivariate regression analysis	+	Crashes involving drivers with a restricted licence were less likely to have occurred at night, less likely to have involved passengers, and less likely to have been suspected of involving alcohol compared with crashes involving licensed under the old system. But other strategies concerned with drinking and driving aimed at the whole population could in part explain reductions
Bernat et al. (2004)	USA	BAC law 0.10 to 0.08	Panel data analysis 19 states	+	5.2% reduction in single night-time fatal traffic crashes associated with 0.08 law across all states; effect does not vary significantly by state or baseline rate of fatal traffic crashes in a state
Bernhoft and Behrensdorff (2003)	Denmark	BAC law 0.08 to 0.05 with publicity	Cross-sectional survey before-and-after; and trend analysis	-	Significant increase in knowledge of new BAC limit; significant decreases in reported number of drinks consumed in 2-hour period before driving and reported due to new limit. No marked decrease in proportion of DUI injury accidents vis total injury accidents; but proportion of fatal accidents involving DUI drivers increased significantly. Other factors likely to confound effect. Short evaluation period post implementation would not detect longer-term effect.

					Descriptive stats and non-parametric statistical tests used for category data.
Borschos (2000)	Sweden	BAC limit for aggravated drink-driving lowered from 0.15 to 0.10 (1994)	Time series analysis	-	Reduction of 13% in fatal collisions. Analysis indicates effect at high levels of BAC
Brooks and Zaal (1993)	Australia	BAC law 0.08 to 0.05	Time series trend data based on road side surveys. Australia Capital Territory	-	41% reduction in drink driving at BAC greater than 0.15, 90% reduction BAC 0.05-.0.08. Small reduction in BAC 0.10–0.15 – not statistically significant. Supports argument that lower BAC limit effects drink-driving at very high BAC levels, not just at lower levels
Carpenter (2006)	Ontario Canada	Zero tolerance and graduated licensing law on youth drink driving (1994)	Time series analysis (Student Drug Survey data)	-	Decrease in self-reported drink driving by age group 16–17 after zero tolerance/GLP law but little effect after taking account of existing downward trends in youth drink-driving trends during the 1980 and 1990s, as well as changes in outcomes of control groups (younger and older). Attributes lack of effect to cultural differences
Carpenter (2007)	USA	Zero tolerance and graduated licensing law on youth drink driving (1994)	Regression analysis (Survey data)	+	Main effect – statistically significant reduction of 13–20% in heavy episodic drinking behaviour and overall number of drinks consumed in the previous month among underage males Shift in the distribution of drinking among young men from heavy episodic use to more moderate light drinking
Dee (2001)	USA	0.08 BAC law	Multivariate analysis	+	Statistically significant reductions in traffic fatality rates of 7.2% for the whole population; greater

					impact for young drivers. Analysis indicates that without controlling for potential determinants of traffic safety, effect sizes of BAC law will be biased upwards
Desapriya et al. (2007)	Japan	0.03 BAC law male, female and teenage (2002)	Before-and-after comparison	-	Significant decrease in alcohol-related crashes among subgroups versus no change in total crash rates
Desapriya et al. (2006)	Japan	0.03 BAC law teenage DD	Before-and-after comparison – regression analysis	-	Significant decreases for age group 16–19 in rates of alcohol-related crashes and alcohol-related injuries and single vehicle night-time crashes compared with rates for pedestrians and all non-alcohol drivers
Eisenberg (2003)	USA	Graduated licensing (and other drink driving policies)	Multivariate regression analysis 50 US states plus District of Columbia	++	Graduated licensing effect in reducing fatal crash rates for all drivers by 4%, and fatal crash rates for drivers under 21 by 9.4%
Foss, Stewart and Reinfurt (2001)	USA North Carolina	0.08 BAC law	Time series	-	No impact of BAC reported on alcohol-related crash data. Pre-existing downward trends in alcohol-related crashes may have obscured impact of 0.08 BAC
Freeman (2007)	USA	Drink-driving legislation: BAC law from 0.10 to 0.08 administrative licence revocation (ALR)	Pooled cross section time series analysis (correction for serial correlation)	++	Lowering of BAC limit to 0.08 had no measurable effects on traffic fatality rates. Author attributes difference of findings to previous studies to extended sample, and methodological development of analysis administrative license revocation significant effects on fatalities

Henstridge et al. (1997)	Australia	Random breath testing and 0.05 BAC law	Time series – four states:	+	In Queensland there was a significant 18% reduction in fatal collisions, and in New South Wales an 8% reduction in fatal collisions. Similar effect of random breath testing
Hingson et al. (1998)	Maine state	0.05 BAC limit for DD with prior driving while intoxicated convictions	Controlled before-and-after comparison Maine vs five New England States	-	Proportion of fatal crashes involving drivers with prior DWI convictions in Maine declined by 25% in comparison with a rise of 46% in NE states. However, Maine had prior higher levels of fatal crashes involving target population compared with control states. Effects also likely to be influenced by other policies: new 0.08 for all adult drivers; zero tolerance for under 21; adoption of ALR* for all drivers with illegal BAC levels
Hingson et al. (2000)	USA	0.08 BAC law	Controlled before-and-after study six states vs matched six control states	+	Grouped state comparison showed that 0.08% states experienced significantly greater post-BAC law declines in alcohol-related fatal crashes than comparison states. The relative post-law declines were significantly greater with longstanding ALRs suggesting that post 0.08% law declines were independent of ALR laws
Hingson et al. (1996)	USA	0.08 BAC law	Controlled before-and-after study five states	-	16% reduction in alcohol involvement in fatal crashes. But three of five states adopted ALR, and therefore not possible to discern effect of BAC law. Appropriateness of selection of comparison states unclear
Johnson and Fell (1995)	US five states	Lowering to 0.08 BAC	Before-and-after comparison	-	Reductions in alcohol-related fatal crashes in four of five states (range 4–40% reductions)

Kaplan and Prato (2007)	USA	BAC 0.08 and ALR law differences in compliance between different population groups (gender, age, car occupants)	Time series	+	BAC law associated with a reduction of 7.9% to 8.4% in alcohol-related traffic fatalities, and from 6% to 7.7% in alcohol-related traffic accidents. There were similar reductions associated with the ALR laws. Women and older people exhibit higher law compliance with respect to men and young adult/adult population; presence of passengers in vehicle enhances sense of responsibility of driver. People younger than 21 years excluded from study.
Kloedon and McLean (1997); (1994)	Australia	0.05 BAC law 1991	Trend analysis of roadside survey data (surveillance)	N/A	14% reduction in proportion of drivers with positive BAC levels evident after 2 years. Reductions at all BAC levels
Liang and Huang (2008)	USA	Zero tolerance (ZT) laws on young drivers	Multivariate regression analysis	+	ZT laws reduce drinking and driving among college students. ZT laws are particularly effective at reducing the probability of driving after drinking for those who reported drinking away from home
Mann et al. (2003)	Ontario, Canada	Drink-driving laws:0.08 BAC law and administrative driver's licence suspension (ADLS) law (1996) Tested the differential deterrence hypothesis	Analysis of data of cross-sectional surveys (1996–97)	-	Significant increase in mean alcohol consumption of those who reported drinking driving after introduction of ADLS law compared with alcohol consumption of those who did not drive after driving which remained constant. Author argues that this supports the deterrence hypothesis; i.e. that lighter or more moderate drinkers tend to stop driving after drinking completely and therefore drop out of the drink-driving population, and heavier drinkers remain
Mann et al.	Ontario,	Administrative	Time series with	-	ADLS law associated with a reduction of 17.3% in

(2002)	Canada	driver's licence suspension (ADLS) law	ARIMA modelling		proportion of driver fatalities with a BAC over 0.08 1996–97. Other explanation also possible (increased enforcement)
Mathijssen (2005)	Netherlands	Drink-driving policy	Trend BAC data from national roadside programme of survey	-	Immediate reduction in proportion of drivers with BAC level above 0.05 with new BAC 0.05 law in 1974, decline attributed in part to random breath testing, publicity and enforcement. Large immediate effect faded after 1 year. Other potential confounding factors not considered
McCartt et al. (2006; 2007)	Washington State, USA	Zero tolerance (ZT) law	Time series analysis	-	Significant 51% increase in number of underage arrestees associated with ZT law (p less than 0.001) (taking account of 21–24 year arrest trend and implementation of BAC 0.08 law)
Nagata et al. (2008) Nagata et al. (2006)	Japan	New law 2002 lowering BAC limit from 0.05 to 0.03 and increased penalties	Time series	-	38% decrease in annual average rates of alcohol-induced driving fatalities reported post new law 2002. significant and substantial reduction in alcohol-induced driving traffic problems: fatalities, severe injuries, and all injuries. Law had an effect over and above the existing decline in alcohol induced driving traffic fatalities. But analysis did not control of other alcohol-related policies
Norstrom (1997) Norstrom and Laurell (1997)	Sweden	0.02 BAC law	Time series	-	Statistically significant 10% reduction in fatal accidents,11% reduction in single vehicle accidents, 7% reduction in all traffic accidents. Potential confounding factors not included in the analysis

Tippetts et al. (2005)	18 US states plus District of Columbia	0.08 law	ARIMA model	+	Significant reductions in drink-drivers in fatal crashes in nine of 19 jurisdictions and effects in further seven (not statistically significant). 15% average reduction based on pooled estimates
Ulmer et al. (2000)	Florida	Graduated licensing young drivers	Controlled before-and-after Florida vs Alabama	-	Statistically significant 9% reduction in fatal and injury crashes 15–17 years (p less than 0.01) in Florida. There was no significant changes for any of the age groups in Alabama
Villaveces et al. (2003)	USA	Alcohol-related laws	Time series (regression models)	+	14% reduction in alcohol-related deaths due to BAC 0.08 laws. (Adjusted rate ratio = 0.97 (95% CI 0.96–0.98) , association strongest for alcohol-related deaths. 12% reduction in alcohol-related deaths due to zero tolerance laws. 5% reduction in overall mortality and alcohol related mortality due to administrative license revocation laws
Voas et al. (2003)	US 50 states plus DC	Minimum legal drinking age and zero tolerance laws	Pooled cross-sectional time series	+	Reductions in proportion of underage drink-drivers in a fatal crashes: MDAL 18.9 % Zero tolerance law 24. 4 % These reductions were in addition to contribution of any general alcohol laws
Voas et al. (2001)	Illinois	0.08 law and simultaneous administrative license revocation law (1997)	Time series Pooled regression model (vs five	+	Proportion of drink-drivers in fatal crashes decreased by 14% in Illinois and increased by 3% in neighbouring states

			bordering states)		
Wagenaar and Maldonado-Molina (2007)	US 46 states	License suspension policies	Time series Pooled regression models	+	Administrative (pre-conviction) drivers suspension policies associated with 5% reduction in alcohol-related fatal crashes (p less than 0.05). Reductions consistent for single vehicle night-time crashes and all levels of BAC. Laws providing post-conviction penalties little effect – possibly due to lack of enforcement. Authors state findings support deterrence theory i.e. effectiveness linked to speed by which punishment is applied after offending behaviour rather than by the high severity of the penalty
Wagenaar et al. (2007)	US 28 states	BAC laws (1976–2002)	Time series analysis Pooled regression model	+	Variability in estimated effects at state level. Pooled analysis significant reduction in alcohol-related fatal crash involvement for single vehicle night-time accidents and different BAC levels
Wagenaar (2007)	US 32 states	General deterrence effects of US statutory DUI final and jail penalties	Time series ARIMA pooled	+	Average reduction in alcohol-related fatal crashes with BAC greater than 0.08 of 8% (significant). Jail penalties associated with average decline in single vehicle night fatal crashes of 6%
Wagenaar (2001)	US 30 states	Lowered legal blood alcohol limits for young drivers 0.02 BAC (ZT}	Time series cross sectional survey dataset	+	Frequency of driving after any drinking and driving after five or more drinks declined 19% and 23% respectively. Effects at lower risk moderate drinkers and higher risk drivers

6 Impact evaluation: modelling the effect of changes in the BAC limit

Modelling exercises were conducted by the School of Health and Related Research - ScHARR (University of Sheffield) to estimate the impact of a lowering of the BAC limit to 0.05 in the UK in terms of reduction in the number of deaths and injuries.

A model was developed and was populated with best evidence identified during the systematic review. There was limited direct evidence on the pattern of drink-driving in the UK in terms of an up to date BAC distribution as the last roadside survey was conducted more than 10 years ago. Obviously, since a reduced limit has not been implemented in the UK, there is also a lack of direct UK evidence on how reducing the limit would affect drink-driving behaviours and associated risk of casualties. Consequently, several model parameters were either calibrated or estimated from evidence from the international literature.

The majority of the modelling work employed an indirect approach, calibrating a baseline BAC distribution, modelling a shift in the BAC distribution among drivers, and then estimating savings in fatal or non-fatal casualties. Benefits to other road users were extrapolated from benefits observed among drivers.

The indirect approach involved:

- Calibrating the distribution of the BAC using evidence about the relationship between alcohol and the risk of fatal casualties and the distribution of deaths according to BAC levels in England and Wales.
- Modelling the trend in the BAC distribution using regression methods to account for the natural variation in the BAC distribution in the absence of policy change.
- Modelling the shift of drivers across all of the BAC distribution (including abstainers) after the implementation of the lower BAC limit of 0.05 using evidence available from Australian studies (Brooks & Zaal 1993, Kloeden &

McLean 1997). These studies showed that the effect was immediate but decayed gradually over a period of up to 6 years. It is unclear from these studies the extent of the contribution of confounding factors such as additional enforcement measures. Two scenarios were tested, one assuming the same relative effect and another scenario assuming only half of the relative effect observed in Australia.

- Calculating the variation in the number of casualties over time attributable to the shift in the BAC distribution, assuming all other factors remain constant in England and Wales in the absence of policy and after implementation of the 0.05 BAC law. This was calculated using the 'Population impact fraction' approach (how the risk changed over time) and the baseline number of casualties.

A simpler direct approach was also employed, extrapolating European evidence on the effects of reducing the legal limit to England and Wales using results from a multivariate regression modelling study conducted by Albalate (2006).

The primary outcomes were the reduction in fatal and non fatal casualties in England and Wales for drivers, passengers and pedestrians killed or injured by drivers. Note that this study examined all road casualties not just those defined as drink-drive casualties (i.e those over the current legal limit). A much broader definition was selected. This is because the policy change would affect the BAC distribution even at very low BAC and hence translate into a change in the overall number of casualties.

The model results suggest that, assuming that the policy produces the same relative effect on the BAC distribution as observed in Australia and after accounting for the recent trends in the estimated BAC distribution, then lowering the legal limit would reduce fatalities by 6.4% and injuries by 1.4% in the first year after its implementation. This translates into a reduction of 144 fatal casualties and 2,929 injuries out of the overall number of casualties predicted by the model for 2010 in the absence of policy change (2,253 fatal, 212,329 non fatal). Results for the year 2015 and for the secondary scenario

assuming half of the relative effect observed in Australia is presented in the table below. Detailed results for each of the 6 years modelled are available in the full modelling report.

Table 1: Model outcomes: proportional and absolute reduction in the number of casualties overall

Modelling approach		Modelling results: estimates of avoidable deaths and injuries Avoidable deaths	Avoided serious injuries	Avoided non serious injuries	Total avoided casualities
Indirect approach: model the shift in the BAC distribution					
Base case*	2010	144 (6.4%)	323 (1.4%)	2,606 (1.4%)	3,073
	2015	303 (13.8%)	708 (3.1%)	5,715 (3.1%)	6,726
Sensitivity analysis**	2010	70 (3.1%)	139 (0.6%)	1,121 (0.6%)	1,330
	2015	158 (7.2%)	274 (1.2%)	2,213 (1.2%)	2,645
Simple direct approach : Extrapolating results from the Albalate study					
Upper limit	Base case***	168 (7.4%)	1,746 (7.4%)	14,086 (7.4%)	16,000
	Sensitivity analysis****	168 (7.4%)	873 (3.7%)	7,043 (3.7%)	8,084
Lower limit	Base case***	77 (3.4%)	797 (3.4%)	6,427 (3.4%)	7,300
	Sensitivity analysis ****	77 (3.4%)	398 (1.7%)	3,213 (1.7%)	3,688

* assuming the full relative effect, as observed in Australia

** assuming only half of the relative effect observed in Australia

*** assuming the same proportional reduction for non fatal casualties as for fatal (Albalate, 2006)

**** assuming the reduction for non fatal casualties is half of the reduction observed for fatal casualties (Albalate, 2006)

The results of extrapolating findings from the Albalate study suggest a saving of fatal casualties ranging between 3.39% to 7.43%. Assuming the same

proportional reduction for non fatal casualties as for fatal produces an estimated total reduction of casualties ranging between 7,300 to 16,000 (3,688 to 8,084 if we assume that non fatal effect are 50% of fatal). (Estimates for upto 2015 were not calculated for this simple direct approach.)

A set of sensitivity analysis was also conducted to test the robustness of the model to the main model assumptions and results were sensitive to the method used to model the trend in the BAC distribution in the absence of policy change, the effect of the policy using a proxy of the 95% CI from the Kloeden study and the risk function used for serious injuries.

While best evidence available was used, these results have to be taken with considerable caution as the modelling exercise was limited by evidence and data available. There were many uncertainties and unknowns and several parameters were not observable and so estimated indirectly.

Estimates were also compared with findings of other evaluation studies. These included the study by Allsop (2005, 1996). This study estimated 65 avoidable deaths each year and 230 serious injuries. The assumptions underpinning Allsop's approach are more conservative: it was assumed (no supportive evidence) that those drinking and driving with a BAC above 0.11 would not be affected by the lowering of the BAC limit to 0.05. A number of studies (Australia and elsewhere) show that the lowering of the BAC limit could reduce alcohol related deaths at BAC levels well above the BAC low limit, although the underpinning behaviour change mechanisms are unclear. Benefits for drivers with a low BAC were also not considered in the Allsop study. These two assumptions have been replaced in the ScHARR work using international evidence available. The ScHARR work also modelled the shift in the BAC across the entire distribution and was not constrainted to "drink-drivers" alone because a change at even low BAC would translate into savings in casualties.

To conclude, two modelling approaches have been used to provide estimates of the policy effects. This modelling work suggests that the policy could be

effective in reducing road fatalities by around 6-7%, although there will remain uncertainty around this estimate until the implementation of a lower limit in England and Wales.

References

Albalate D (2006) Lowering blood alcohol content levels to save lives: the European experience. Journal of Policy Analysis and Management 39

Allsop R (2005) Reducing the BAC level to 50 mg – what can we expect to gain? PACTS research briefing. available from http://www.pacts.org.uk/docs/pdf-bank/lowerlimit.pdf

Brooks C, Zaal D (1993) Effects of a reduced alcohol limit for driving. Australia: Department of Transport

Kloeden C, McLean AJ (1997) Night-time drink driving in Adelaide: 1987-1997 report series 5/97. South Australia: Office of Road Safety Department of Transport

Maycock G (1997) Drinking and driving in Great Britain – a review. TRL Report 232, UK.

7 International review: comparative analysis

The comparison of international policies was based on appraisal of the following themes:

- the scope of alcohol control and road safety policies and views on effectiveness
- international comparisons of alcohol control and road safety policy impact
- trends in alcohol control and road safety policies, specifically BAC limits and related measures
- public attitudes on alcohol control measures and driver attitudes and behaviours
- issues in decision-making about changes to BAC limits.

The focus on these themes was intended to provide practical illustration and testing of the policy aspects of the conceptual framework. The aim is to support the interpretation and review of the evidence of effectiveness, particularly on the nature of alcohol control policies and their inter-relationship, and enable consideration of the potential applicability of findings to the UK context. To sharpen the focus we selected a small number of developed countries as reference points for some of the analysis: the Netherlands, Sweden, Japan, Australia, New Zealand, Canada, and the USA.

The international literature mainly comprises documentation from national governments and their various research and advisory agencies, supranational and international bodies, national and international non-governmental organisations, and independent academic researchers and policy analysts. The documentation was very diverse and included country-related research, analysis, technical reports, monitoring reports, and reviews of strategies, along with international overviews and comparative analyses. The following points and cautions about this literature should be noted:

- Policy literature from and about individual countries is predominantly from the English-speaking world: Australia, Canada, New Zealand, and the

USA. International overviews are the main source of information about policies in Europe and the rest of the world.

- There are barriers to assessing whether a country's experience can be generalised. Literature from individual countries provides detail but tends not to be explicit about underlying assumptions and contextual factors that condition policies or their impact. On the other hand, comparative overviews are based on patchy data of variable quality, may categorise policies which work in very different ways from country to country as the same, and tend to assume declared policies have been effectively implemented.
- Literature produced or commissioned by bodies such as the European Commission and World Health Organization, and related non-government organisations, often has the aim of advocating universal application of a particular policy template for alcohol control or road safety. It tends to use very high-level summaries of the supporting evidence, and, for practical reasons, pays little attention to contextual features. There is little analysis of how policies interact, or, in the absence of evidence, an explicit theory or model of why they might interact.

7.1 Policy contexts for measures against drink-driving

The international literature looks at BAC limits and drink-driving from two main but overlapping points of view: as part of alcohol control policies and as part of road safety policies. Whether at international or national level, the range of interested policy makers includes those in the fields of transport, health, and criminal justice most directly, but also local government, education, trade and industry, culture, and finance.

Drink-driving within alcohol control policies

There is little variation worldwide in the components of alcohol control policies, although there are differences in how they are conceptualised or categorised. Measures against drink-driving are a core component.

The typical range of interventions within alcohol control policies is illustrated in an overview of approaches in the World Health Organization (WHO) European Region (Rehn 2001):

- Information and education
- Public, private and working environments
- Drink-driving:
    - legal BAC levels
    - high visibility road checks
    - random breath testing
    - penalties
    - mandatory education and treatment programmes
- Availability of alcohol products:
    - licensing and monopolies
    - restrictions of sale
    - age limits
    - alcohol prices – taxation
    - promotion and advertising
- Treatment
- Responsibilities of the alcohol industry, including:
    - alcohol content information
    - maximum alcohol content limits
    - server training and liability
- Enhancing society's capacity to respond to alcohol-related harm
- Working with non-government organisations
- Implementation and monitoring of policy.

WHO, individual WHO regions, the EU, and other supranational bodies and non-government organisations promote and make recommendations on developing alcohol control policies, including measures against drink-driving.

There is general consensus among international policy makers about the policies and interventions that are effective, value for money, and best

supported by evidence, although there are some differences in estimates of the degree of effectiveness and efficiency. A recent WHO Regional Office for Europe report gives the highest rating to introduction and/or reduction of legal BAC levels, when they are enforced through the introduction of sobriety checkpoints and random breath testing (WHO 2009). These are the only drink-driving interventions for which it finds the evidence 'convincing' on a descending scale of 'convincing', 'probable', 'limited-suggestive'. It found some evidence that lower BAC levels for novice drivers reduce motor vehicle accidents and fatalities.

The example below is a more detailed assessment of the evidence by the Institute of Alcohol Studies (2007) for the European Commission. (Note that BAL refers to blood alcohol concentration level.)

	Effectiveness[1]	Breadth of Research Support[1]	Cost Efficiency[1]
Lowered BAL levels	+++	+++	+++
Random breath testing (RBT)	+++	++	+
License suspension	+++	++	++
Alcohol locks	+	+	+
Low BAL for youth	+++	++	+++
Graduated licensing	++	++	+++
Server training and civil liability	+	++	+
Designated drivers and ride services	O	+	++
School based education courses	?/O	+	+
Mass media campaigns	++	+	+
Community programmes	++	++	+

Effectiveness: 0 Evidence indicates a lack of effectiveness; + Evidence for limited effectiveness; ++ Evidence for moderate effectiveness; +++ Evidence of a high degree of effectiveness; ? No studies have been undertaken or there is insufficient evidence upon which to make a judgment..

Breadth of research support: 0 No studies of effectiveness have been undertaken; + Only one well designed study of effectiveness completed; ++ From two to four studies of effectiveness have been completed. +++ Five or more studies of effectiveness have been completed; ? There is insufficient evidence.

Cost efficiency: 0 Very high cost to implement and sustain; + Relatively high cost to implement and sustain; ++ Moderate cost to implement and sustain; +++ Low cost to implement and sustain; ? There is no information about cost or cost is impossible to estimate.

In 2001, the European Commission recommended that all member states of the EU should adopt a legal maximum BAC limit of 0.05 or lower for drivers and riders of all motorised vehicles, and a lower legal maximum of 0.02 or lower for inexperienced drivers, riders of two-wheeled motor vehicles, drivers of large vehicles, and drivers of vehicles carrying dangerous goods (European Commission 2001). It also recommended the adoption of random breath testing at a frequency that would mean that there was a realistic probability that drivers would be tested at least once every 3 years, and called for harmonisation of the accuracy of alcohol breath testing devices.

Drink-driving within road safety policies

The 2004 World Bank and WHO report on road traffic injury prevention (WHO 2004) is still the definitive international statement of concern about the detrimental impact of an unsafe road transport system on public health and global development. The report calls for adoption of a systems approach to preventing road crash injury, as defined in the 'Haddon matrix' (see below), with strategies focusing on the 'human', 'vehicles and equipment', and 'environment' factors involved in the three phases of the time sequence of a crash event: pre-crash, crash, and post-crash.

The Haddon Matrix

		FACTORS		
PHASE		HUMAN	VEHICLES AND EQUIPMENT	ENVIRONMENT
Pre-crash	Crash prevention	Information Attitudes Impairment Police enforcement	Roadworthiness Lighting Braking Handling Speed management	Road design and road layout Speed limits Pedestrian facilities
Crash	Injury prevention during the crash	Use of restraints Impairment	Occupant restraints Other safety devices Crash-protective design	Crash-protective roadside objects
Post-crash	Life sustaining	First-aid skill Access to medics	Ease of access Fire risk	Rescue facilities Congestion

Source: WHO (2004)

The report recommends interventions on the basis of effectiveness and/or cost effectiveness in the following categories:

- managing exposure to risk through transport and land-use policies
- shaping the road network for road injury prevention

- providing visible, crash-protective, 'smart' vehicles
- setting and securing compliance with key road safety rules
- delivering post-crash care.

In relation to the 'human' and 'vehicles and equipment' factors in the matrix, the category on 'providing visible, crash protective, "smart" vehicles' includes alcohol ignition interlock devices. And the category on 'setting and securing compliance with key road safety rules' covers behavioural factors, including setting and enforcing alcohol impairment laws (including BAC limits, lower BAC limits for young and novice drivers, deterrence through breath testing, penalties, and interventions for high-risk offenders).

The 1992 Maastricht Treaty gave the European Union the legal means to establish a framework and introduce measures in the field of road safety. A European Commission white paper in 2001 set a target for the EU of reducing by half the number of people killed on European roads by 2010, and proposed for policy development speeding, drink-driving, seat-belt use, and driver education, among other issues (European Commission 2001). An action programme in 2003 proposed measures in pursuit of the 2010 target in the three areas of: driver behaviour, vehicle safety, and road infrastructure (European Commission 2003). The programme identified the failure of drivers to comply with basic road safety legislation on drink-driving, wearing a seat belt or crash helmet, and speeding as the main cause of serious accidents and thus the focus of action on driver behaviour.

The European Transport Safety Council[3] identifies alcohol among a number of key causes of road traffic accidents and proposes solutions to each problem framed according to the European Commission's targeted three areas (European Transport Safety Council 2009). It recommends alcohol interventions in the areas of behaviour and vehicle technology:

- Behaviour:

[3] The European Transport Safety Council (ETSC) is an international non-governmental organisation which was formed in 1993 in response to the 'persistent and unacceptably high European road casualty toll and public concern about individual transport tragedies'.

  - a 0.02 BAC limit for commercial and novice drivers
  - strict follow-up of drink-driving offences
  - support for non-government organisations addressing drink-driving among young people
  - involve commercial organisations in initiatives on drink-driving among workforces
  - integrate drink-driving measures and health and safety at work initiatives
  - adoption of standardised definitions of drink-driving and alcohol-related accidents and road deaths in the EU
  - appropriate labelling of alcohol drawing attention to the consequences of drink-driving
  - promote rehabilitation of drink-drivers
  - an EU-wide monitoring system

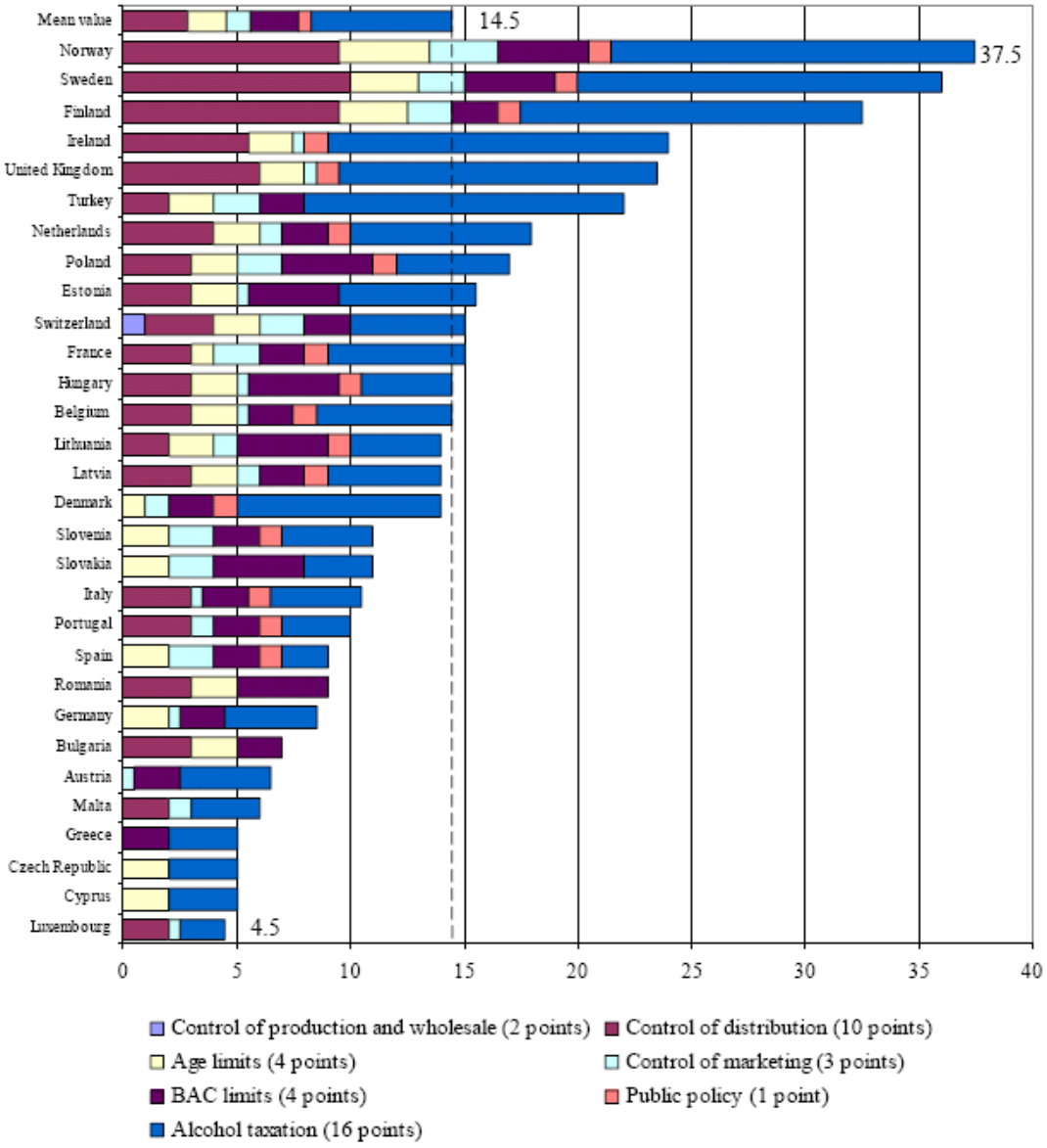
- Vehicle technology:
  - uniform standards for alcohol ignition interlock devices
  - legislate for reliability of alcohol ignition interlock devices
  - further research into alcohol ignition interlock devices in rehabilitation
  - research into development of non-intrusive alcohol ignition interlock devices
  - mandatory alcohol ignition interlock devices for commercial drivers and recidivist drink-drivers
  - legislation in the long term making alcohol ignition interlock devices mandatory for all drivers.

7.2 Comparative assessments of national alcohol control policies

It is accepted that the impact of alcohol control policies is related to the number of effective interventions they contain. Researchers have attempted to rank countries' alcohol control policies in the EU and more widely according to comprehensiveness and strictness. This has involved the construction of

increasingly sophisticated rating scales, with the number of points awarded in the various domains of the scales depending on the strictness of application of each intervention and evidence-based assessments of the intervention's effectiveness.

Strictness of alcohol control policies in the 'Bridging the gap' countries in 2005 according to subgroups of alcohol control



Source: Karlsson and Osterberg (2006)

One example is the Bridging the Gap (BtG) scale (Karlsson and Osterberg 2006) – see above. This has seven subgroups of intervention: control of production and wholesale; control of distribution; personal control (age limits);

control of marketing; social and environmental controls (i.e. BAC limits); public policy; and alcohol taxation. The scale has 40 points, to which BAC limits contribute 4 points, or 10% of the total. By share of the total score, BAC limits along with personal control (age limits) are in third place, behind alcohol taxation (16 points, 40%) and control of distribution of alcohol (10 points, 25%).

Alcohol Policy Index

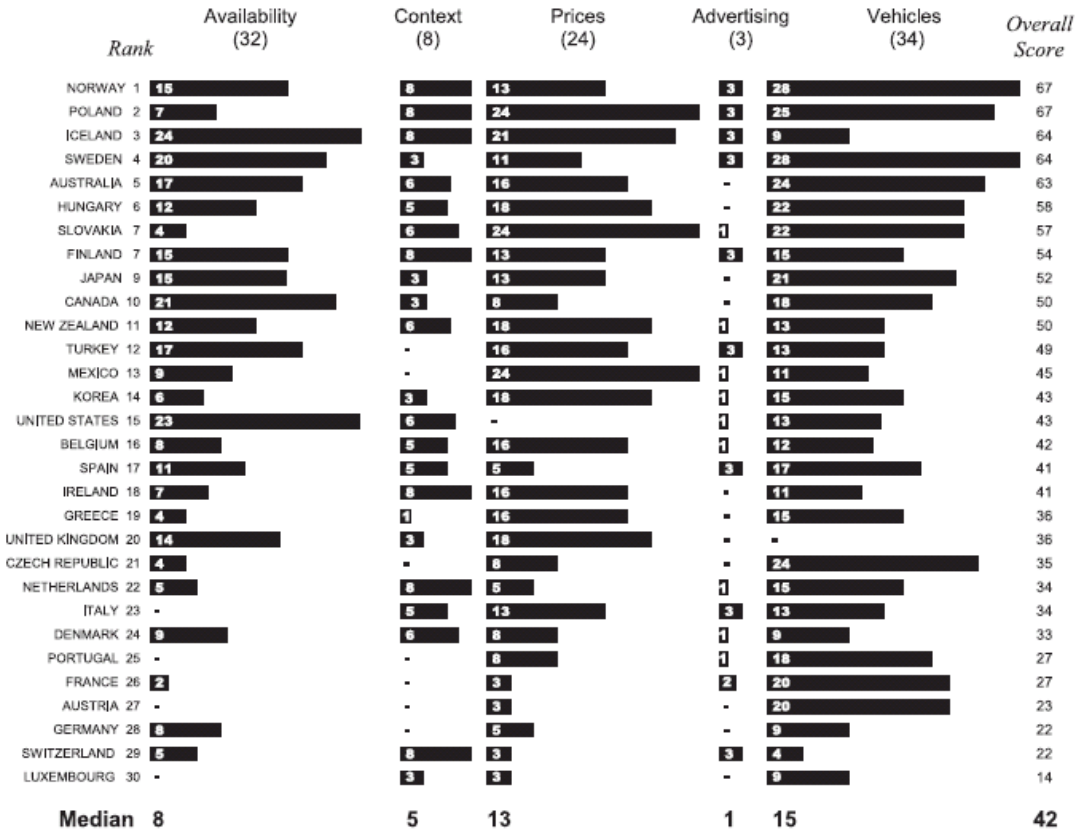


Figure 2. Point Breakdown of Alcohol Policy Scores by Regulatory Domain

Bar lengths indicate points credited to countries for alcohol control policies in each of five regulatory domains (physical availability of alcohol, drinking context, alcohol prices, alcohol advertising, and motor vehicles). –, zero points in a given domain. Points do not always add up to overall scores due to rounding errors. Numbers in parentheses indicate the full point value of each domain. Median scores within each domain and the overall median appear beneath the bars.

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Source Brand (2007)

Another example is the ‘Alcohol policy index’, which rates and compares the 30 countries in the Organization for Economic Cooperation and Development (OECD) on the extent to which they have implemented alcohol policies assessed as effective – see above (Brand 2007). Countries achieve a higher score for implementing policies of greater effectiveness. The index is based

on five domains: physical availability; drinking context; alcohol prices; alcohol advertising; and motor vehicles, which covers policies on random breath testing, legal BAC levels (for adults and youths), mandatory penalties for exceeding the legal limit, and graduated licensing for young drivers. The possible maximum score in this domain is higher than that for the other four domains. The index therefore attaches greater importance than the 'Bridging the gap' scale to the domain concerned with drink-driving: in the former drink-driving accounts for around one-third of the points available, compared with one-fifth in the latter. The index's domain also breaks the BAC limit down into an adult and youth intervention and includes interventions that don't feature at all on the 'Bridging the gap' scale, namely random breath testing, mandatory penalties for exceeding the legal limit, and graduated licensing for young drivers.

In addition, the index, unlike the 'Bridging the gap' scale, relates scores to an outcome – countries' annual per capita alcohol consumption. Brand et al (2007) found that the strength of policies varied widely, and that there was a strong negative correlation between score and alcohol consumption: a 10 point increase in the score was associated with a 1 litre decrease in absolute alcohol consumption per person per year.

There are several shortcomings to these rating scales (Brand et al 2007; Karlsson and Osterberg 2006; Ritter 2007):

- They only measure the strictness of formal controls and do not capture the informal alcohol controls said to be typical of Mediterranean countries and other cultural factors that affect the pattern of alcohol consumption.
- They are unable practically to accommodate the whole range of alcohol policy options.
- They measure stated policy objectives and programmes but not the effectiveness of implementation or of enforcement – for example, whether policies concerned with drink-driving have had an impact on reducing road casualties.

- They do not capture variation within countries such as those in federal states or with internal cultural or linguistic differences.
- In the case of the outcome-related alcohol policy index, the dependent variable is alcohol consumption rather than alcohol-related harm.
- One cannot infer a causal relationship between policy score and alcohol consumption, although Brand et al. (2007) argue that longitudinal data suggest that strong regulation reduces consumption.
- In the view of Karlsson and Osterberg (2006), the 'Bridging the gap' scale provides an easy way of comparing different countries' policies, but is a simplistic tool, which should be used cautiously.

In addition, the scales are based on the assumption that the impact of policy increases as interventions are added on. This proposition has commonsense appeal, but is difficult to test because of lack of evidence about the effect of interactions among alcohol interventions. Researchers evaluating policies have attempted to explore these interactions by developing conceptual frameworks or logic models in which they make the assumptions of interest explicit (see Shults et al. 2001).

A particular problem in relating drink-driving policies to outcomes is the incomparability of country-level data on key outcomes such as drink-driving-related mortality rates because of large differences in the ways in which countries define and record drink-driving-related crashes (European Transport Safety Council 2007).

According to the 'Bridging the gap' scale, alcohol control policies are:

- most strict in Norway, Sweden and Finland
- medium strict in Ireland, the UK, the Baltic states, Poland, Hungary, the Netherlands, Belgium, France, Switzerland and Turkey
- least strict in the wine-producing countries, Austria, Bulgaria, Cyprus, the Czech Republic, Germany, Greece, Italy, Luxembourg, Malta, Portugal, Romania, Slovakia, Slovenia and Spain.

On this scale, the UK ranks sixth out of 30 countries in Europe. The highest scoring third of countries in the index includes, from Europe, the Nordic countries (Norway, Iceland, Sweden, and Finland), Hungary and Slovakia, along with Australia, Japan, and Canada, The middle ranking third includes, from Europe, the UK, Turkey, Belgium, Spain, Ireland, and Greece, along with New Zealand and the USA. The Netherlands and several other European countries are in the bottom third.

A legal BAC limit higher than 0.05, the lack of a lower legal limit for young drivers, and an enforcement policy that does not include random breath testing are the reasons for the UK's lower ranking on these scales than might be expected given its record on road safety (see the following section).

7.3 Comparative assessments of road safety policies

On the basis of policies and their impacts, the UK has a high ranking on the key road safety priorities of speeding, drink-driving, and seat belt use. In a comparison of the then 25 EU countries' performance on enforcement related to these priorities, the European Transport Safety Council (2006) places the UK fifth (the Netherlands third and Sweden fourth) – see the table below.

On policy outcomes, the UK ranks among the EU countries with the lowest rates of road deaths per million population: in fourth place behind Malta, the Netherlands and Sweden (European Transport Safety Council 2008).

EU countries performance: speeding, drink driving and seat belt use

	Speeding	Drink driving	Seat belt use
Finland	+++++	+++++	+++
Germany	+++	+++	+++++
Netherlands	+++++	+++	+++
Sweden	+++	+++	+++++
UK	+++	+++	+++++
Austria	+++	+++	+++
Belgium	+++	+++	+++
Denmark	+++	+++	+++
France	+++	+++	+++
Luxembourg	+++	+++	+++
Slovenia	+++	+++	+++
Czech Republic	-	+++	+++
Ireland	+++	-	+++
Malta	+++	-	+++
Portugal	+++	-	+++
Estonia	-	+++	-
Greece	-	+++	-
Hungary	-	+++	-
Italy	-	+++	-
Latvia	-	+++	-
Lithuania	-	+++	-
Slovakia	-	+++	-
Spain	-	-	+++
Cyprus	-	+++	-
Poland	-	-	+++

-	needs to do more
+++	is improving
+++++	is a champion

Source: European Transport Safety Council (2006)

7.4 Broad trends in alcohol control and road safety policies: BAC limits and related measures

In Europe since the 1960s there has been a shift towards stricter and more similar alcohol policies, particularly between 1980 and 1990. The main factor in harmonisation is the increase in alcohol-related policy-making in many countries, particularly in the area of drink-driving where all European countries now have a legal BAC limit. Marketing controls, minimum ages to buy alcohol, and public policy structures to deliver policy are now much more common (Institute of Alcohol Studies 2006).

It is evident that countries are influenced by general trends in policy elsewhere and by the advocacy of the WHO. European countries are influenced by EU policies; there is mutual influence among English-speaking countries – Australia, Canada, New Zealand, the USA, and the UK; and Canada and the USA are influenced by developments in Europe.

Significant declines in the last two decades in alcohol-related motor vehicle deaths and injuries worldwide have been attributed to a dramatic shift in public attitudes so that drink driving is no longer socially acceptable (Worldwide Brewing Alliance 2008). The European Transport Safety Council (2007) concluded from evidence from 15 countries that deaths from drink-driving crashes in Europe were decreasing faster than road deaths from other causes, though acknowledging that it was a mixed picture and that recording of drink-driving crashes is 'patchy'.

However, progress in reducing injuries and deaths has slowed in recent years, and in some countries trends have reversed. Among our selected comparator countries:

- In Australia, there has been a significant long-term reduction in the incidence of driving-related accidents, but the trend over recent years in the incidence of drink-driving across states is stable.
- In Canada, the rate of fatally injured drivers with a BAC over the legal limit has flat-lined in the last 5 years, after a sharp drop between 1987 and 1999.
- In New Zealand, there has been a levelling off in the incidence of alcohol-related accidents in the last 5 years, although in the long term there has been a dramatic reduction.
- In Sweden, drink-driving is increasing: about 25% of fatal accidents are alcohol-related, a rise from 18% a couple of years ago.

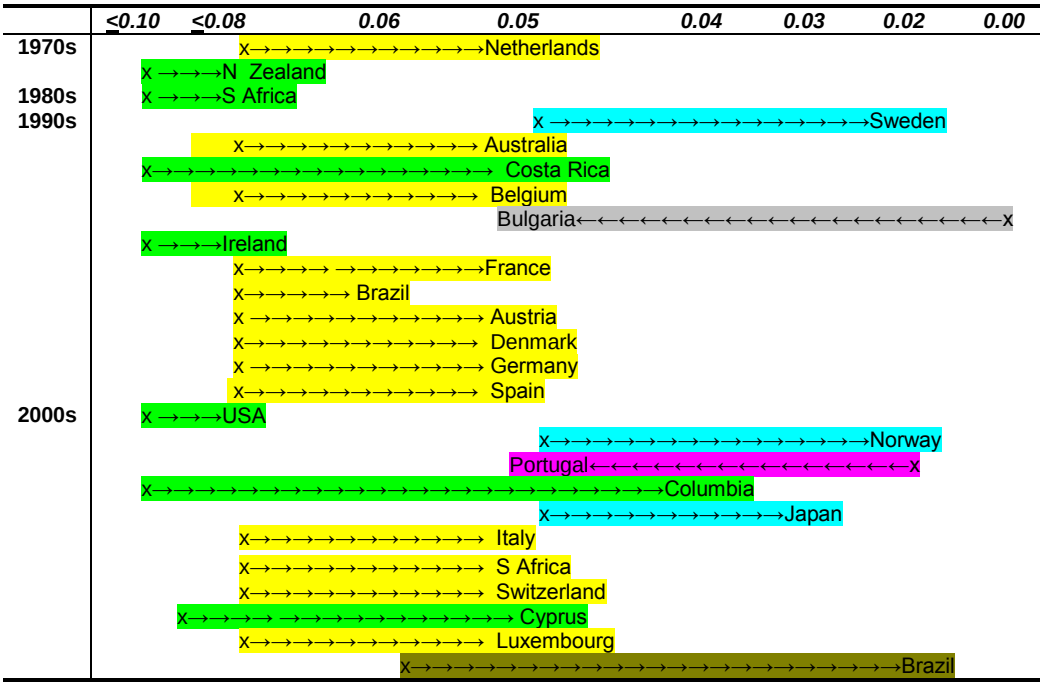
In Japan, by contrast, drink-driving and alcohol-related accidents decreased dramatically in the month since introduction of stiffer penalties in 2007; and, in

the Netherlands, the lowest rate of tested drivers over the legal limit since 1975 is attributed to a combination of intensive enforcement and education.

The UK is among a relatively small group of countries whose legal BAC limit is 0.08, and it has not changed the legal limit in the 43 years since establishing it. The trend of change worldwide is predominantly in the direction of reducing BAC limits, mainly to 0.05 or lower.

The table below shows the direction of travel of legal BAC limits in the 24 countries in Europe and worldwide which have made changes since the mid-1990s. (The colour-coding identifies countries with similar BAC limits before they made changes.)

The direction of change in BAC limits worldwide



Sources of data: Rehn (2001); Worldwide Brewing Alliance (2008)

In recent years among the selected comparator countries, Japan has reduced its BAC limit to 0.03. (Outside the comparator group, Russia and Korea have considered respectively raising and lowering their BAC limits.) Canada has considered and rejected proposals to further reduce the federal criminal code BAC limit from 0.08 to 0.05. Because the debate in Canada was recent, we

have included a case study (see Appendix A) summarising how the argument evolved and highlighting some more generally relevant issues, such as:

- the policy response when effective strategies begin to lose momentum
- the risk that a reduction in the legal limit will overburden a legal system without increasing the law's deterrent effect
- concerns that a reduction would cover a group of drivers who were not a substantial problem and have minimal effect on the problem group
- worries about unnecessary criminalisation and the proportionality of policies
- the role of administrative rather than criminal sanctions at lower than legal BAC limits
- growing interest in enforcement measures beyond the BAC limit, especially random breath testing
- growing interest in lower BAC limits for young and novice drivers.

The case of the USA illustrates how special factors can affect policy-making. There, the conjunction of a particularly effective grassroots organisation – Mothers against Drunk Driving (MADD) – with a growing body of scientific evidence on impairment of driving-related skills at low BAC levels encouraged a trend towards the lower legal BAC limit of 0.08, assisted by financial incentives for states from the federal government (Fell and Voas 2003).

Lower BAC limits for certain categories of driver

Many countries have introduced enforceable BAC limits below the legal maximum, sometimes called 'zero tolerance laws'. They apply to certain categories of driver – typically, young, learner, probationary and professional drivers. The limits vary from country to country but are mainly in the range zero to 0.04. Among the selected comparator countries, the states and territories of Australia, the provinces and territories of Canada, the states of the USA, the Netherlands, and New Zealand have variously set lower BAC levels (from zero to 0.03) for learner, probationary and professional drivers. Japan and Sweden, which at 0.03 and 0.02 respectively are among a small

group of countries with the lowest BAC limit (apart from those with a zero limit), have not done so.

Graduated driver licensing

Graduated driver licensing is a system designed to give young drivers more driving privileges as they become more mature and develop their driving skills. Phases may include a learner phase, which has a defined minimum length, and a novice or provisional phase leading to a full licence. Among the selected comparator countries, there are graduated driver licensing schemes in Sweden, all Australian states, New Zealand, most Canadian provinces, and in states in the USA.

7.5 Enforcement of BAC limits

The important role of enforcement in reducing drink-driving in conjunction with the BAC limit is emphasised in the ESCAPE consortium's European review (Makinen et al 2002). This shows a correlation between the objective risk of detection (as measured by proportion of drivers tested) and frequency of drink-driving. Countries fulfilling most of the following criteria have the lowest drink driving figures:

- Long tradition in drink driving enforcement including low legal limits
- Relatively high objective risk of detection
- Mass media supporting enforcement.

The meta-analysis conducted by Elvik (2000) included 39 experimental enforcement schemes. The overall effects of enforcing against drinking and driving were reductions of 9% and 7% in the numbers of fatal and injury-causing accidents respectively.

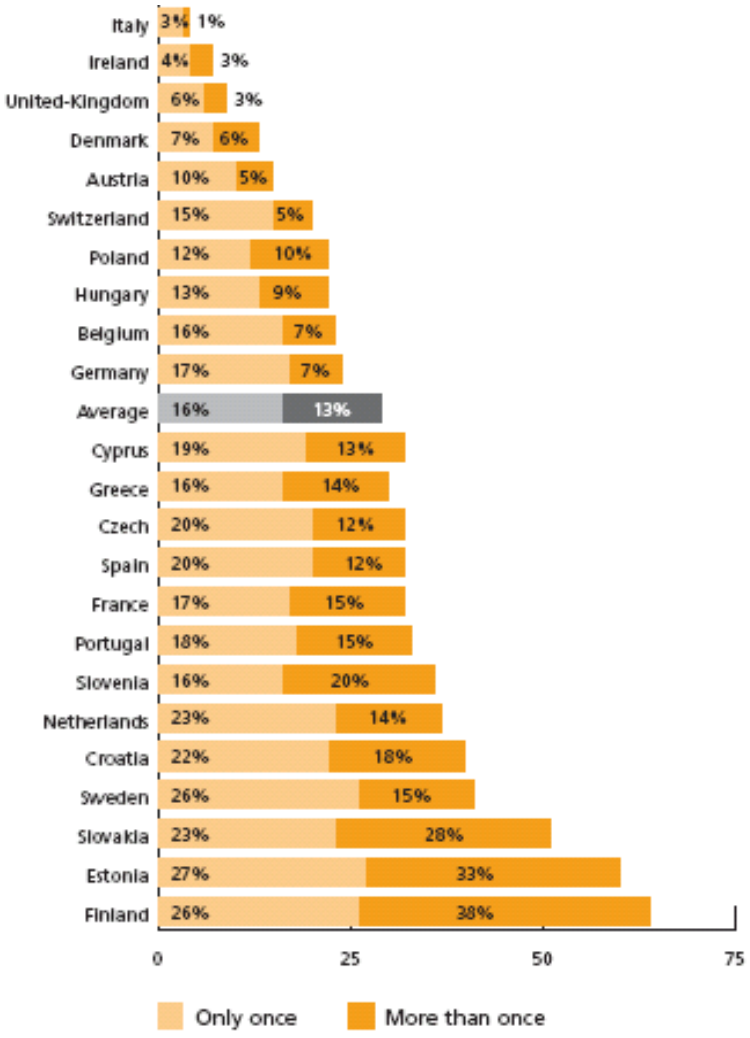
Random breath testing

Random breath testing is becoming more prevalent – it is now used in around 85% of countries in the European region (including, since 2006, Ireland). There is evidence that frequency of testing is increasing. The available data do not take account of random breath testing at state or provincial level in

jurisdictions with no federal policy on the issue, or of practices such as sobriety checkpoints in some states in the USA.

The UK stands out from the European average in the high proportion of its drivers who have not been checked for alcohol levels: 91% compared with 71% (and 63% in the Netherlands; 59% in Sweden) (SARTRE 2004) – see the chart below. Drivers in countries such as the UK without systematic random breath testing are more likely to say they have not been checked in the last 3 years than those in countries where random breath testing is common (86% versus 65%); and twice as likely as drivers where such testing is common to think they will never be checked (46% versus 22%).

Proportion of drivers checked for alcohol over the last three years



Source: European Transport Safety Council (2006) from SARTRE (2004)

Among the selected comparator countries:

- there are no federal-level policies on random breath testing in Australia, Canada, and the USA, but there are policies on testing in some states/provinces/territories of Australia and Canada, though not in the USA. Twelve US states use ‘sobriety checkpoints’.
- there is random breath testing in Japan, New Zealand, the Netherlands, and Sweden (and the Netherlands and Sweden are among the EU countries where the highest proportion of drivers are checked).

The European Transport Safety Council (2006) claims that the best results in reducing road traffic casualties are achieved by countries that run random alcohol screening tests in conjunction with evidential breath testing, and gives as examples Finland, France, Sweden, and the Netherlands. However, it also highlights some ambiguities about the relative roles of BAC limits and enforcement intensity in the resulting rate of deaths caused by drivers over the limit. This illustrates a more general problem in extracting lessons for a particular country when there are unexplained anomalies in comparative overviews of this sort. For example, the UK, the Netherlands, and Sweden are among countries with the lowest rates of traffic fatalities in the EU, but the UK is among the countries which check drivers for alcohol the least, whereas the Netherlands and Sweden are among those that check the most. On the other hand, the UK is one of the three countries with the highest proportion of alcohol tests resulting in sanctions for drink-driving offences, whereas Sweden and the Netherlands are the lowest and second lowest respectively. As a further complication, UK citizens’ lack of knowledge of their country’s legal BAC limit is in sharp contrast with the much higher awareness in the Netherlands and Sweden (see section 7.6 below).

BAC limit-related penalties

Sanctions for drink-driving offences related to BAC limit violations vary greatly from country to country and can be criminal or administrative, criminal only, or administrative only. A study by a PEPPER (Police Enforcement Policy and Programmes on European Roads) project on ‘traffic enforcement chains’ in 18

EU member states found a great variety of combinations of criminal and administrative sanctions, along with examples of exclusive use of either criminal or administrative sanctions, for driving offences, including drink-driving (Larsen 2006). Of the 16 states which provided information, the majority – eight – used a combination of criminal and administrative sanctions; two used exclusively administrative sanctions (along with a further two in cases where there was no injury); and five (including the Netherlands, Sweden and the UK) used exclusively criminal sanctions.

Sanctions escalate according to the range or band within which the BAC reading falls. In countries with both types of sanction, criminal sanctions take over from administrative sanctions as offences become more serious or are repeated or involve injury. There is considerable inconsistency among countries in the severity of sanctions, whether administrative or criminal, although they tend to be more severe in cases of repeated violation. Also, sanctions in one country by an administrative route can be similar to those in another country by the criminal route. The final PEPPER study report (Kallberg 2008) comments that a comparison of the countries with criminal traffic law with those having primarily an administrative system, suggests that the nature of the legal system is not a determining factor in the level of road safety in the country.

Canada is a country where a tiered approach has arisen from differences in legal powers between federal and provincial jurisdictions: federal criminal code sanctions apply at a BAC level of 0.08, whereas provinces and territories can apply administrative sanctions for BAC levels lower than 0.08. In the USA too powers over drink-driving and road safety are divided between the federal government and states, with the states setting legal BAC limits and the federal government having certain powers to encourage legislative changes.

The provinces or states of these countries can use the administrative sanction of suspending or revoking with immediate effect the licence of drivers based on the result of a breath test. In the USA, 41 states and the District of Columbia have introduced administrative licence revocation laws, with the

encouragement of the federal agency, the National Highway Traffic Safety Agency (NHTSA). These laws are part of enforcement of state legal BAC limits whereas in Canada they can also be an intervention against drink-driving at BAC levels below the legal limit. In the USA they have been controversial and have withstood legal challenges that they are unconstitutional (on grounds of double jeopardy – i.e. they enable two punishments for a single offence) and a violation of due process. The advice from the NHTSA highlights the importance of framing the law within the terms of state legislation on administrative procedures (NHTSA 2008).

As illustrated in the case study in appendix A, there have been concerns in Canada about consistent and stringent imposition of administrative licence suspensions on drink-drivers with BACs below the legal limit (Canadian Council of Motor Transport Administrators 2003, 2005, 2007, 2008). The main argument in support of this sanction is the increased deterrent effect of its immediacy. Suspensions are typically for a period of 24 to 72 hours for drivers below the criminal code threshold of 0.08 and above the range 0.04–0.05. The Canadian Council of Motor Transport Administrators (2008) has argued for longer suspension periods – of 7 to 14 days – and graduated extensions of the period for subsequent offences.

Ignition interlock devices

The Worldwide Brewing Alliance (2008) found that breath alcohol ignition interlock devices were being used or tested in nine EU countries (including Sweden and the UK), Mexico, Australia, Canada, and the USA. In the USA, 45 states permit judges to require installation of ignition interlocks in the car of convicted drink-driving offenders, with numerous thresholds for implementation. The Netherlands plans to initiate an interlock programme for serious offenders during 2010 (SWOV 2009).

Tests of alcolocks include a European Commission-funded feasibility study and a field trial involving Norway, Spain, Germany, and Belgium (see Silverans et al. [2006] for the report of the study); and studies in the states of Queensland, South Australia, and Victoria in Australia.

The European field study concluded that participants found the alcolocks easy to use and useful, and that the device had a ‘decisive’ positive impact on drink-driving behaviour (Silverans 2006). It also proposed ‘ideal’ features of an alcolock programme for offenders:

- mandatory successful completion of the programme as a condition of full licence reinstatement
- tailoring to distinct target groups (varying from first to alcohol-dependent offenders)
- flexibility in duration of the interlock sanction
- not preceded by a (lengthy) period of hard suspension
- administration by licensing authorities
- recording of the sanction on the driver's licence
- regular monitoring, including medical assessments for alcohol-dependent drivers
- use in combination with some kind of rehabilitation.

The PEPPER study final report (Kallberg 2008) concluded that tests of alcolocks had shown good potential to prevent recidivism on drink driving and reduce frequency of violations and alcohol-related accidents. It also noted that, although the idea of alcolocks was acceptable to politicians, traffic law professionals and other stakeholders who had had some experience with them, others were more sceptical.

The findings of the UK demonstration project were inconclusive (Beirness 2008). Participants found interlocks acceptable and beneficial, despite technical difficulties, but, because they were self-selected volunteers who were compensated for their involvement and did not have to pay for use of the device, the project conditions were not necessarily representative of the conditions for future routine use of interlocks. Also, it was difficult to distinguish the impact of the interlock from that of the drink-drive rehabilitation courses that both the project group and a control group had been recruited from.

7.6 Measures against drink-driving: public and drivers' awareness and attitudes

Public attitudes

As already noted, the Worldwide Brewing Alliance (2008) attributes the decline in the last 2 decades in alcohol-related motor vehicle deaths and injuries to a shift in public attitudes on the social acceptability of drink-driving. A survey of attitudes towards alcohol in Europe found as follows (Eurobarometer 2007):

- A very low proportion of UK citizens know what the legal BAC limit in the UK is (9%) compared with the European average (51%) and with the Netherlands (58%) and Sweden (72%). And a high proportion of UK citizens admit to not knowing what the UK legal BAC limit is (70%) compared with the European average (36%) and the Netherlands (28%) and Sweden (15%).
- A slightly higher proportion of UK citizens (75%) than the European average (73%) would agree to a lower BAC limit for young and novice drivers of 0.02 (The Netherlands, 87%; Sweden 85%).
- A slightly higher proportion of UK citizens (82%) than the European average (80%) believe that random police checks would reduce people's alcohol consumption before driving (the Netherlands, 74%; Sweden, 90%).

The UK thus stands out from the European average in the ignorance of its citizens about the legal BAC limit. However, the UK public's attitude to measures such as lower BAC limits for young drivers and implementation of random breath testing are in line with the European average.

Driver behaviour and attitudes

The report of the Social Attitudes to Road Traffic Risks in Europe (SARTRE) survey of European drivers (2004) found high awareness of the problem of drinking and driving, and consensus across all European countries (UK 91%; Sweden 94%; the Netherlands 84%) on alcohol as a major cause of road

accidents, which was also reflected in drivers' attitudes to policies and measures to prevent drinking and driving.

UK drivers are generally not out of line with those in other European countries on frequency of drinking, abstention from drinking, drink-driving over the legal limit, and attitudes to penalties for drink-driving.

Cultural factors and ethical issues

There are few observations in the policy literature or commentaries on surveys of attitudes or behaviour about cultural factors in relation to drink-driving, beyond distinguishing behaviours in southern and south eastern European wine-producing and consuming countries, and, to a lesser extent, the Scandinavian countries and eastern European countries, from the European norm. A comment in the recent WHO European Region report on the evidence for the effectiveness and cost-effectiveness of alcohol interventions (2009) links sociocultural and economic factors when it attributes the considerable fall in wine consumption in southern European Mediterranean countries *before* the introduction of alcohol policies and prevention programmes to factors such as urbanisation, shifts from agricultural to factory and service work, changes in family structure, and de-structuring of meals.

The fact that most countries in Europe have set a 0.05 BAC limit indicates that cultural, attitudinal or behavioural differences do not necessarily result in diverse policies. Nor does divergence from the European norm on the BAC limit, as in the case of the UK, mean that a country's attitudes and behaviour vary significantly from the average. However, the diversity of criminal justice and administrative procedures and penalties indicates the influence of varied legal and other traditions.

An underlying premise of the Eurobarometer and SARTRE surveys is that policy on drink-driving must go with the grain of public and driver opinion. However, there is little explicit discussion of ethical dimensions of anti-drink-driving measures in the literature on alcohol control and road safety

measures. An exception is a Canadian report (Canadian Council of Motor Transport Administrators 2008) that assessed measures to accompany a proposal to lower the BAC limit by reference to human rights concerns about random breath testing, specifically that:

- the objective must relate to concerns that are pressing and substantial in a free and democratic society
- the law must be rationally connected to the objective
- the law must be minimally impairing
- there must be proportionality between the objective and the limitations.

The WHO European Region (2009) report touches on these issues. It argues that the concept of stewardship, as proposed by the Nuffield Council on Bioethics (2007), implies that liberal states have a duty to look after the important needs of people individually and collectively, recognising that a primary asset of a nation is its health. It highlights the Nuffield Council's emphasis on the obligation of states to provide conditions that allow people to be healthy and, in particular, to take measures to reduce health inequalities. It also notes that the optimal mix of alcohol policy will depend on each society's particular goals and willingness to accept different policy instruments.

7.7 Lessons for UK policy development

The quality, comprehensiveness, and reliability of data in this comparative literature on drink-driving and related measures are acknowledged to be variable and may be a poor guide to the extent of policy implementation. In addition, there is a lack of information about contextual factors that might be important in explaining differences in approach or outcomes, beyond occasional distinctions among groups of countries on the basis of rather unspecific socioeconomic or cultural characteristics. General conclusions about the impact of interventions may not be a reliable guide for policymakers in any particular country and should therefore be treated with some caution.

There is considerable variation in the rate and stage of development of alcohol control policies internationally, but also clear evidence that they are

becoming more similar. Measures on drink-driving tend to include most or all of the following: setting legal BAC limits (or lowering existing ones), lower legal BAC limits for young drivers, random breath-testing, alcohol interlock ignition devices, designated driver schemes, and mass media campaigns. They may also include important general road safety and alcohol control measures, in particular, graduated driver licensing and minimum legal drinking ages, and, where they are feasible, administrative licence suspensions with immediate effect when drivers fail a breath test.

There is a clear trend, especially in Europe, towards harmonisation around a legal BAC limit of 0.05.

There are signs in several countries that returns from a change to a lower BAC limit – such as reductions in the rates of drink-driving and alcohol-related road accidents and fatalities – are beginning to diminish after periods of sometimes dramatic impact. This tendency is acknowledged in policy advice from international agencies, such as the WHO, and non-government organisations connected with the EU.

There has been a consequent shift of interest to a further wave of interventions linked to the BAC limit in the hope that they will renew the momentum of the policy, particularly lower legal BAC limits for young, learner, probationary, and professional drivers, and more intensive enforcement measures, particularly random breath testing.

Harmonisation at 0.05, a lower BAC limit for young drivers, and adoption of random breath testing are policy objectives of the EU. Policy advice from WHO and other international agencies on effective interventions promotes either introducing a legal BAC limit (preferably at 0.05 or less) or lowering the existing limit. But the advice is ambiguous about the degree of effectiveness of these interventions on their own and the extent to which they depend on intensity of enforcement through random breath testing or roadside checkpoints. It is cautious on the effectiveness of lower BAC limits for young drivers and other accompanying interventions.

Throughout this chapter we have where possible provided information about policies in seven countries, for purposes of comparison with the UK. These countries were selected because they are developed countries with active alcohol control and road safety policies. The selected European countries, as northern European countries, have some similarity with the UK in culture of drinking. Australia, New Zealand, Canada, and the USA are assumed to have certain cultural affinities with the UK. Japan stands apart in these respects. The table below brings together this information. It also includes data on two outcomes measures about which there was some information from most of the countries – road deaths per 100,000 of the population and drink-driving deaths as a percentage of all road traffic deaths. However, earlier cautions about the comparability of this information should be noted (see section 7.2).

There is a distinction in the governance of policy on drink-driving and road safety between countries with a federal structure (Australia, Canada, and the USA) and unitary states such as the selected European countries and Japan. However, the practical impacts of these different structures are difficult to identify, although there may be signs of the disadvantages and advantages of federal systems suggested by Single (1990), that is, complexity in developing and implementing policies but more opportunities for policy initiatives and learning about policy in diverse contexts.

Drink-driving measures in selected comparator countries

	UK	N/lands	Sweden	Japan	Australia	NZ	Canada	US
Current BAC limit	0.08	0.05	0.02	0.03	0.05	0.08	0.08	0.08
Road deaths per 100k of population	5.4	4.5	4.9	5.7	7.8	9.5	8.9	14.3
Drink-driving deaths as % of all road traffic deaths	16	25	25	n/a	n/a	34.6	35	32
Alcohol control strictness rating (BTG[4]): **H**igh; **M**edium; **L**ow	M	M	H	n/a	n/a	n/a	n/a	n/a
Alcohol control strictness rating (API[5]): **H**igh; **M**edium; **L**ow	M	L	H	H	H	M	H	M
Road safety policy rating: **H**igh; **M**edium; **L**ow	H	H	H	n/a	n/a	n/a	n/a	n/a
Lower BAC limit for young drivers: **Y**es/**N**o	N	Y	N	N	Y (states)	Y	Y (some provinces)	Y (states)
Random breath-testing: **Y**es/**N**o	N	Y	Y	Y	Y (some states)	Y	Y (some provinces)	N
Proportion of drivers checked: **H**igh; **M**edium; **L**ow	L	H	H	n/a	n/a	n/a	n/a	n/a
Alcolocks: **U**sed; **T**ested; **N**either	T	N	T	N	T	N	U (provinces)	U (most states)
Graduated driver licensing: **Y**es/**N**o	N	N	Y	N	Y (all states)	Y	Y (most provinces)	Y (states)
Knowledge of BAC limit: **A**bove or **B**elow EU average	B	A	A	n/a	n/a	n/a	n/a	n/a
Support for lower BAC limit for young drivers: **A**bove or **B**elow EU average	A	A	A	n/a	n/a	n/a	n/a	n/a
Awareness of problem of drink-driving: **A**bove or **B**elow EU average	A	B	A	n/a	n/a	n/a	n/a	n/a

All the selected countries have a comprehensive approach, but with differences in uptake of particular interventions and in outcomes. For example:

- The UK, along with the selected European countries and Japan, performs better on the road death measure than Australia, New Zealand, Canada and the USA.

[4] Bridging the gap scale – see section 7.2
[5] Alcohol policy index – see section 7.2

- The UK and the Netherlands have a relatively low proportion of drink-driving deaths within total road traffic deaths.
- The UK is with New Zealand, Canada and the USA in having a higher (0.08) legal BAC limit.
- The UK is in the minority of selected countries that do not have a lower legal limit for young drivers.
- The UK is in the small minority of selected countries without systematic random breath testing.
- The UK stands out from the two other European countries selected (and almost all European countries) in the very low proportion of drivers checked for alcohol consumption.
- The UK is in the minority of selected countries that do not have a graduated driver licensing system.
- The UK stands out from the two other European countries selected (and is well below the European average) in awareness among citizens of its legal BAC limit.
- However, there are no significant differences between UK and other European citizens in public and driver attitudes to drink-driving and to anti-drink-driving measures.

It is difficult to draw lessons for UK policy-makers from the policy literature, given this pattern of variation, about what particular combinations of interventions are most likely to achieve greater reductions in alcohol-related road traffic deaths and injuries. However, the following table provides a tentative assessment of some of the factors affecting the transferability to the UK of interventions not currently part of the UK's approach or which would modify the UK's approach. This policy-based analysis needs to be considered alongside the review of the evidence on the effectiveness of the BAC laws and related measures documented in the previous sections of this review.

Intervention	**Transferability factors**
A lower legal BAC limit of 0.05	It would make an existing intervention more stringent. It has been proposed and debated before. Public opinion might be favourable. It would bring the UK into line with the rest of Europe and a more general international trend. It is

	recommended by the European Commission.
Lower legal BAC limits for young drivers and other categories of driver	It would modify an existing intervention, making it more sensitive to differential risks. It is common in Europe and elsewhere in the world, including Anglophone countries. Public opinion might be favourable. It is recommended by the European Commission. (It can be combined with graduated licensing – see below.)
Random breath testing	Although akin to current breath-testing arrangements in the UK, it would introduce a different – and perhaps alien – enforcement principle and imply a commitment to more intense enforcement. Public opinion might be favourable. It is common in Europe and elsewhere in the world, including most Anglophone countries. It is recommended by the European Commission. There might be practical difficulties implementing it in the UK's dense and heavily used road networks. There might be cost implications.
Alcolocks	It could augment certain drink-drive penalties. Public opinion might be favourable. Professionals and policymakers seem to be divided on the merits of alcolocks. The findings of a UK study were inconclusive and highlighted technical and other challenges. Careful consideration of circumstances and criteria for use would be important.
Graduated driver licensing	It is a new intervention (and can be linked with lower BAC limits for young and other categories of driver – see above). It could be seen as building on current rules for new drivers, e.g. on what vehicle they are allowed to drive. It is common in Europe and Anglophone countries. It would make licensing a more complex process, which might have cost implications.
A higher legal drinking age	It would be a radical proposal, particularly if, on the US model, 21 were proposed as the legal age. It is a broader alcohol control policy issue than drink-driving and so a cross-government consensus would be necessary. Public opinion is unlikely to be favourable. Commercial interests might be hostile. Legal drinking ages vary across the world, but the USA is an outlier. It might raise issues of age discrimination.
On-the-spot administrative licence suspension	It would be a new intervention and would go against the grain of established UK policy on enforcement. Public opinion might be favourable. It is common in the USA and Canada (though with differences in how it is used). Legal and technical issues would need resolving. There might be cost implications.

References

Bax C, Karki O, Evers C et al. (2001) Alcohol interlock implementation in the European Union: Feasibility study. SWOV: Leidschendam.

Beirness DJ, Clayton A and Vanlaar W (2008) An investigation of the usefulness, the acceptability and impact on lifestyle of alcohol ignition

interlocks in drink-driving offenders [online]. Available from http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme3/investigation.pdf

Brand DA, Saisana M, Rynn LA et al. (2007) Comparative analysis of alcohol control policies in 30 countries [online]. Available from www.plosmedicine.org/article/info:doi/10.1371/journal.pmed.0040151

Canadian Council of Motor Transport Administrators (2003) CCMTA's position on the criminal code BAC [online]. Available from http://www.ccmta.ca/english/committees/rsrp/strid/pdf/bac_doc.PDF

Canadian Council of Motor Transport Administrators (2005) Strategy to address lower BAC drinking drivers [online]. Available from http://www.ccmta.ca/english/committees/rsrp/strid/pdf/strid_bac_strategy.pdf

Canadian Council of Motor Transport Administrators (2007) Road safety vision 2010 mid-term review - final report [online]. Available from http://www.ccmta.ca/english/pdf/rsv2010_midtermreport_final.pdf

Canadian Council of Motor Transport Administrators (2008) The Canadian Council of Motor Transport Administrators submission to the Standing Committee on Justice and Human Rights regarding impaired driving [online]. Available from www.ccmta.ca/english/pdf/strid_ccmta_position_feb2008.pdf

Eurobarometer (2007) Attitudes towards alcohol [online]. Available from http://ec.europa.eu/health/ph_determinants/life_style/alcohol/documents/ebs272_en.pdf

European Commission (2001) Commission recommendation of 17 January 2001 on the maximum permitted blood alcohol content (BAC) for drivers of motorised vehicles [online]. Available from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:043:0031:0036:EN:PDF

European Commission (2001) White Paper: European transport policy for 2010: time to decide [online]. Available from

http://ec.europa.eu/transport/white_paper/documents/doc/lb_com_2001_0370_en.pdf

European Commission (2003) European Road Safety Action Programme - Saving 20,000 lives on our roads: A shared responsibility [online]. Available from http://ec.europa.eu/transport/road_safety/observatory/doc/rsap_en.pdf

European Transport Safety Council (2006) Traffic law enforcement across the EU. An overview [online], Available from www.etsc.eu/documents.php?did=20

European Transport Safety Council (2007) Raising compliance with road safety law [online]. Available from www.etsc.be/documents/PIN_Report.pdf

European Transport Safety Council (2008) Road safety as a right and responsibility for all. A blueprint for the EU's 4th road safety action programme 2010–2020 [online]. Available from www.etsc.eu/blueprint-4th-road-safety-action-programme.php

Fell JC and Voas R (2003) The effectiveness of reducing illegal blood alcohol concentration (BAC) limits for driving: evidence for lowering the limit to .05 BAC in Canada [online]. Available from www.madd.ca/english/research/pubs.html

Institute of Alcohol Studies (2007) Reducing drinking and driving in Europe [online]. Available from www.ias.org.uk/resources/papers/europe/phproject/drinkdriving-report.pdf

Kallberg V-P, Zaidel David, Vaa T et al (2008) Police enforcement policy and programmes on European roads. Final report [online]. Available from www.pepper-eu.org/

Karlsson T and Osterberg E (2006) Scaling alcohol policies across Europe. Eurocare bridging the gap project [online]. Available from www.ias.org.uk/btg/index.html

Larsen L, Vavakos V, Zaidel D (2006) Comparison and analysis of traffic enforcement chains across EU member states and in relation to EU policies [online]. Available from www.pepper-eu.org/

NHTSA (2008) Administrative license revocation. Traffic safety facts laws [online]. Available from www.nhtsa.dot.gov/staticfiles/DOT/NHTSA/Communication%20&%20Consumer%20Information/Articles/Associated%20Files/810878.pdf

Nuffield Council on Bioethics (2007) Public health: ethical issues [online]. Available from www.nuffieldbioethics.org/go/ourwork/publichealth/publication_451.html

Osterberg E (2004) What are the most effective and cost-effective interventions in alcohol control? [online]. Available from www.euro.who.int/document/E82969.pdf

Rehn N, Room R, Edwards G (2001) Alcohol in the European region – consumption, harm and policies. WHO: Copenhagen.

Ritter A (2007) Comparing alcohol policies between countries: science or silliness? [online]. Available from www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.0040153

Shults RA, Elder RW, Sleet DA et al and the Task Force for Community Preventive Services (2001) Review of evidence regarding interventions to reduce alcohol-impaired driving. Am J Prev Med 2001;21 (4S).

Single E (1990) The development of alcohol policies in federal countries [online]. Available from http://whqlibdoc.who.int/hq/1990/WHO_MNH_ADA_90.6.pdf

Social Attitudes to Road Traffic Risks in Europe (2004) SARTRE Project [online]. Available from http://sartre.inrets.fr/english/pub-en.htm

Silverans P, Alvarez J, Assum T et al. (2006) Alcolock implementation in the European Union; an in-depth qualitative field trial [online]. Available from http://ec.europa.eu/transport/road_safety/projects/doc/alcolock.pdf

SWOV Institute for Road Safety Research (2009) Factsheet: alcolock [online]. Available from www.swov.nl/UK/Research/Publicaties/inhoud/factsheets.htm

World Bank and World Health Organization (2004) World report on road traffic injury prevention [online]. Available from http://whqlibdoc.who.int/publications/2004/9241562609.pdf

WHO-Euro (2009) Evidence for the effectiveness and cost-effectiveness of interventions to reduce alcohol-related harm [online]. Available from www.euro.who.int/InformationSources/Publications/Catalogue/20090918_2

Worldwide Brewing Alliance (2008) Drinking and driving report 8th edition. Recent trends and programmes [online]. Available from www.brewers.ca/UserFiles/BI_DrinkDriveRpt08_6_LR.pdf

8 Summary and conclusions

The review aims to assess the evidence on the effectiveness of BAC laws in reducing road traffic injuries and deaths.

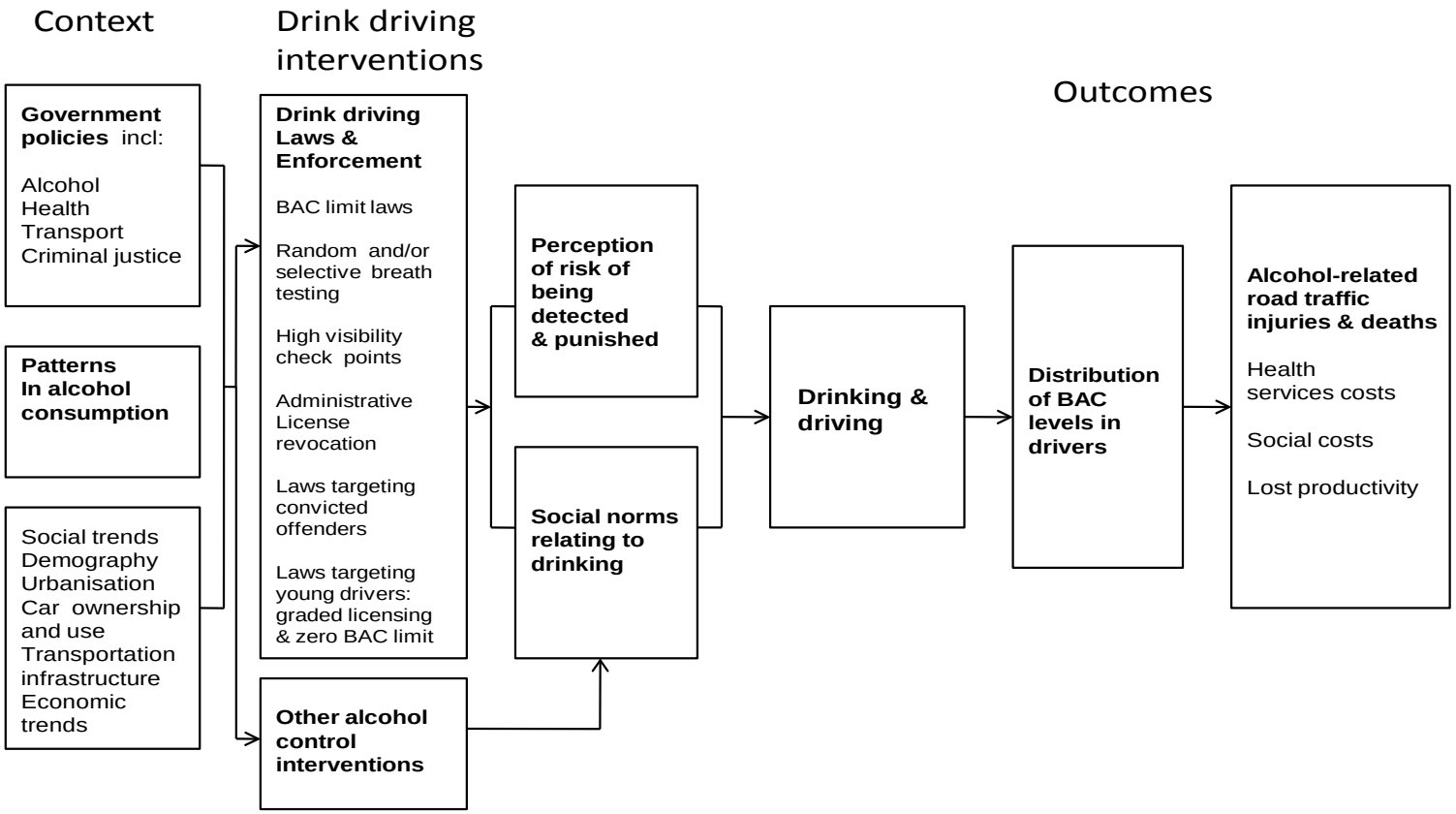
The research literature relevant to BAC laws is considerable and has been developed over the last three decades. This review is not exhaustive but aims to build on and extend previous review work. In particular it encompasses more recent studies not previously reviewed.

The review focuses on the main policy questions (set out in the introduction) relating to:

- the pattern of drink-driving and associated risk of being injured or killed in a road traffic accident
- the effect of BAC limits and related legislative measures in changing drink-driving behaviours and achieving reductions in alcohol-related road traffic injuries and deaths
- The lessons from other countries on the effect of BAC laws as part of overall alcohol control policies
- The modelling of the potential impact of lowering the BAC limit in England and Wales from 0.08 to 0.05.

The review was also informed by the conceptual framework (presented in section 2). This set out the theoretical pathways between interventions, changes in drink-driving behaviours and alcohol-related road traffic injuries and deaths. These pathways are underpinned by a set of assumptions. The review serves to test the robustness of the assumptions.

Logic model: Laws limit blood alcohol concentration level of drivers



8.1 Quality of evidence

Although there is a considerable research literature there are important gaps and areas of uncertainty relating to the evidence base.

Despite a number of early UK studies (including Ross 1973 and Maycock 1997), there is lack of recent UK research and evaluation work in this area. Evidence is derived from USA, Australia, New Zealand, other European countries (mostly Scandinavian) and Japan.

There is a lack of recent UK evidence on drink-driving behaviours and specifically the distribution of BAC levels in the population. Evaluation of the effectiveness of BAC laws and related measures is subject to uncertainties. This is in part due to the complex nature of such interventions and the methodological constraints involved in conducting rigorous evaluations of the population impact of legislative measures. True experimental designs are not possible; the evidence is largely derived from controlled before-and-after studies, time series analyses or other regression analyses. The quality of studies is variable both in design and execution. The degree of confidence about whether reductions in alcohol-related injuries and deaths can be attributed to changes in BAC limits (that is, internal validity) is variable. However there has been considerable methodological development and strengthening of evaluative approaches. The ‘best available evidence’ is provided by studies based on time series and multivariate regression analyses that have sought in particular to control for confounding factors (including underlying trends in alcohol consumption, economic and social changes as well as other alcohol control and road safety policies).

There are difficulties in assessing the applicability of the findings of non-UK based evaluations to the UK context. There are marked historical, institutional, social and cultural differences across countries, as well as more precise differences in political, policy and legal frameworks relevant to traffic safety, alcohol consumption and drink-driving.

Studies have sought to take account of a range of contextual factors and estimate the 'independent' effect of the BAC laws and related measures. However whether this effect is transferable to the UK is subject to uncertainty. There are important differences in the alcohol control context between the UK and other countries particularly with respect to:

- Enforcement strategies, (including use of administrative and criminal sanctions)
- Legal age of driving
- Legal age for purchasing and consumption of alcohol.

8.2 Review findings

The main findings of the different components of the review are presented below. This includes a set of 'evidence statements' that summarise the findings of the systematic review of the review-level evidence and primary evaluations on the effectiveness of BAC laws and related legislative measures. Evidence statements aim to summarise the overall strength of the evidence (quality, quantity and consistency). Assessment of applicability to the UK context will need to consider especially the factors highlighted above.

The findings of the comparative analysis of international policies helps assess whether the experience and evidence on lowering BAC limits is relevant and applicable to the current UK context.

The modelling of the impact of lowering the BAC limit from 0.08 to 0.05 in England and Wales was undertaken by Sheffield University and is presented in full in a separate report. This modelling work is summarised in section 6 of this report.

8.3 Drink-driving and risks of involvement in road traffic accidents

Evidence on the pattern of drink-driving and associated risks of being injured or killed in road traffic accidents is derived from a number of different types of

studies: laboratory and driver simulation studies, roadside surveys and epidemiological studies. Although not fully comprehensive, the principal and recent studies were examined in this review.

These studies are consistent in demonstrating the principal relationship between alcohol consumptions and risk of crash involvement: the exponential increase in crash risk with increasing levels of alcohol consumption.

A review of 112 studies provided strong evidence that impairment in driving functions begins with any departure from a zero BAC (Moskowitz and Fiorentino 2000). The majority of studies reported impairment by 0.05 BAC.

Zador et al. (2000) compared the BAC levels of drivers in accidents with drivers not involved in accidents. The results showed that males and females at all ages who had a BAC level between 0.02 and 0.05 had at least a three times greater risk of dying in a single vehicle crash. The risk increased to at least six times with a BAC between 0.05 and 0.08 and to 11 times with a BAC between 0.08 and 0.10.

Keall et al. (2004) reported that risk increases exponentially up to about 0.20 BAC followed by a flattening in the rate of increasing risk. This might be due to drivers at BAC 0.2+ having developed a reasonably high degree of tolerance to alcohol for them to undertake basic aspects of driving.

Peck et al. (2008) reported that the crash risk is elevated at all positive BAC levels for under 21s , and the risk rises more steeply compared to older drivers.

The results clearly indicate that positive BAC levels in drivers under 21 are associated with higher relative crash risks than would be predicted from the additive effect of BAC and age. This is attributable to the fact that the crash avoidance skill of young novice drivers would be more adversely affected by alcohol due to their driving inexperience, immaturity, and less experience with alcohol. Also drivers under 21 who choose to drink and to drive after drinking probably have pre-existing characteristics that predisposed them to risk taking

and crash involvement apart from any increased vulnerability to alcohol impairment.

8.4 Effectiveness of BAC laws and related policy measures

Effectiveness of BAC laws

Overall, there is sufficiently strong evidence to indicate that lowering the legal BAC limit for drivers does help reduce road traffic injuries and deaths in certain contexts.

The evidence on the effect of lowering of the BAC from 0.08 to 0.05 (or lower) is less extensive than the evidence on lowering the limit from 0.10 to 0.08 (that is largely US-based).

There is review-level evidence of high quality (++) to indicate that the lowering of the BAC limit from 0.10 to 0.08 is effective in reducing road traffic injuries and fatalities (Shults et al. 2001). This review is supplemented by more recent good quality studies that show largely positive effects, although degree of effect varies. This effect is independent of other control measures (in particular the use of administrative licence suspension) and also appears to be evident regardless of the baseline level of alcohol-related crashes.

One high quality evaluation (++) of the effect of the transition to the 0.05 BAC limit in European countries (15 former EU countries) (Albalate 2006) provides the most recent and policy-relevant study. The results showed that the lowering of the BAC limit to 0.05 produced statistically significant benefits as measured by reductions in total fatality rate per population or the total fatality rate per kilometre driven. However the effectiveness of the law was differentiated according to gender, age and zone.

The analysis controlled for a large number of potential confounding factors: unemployment, economic growth, transportation and use of vehicles, road infrastructure, and educational backgrounds. In addition the analysis took

account of related policies and enforcement: minimum legal driving age, points-based licensing and random checks.

The reductions relating to the 0.05 BAC limit were not found to be statistically significant for the whole population when controlling for other concurrent policies and infrastructure quality. The lowering of the BAC limit had greatest effects in reducing fatality rates among young men, and men in urban areas (discussed below).

A good quality Australian-based study (+) (time series analysis) showed that significant reductions of 18% in fatal accidents in Queensland and 8% in New South Wales was associated with lowering the BAC law to 0.05 (Henstridge et al. 2004).

Other European-based evaluation studies (three -) that have examined the effect of the lowering of BAC limit to 0.05 were primarily before-and-after comparison designs in single countries, and have methodological weaknesses (Assum 2002; Bartl and Esberger 2002; Mathijssen 2005). These studies overall showed positive findings, but variation in degree of effect. The study of the 0.05 BAC limit in Denmark (-) for example showed very little effect on alcohol-related accidents, although survey self-reported data indicated positive changes in drink-driving behaviour (Bernhoft and Behrensdorff 2003). Norstrom and Laurell's study (-) of the effect of adoption of the lower 0.02 BAC limit in Sweden (1997) used time series analysis and showed a 9.7% reduction in fatal crashes.

Beyond the 'immediate effect' few studies have examined in detail the timing of the impact of BAC laws. There is insufficient evidence to judge what level of effect might be sustained, although certain studies indicate positive long-term gains.

Two high quality (++) evaluations (Albalate 2006; Eisenberg 2003) reported that full impact may be achieved subsequent to implementation: at years 2 or 3, and up to 6/7 years. Albalate's analysis of the effect of the 0.05 law in

Europe reported that effects were evident after 2 years and increased over time with the greatest impact between 3 and 7 years.

Public awareness and enforcement of BAC laws

There is sufficiently strong evidence to indicate that publicity and visible, rapid enforcement is needed if BAC laws are to be effective. Drivers need to be aware of – and understand – the law. They also need to believe they are likely to be detected and punished for breaking the law.

There is review-level evidence of high quality (two ++) indicating that sobriety checkpoints (random breath testing and selective breath testing) are effective in reducing road traffic injuries and deaths (Shults et al. 2001; Peek-Asa 1999). It is important to recognise that enforcement strategies vary significantly. Sobriety checkpoints/random breath testing are not uniform interventions; but evaluations have not compared alternative strategies or different components of enforcement and public education programmes (Hendrie 2003).

The (++) review conducted by Goss et al. (2008) concluded that studies evaluating increased police patrol programmes were generally consistent in reporting reductions in traffic crashes and fatalities. However given the methodological limitations, the evidence could not firmly establish that police patrols reduced traffic crashes, fatalities and injuries.

There is review-level evidence of high quality (++) indicating that mass-media campaigns are effective in reducing alcohol-impaired driving and alcohol-related crashes (Elder et al. 2004).

The Australian-based (+) study by Henstridge et al. (1997) estimated the long-term effectiveness of random breath testing in four states. The authors concluded that random breath testing had ‘an immediate, substantial and permanent impact on accidents in all states (except one). In New South Wales random breath testing was estimated to reduce fatal accidents initially by 48%, and by 15% on a permanent basis. This sustained effect was attributed to increased levels of enforcement after the ‘introduction effect’.

Overall, studies evaluating the impact of new BAC limits have found it difficult to take account of the level of enforcement in analysis, given that enforcement (in terms of breath testing) is mainly determined by local police policies. Certain studies have reported on the contribution of enforcement.

One (+) study showed the use of sobriety checkpoints in US states enhanced the positive effects of the 0.08 law as a function of checkpoint frequency (Tippetts et al. 2005). The effects of the BAC law in Austria and the Netherlands were attributed in part to publicity and enforcement measures (Bartl and Esbager 2000 [-]; Mathijssen 2005 [-]).

The important role of enforcement measures in reducing drink driving, in conjunction with the BAC limit, is emphasised in the European review –of the ESCAPE consortium[6] (Makinen et al 2002). This showed that there was a correlation between the objective risk of detection (as measured by proportion of drivers tested) and frequency of drink driving. Countries fulfilling most of the following criteria have the lowest drink driving figures:

- Long tradition in drink driving enforcement including low legal limits
- Relatively high objective risk of detection
- Mass media supporting enforcement.

The meta-analysis conducted by Elvik (2000) included 39 experimental enforcement schemes (ESCAPE working paper). The overall effects of enforcement of drink drive control measures were reductions of 9% and 7% in the number of fatal and injury accidents respectively.

BAC laws and changes in drink-driving behaviour

There is sufficiently strong evidence to indicate that lowering the BAC limit changes the drink-driving behaviour of drivers at all BAC levels.

The BAC law appears to act as a general deterrent and the beneficial effects are not just restricted to the drivers at the BAC levels involved.

[6] ESCAPE- Enhanced Safety Coming from Appropriate Police Enforcement

Shults et al. in their (++) systematic review of the effect of 0.08 BAC laws (2001) stated that the results of the systematic review show five of the nine studies included in the review measured fatalities involving drivers with BACs of 0.10 or higher and these studies reported post-law reductions for most states.

Waganaar (2007 [+]) assessed the impact for fatal crash involvement among drivers with different BAC levels. The study showed that the BAC limit affected drivers at all levels of drinking from severely impaired drivers at 0.15 or over to drivers with more modest levels of BAC levels (0.01 to 0.07).

The (-) study conducted by Mann et al. (2003) indicated a shift in drink-driving behaviours across drivers at different BAC levels as a result of the lowering of the BAC limit to 0.08 and the administrative licence suspension law. Lighter and more moderate drinkers stopped driving after drinking, and dropped out of the drink-driving population, leaving heavier and more problem drinkers in this population. The self-reported consumption levels of those who reported driving after drinking were about three times higher (in terms of drinks in the past year) than that of drinkers who did not report drinking and driving. But the average levels of consumption were lower than that of alcoholics in treatment. The researchers suggest that ‘hard core’ drink-drivers may be involved in a more ‘deviant lifestyle’ and have a propensity for antisocial and risk-taking behaviours (associated with low self-control).

Certain studies have reported the effect on drivers with high BAC levels where BAC limits were reduced to 0.05 or lower (Brooks and Zaal 1993; Kloeden and McLean 1997; 1994; Norstrom and Laurell 1997).

Brooks and Zaal (1993) assessed the effects of the lowering of the BAC limit from 0.08 to 0.05 in 1991 in the Australian Capital Territory. There was a 34% decrease in the proportion of random breath tested drivers with BAC levels between 0.15 and 0.19 and a 58% decrease in the proportion of drivers above 0.20. The evidential breath tests showed a 31% decrease in drivers with BAC levels above 0.15 and a 46% decrease in drivers above 0.20. The authors argue that the study provided evidence that the lowering of the BAC limit from

0.08 to 0.05 led to a reduction in drink-driving well above the original 0.08 limit.

Analysis of a series of six roadside surveys between 1987 to 1997 in Adelaide, South Australia (Kloeden and McLean 1997) indicated a shift in BAC levels in the drink-driving population with the introduction of the lower BAC limit in 1991, in the context of a comparatively low level of random breath testing. This trend analysis reported that the percentage of night-time drivers with BAC levels at or above 0.01, 0.05 and 0.08 decreased at an almost uniform rate across all three BAC levels. (The rate of decrease was more rapid among men than women.)

A minority of studies have examined the effect of BAC laws on different age groups and other subgroups of drivers.

Dee's (++) study (2001) showed that the 0.08 BAC law had a differential impact according to age, with reductions in fatality rates being highest among younger drivers (14% reduction among age 18–20, 9.7% among age 21–24 and 6.7% among those 25 and older).

The pan-European (++) study of the lowering of the BAC limit to 0.05 (Albalate 2006) reported that the effects were statistically significant for people aged 18–25 (11.5%), men (5.7%) and for men in urban areas (9.2%). The effects were evident after 2 years and increased over time with the greatest impact between 3 and 7 years.

The lowering of the general BAC limit to 0.03 in Japan appeared to have a greater impact on younger drivers (Desapriya 2006 [-]; 2007 [-]), even in the presence of zero tolerance laws for younger drivers.

Kaplan and Prato (2007 [+]) reported in their evaluation of administrative licence suspension alongside BAC laws that the behaviour of particular subgroups was consistent with broader literature and theory regarding compliance. Women and older drivers demonstrated a higher degree of compliance that is, greater relative effect. Also analysis of differences in terms

of car occupancy showed that single occupancy vehicles were less influenced by the BAC limit. The authors suggest that law compliance is therefore much higher when more than one occupant is involved and is related to some sense of responsibility for the life of others.

Patterns of drink driving are complex, and the evidence indicates that BAC laws and related measures have a differential effect on different subgroups. As discussed above the evidence shows that lowering the BAC limit can effect changes in drink driving at all BAC levels, including levels well over the BAC limit currently operating, however it remains unclear how these changes in behaviour are achieved (the underpinning mechanism relating to willingness and capacity for change). The extent to which lowering the BAC limit in the UK could change the behaviour of those drink driving at high BAC levels is a key question.

Review work suggests that a combination of specific measures will be required in conjunction with a reduced BAC limit. Simpson et al (2004) highlight the need for effective measures to detect, arrest, prosecute, convict, sanction and monitor offenders.

Administrative licence suspension or revocation (ALS/R)

There is sufficiently strong evidence from good and high quality studies to show that administrative licence suspension can help reduce road traffic injuries and deaths.

This effect is independent and additional to the effect of the lowering of the BAC per se law. However administrative licence suspension presupposes that a BAC limit is in place. Therefore the lowering of the BAC limit to 0.05 alongside administrative licence suspension may in principle enhance the overall impact.

It is important to note that administrative licence suspension is not a uniform intervention, and there are important variations in application in terms of level of severity of sanction imposed.

Wagenaar and Maldonado-Molina (2007) showed that administrative or pre-conviction drivers licence suspension policies have statistically significant effects on alcohol-related fatal crash involvement by 5%. The analysis also showed licence suspension policies affected drivers at all levels of drinking. Furthermore the laws mandating licence suspension penalties after conviction had little effect, and did not appear to be an effective deterrent. This showed the importance of speed – penalties that are delayed do not have a demonstrable effect on behaviour.

Villaveces at al. (2003) showed administrative licence revocation laws were associated with a 5% reduction in overall mortality and 5% reduction in alcohol-related crash fatalities. The study conducted by Kaplan and Prato (2006) reported that administrative licence revocation was associated with a reduction of between 8.6% and 10.6% in alcohol-related fatal accidents.

Mann et al. (2003 [-]) evaluated the effect of the administrative licence suspension law in Ontario, Canada. The mean alcohol consumption of those who reported drink-driving increased significantly after the administrative licence suspension was introduced, whereas the alcohol consumption of those who did not drive after drinking remained the same. This was viewed as consistent with the predictions of differential deterrence: that light to moderate social drinkers were most affected and dropped out of the drinking population, while compulsively motivated or hard core offenders were less influenced.

Freeman (2007 [++]) modelled estimates of the effect of control legislation: BAC, administrative licence revocation, graduated driver licence, seat belt, and speed limit laws; and other controls (variables for the business cycle, mileage travelled, and demographic characteristics). The model for administrative licence revocation laws showed significant reductions in crash fatalities. Freeman pointed out that because administrative licence revocations almost always used a BAC limit as a criterion, the results should be ‘properly interpreted as a partial effect conditioned on the existence of a BAC law’.

Young drivers: zero tolerance laws and graduated licensing schemes

There is sufficiently strong evidence to indicate that zero tolerance laws and graduated licensing can help reduce alcohol-related injuries and deaths.

Shults et al. (++) systematic review (2001) reported reductions in crash fatalities in the range 9– 24%. The Zwerling and Jones (++) systematic review (2001) reported reductions in crash fatalities in the range of 11–33%.

Additional evidence is provided by primary evaluation studies of high or good quality. The precise age of younger drivers covered by these laws (and studies) is specific to the jurisdiction –and accords to legal age for driving. In the US this is typically under 21 and in Australia under 18, but lower in certain other jurisdictions such as New Zealand (age for driving of 15 years).

Eisenberg (2003 [++]) reported that the effect of zero tolerance laws in the US appeared to be linked to the presence of administrative licence revocation law. The combined effect was a 4.5% reduction in the fatal crash rate for young drivers. Also the effect appeared to operate well before the year of enactment of the law. This suggested that unobserved changes in attitudes or anti drunk-driving campaigns targeting young people could be responsible for policy adoption and observed reduction in fatal crashes.

Voas et al. (2003 [+]) showed the zero tolerance laws reduce the proportion of underage drink-drivers (under 21) in fatal crashes by 24.4%. The analysis took account of differences among the 50 states in various background factors, changes in economic and demographic factors within states over time, and the effects of other related laws.

The (+) study conducted by Villacaves et al. (2000) assessed the impact of a number of alcohol-related policies in the USA 1980–1997 including zero tolerance laws on deaths due to alcohol-related crashes. The analysis showed that zero tolerance laws were associated with a 12% reduction in alcohol-related fatalities and 4% reduction in overall crash fatalities.

Three studies investigated how zero tolerance laws changed alcohol consumption and drink-driving behaviours of young people (that is, the mechanisms that produce the reduction in crash fatalities). While overall the studies showed important positive benefits, there was some inconsistency in the nature of changes in alcohol-related behaviours.

Wagenaar et al. (2001 [+]) used survey data for high school seniors (covering 30 US states) to assess the impact of the zero tolerance laws on drinking, heavy episodic drinking, drink-driving, riding with a drunk driver and total miles driven. The results showed the laws were associated with significant reductions in self-reported driving after any drinking of 19 %, and driving after five or more drinks of 23%. However the law did not effect overall drinking or binge drinking participation.

The results of the US (+) study by Carpenter (2004) of underage drinkers (aged under 21) showed that the laws (zero tolerance and graduated licensing) reduced heavy episodic drinking (five or more drinks at one sitting) and overall number of drinks consumed in the previous month by underage males of the order 13%. This was accompanied by increases in the likelihood of being a 'light' drinker. There were no robust effects on the indicators of drinking participation and drink-driving. 'Underage males still drank, but drank less recklessly.' These findings differ from those of Wagenaar above, in showing reductions in alcohol consumption and heavy drinking among young males. The author concludes that the main mechanism through which drink-driving policies relate to behaviour was via reductions in heavy drinking for the targeted groups.

Liang and Huang (2008 [+]) showed that zero tolerance laws reduced drinking and driving among college students (aged under 21): 14–17% reduction in reported occasions of drinking and driving in the last 30 days. The results showed that the zero tolerance laws were associated with a 26–27% reduction in the probability of drinking and driving among those who reported drinking away from home. Also the zero tolerance laws were associated with an approximate 7% reduction in the probability of drinking away from home.

The authors conclude that the primary response to the law was to refrain from driving after drinking, with the greatest effect among whose who reported drinking away from home than that among all drinkers regardless of drinking locations (at home or away from home).

Although not comprehensive, the studies included in this review provide good quality evidence that graduated driver licensing restrictions are effective in reducing crashes among young drivers.

The systematic (++) review conducted by Hartling et al. (2004) reported reductions in crash rates for all crash types across studies. Among young people aged 16, the median decrease in overall crash rates during the first year of graduated driver licensing was 31% (range 26–41%). Reductions in injury crash rates were similar (median 28%, range 4–43%). The authors concluded that despite methodological limitations, the direction of the findings are consistent, indicating that graduated driver licensing is effective in reducing crash rates of teenage drivers, although the magnitude of the reduction is unclear.

Begg et al. (2001 [+]) evaluated the impact on young driver crashes of the three main driving restrictions in the New Zealand graduated driver licence system. The results (statistically significant) showed that crashes that involved a driver with a restricted licence were less likely to have occurred at night, less likely to have involved passengers and less likely to have been suspected of involving alcohol, compared with crashes involving a driver licensed under the old system. The authors concluded that the graduated driver licensing was effective in contributing to the reduction in the proportion of crashes among young people where alcohol was suspected.

The potential effect of introducing lower BAC limits and graduated licensing schemes in the UK is unclear given the many differences in contextual factors, including differences in age limits for driving.

8.5 Lessons for UK policy development based on international experience

- There is a clear trend, especially in Europe, towards a lower legal BAC of 0.05, and it is generally accepted that reducing the BAC limit is an effective intervention.
- There are signs in some countries that the returns from alcohol control policies are diminishing after extended periods of sometimes dramatic impact.
- A further wave of interventions linked to the BAC limit are being advanced in the expectation that they will renew the momentum of the policy. These interventions include graduated BAC levels for learner, probationary, and professional drivers, and enforcement measures, particularly random breath testing, alcohol ignition interlock devices, and more consistent and intensive enforcement in general.
- At the same time, there is evidence of uncertainty about the relative contribution to desired outcomes of each of the various interventions on drink-driving.
- In general, the public and drivers in Europe appear to support the drink-driving policies already in force as well as proposals to extend them. The attitudes of the UK public and UK drivers are in line with those in the rest of Europe.
- UK citizens stand out from the rest of Europe in their lack of knowledge of their country's legal BAC limit; and UK drivers are among the least likely to have experienced a check for alcohol levels, and, in common with drivers in other countries without systematic random breath testing, are more likely to think they will never be checked.

References

Elvik R 2000 Cost Benefit Analysis of Policy Enforcement. Working Paper ESCAPE WP1.Technical research centre of Finland

Hendrie D 2003 Random Breath Testing: its effectiveness and possible characteristics of a best practice approach. Western Australia: University of Western Australia Injury Research Centre.

Makinen T, Zaidel DM 2003 Traffic enforcement in Europe: effects, measures, needs and future. Final report of the ESCAPE consortium. Brussels: European Commission.

Ross H L 1973 Law Science and Accidents. The British Road Safety Act of 1967. Journal of Legal Studies 2 (1):78.

Simpson HM et al 2004 Hard core drinking drivers. Traffic Injury Prevention, 5:261-269.

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Glossary

Administrative licence revocations – see sanctions for drink-driving offences.

Administrative licence suspensions – see sanctions for drink-driving offences.

Alcohol ignition interlocks – see alcohol interlocks.

Alcohol interlocks (also known as alcohol ignition interlock devices and alcolocks) are devices that prevent drivers from starting a vehicle if their BAC exceeds a predetermined threshold level. The threshold can be set at different levels depending on the particular alcohol limit suitable for the driver. The device also analyses the driver's breath while driving. If the alcohol concentration is over the legal limit the driver has a few minutes to park the vehicle before the engine stops. The device may be used either as a preventive measure or as ordered by a court.

Alcolocks – see alcohol interlocks.

Blood alcohol concentration (BAC) is the concentration of alcohol in a person's blood expressed as the weight of alcohol in a fixed volume of blood. BAC levels can be expressed in various ways. Using the UK's legal BAC limit as an example, these are as: milligrams of alcohol per 100 millilitres of blood (80mg/100ml); grammes of alcohol per 100 millilitres of blood (0.08g/100ml); and grammes of alcohol per litre of blood (0.8g/litre). (In the USA, decilitre is sometimes used instead of 100 millilitres: e.g. 0.08g/dl.) Often, the BAC level is expressed as a percentage (e.g. 0.08% instead of 0.08g/100ml) or in the shorthand forms 80, 0.08, or 0.8). Another way of measuring the BAC level is via a urine test, where the result is expressed as milligrams of alcohol per 100 millilitres of urine.

Breath alcohol concentration (BrAC) testing – see breath testing.

Breath testing is the use of a screening device, usually known as a breathalyser or alcohol meter, to measure a driver's blood alcohol concentration level (BAC) as part of enforcement of road traffic laws. Breath alcohol concentration (BrAC) testing is the official UK method of measurement, with results expressed as microgrammes of alcohol per 100 millilitres of breath – 35 µg/100ml of breath is the UK's legal limit. In most countries, including the UK, those who fail the test must undergo more accurate and reliable tests at a police station – i.e. evidential tests, which provide evidence that is admissible in court. On-the-spot evidential testing becomes possible when screening devices are technologically advanced enough to provide admissible evidence. Internationally, the circumstances in which breath testing is permitted vary – see breath testing after reasonable cause for suspicion; checkpoint breath testing; and random breath testing.

Breath testing after reasonable cause for suspicion refers to the police power to stop and breath test a driver if there is reasonable cause to suspect that alcohol has been consumed, or there has been involvement in a road traffic offence or accident, as in the UK.

Checkpoint breath testing can include random and selective breath testing checkpoints. (At selective checkpoints the police can only conduct a breath test if they have reason to suspect the driver has been drinking.) Checkpoints may be set up at locations where there is a greater likelihood that drivers have been drinking. At 'sobriety checkpoints' in the USA, the police stop all motorists but can only conduct a breath test if they have reason to suspect the driver has been drinking. See also random breath testing.

Drink-driving is a broad term used to describe driving a vehicle on a road or in another public place while under the influence of alcohol. Other terms include driving under the influence (DUI) and driving when intoxicated (DWI).

Driving under the influence (DUI) – see drink-driving.

Driving when intoxicated (DWI) – see drink-driving.

Evidential breath testing – see breath testing.

Graduated driver licensing is a system designed to give young drivers more driving privileges as they become more mature and develop their driving skills. Phases may include a learner phase, which has a defined minimum length, and a novice phase leading to a full licence. An enforceable BAC limit lower than the legal maximum for other drivers may apply before they receive a full licence. See also zero tolerance laws.

Minimum legal drinking age (MLDA) laws specify an age below which the purchase or consumption of alcohol is illegal. These vary from country to country.

Random breath testing or **unrestricted breath testing** refers to the police power to stop and breath test either all or a sample of drivers chosen randomly at roadside checkpoints, even if they are not suspected of an offence – particularly drink-driving – or of being involved in an accident. These checkpoints may or may not be publicised and may or may not be made highly visible. See also checkpoint breath testing.

Sanctions for drink-driving offences related to BAC level violations vary greatly from country to country and can be criminal or administrative, criminal only, or administrative only. The nature of the sanction depends on how the offence is defined and the status of the process for dealing with it. In countries with both types of sanction, criminal sanctions take over from administrative sanctions as offences become more serious or are repeated. Graduation relates to the gravity of the BAC level violation, as defined by BAC level bands. There is considerable inconsistency among countries in the severity of sanctions, whether administrative or criminal. Administrative sanctions available in the USA and Canada include immediate revocation or suspension of the driver's driving licence (also known as an administrative licence suspension or revocation) upon failure of a breath test. An important advantage claimed for this particular administrative sanction is that it enables the immediate imposition of a significant punishment from the driver's point of

view, thereby reinforcing the deterrent effect of drink-driving measures related to legal BAC limits.

Selective breath-testing checkpoints – see checkpoint breath testing.

Sobriety checkpoints – see checkpoint breath testing.

Unrestricted breath testing – see random breath testing.

Zero tolerance laws refer to enforceable BAC limits beneath the legal maximum that apply to certain categories of driver – typically, young, learner, probationary and professional drivers. These limits vary from country to country but are mainly in the range zero to 0.04.

Appendix A Case study: Canada

Debate in Canada on BAC levels and enforcement

Background

Canada has a federal system of government and no single level of government has complete authority over the issue of impaired driving. The federal government has exclusive power to enact legislation on criminal law and procedure, and this is the basis for federal impaired driving offences, penalties and driving prohibitions, and the Criminal Code of Canada BAC limit of 0.08.

The federal government has no authority to regulate driving and licensing, nor impose licence-related administrative sanctions. The provinces have authority for these matters and impose a variety of administrative sanctions.

There has been a debate over the last few years in the context of Canada's ongoing 'Strategy to reduce impaired driving' (STRID) about the regime of criminal and administrative sanctions and about whether the criminal code BAC limit should be lowered from 0.08 to 0.05. This debate has been conditioned to an extent by the fact of the division of powers but has been more about the optimal mix of sanctions to deal with the drink-driving problem.

The Canadian Council of Motor Transport Administrators (CCMTA), a non-profit organisation comprising representatives of the provincial, territorial and federal governments, has responsibility for making decisions about administrative and operational matters to do with vehicle transportation and highway safety. The following brief account of how the debate has developed draws on CCMTA documents.

CCMTA's position in 2003

In 2003 CCMTA concluded that there had been good progress in reducing fatalities and serious injuries involving drinking drivers, and good implementation of various components of STRID, including administrative

sanctions for drink-driving between 0.05 and 0.08, and a zero BAC for novice drivers. The CCMTA:

- endorsed the status quo of dealing administratively with BAC levels in the 0.05–0.08 range on grounds of rapid and certain response, greater flexibility in options and sanctions, and because it did not need a criminal court process.
- recommended against lowering the legal BAC limit (but with more systematic enforcement of the existing limit), because it would unnecessarily involve the federal government in an issue (drivers in the 0.05–0.08 range) that the provinces were better able to deal with, and would further burden an overtaxed criminal justice system without increasing the deterrent effect of the law. More detailed reasons were:
  - Over 80% of fatally injured drivers testing positive for alcohol had BAC levels in excess of 0.08, as opposed to 6% in the 0.05–0.08 range. This group would be unlikely to be influenced by lowering the legal BAC limit.
  - There were wide variations in rates of charging drivers above the legal limit, and often police were using short-term suspensions rather than criminal code charges because of the time required to process the criminal charges.
  - Worries about criminalisation, particularly given differences in how people are affected at a low BAC level: ‘The lower the per se level for criminal impaired driving is set, the greater the concern that the weight of the criminal justice system will be brought to bear upon an individual whose conduct is less risky or less morally reprehensible’.

CCMTA’s position in 2005

In 2005 CCMTA views had changed. It acknowledged that the pace of improvement had ‘slowed and perhaps plateaued’ and that current federal and provincial BAC limits gave the erroneous message that it was safe to drink and then drive. It criticised lack of consistency in implementing administrative sanctions and frequent lack of recording of suspensions so that sanctions couldn’t be escalated for subsequent infractions. This meant in effect that

Canada, unlike many countries, did not have a comprehensive, tiered BAC system.

It placed greater weight than before on evidence about the adverse effects of modest amounts of alcohol on driving skills, and noted downward trends in permissible BAC limits in other countries.

It noted the strength of the case for lowering the criminal code limit to 0.05, but, for some of the reasons put forward in 2003 about cumbersome criminal justice processes and quick and efficient administrative measures, recommended that the provinces create new administrative sanctions for drivers in the 0.05–0.08 BAC range, with consistent implementation and enforcement, so as to move towards a clear, BAC level-related tiered system of sanctions.

CCMTA's position in 2008

In 2007 an independent evaluation of STRID commissioned by CCMTA found continuing shortcomings in implementation of the strategy, particularly inadequate deterrence at lower BAC impairment levels. The evaluation report recommended a parliamentary review to look at the case for lowering the criminal code limit to 0.05 and to zero for groups such as young drivers, public service drivers, and multiple serious offenders. It also recommended full use of a random breath testing programme and consideration of extending alcohol ignition interlock programmes to more convicted drivers.

In 2008 a CCMTA submission to the federal parliament's standing committee on justice and human rights regarding impaired driving acknowledged that trends in alcohol-related road deaths and injuries had been moving in the wrong direction for some years. The submission pointed out that:

- All but one province had an administrative programme to deal with the issue of lower BAC drivers by issuing short-term administrative suspensions (typically of 24 to 72 hours) to drivers who were below the legal threshold but above the 0.04–0.05 range.

- There was a substantial burden on police time of criminal code-related investigations, with an average time for cases to clear the courts when the accused pleaded guilty and not guilty of 15 and 35 weeks respectively.
- The effectiveness and efficiency of the criminal justice system in dealing with impaired driving cases was deteriorating.

The submission presented the CCMTA's model programme for addressing the lower BAC driver administratively. This included the following measures:

- Immediate roadside suspension of 7 to 14 days if the driver registered a BAC of 0.05 or more.
- Police must forward the surrendered driving licence to the licensing authority to increase the driver's risk of being caught if driving during the suspension period.
- An increase in the suspension to 30, 45 and 60 days respectively, should the driver receive a 2nd, 3rd or 4th offence during the following 3 years.
- Drivers with 2 or more suspensions within a 3-year period should have to attend an alcohol assessment and complete all identified treatment to have their licence reinstated.
- Drivers with 3 or more suspensions in a 3-year period would have to have an ignition interlock installed in their vehicle and at their own expense.

The submission also made the case for random breath testing programmes to increase the probability of impaired drivers coming into contact with the police and thus increasing the deterrent effect of police enforcement, and for the use of advances in technology, particularly alcohol ignition interlock devices.

The submission recommended that the criminal code BAC limit of 0.08 should *not* be changed but that provinces should be encouraged to strengthen roadside suspension, as proposed in the model programme.

Appendix B Search strategy

The search strategy used for MEDLINE is provided as an example below. The subject headings uses in this strategy were adapted accordingly for the searches conducted in the databases.

MEDLINE literature search strategy:

Database: Ovid MEDLINE(R) <1950 to February Week 1 2009>

1 Automobile Driving/
2 Motor Vehicles/
3 Automobiles/
4 (car or cars or automobile$ or auto-mobile$ or auto mobile$ or automot$ or auto-mot$ or auto mot$ or motor$ or vehicle$).tw.
5 driv$.tw.
6 passenger$.tw.
7 Accidents, Traffic/
8 ((traffic$ or road$ or street$ or highway$ or motorway$) and (accident$ or safe$ or crash$ or injur$ or death$ or mortal$ or fatal$)).tw. (14522)
9 or/1-8
10 exp Drinking Behavior/
11 exp Alcoholic Beverages/
12 exp Ethanol/
13 Alcoholism/
14 Alcoholic Intoxication/
15 ethanol$.tw.
16 alcohol$.tw.
17 drink$.tw.
18 intoxicat$.tw.
19 (inebriat$ or inebriet$).tw.
20 impair$.tw.
21 drunk$.tw.
22 or/10-21

23 Breath Tests/

24 (breath$ adj5 (test$ or exam$ or analy$)).tw.

25 breathal$.tw.

26 ((alcohol$ or ethanol$ or drink$ or drunk$ or intoxicat$) adj5 (test$ or exam$ or analy$)).tw.

27 ((sober$ or sobriet$) adj5 (test$ or exam$ or analy$)).tw.

28 or/23-27

29 22 or 28

30 9 and 29

31 ((under adj3 influenc$) or (driv$ adj3 influenc$)).tw.

32 (dui or duis or dwi or dwis or omvi or omvis).tw.

33 or/31-32

34 30 or 33

35 ((alcohol$ or ethanol$) adj5 (level$ or concentration$ or limit$)).tw.

36 (bac or bacs).tw.

37 (brac or bracs).tw.

38 Ethanol/bl [Blood]

39 Alcohols/bl [Blood]

40 Alcohol Drinking/bl [Blood]

41 Alcoholic Intoxication/bl [Blood]

42 zero.tw. (38616)

43 or/35-42

44 34 and 43