Modelling methods to estimate the potential impact of lowering the blood alcohol concentration limit from 80 mg/100ml to 50 mg/100ml in England and Wales

Report to the National Institute for Health and Clinical Excellence

Revised version: 12 January 2010

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Executive summary

Despite the substantial decline in drink-driving and road traffic casualties in England and Wales, the number of drivers involved in fatal or non-fatal casualties attributable to alcohol remains high[1]. Up to now, the legal limit for drink driving is set at 80 mg/100 ml in England and Wales, whereas the European Commission recommends a drink-drive limit of 50 mg/100 ml blood alcohol content (BAC) for experienced drivers and 20 mg/100 ml for novice drivers. In this context, discussions are taking place to consider lowering the current BAC limit from 80 mg/100ml to 50 mg/100ml for all drivers in England and Wales and maybe a further reduction for young drivers.

A systematic review was conducted as part of this project to identify evidence about the profile of drink-drivers in England and Wales, the relationship between BAC and the risk of casualty, and the effectiveness of different policy options aimed at reducing drink-driving[2]. The systematic review indicated that there is sufficiently strong evidence to support the assertion that laws lowering the legal limit for BAC for drivers are effective in reducing road traffic injuries and deaths in certain contexts. Albalate[3] indicated that lowering the legal limit from 80 mg/100 ml to 50 mg/100 ml in Europe was associated with a reduction in fatal casualties ranging between 3.3% and 7.4% using different regression models and controlling as far as possible for confounding factors.

Individual country experiences also provide evidence that lowering the BAC limit to 50 mg/100 ml is effective in reducing drink-driving and road traffic casualties to a certain extent. Given the large amount of evidence demonstrating the potential effectiveness of lowering the legal limit in or outside Europe, the question arises about the extent of potential benefits of such a policy in England and Wales in the context of the progress already made against drink-driving in the past 20 years. To inform policy makers, modelling exercises were undertaken to estimate the potential number of casualties that may be avoided after the implementation of a 50 mg/100 ml BAC law in England and Wales. The bulk of the modelling work employed an indirect approach to model a shift in the BAC distribution which may translate into savings in fatal or non fatal casualties. A simpler direct approach was also employed, extrapolating results from the Albalate study[3] to England and Wales.

Where possible, the model was populated with UK-based evidence identified by the systematic review[2], though some evidence was extracted from the international literature. The relationship between BAC and the risk of casualty for England and Wales was extracted from Maycock et al[4]. No direct ’robust’ data were available about the distribution of BAC among drivers in England and Wales, and so this was estimated indirectly using data about the distribution of fatal casualties by BAC band in England and Wales and published risk functions[4]. The potential effectiveness of the policy was modelled using evidence from two Australian studies[5, 6] in the absence of a detailed evidence base from Europe about the shift in the BAC distribution after the implementation of the 50 mg/100 ml BAC law.

A three-step model was constructed in Microsoft Excel to account for the natural shifting in the BAC distribution in the absence of policy change. The first step was to approximate the BAC distribution among drivers and the natural shifting over time in the absence of policy change. This was made indirectly based on observed data about the distribution of fatal casualties by BAC band[7], published risk functions[4] and regression methods. The second phase was to model the shift in the distribution of BAC after the implementation of the 50 mg/100 ml BAC law using evidence from two Australian studies[5, 6]. Finally, the third and last step was to estimate the number of casualties over 6 years in the absence of a policy change or after implementation of the policy based on the baseline number of casualties in England and Wales and the calculated excess risk. We then compared the estimated number of casualties in the absence of policy change to the predicted number of casualties after the implementation of the 50 mg/100 ml BAC law to determine the additional number of casualties avoided with the adoption of the lower BAC limit.

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). The reduction in casualties is estimated to be sustained over years with an expected proportional reduction of 13.8% and 3.1% for fatal casualties and non fatal casualties at 6 years equating to a saving of 303 and 6,424 casualties respectively.

In a secondary analysis, assuming only half of the relative effect of the policy as observed in Australia, the estimated proportional reduction in fatal and non-fatal casualties at 6 years was 7.2% and 1.2% respectively. This equated to a saving of 158 fatal casualties and 2,487 non fatal casualties.

Using data from the Albalate study[3], the number of fatal casualties avoided at 6 years is estimated to range between 77 and 168. 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).

Different sensitivity analyses were also performed to test the robustness of the model prediction to the main model assumptions. Not surprisingly, our estimate was sensitive to the method used to estimate the shift in the BAC distribution in the absence of policy change and the effectiveness of the policy using a proxy of 95% confidence interval (CI). Our estimate was also shown to be within the range of estimates in other countries, given the wide variation of the estimated effect of the policy.

While the best evidence available was used, our results have to be taken with considerable caution. There were many uncertainties and unknowns and several parameters were not observable and so estimated indirectly. We did not have ‘direct’ data about the BAC distribution in England and Wales and its natural shifting in the absence of policy change. The indirect approach used was based on the best data available about the risk function and the distribution of fatal casualties by BAC band. It is unclear exactly how reliable the predicted BAC distribution is, and more research is needed to determine the distribution of the BAC among drivers in England and Wales and how that distribution has been shifting in the absence of policy change.

More research is also necessary to describe the relationship between alcohol consumption and the risk of being involved in a fatal or non-fatal casualty in England and Wales using recent data rather than data from the Maycock study[4]. We were also limited by the available evidence regarding the shift in the BAC distribution after the implementation of the 50 mg/100 ml legal limit. Since the 50 mg/100 ml has not yet been introduced in the UK, there is no direct UK evidence on its effects on the BAC distribution for drivers. We reviewed all of the available international evidence and have selected two Australian studies to form the evidence for the model base case. These were selected in the absence of any detailed evidence from Europe and because they provided detailed information on the changes in BAC distribution over a long follow-up period. If the 50 mg/100 ml legal limit is implemented in England and Wales, we would recommend collection of data on shifts in the BAC distribution using a series of roadside surveys over time in order to assess how well the Australian evidence assumptions are reflected in a UK context.

To conclude, despite the considerable amount of uncertainties, these modelling exercises confirm findings from the systematic review[2] that a policy lowering the legal limit to 50 mg/100 ml could be effective in reducing road traffic injuries and deaths in England and Wales.

1 Introduction

1.1 Background

Despite a substantial decline in drink-driving and associated road traffic casualties during the past two decades, the number of casualties attributable to alcohol remains high. In 2008, it was estimated that approximately 13,020 casualties occurred when someone was driving and drinking over the current UK legal blood alcohol content (BAC) limit (80 mg/100 ml), with 430 deaths attributable to alcohol (provisional figure in 2008)[1].

In recent years, a number of European countries have adopted a lower legal limit for BAC when driving, with levels of 50 mg/100 ml, 20 mg/100 ml or even zero. There are recommendations from the European Commission for a drink-drive limit of 50 mg/100 ml for experienced drivers and 20 mg/100 ml for novice drivers. Despite this movement towards a reduction in the legal limit for drink driving in Europe, no change has been made in the legislation in England and Wales since 1967.

1.2 Experience and evaluation in other countries

Most published evaluations carried out to estimate benefits associated with lowering the legal limit from 80 mg/100 ml to 50 mg/100 ml showed that considerable benefits can be attained either in terms of reduction in the number of drivers killed or injured[8, 9] or BAC among drivers arrested[6]. These evaluations were carried out using time-series analysis (comparison before-and-after policy) and/or regression modelling[3]. Given the considerable benefits achieved by the implementation of the 50 mg/100 ml BAC law in other countries, the question arises as to whether the limit should be lower in England and Wales. Some studies attempted to capture the potential benefits of this policy in England and Wales, but with limitations[10, 11]. For instance, Starks et al.,[10] estimated that lowering the legal limit would be associated with a reduction of 21% in both drink-driving and casualties. Similarly, Allsop et al.,[11] suggested that reducing the legal limit would save 65 lives each year and prevent 230 serious injuries. Since these studies, new evidence is now available and there is a better understanding of appropriate methods to model alcohol policies.

1.3 Objectives

The primary objective of this study is to estimate the impact of lowering the legal limit from 80 mg/100 ml to 50 mg/100 ml in England and Wales in terms of lives saved and injuries avoided.

The researchers were also asked to try to capture benefits associated with other policies, such as an increase in enforcement or a differential BAC law for novice and experienced drivers, if sufficient evidence were available.

2 Method

2.1 Overview of the model structure

In the absence of direct evaluation of the impact of the implementation of a 50 mg/100 ml BAC law in England and Wales, modelling approaches can be used to approximate potential benefits of the policy. Two types of approaches can be used. Direct approaches consist of simply applying evidence about the proportional reduction in casualties to the actual number of casualties. Indirect approaches can be employed by summarising and linking best evidence available about the profile of drink-drivers, the effectiveness of the policy in terms of change in alcohol consumption, the risk of casualties as the alcohol consumption increases, and so on.

The bulk of the modelling work employed an indirect approach to model a shift in the BAC distribution which might translate into savings in fatal or non-fatal casualties. A simpler direct approach was also employed extrapolating results from the Albalate study[3] to England and Wales.

Ideally, a model explicitly capturing the behaviour of road users should be constructed. However, it was not possible to model the behaviour of road users in our study explicitly, given the paucity of evidence. It was also expected that the additional complexity in the model would not add any additional information, given the large number of unknown or uncertain parameters. Consequently a simple approach was employed using a population-based approach, requiring fewer inputs and assumptions.

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 was populated with best evidence identified during the systematic review where possible[2]. Non-observable parameters were calibrated, derived from other observed parameters. The effectiveness of the policy was modelled using evidence from two Australian studies in the absence of detailed evidence from Europe about the shift in the BAC distribution after the implementation of the 50 mg/100 ml BAC law[5, 6]. Given the uncertainty about the applicability of these studies to the UK context, a secondary analysis was performed assuming only half of the relative effect of the policy as observed in Australia.

We modelled how the shift in the BAC distribution among drivers would translate into savings in casualties among this road user group. Benefits to other road users who might otherwise be killed or injured, such as passengers and/or pedestrians, were implicitly extrapolated from benefits observed among drivers.

The model was constructed in Microsoft EXCEL. The first step was to calibrate the BAC distribution and determine the natural shift in the BAC distribution in the absence of policy change from the distribution of fatal casualties by BAC band in England and Wales, published risk functions[4] and regression methods. This was necessary in the absence of ’robust’ observed data about the BAC distribution in England and Wales.

We then calculated the change in the number of casualties in the absence of policy change attributable to the natural shift in the BAC distribution using the population impact fraction (PIF) approach (that is, proportional reduction in average disease risk over a specified time interval that would be achieved by eliminating the exposure of interest from the population if the distributions of other risk factors remain unchanged). The PIF is a traditional epidemiological approach to modelling risk reductions and was recently employed in our modelling of the potential effects of alcohol pricing and promotion policies in England and Wales[12].

Similarly, we modelled the shift in the BAC distribution after the implementation of the 50 mg/100 ml BAC law derived from evidence from two Australian studies[5, 6] and calculated the change in the number of casualties attributable to the shift in the BAC distribution using the PIF. Finally, we compared the estimated number of casualties in the absence of policy change to the predicted number of casualties after the implementation of the 50 mg/100 ml law to estimate the additional number of casualties that would be avoided due to the lower BAC limit in England and Wales.

A simplified schematic of the model structure including the key evidence sources used is presented at the end of the method section (section 2.6).

2.2 Statistics about the number of casualties in England and Wales

In the absence of statistics about the number of casualties in 2009, we used statistics from 2008 as a proxy. Statistics for 2008 were obtained from an analysis made by the Department of Transport[1] and is presented in table 1. Casualties were divided into road users killed, killed or seriously injured (KSI), and all severities. In the model, we separated road users killed from road users seriously injured and road users non-seriously injured. This analysis includes all road users and was not constrained to road users killed or injured by drink-drivers (we were not interested in the number of casualties attributable to drink-driving given that we model a shift in the BAC distribution including abstainers).

table 1: Number of casualties in England and Wales in 2008[1]

All road users	
Killed	2,266
KSI	23,499
All severities	189,577

The model was constructed around drivers and we modelled how the shift in the BAC distribution among drivers would translate into savings in casualties among this road-user group. Benefits in terms of avoidance of death or injury to other road users, such as passengers and/or pedestrians, were extrapolated from benefits observed among drivers applying the PIF to the overall number of casualties.

Finally, for interest, we also obtained information about the number of casualties among drivers in the UK (not adjusted for England and Wales) from 1997 onwards[1] to determine if any trend in the number of casualties can be observed before the implementation of the policy. The number of casualties from 1997 to 2008 was plotted in figure 1, figure 2 and figure 3. Overall, there is a clear tendency for the number of casualties to decrease over time. While the trend for serious and minor injuries was very similar, there was a small variation between trends in fatal and non-fatal casualties, especially before 2003.

figure 1: Trend in fatal casualties among drivers from 1997 onwards in the UK

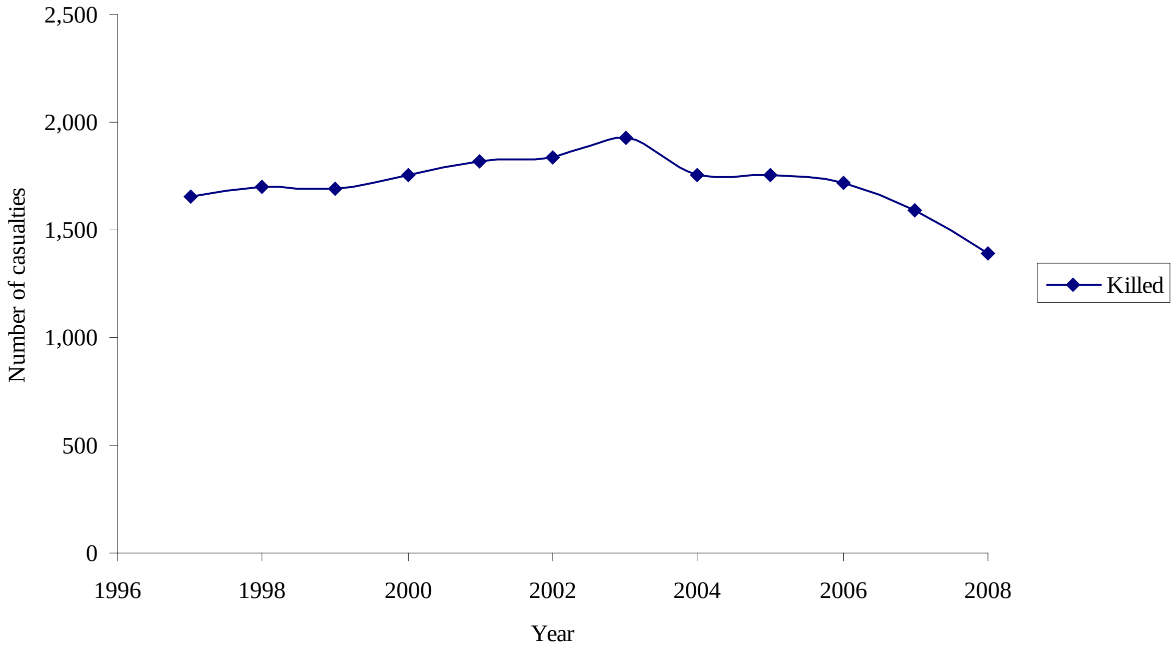


figure 2: Trend in serious casualties among drivers from 1997 onwards in the UK

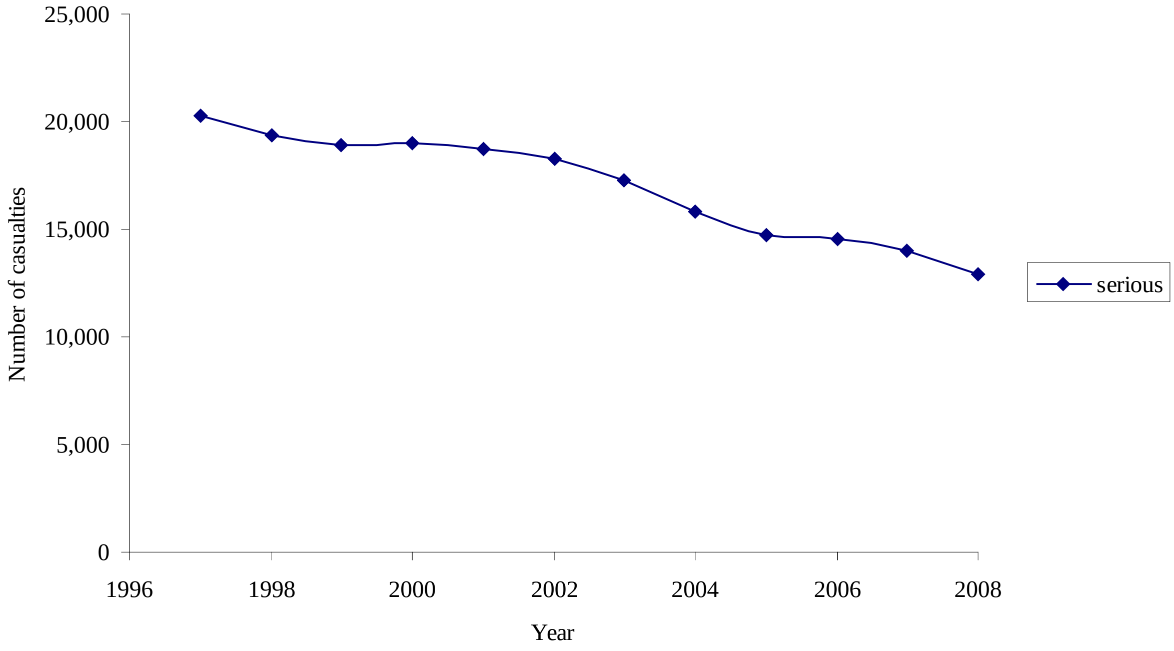
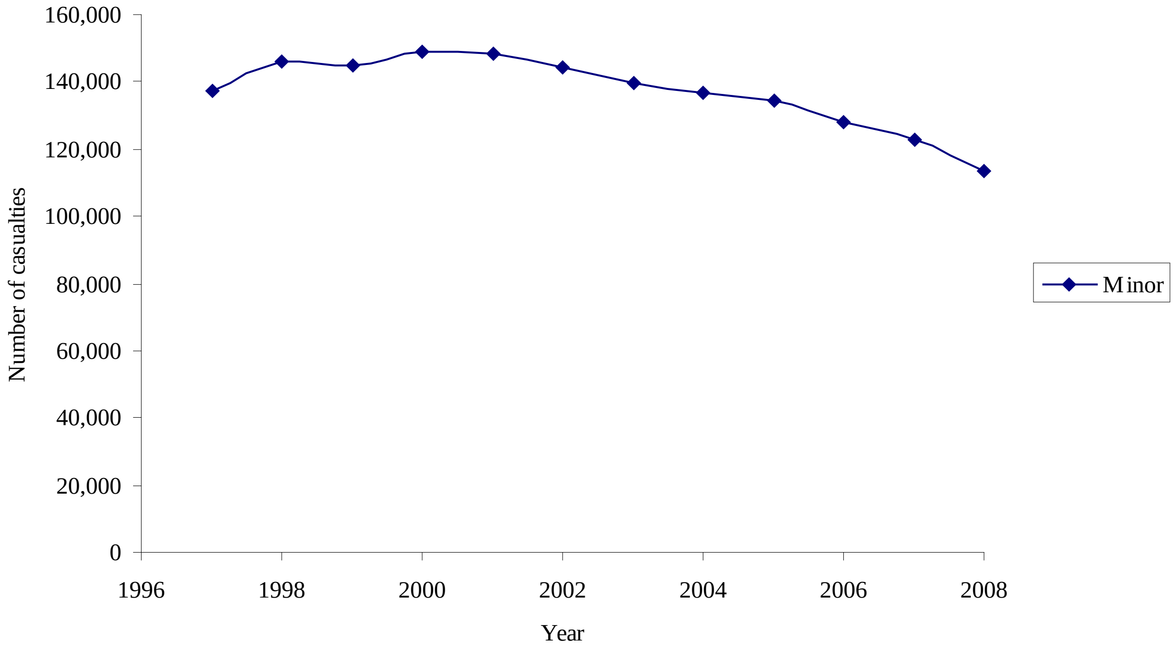


figure 3: Trend in minor casualties among drivers from 1997 onwards in the UK



2.3 Relationship between alcohol consumption and risk of fatal and non-fatal accident

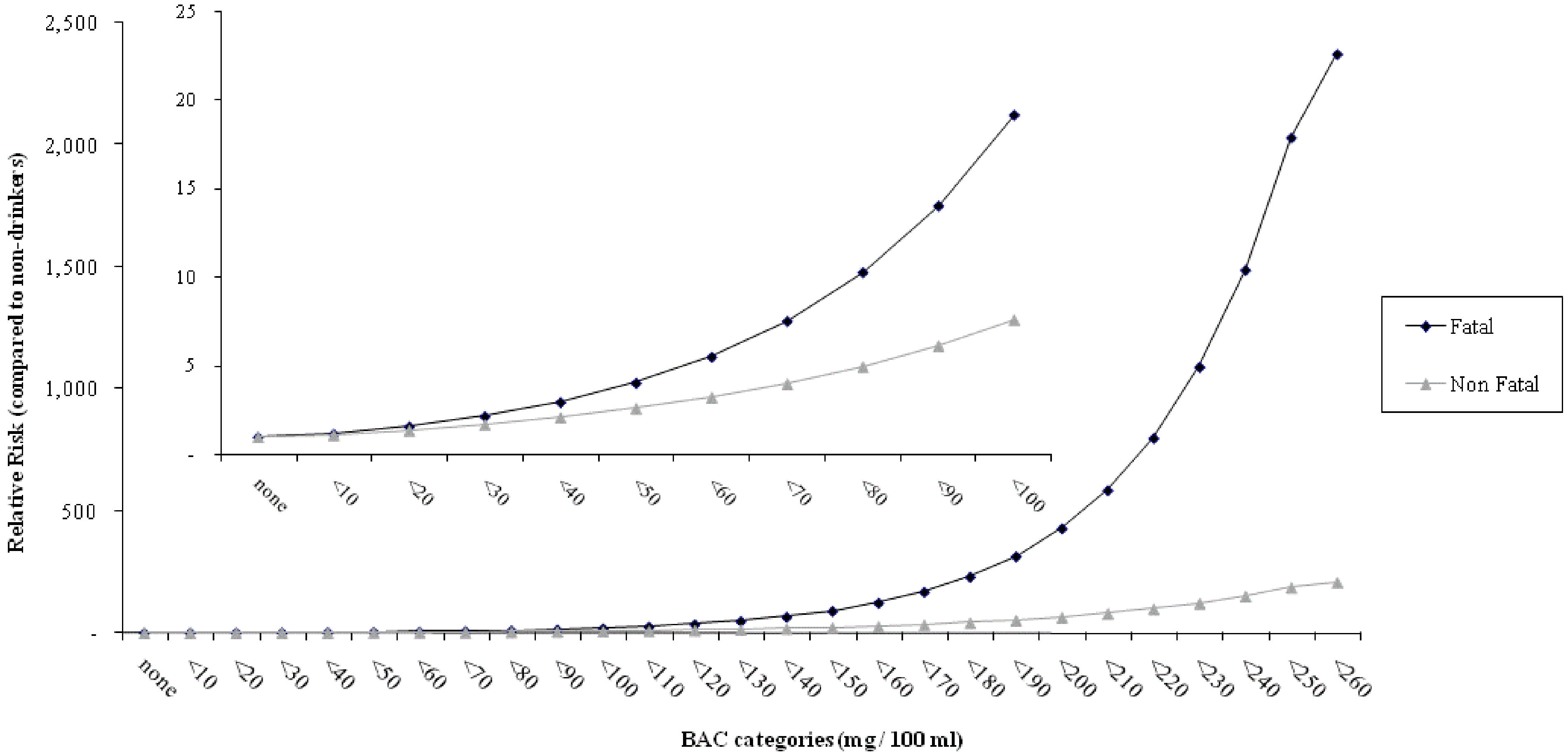
The relationship between the BAC and the risk of being involved in a fatal or non-fatal accident has been extensively studied over the past two decades[4, 13, 14, 15, 16]. Despite differences in methodology, all these studies demonstrate that the risk increases as the BAC increases, following a positive exponential curve.

2.3.1 Evidence from England and Wales

Evidence review indicates that the relationship between alcohol consumption and risk of fatal and non-fatal accident in England and Wales was reported only by Maycock et al. [4] This study compared data from roadside surveys and the distribution of BAC among drivers involved in fatal and non-fatal accidents. Data were collected at weekends during peak hours. There are uncertainties about the comparability of drivers in the exposure group and casualty data used. Notably, Maycock et al., [4] used the simplified assumption that the BAC distribution collected during roadside surveys was reasonably representative of a full 24 hour distribution. Furthermore, the relationships were not disaggregated by age group. Data from this study were used as it represents the best evidence available about the relationship between alcohol consumption and risk of fatal and non-fatal accident for England and Wales.

The risk of being involved in a fatal or non-fatal accident was shown to increase exponentially as the BAC increases. This finding has already been observed in other countries[13, 15, 16, 17]. However, compared to previous studies, no beneficial effect for injuries at low BAC level was observed as in the ‘Grand rapid study’[14] or recent analysis in the US for drivers aged over 21 years[16]. These studies demonstrated that non-drinkers may be at higher risk for injuries compared to ’light drinkers’ and may be attributable to the possible tiredness of sober drivers compared to drink drivers[18] or limitations in the method used to calculate risk functions. While it is unclear if this effect is realistic, no beneficial effect could have been observed in the Maycock study[4] given the broad definition of the lowest BAC band (approx 50 mg/100 ml).

figure 4: Relative risk of being involved in a fatal or non-fatal accident in England and Wales[4]



2.3.2 Application of the risk function in the modelling

This parameter (relationship between BAC and risk of casualty) was employed for two purposes:

- to calibrate the BAC distribution from the distribution of fatal casualties by BAC band (see section2.4.2).
- to calculate the PIF or excess risk (see section 2.6).

The risk function used in this study follows an exponential curve. This may represent a limitation given that, at very high BAC, even a small difference in the BAC would generate large relative risk. Furthermore, Keall et al.,[17] reported that the driver risk of fatal injury for all three age groups analysed (15–19, 20–29 and 30+) increases exponentially up to about 200 mg/100 ml and then less exponentially thereafter. To our knowledge, there is no consensus about how to deal with this type of risk function, as it is very unlikely that the risk increases exponentially indefinitely as shown by Keall et al.[17] In our central estimate analyses, we have assumed that the risk was truncated, that is, remained at a constant level, above 250 mg/100 ml. This threshold was selected for calibration purposes (see section 2.4.2) as the calibration process was less accurate when a higher or no threshold was selected. A sensitivity analysis was conducted using different thresholds for truncation (150, 200, 300 mg/100 ml).

We modelled the proportion of drivers in broad BAC categories of 10 mg/100 ml up to 300 mg/100ml. Given that a parametric risk function was used, we selected the risk at the midpoint between the lower and upper range of the BAC band considered (for example, the risk for a BAC of 15 mg/100 ml was selected for the BAC band 10–20 mg/100 ml).

One important assumption when we applied the risk function was that the risk was assumed to be constant over time. This assumption, while simplistic, was selected in the absence of evidence about the natural trend in the risk function. This represents a limitation, as the relative risk is influenced by external factors such as road infrastructure. The risk function was also derived from data collected more than 15 years ago which may bias results[4].

Finally, we needed to model three types of outcomes: road users killed, seriously injured and non-seriously injured. The evidence from Maycock et al.,[4] was slightly less specific than this, however, splitting fatal from non-fatal casualties. Given the similar trend in casualties for road users seriously and non-seriously injured, a similar risk function was used for non-fatal casualties. Results using the risk function for fatal casualties to represent serious injuries were examined in sensitivity analysis.

2.4 Estimate of the BAC distribution among drivers in England and Wales

2.4.1 Existing evidence from roadside BAC surveys

Roadside surveys are usually used to determine the BAC distribution among drivers at a certain point in time. This involves randomly sampled drivers being stopped and asked to provide a sample breath test which is then analysed to estimate the alcohol content. Few roadside surveys have been conducted in England and Wales to provide a general picture of the BAC distribution. Here we briefly review the existing surveys.

In the 1962–64 roadside survey, 1,739 drivers were recruited between 6pm and midnight on Thursday, Friday and Saturday and about 16.8% of drivers were found with a BAC over 50 mg/100 ml[19].

In Spring 1988, a survey was conducted in Sussex and Warwickshire[20]. Drivers were surveyed between 10 pm and 3 am on Thursday, Friday and Saturday over an 8-week period between April and June. Among drivers with a valid breath sample (n = 2,488), about 1.7% were found with a BAC over 80 mg/100 ml, and significant differences were observed between Sussex (1.0%) and Warwickshire (2.4%).

In 1990, a roadside survey was carried out in 10 counties of England and Wales between April and October and drivers were stopped randomly between 7 pm and 2 am on Thursday, Friday and Saturday night[21]. Among the 13,476 drivers who provided a valid breath test, about 1.02% were over the legal limit (80 mg/100 ml), 0.16% exceeded twice the legal limit and 3.2% exceeded half of the legal limit. As in the previous roadside survey, variations were found between counties.

Finally, the most recent surveys were conducted in 1998 and 1999 across 11 counties[22]. Among the 10,717 and 9571 drivers with a valid breath test, about 1.0% and 0.7% were over the legal limit (80 mg/100 ml). While differences were observed between the 1998 and 1999 surveys, these were mostly attributable to differences in location (rural versus urban).

Data from the combined 1988 and 1990 roadside surveys[21] were analysed by Maycock et al.,[4] in a recent review of drinking and driving in Great Britain. The author found that the distribution of the BAC follows a negative exponential form. The fit was, however, not very accurate for drivers who do not drink while driving or drivers with a BAC over 250 mg/100 ml.

Despite the availability of data from this study[4], the reported distribution of BAC may not fully represent the actual distribution in England and Wales for the following reasons:

- First, the BAC was collected during the night when it tends to reach a peak.
- Second, importantly, it is believed that the extent of drinking and driving and the characteristics of drinkers who choose to drive may have changed since the 1988–90 period because there have been changes in the last 15 years (both increased enforcement and breath testing and some changes in societal, cultural and drinking behaviour).
- Third, the assumption of a negative exponential is very simple and does not allow accounting for small variations which may be important given the form of the relative risk functions.
- Fourth, it is believed that the BAC distribution is different between car drivers and motorcycle riders.
- Finally, it was not possible from the Maycock study[4] to disaggregate the BAC distribution by age. It is believed that age may well affect the BAC distribution given differences in behaviour inferred from relative risk studies between younger and older drivers.

Moreover, no information was available about the natural shift in the BAC distribution among drivers in the absence of policy change.

2.4.2 A calibration approach to estimate baseline BAC distributions for England and Wales

In the absence of a perfect evidence base on the distribution of BAC among drivers in England and Wales, a calibration approach was used deriving the baseline BAC from two key sources:

- the relative risk function for fatal casualties[4]
- the distribution of fatal casualties among drivers by BAC categories[7].

The distribution of fatal casualties by BAC was obtained through the Department for Transport for road users between the years 1998 and 2008. The detailed individual-level dataset included more than 18,000 fatal casualties in the UK with information about the BAC at the time of death. While data collected may not be totally accurate, this was the best available data. Specifically uncertainty notably exists about the imputation of BAC for missing data. Data were analysed to determine the distribution of fatal casualties for all drivers/riders. Passengers and pedestrians were excluded from the analysis. Unfortunately, it was not possible to isolate the fault of the driver, that is, whether the driver was responsible for his or her own death or died due to someone else's behaviour. The calculated distribution of fatal casualties is presented below in table 2.

table 2: Observed distribution of fatal casualties by BAC categories

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	n=1,096	n=1,146	n=1,188	n=1,293	n=1,240	n=1,400	n=1,291	n=1,352	n=1,341	n=802
none	57.2080%	51.5707%	52.3569%	50.1933%	53.2258%	57.0714%	55.1510%	56.7308%	61.5958%	65.7107%
<10	15.5109%	19.2845%	15.9091%	20.1083%	14.8387%	11.4286%	12.0837%	13.0917%	8.5757%	5.4863%
<20	6.2956%	6.2827%	7.6599%	6.2645%	6.6129%	7.1429%	5.5771%	4.7337%	4.6234%	4.8628%
<30	1.5511%	2.3560%	1.2626%	1.3921%	1.9355%	1.6429%	1.4717%	1.4793%	1.3423%	1.7456%
<40	0.8212%	1.0471%	1.3468%	0.8507%	1.2903%	0.7143%	0.7746%	0.8136%	0.8949%	1.1222%
<50	0.4562%	1.0471%	1.3468%	0.7734%	0.9677%	0.9286%	1.6266%	0.5917%	0.4474%	1.1222%
<60	0.6387%	0.5236%	0.6734%	0.6961%	0.6452%	0.7857%	0.7746%	0.8136%	0.4474%	0.7481%
<70	1.3686%	0.7853%	0.4209%	0.2320%	0.7258%	1.0000%	0.6971%	0.8136%	0.1491%	0.2494%
<80	0.6387%	0.6981%	0.6734%	0.9281%	0.4032%	0.5714%	0.5422%	0.8136%	0.6711%	0.3741%
<90	0.0912%	0.5236%	0.5051%	0.9281%	0.3226%	0.8571%	0.3098%	1.0355%	0.7457%	0.3741%
<100	0.8212%	0.6108%	0.3367%	0.4640%	1.1290%	0.7857%	0.4648%	0.8136%	0.5966%	0.7481%
<110	1.2774%	0.6981%	1.0101%	0.8507%	0.5645%	0.5000%	0.7746%	0.5917%	0.8203%	1.1222%
<120	0.4562%	0.6108%	0.5892%	0.6961%	0.4839%	0.3571%	1.2393%	0.9615%	0.8203%	1.1222%
<130	0.3650%	0.5236%	0.5892%	1.3921%	1.0484%	1.0714%	1.3943%	0.8876%	0.9694%	0.8728%
<140	0.7299%	0.6108%	0.7576%	0.6187%	1.8548%	1.7857%	1.3168%	1.0355%	0.8203%	1.1222%
<150	0.7299%	0.5236%	1.4310%	1.2374%	0.8871%	1.1429%	1.1619%	1.3314%	1.3423%	1.2469%
<160	1.0949%	0.7853%	1.5152%	1.1601%	1.1290%	1.0000%	1.1619%	0.8136%	1.1186%	0.8728%
<170	0.8212%	0.8726%	1.0101%	1.1601%	1.7742%	1.0714%	1.2393%	0.9615%	1.9389%	0.9975%
<180	0.8212%	0.8726%	0.8418%	0.9281%	0.5645%	0.7143%	1.0844%	0.8876%	1.2677%	0.6234%
<190	1.0036%	1.5707%	0.9259%	1.2374%	1.1290%	1.2857%	1.4717%	1.6272%	0.8203%	1.3716%
<200	0.8212%	1.4834%	0.5892%	0.6961%	0.8871%	1.1429%	1.6266%	1.3314%	1.3423%	1.2469%
<210	0.8212%	0.6981%	0.8418%	1.3921%	1.4516%	1.1429%	1.0844%	1.3314%	0.9694%	0.9975%
<220	0.4562%	1.5707%	1.0101%	0.8507%	0.8065%	0.9286%	0.8521%	1.3314%	1.1186%	0.7481%
<230	0.1825%	0.3490%	0.4209%	0.6961%	0.8065%	0.8571%	1.1619%	0.8876%	1.0440%	0.4988%
<240	0.7299%	0.7853%	0.6734%	0.6187%	1.2097%	0.2143%	1.0844%	0.9615%	1.2677%	0.4988%
<250	0.7299%	0.5236%	1.0101%	0.6187%	0.5645%	1.1429%	0.8521%	0.5178%	1.0440%	1.2469%
<260	0.6387%	0.6108%	0.8418%	0.5414%	0.6452%	0.6429%	0.4648%	0.4438%	0.5966%	0.6234%
<270	0.6387%	0.5236%	0.7576%	0.3867%	0.4839%	0.0000%	0.2324%	0.1479%	0.1491%	0.3741%
<280	0.4562%	0.5236%	0.5892%	0.3867%	0.3226%	0.2857%	0.3873%	0.4438%	0.4474%	0.9975%
<290	0.1825%	0.4363%	0.5051%	0.4640%	0.1613%	0.1429%	0.0775%	0.5178%	0.2237%	0.2494%
<300	0.3650%	0.2618%	0.5051%	0.0773%	0.3226%	0.1429%	0.2324%	0.2959%	0.2983%	0.1247%
300+	1.2774%	0.4363%	1.0943%	1.1601%	0.8065%	1.5000%	1.6266%	0.9615%	1.4914%	0.4988%

A predicted distribution for the proportion of fatal casualties by BAC band can be modelled based on the relative risk functions for fatalities from section 2.3 and a hypothetical baseline BAC distribution for drivers. This predicted distribution of fatal casualties can then be compared with the observed data from the Department for Transport given in table 2 using root mean squared differences. The starting hypothesised baseline BAC distribution is then adjusted via a calibration process to minimise the root mean square error (RMSE) between the predicted and observed distribution of fatal casualties using a linear optimiser (Solver in Excel). The calibration was done manually until the RMSE was close to zero. Logical constraints were also applied, that is that the sum of all the probabilities of being in each BAC category must be equal to one and the impossibility of having negative probabilities.

This process was repeated for each year between 1998 and 2007 using all the different tested thresholds for truncation examined in sensitivity analysis.

After calibration of the BAC distribution, the estimated distribution of fatal casualties was very similar to the observed distribution (figure 5, figure 6). Note that the fit was more accurate using a lower threshold for truncation. The observed and predicted distribution of fatal casualties was plotted in the log and non-log scale for the year 2007 in figure 5 and figure 6.

The predicted BAC distribution between 1998 and 2007 is presented below in table 3.

2.4.3 Limitations of the calibration of the BAC distribution

Despite the good fit, our calibrated BAC distribution has several limitations. One was the uncertainty in the risk function used to calibrate the BAC distribution. The risk function was estimated around 15 years ago and it is possible that the risk function has changed since this study[7]. There is also uncertainty in the way the risk function was calculated, as the alcohol content among the control group was collected only during weekend peak hours.

We used the same risk function to calibrate the BAC distribution for each of the years 1998–2007, but it is possible that the risk function has changed over time, given progress in road safety. Unfortunately, it was not possible to estimate the effect of varying the risk function over time as the number of non-observable parameters to calibrate was too large. To a much smaller extent, the distribution of fatal casualties by BAC band used contains some uncertainty regarding whether it is fully representative of the distribution of fatal casualties in England and Wales.

Finally, it was not possible to validate our calibrated BAC distribution in the absence of robust observed data about the BAC distribution in England and Wales. Roadside surveys were last conducted in 1998 and 1999. These surveys were conducted at the weekend during peak hours and reported that about 1.0% and 0.7% of surveyed drivers were over the legal limit (80 mg/100 ml). Estimations from our calibration approach were considerably lower (about 0.22%); however, this may reflect the fact that more drivers at higher BAC bands are expected during the weekend and peak hours.

2.4.4 Modelling trends in the distribution of BAC in the absence of policy change

Different approaches can be used to estimate the trends in the BAC distribution in the absence of policy change using ‘observed calibrated’ data about the BAC distribution for the years 1998–2007. Given the time constraints, in our study we employed a simple approach using linear regression models (logarithm regression models were used when appropriate when the extrapolation using linear models gave negative future proportions of drivers within a particular BAC band). For the central case, the model was fitted using data for the years 2003–7. However, different models were also examined in sensitivity analysis by using 1998 onwards for the starting year for the fit of the regression models. The predicted BAC distribution for the years 2009–15 is presented in table 4.

A further sensitivity analysis assumed that in the absence of policy change, the BAC distribution would remain constant over time.

figure 5: Calibration in 2007: comparison of the observed and predicted distribution of fatal casualty (in the log scale)

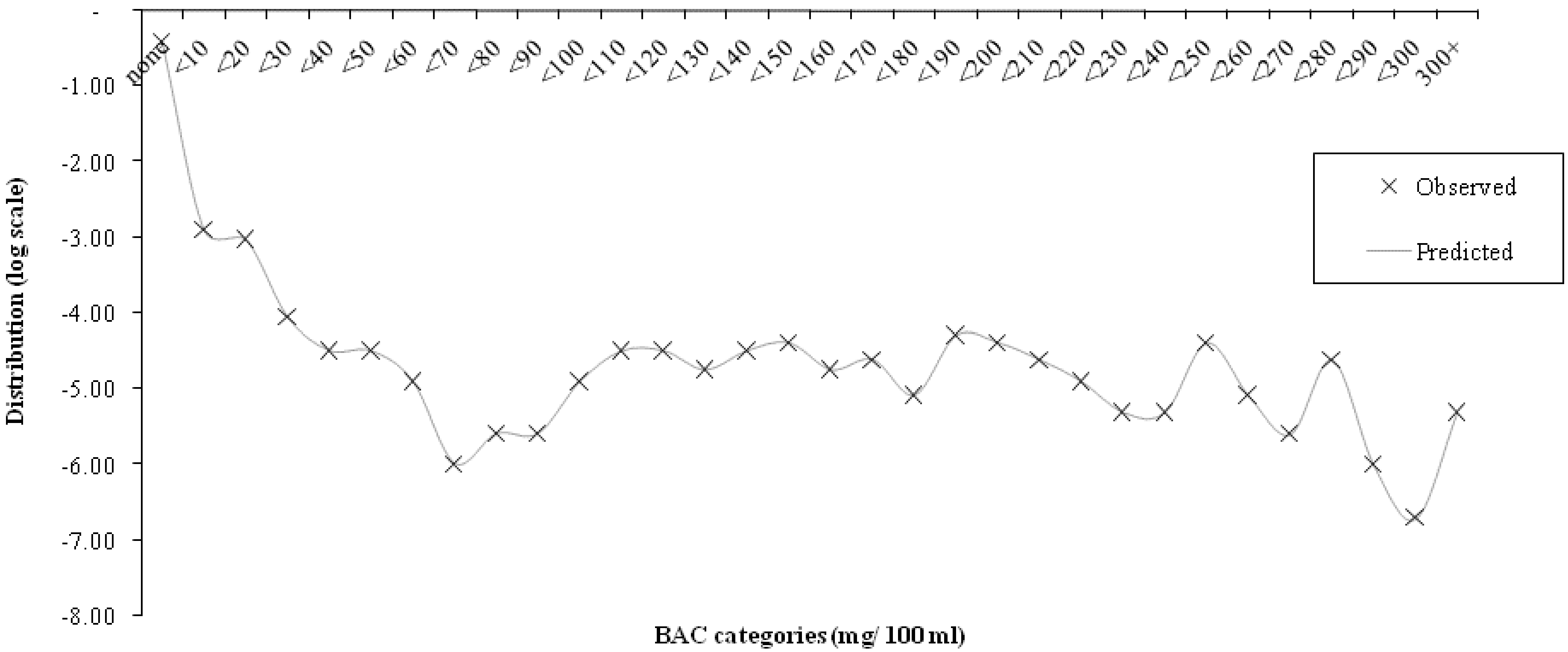


figure 6: Calibration in 2007: comparison of the observed and predicted distribution of fatal casualty

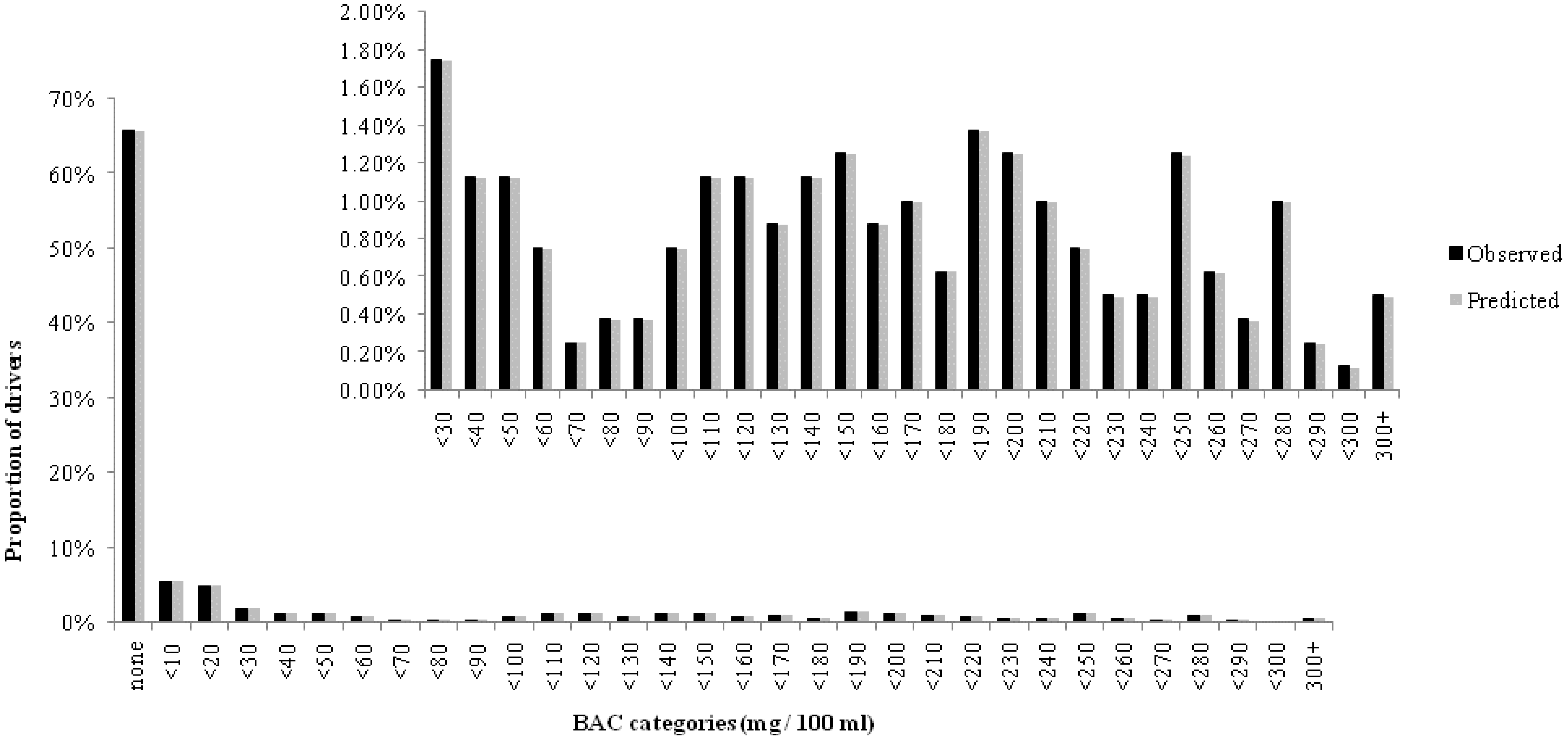


table 3: Calibrated BAC distribution for the years 1998– 2007 derived from the BAC distribution among fatal casualties

Blood Alcohol Concentration	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
none	75.2126%	69.5608%	72.1537%	68.8476%	73.8212%	78.0490%	77.8578%	78.1436%	84.0765%	87.2113%
<10	17.4547%	22.2543%	18.7615%	23.5886%	17.6175%	13.3825%	14.6112%	15.4432%	10.0235%	6.2432%
<20	5.1942%	5.3160%	6.6196%	5.3857%	5.7545%	6.1325%	4.9422%	4.0963%	3.9574%	4.0476%
<30	0.9362%	1.4578%	0.7986%	0.8765%	1.2313%	1.0355%	0.9557%	0.9377%	0.8436%	1.0644%
<40	0.3644%	0.4746%	0.6247%	0.3918%	0.6030%	0.3302%	0.3694%	0.3772%	0.4141%	0.5041%
<50	0.1476%	0.3488%	0.4580%	0.2608%	0.3318%	0.3139%	0.5657%	0.2026%	0.1517%	0.3681%
<60	0.1521%	0.1286%	0.1684%	0.1722%	0.1615%	0.1943%	0.1982%	0.2023%	0.1107%	0.1800%
<70	0.2392%	0.1409%	0.0771%	0.0425%	0.1333%	0.1809%	0.1307%	0.1488%	0.0272%	0.0447%
<80	0.0823%	0.0913%	0.0895%	0.1230%	0.0543%	0.0762%	0.0745%	0.1094%	0.0889%	0.0484%
<90	0.0088%	0.0502%	0.0495%	0.0911%	0.0318%	0.0835%	0.0314%	0.1016%	0.0726%	0.0356%
<100	0.0564%	0.0432%	0.0244%	0.0337%	0.0814%	0.0562%	0.0344%	0.0588%	0.0425%	0.0519%
<110	0.0641%	0.0362%	0.0533%	0.0448%	0.0300%	0.0262%	0.0419%	0.0312%	0.0429%	0.0569%
<120	0.0170%	0.0232%	0.0229%	0.0269%	0.0188%	0.0138%	0.0490%	0.0372%	0.0314%	0.0418%
<130	0.0100%	0.0145%	0.0168%	0.0393%	0.0299%	0.0302%	0.0404%	0.0252%	0.0272%	0.0238%
<140	0.0145%	0.0124%	0.0158%	0.0128%	0.0387%	0.0368%	0.0280%	0.0215%	0.0169%	0.0224%
<150	0.0106%	0.0078%	0.0218%	0.0187%	0.0136%	0.0173%	0.0181%	0.0202%	0.0202%	0.0183%
<160	0.0116%	0.0086%	0.0169%	0.0129%	0.0127%	0.0111%	0.0133%	0.0091%	0.0124%	0.0094%
<170	0.0064%	0.0070%	0.0083%	0.0094%	0.0145%	0.0087%	0.0104%	0.0079%	0.0157%	0.0079%
<180	0.0047%	0.0051%	0.0051%	0.0055%	0.0034%	0.0043%	0.0067%	0.0053%	0.0075%	0.0036%
<190	0.0042%	0.0068%	0.0041%	0.0054%	0.0050%	0.0056%	0.0066%	0.0071%	0.0036%	0.0058%
<200	0.0025%	0.0047%	0.0019%	0.0022%	0.0029%	0.0036%	0.0054%	0.0043%	0.0043%	0.0039%
<210	0.0018%	0.0016%	0.0020%	0.0033%	0.0034%	0.0027%	0.0026%	0.0031%	0.0023%	0.0023%
<220	0.0008%	0.0027%	0.0017%	0.0015%	0.0014%	0.0016%	0.0015%	0.0023%	0.0019%	0.0012%
<230	0.0002%	0.0004%	0.0005%	0.0009%	0.0010%	0.0011%	0.0015%	0.0011%	0.0013%	0.0006%
<240	0.0006%	0.0007%	0.0006%	0.0006%	0.0011%	0.0002%	0.0010%	0.0009%	0.0012%	0.0004%
<250	0.0005%	0.0003%	0.0007%	0.0004%	0.0004%	0.0008%	0.0006%	0.0003%	0.0007%	0.0008%
<260	0.0004%	0.0003%	0.0005%	0.0003%	0.0004%	0.0004%	0.0003%	0.0003%	0.0003%	0.0003%
<270	0.0003%	0.0003%	0.0004%	0.0002%	0.0003%	0.0000%	0.0001%	0.0001%	0.0001%	0.0002%
<280	0.0003%	0.0003%	0.0003%	0.0002%	0.0002%	0.0002%	0.0002%	0.0003%	0.0003%	0.0006%
<290	0.0001%	0.0002%	0.0003%	0.0003%	0.0001%	0.0001%	0.0000%	0.0003%	0.0001%	0.0001%
<300	0.0002%	0.0001%	0.0003%	0.0000%	0.0002%	0.0001%	0.0001%	0.0002%	0.0002%	0.0001%
300+	0.0007%	0.0002%	0.0006%	0.0007%	0.0005%	0.0009%	0.0010%	0.0006%	0.0009%	0.0003%

table 4: Estimated BAC distribution from 2009 onward using linear regression model from the year 2003– 2007 (derived from the BAC distribution among fatal casualties)

Blood Alcohol Concentration	2009	2010	2011	2012	2013	2014	2015
none	89.6297%	90.9577%	92.0850%	93.0409%	93.8513%	94.5389%	95.1230%
<10	5.2344%	4.2766%	3.4880%	2.8411%	2.3118%	1.8796%	1.5273%
<20	2.9561%	2.6290%	2.3342%	2.0696%	1.8332%	1.6225%	1.4352%
<30	0.9326%	0.9163%	0.8987%	0.8802%	0.8611%	0.8418%	0.8225%
<40	0.5483%	0.5800%	0.6099%	0.6380%	0.6644%	0.6894%	0.7128%
<50	0.1954%	0.1633%	0.1317%	0.1008%	0.0707%	0.0416%	0.0133%
<60	0.1288%	0.1160%	0.1032%	0.0907%	0.0784%	0.0665%	0.0549%
<70	0.0145%	0.0093%	0.0059%	0.0038%	0.0024%	0.0015%	0.0010%
<80	0.0622%	0.0575%	0.0528%	0.0481%	0.0435%	0.0390%	0.0347%
<90	0.0425%	0.0367%	0.0310%	0.0253%	0.0198%	0.0145%	0.0093%
<100	0.0479%	0.0473%	0.0466%	0.0459%	0.0451%	0.0443%	0.0435%
<110	0.0639%	0.0692%	0.0743%	0.0791%	0.0836%	0.0880%	0.0921%
<120	0.0493%	0.0525%	0.0555%	0.0583%	0.0609%	0.0634%	0.0658%
<130	0.0187%	0.0160%	0.0133%	0.0106%	0.0080%	0.0055%	0.0031%
<140	0.0132%	0.0112%	0.0095%	0.0081%	0.0068%	0.0058%	0.0049%
<150	0.0202%	0.0203%	0.0205%	0.0206%	0.0206%	0.0206%	0.0207%
<160	0.0092%	0.0087%	0.0081%	0.0076%	0.0071%	0.0066%	0.0061%
<170	0.0114%	0.0116%	0.0118%	0.0120%	0.0121%	0.0122%	0.0124%
<180	0.0052%	0.0051%	0.0050%	0.0049%	0.0048%	0.0046%	0.0045%
<190	0.0046%	0.0043%	0.0040%	0.0037%	0.0034%	0.0031%	0.0028%
<200	0.0040%	0.0038%	0.0037%	0.0036%	0.0035%	0.0034%	0.0033%
<210	0.0021%	0.0019%	0.0018%	0.0017%	0.0015%	0.0014%	0.0013%
<220	0.0016%	0.0015%	0.0015%	0.0014%	0.0014%	0.0013%	0.0013%
<230	0.0006%	0.0005%	0.0005%	0.0004%	0.0004%	0.0003%	0.0003%
<240	0.0010%	0.0010%	0.0011%	0.0011%	0.0012%	0.0012%	0.0012%
<250	0.0007%	0.0007%	0.0007%	0.0007%	0.0008%	0.0008%	0.0008%
<260	0.0003%	0.0003%	0.0003%	0.0003%	0.0003%	0.0003%	0.0003%
<270	0.0002%	0.0003%	0.0003%	0.0003%	0.0004%	0.0004%	0.0004%
<280	0.0006%	0.0007%	0.0008%	0.0008%	0.0009%	0.0009%	0.0010%
<290	0.0002%	0.0002%	0.0002%	0.0003%	0.0003%	0.0003%	0.0003%
<300	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%
300+	0.0002%	0.0002%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%

2.5 Modelling the shift in the BAC distribution after the implementation of the policy

As discussed in section 1.2 the impact of lowering the legal limit from 80 mg/100 ml to 50 mg/100 ml has mainly been reported in terms of change in the numbers of fatal and non-fatal casualties. For our purposes it would be ideal to have information about how the distribution of BAC shifts across all the distribution following the implementation of a 50 mg/100 ml limit. Few studies have attempted to determine how the distribution of BAC changed after the introduction of the policy, and among those that did, most only reported partial information such as the proportion of drivers above or below the legal limit before and after policy introduction.

Given the limited evidence, we have modelled the shift in the BAC distribution using findings from two Australian studies using a two-step approach[5, 6]. These two studies were selected as they contained enough information to model the shift in the BAC distribution after policy implementation. Kloeden et al.,[5] provides evidence on the number of drivers in four broad BAC bands for up to 6 years following the implementation of the 50 mg/100 ml limit. Brooks et al.,[6] provides evidence to inform the shifting patterns of the distribution within narrower 10 mg/100 ml wide BAC bands in our model. Limitations of using Australian evidence are discussed later in section 4.

2.5.1 Use of Kloeden et al.,[5] evidence on shifts in BAC distribution

Data from Kloeden et al.,[5] was used to estimate how the proportion of drivers with a BAC less than 10 mg/100 ml, 10–50 mg/100 ml, 50–80 mg/100 ml and over 80 mg/100 ml would change after lowering the legal limit from 80 mg/100 ml to 50 mg/100 ml.

This study was conducted in the province of Adelaide and reported the proportion of drivers with a BAC above or equal to 10 mg/100 ml, 50 mg/100 ml and 80 mg/100 ml, before, immediately (next 6 months), 2 years and then 6 years after the introduction of the new policy, using roadside survey data. Samples were collected between the hours of 10 pm and 3 am and were not constrained to weekend nights. Overall, a total of 6,727 drivers were approached in the roadside survey before the introduction of the BAC limit. The sample sizes at 6 months, 2 years and 6 years were 6,627, 7,841 and 5,526 respectively. This study reported the change in BAC distribution for different age and sex groups.

The absolute change in the proportion of drivers with a BAC over or equal to 10, 50 and 80 mg/ 100 ml is presented in figure 7. This study indicated that before the implementation of the 50 mg/100 ml limit, the proportion of surveyed drivers with a BAC over or equal to 10, 50 and 80 mg/100 ml was 16.2%, 5.1% and 2.5% respectively. For comparison the estimated proportion of drivers for these categories in England and Wales in 2009 in the model is 10.37%, 0.5% and 0.3%. Differences are likely to be attributable to the important progress against drink driving in England and Wales.

The relative reductions/increases from this study between baseline and 6 months, 6 months to 2 years and 2 years to 6 years were calculated using central estimates from Kloeden et al.,[5] and are shown in table 5. We assumed for the central case that the same relative effect would occur in England and Wales if the 50 mg/100 ml BAC is introduced. Given the considerable uncertainty about the applicability in England and Wales of the same relative effect as observed in Australia because of existing differences in the starting BAC distribution before the implementation of the policy, a secondary scenario is presented assuming only half of the relative effect observed in Australia for England and Wales.

We also examined in sensitivity analysis results using a proxy of 95% confidence interval (CI). The relative effect of the policy (full or half of that observed in Australia) was used to derive a 'new' proportion of drivers in each of the four BAC categories after policy ≥0 & <10, ≥10 & <50, ≥50 & <80, ≥80 mg/100 ml) at 6 months, 2 years and 6 years. Note that the calculated relative increase/reduction cannot be applied directly in the model, and adjustment needs to be done to ensure that the sum of overall probability equals one. An example of the calculation to estimate the 'new' BAC distribution is presented in box 1. Unfortunately, Kloeden et al.,[5] do not provide information about how the distribution of BAC shifted within these four groups in narrower BAC bands. Hence, evidence from Brooks et al.,[6] was used to inform the shifting pattern within each BAC band (see section 2.5.2)

figure 7: Absolute change in the proportion of drivers with a BAC over or equal to 10, 50 and 80 mg/100 ml

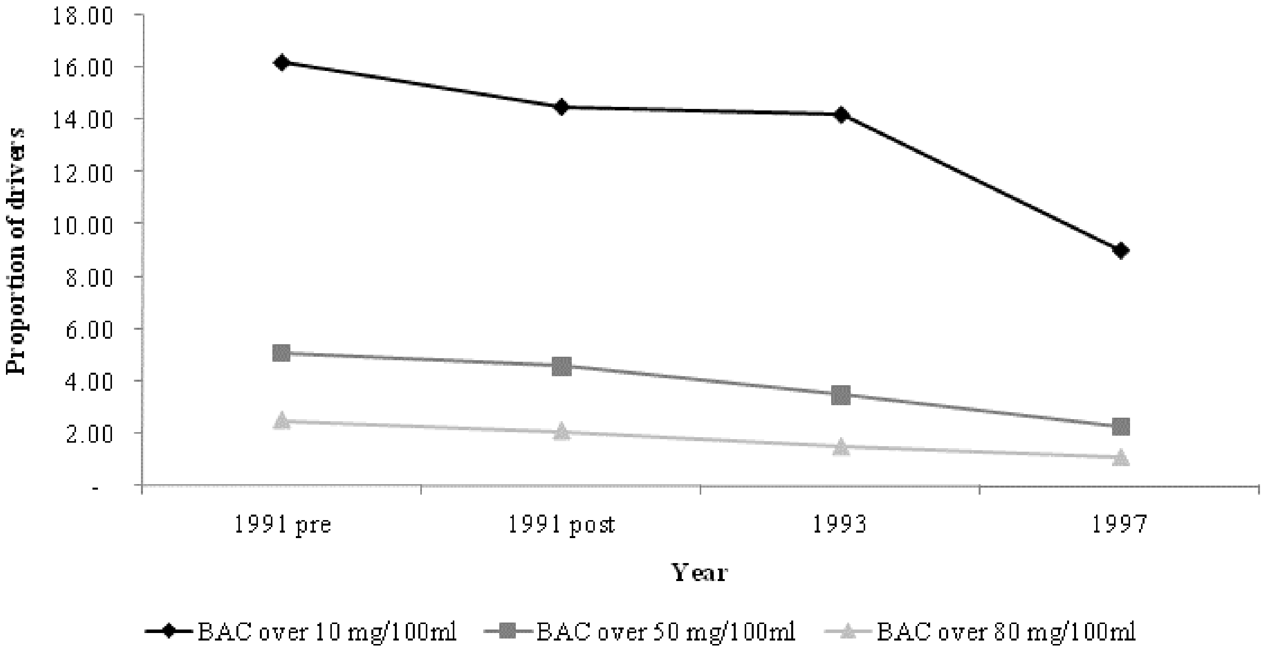


table 5: Time trends for relative change in the number of people in each BAC band following the implementation of the 50 mg/100 ml limit in the province of Adelaide (derived from Koeden et al.[5])

BAC Level	Central estimate
Baseline vs 6 months	
≥0 & < 10	102.03%
≥10 & < 50	89.19%
≥50 & < 80	96.15%
≥80	84.00%
6 months vs 2 years	
≥0 & < 10	100.35%
≥10 & < 50	108.08%
≥50 & < 80	80.00%
≥80	71.43%
2 years vs 6 years	
≥0 & < 10	106.06%
≥10 & < 50	62.62%
≥50 & < 80	60.00%
≥80	73.33%

Box 1: Illustrative example of the estimation of the proportion of drivers in the four BAC categories (comparison of baseline vs 6 months)

	Baseline distribution (X)		Change in the distribution (Y)		
≥0 & < 10	81.31%	*	102.03%	Sumproduct = (X * Y)	83.26%
≥10 & < 50	17.96%	*	89.19%		16.08%
≥50 & < 80	0.38%	*	96.15%		0.37%
≥80	0.35%	*	84.00%		0.30%

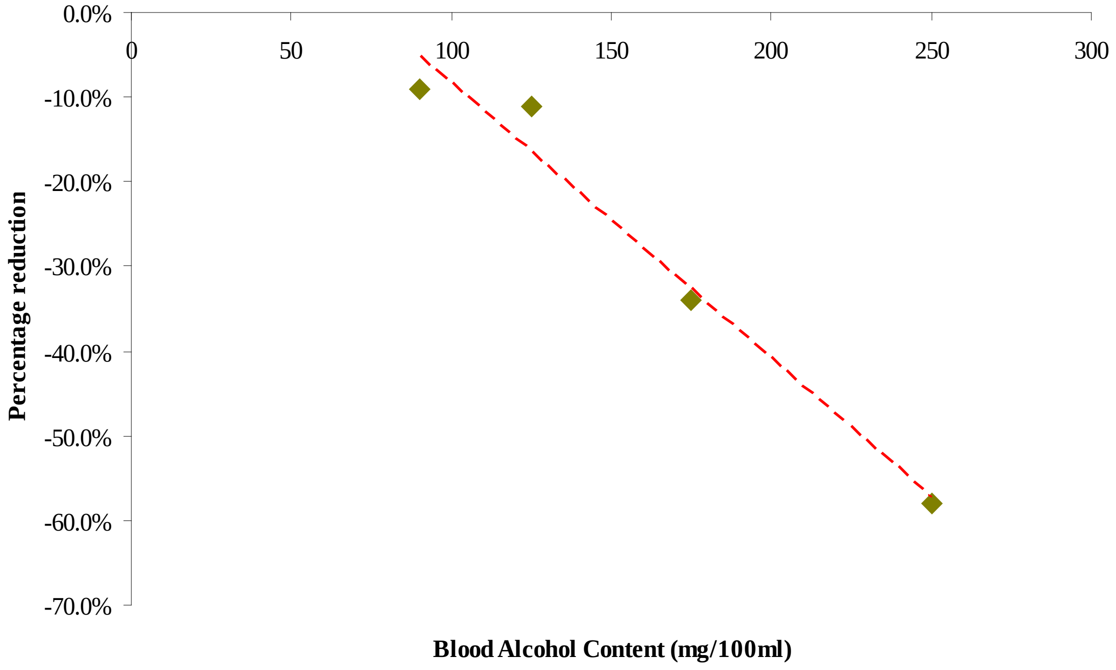
2.5.2 Use of Brooks et al.,[6] evidence to model the shift in the BAC distribution within narrower BAC bands

Brooks et al.,[6] compared BAC results from random breath testing between 1990 (before policy introduction) and 1991 (after policy introduction) for arrested drivers. This evidence showed that there was a substantial drop in the incidence of high BAC levels in 1991 compared to 1990. While the proportion of drivers with a BAC above 100 mg/100 ml decreased by about 26%, the reduction was not constant across all BAC categories and the reduction was more pronounced at higher BAC. Indeed, the proportion of drivers with a BAC between 100 and 149 mg/100 ml, 150 mg/ml to 199 mg/100 ml and over 200 mg/100 ml decreased by about 11%, 34% and 58% respectively. Similar findings were observed when data were disaggregated by age group. As shown in figure 8, the drop in the proportion was more pronounced at higher BAC and appears to follow a linear relationship.

Given the limited evidence about the shifting pattern of the BAC distribution, we have assumed that the percentage increases/decreases in the proportion of drivers by BAC categories for the narrower 10 mg/100 ml wide bands within our three broader BAC categories follow a linear trend. The percentage increase/reduction was modelled using a linear function with a constant and a slope. To determine the parameters of these three linear functions, we chose the slope and constant of each in order to minimise the RMSE between the predicted and observed proportion of drivers in each of the three BAC bands (again using Solver in EXCEL). The starting constant and slope can be of crucial importance, especially when using an optimiser such as Solver, and therefore the constant scale was initially set at one and the slope at 0 which equates to a relative reduction (RR) of one (no change). Constraints were also added so that the RR could not exceed 95%. Residuals were calculated and distributed across the narrower BAC bands so that the overall probability is exactly equal to one. An illustrative example of how the shift was modelled is presented in box 2.

The expected small sample size for drivers at high BAC categories may have introduced bias. Consequently, we examined in sensitivity analysis a constant percentage increase/decrease in the proportion of drivers by BAC categories for the narrower 10 mg/100 ml wide bands within our three broader BAC categories.

figure 8: Percentage reduction in the incidence of roadside breath test readings following implementation of 50 mg/100 ml limit in Australia – derived from Brooks et al.[6]



Box 2: Modelling the shift in the BAC within the three BAC bands (example for all drivers with a BAC below 50 mg/100 ml)

Let us assume a baseline BAC proportion of 10.0%. We also know that the overall proportion would decrease to 4.0%, for example. We therefore want to calibrate the baseline distribution so that the sum of proportions now equals 4.0% but assuming a linear decline, that is, in this case a higher reduction at higher BAC ≥ 40 & <50 compared to lower BAC ≥ 10 & <20. We need to determine the two parameters of the linear function (a and b) that minimise the RSME between the predicted proportion and the target overall proportion (10%). In this case, the difference was minimised for a = -0.131066 and b = 0.430145

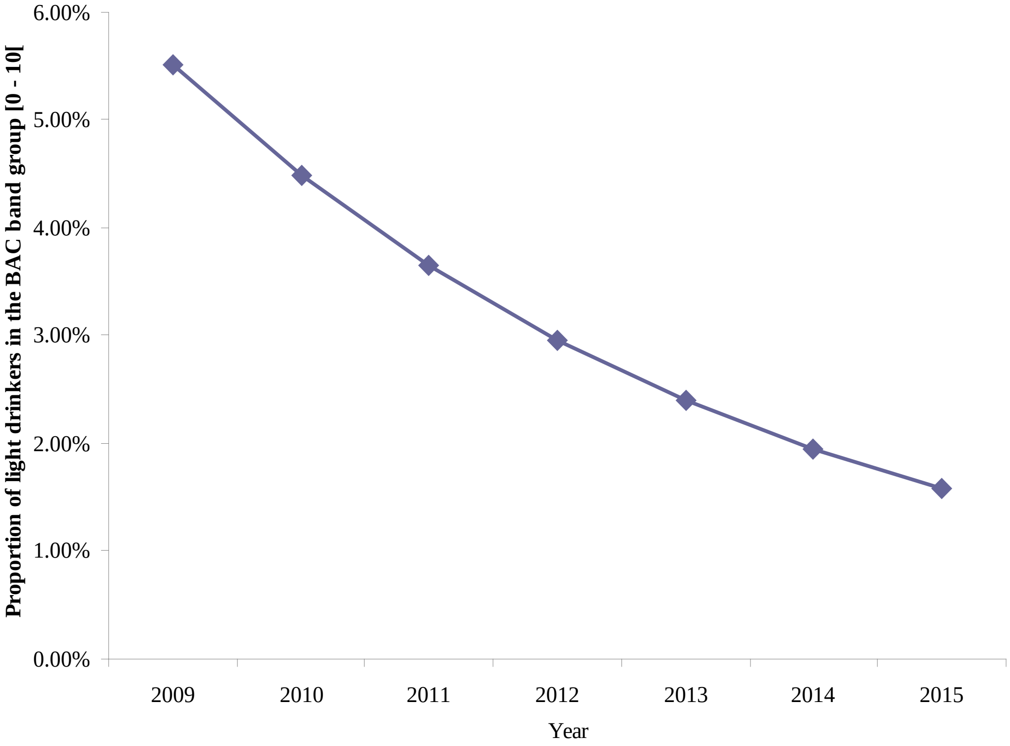
	Baseline distribution		**Linear function**		**Distribution after policy**
≥ 10 & <20	5.5%	*	a*0.15+b = 41.05%	=	2.26%
≥ 20 & <30	2.1%	*	a*0.25+b= 39.74%	=	0.83%
≥ 30 & <40	1.3%	*	a*0.35+b= 38.43%	=	0.50%
≥ 40 & <50	1.1%	*	a*0.45+b= 37.12%	=	0.41%
Sum	10.0%				4.0%

Finally, we need to redistribute potential residuals. In this example the residual was really small (0.00000000068893). The ratio between the predicted and target proportion was calculated and applied across all the distribution.

2.5.3 Other assumption used

As previously described, Kloeden et al.,[5] included abstainers and light drinkers in the same category. However, it is necessary to separate abstainers from light drinkers given that risks of fatal or non-fatal accidents increase even at a very low level of alcohol. Indeed, the risk for drink-drivers with a BAC below 10 mg/100 ml was 1.17 for fatal casualties and 1.11 for non-fatal casualties compared to abstainer drivers. In the absence of evidence, we used the same proportion as estimated in the 'no policy' scenario (figure 9).

figure 9: Proportion of non-abstainer drivers among drivers who drink less than 10 mg/100 ml



Finally, Kloeden et al.,[5] only reported the change at 6 months, 2 years and 6 years. We estimated change within years assuming a linear increase/decrease.

2.5.4 Evidence on lower limits such as 20 mg/100 ml or zero

Evidence was also reviewed about the impact of lowering the legal limit from 80 mg/100 ml to 20 mg/100 ml or zero tolerance for younger drivers. Unfortunately, evidence available was not considered sufficient or robust enough to model the impact of such policy targeted at this age group.

2.6 Computation of the number of casualties attributable to the shift in the BAC distribution

Once we modelled the shift in the BAC distribution for either the ‘no policy change’ or ’policy’ scenario, it was possible to calculate the number of casualties that would be avoided attributable to the shift in the BAC distribution, other factors remaining constant.

This was done using the PIF calculation – proportional reduction in average disease risk over a specified time interval that would be achieved by eliminating the exposure of interest from the population if the distributions of other risk factors remain unchanged. It is a traditional epidemiological approach to modelling risk reductions and was recently employed in our modelling of the potential effects of alcohol pricing and promotion policies in England and Wales[12]. The PIF is a generalisation of the alcohol attributable fraction (AAF) based on arbitrary changes to the prevalence of alcohol consumption (rather than assuming all drinkers become abstainers). The PIF can be calculated using the following formula:

Equation 1: Population impact fraction

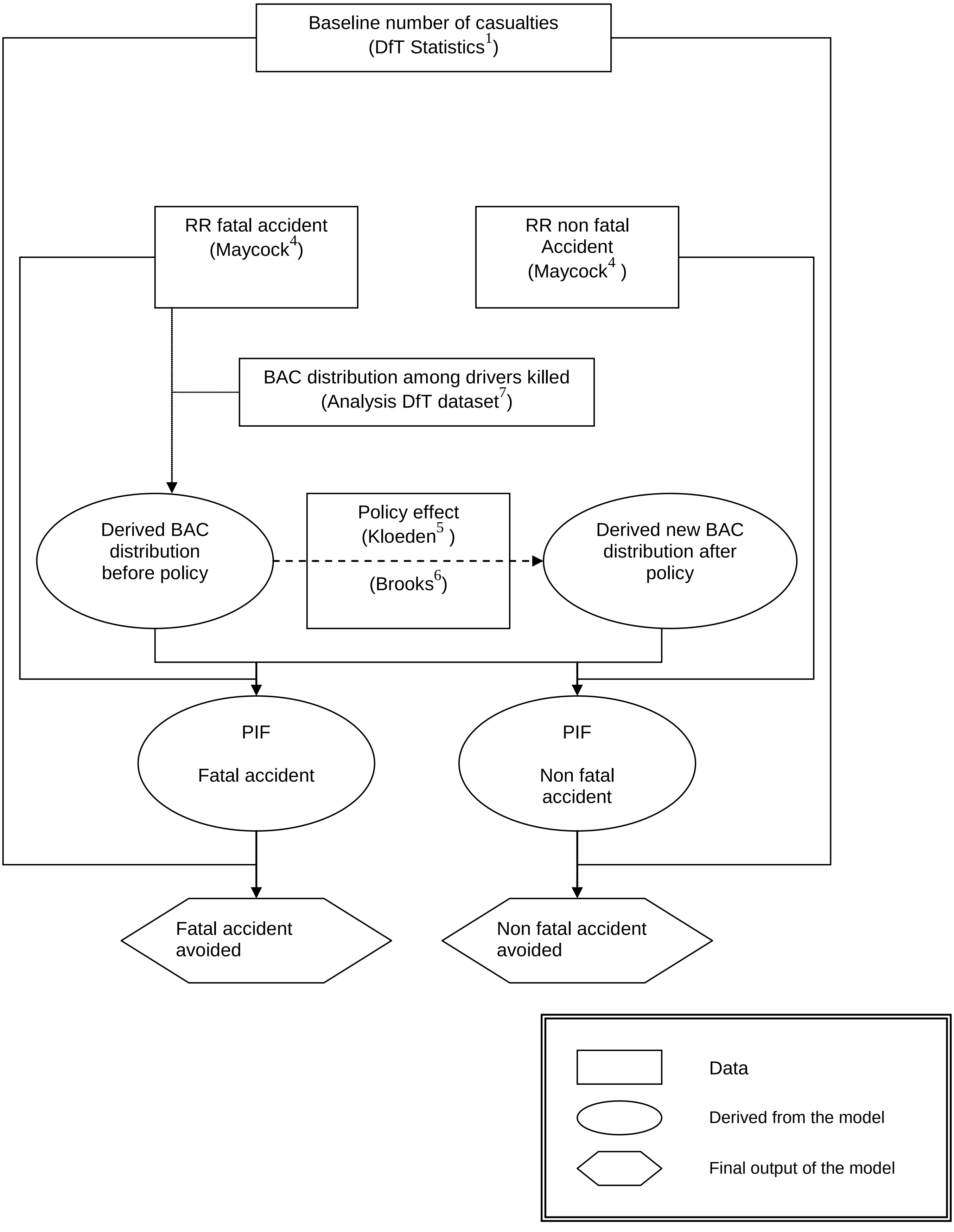
$$PIF = 1 - \frac{\sum_{i=0}^{n} \overline{p_i} RR_i}{\sum_{i=0}^{n} p_i RR_i},$$

where $\overline{p_i}$ is the modified prevalence for consumption state *i* and state 0 corresponds to abstention.

The PIF was employed instead of the TIF (modified version of the PIF) in order to estimate intermediate outcomes, such as the absolute number of casualties over time for the “no policy change” and “policy” scenario. Note that the PIF or TIF give the same answer and the only difference is that the PIF requires an additional step.

Once we calculated the variation in the number of casualties for both scenarios, we were then able to estimate the incremental number of casualties that would be avoided thanks to the implementation of the 50 mg/100 ml limit accounting for the natural variation in casualties attributable to the natural shift in the BAC distribution.

figure 10: Schematic of the detailed indirect model structure



2.7 Simple direct valuation of potential benefits of lowering the legal limit using data from the Albalate study[3]

Albalate[3] evaluated the transition of European countries from BAC limits of 80 mg/100 ml to 50 mg/100 ml and provided one of the most recent and relevant studies of high quality included in the systematic review conducted for this project[2]. Analysis controlled for a large number of potential confounding factors. Overall, the study showed that lowering the legal limit from 80 mg/100 ml to 50 mg/100 ml was associated with statistically significant benefits. The estimated effect of the 50 mg/100 ml BAC law was not significant for the whole population when controlling for other concurrent policies and infrastructure qualities, but statistically significant benefits were observed for males aged 18–25 in urban areas. This study also showed that the effects were evident after 2 years and increased over time, with the greatest impact between 3 and 7 years.

This study estimated that the reduction in fatal casualties would range between 3.39% and 7.43%.

A simple direct approach was employed applying data from this study to the number of casualties in the absence of policy change.

Unfortunately, this study did not report the reduction in non-fatal casualties associated with the implementation of the 50 mg/100 ml BAC law. Consequently, a primary scenario was explored assuming the same benefits for non fatal casualties as for fatal. A second scenario was also explored assuming that the benefits for non fatal casualties would be half of that observed for fatal. This hypothetical figure was selected in the absence of evidence about the differential effect of the policy for fatal or non fatal casualties.

3 Results of the modelling exercise

3.1 Detailed modelling approach using evidence on the shift in the BAC distribution

3.1.1 Modelled shift in the BAC distribution after implementation of a 50 mg/100 ml limit policy

The modelled shift in the BAC distribution after the implementation of the 50 mg/100 ml BAC law assuming the same relative effect as observed in Australia[4, 5] compared to the natural variation in the BAC distribution in the absence of policy change for the central case is presented in figures 11-15. Compared to the 'no policy change' scenario, the implementation of the 50 mg/100 ml BAC law is associated with a greater reduction in the proportion of drivers with a BAC over 80 mg/ 100 ml (figures 15).

figure 11: Modelled proportion of abstainer drivers for the 'policy' and 'no policy' scenario

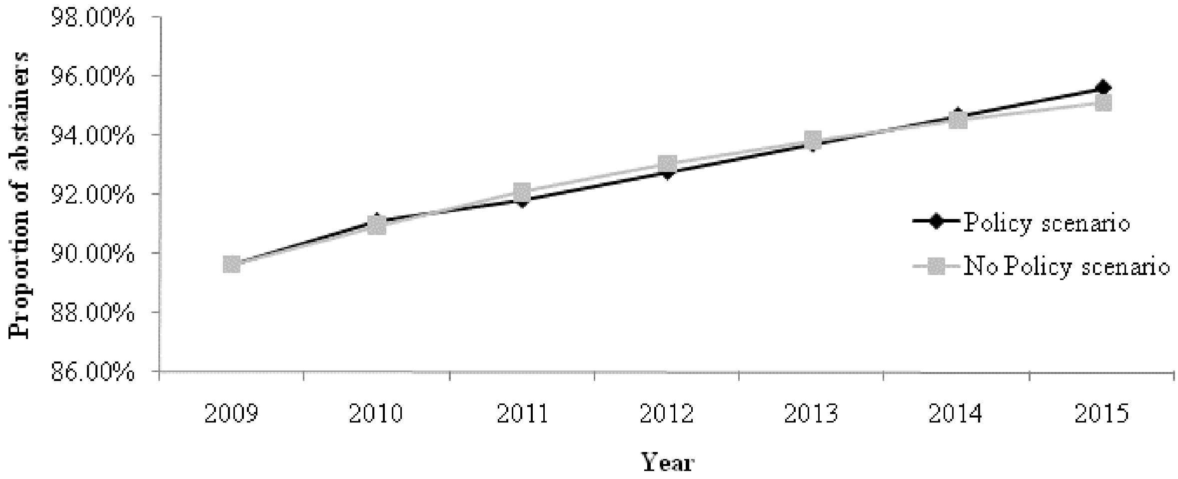


figure 12: Modelled proportion of drivers with a BAC over zero but below 10 mg/100 ml for the ‘policy’ and ‘no policy’ scenario

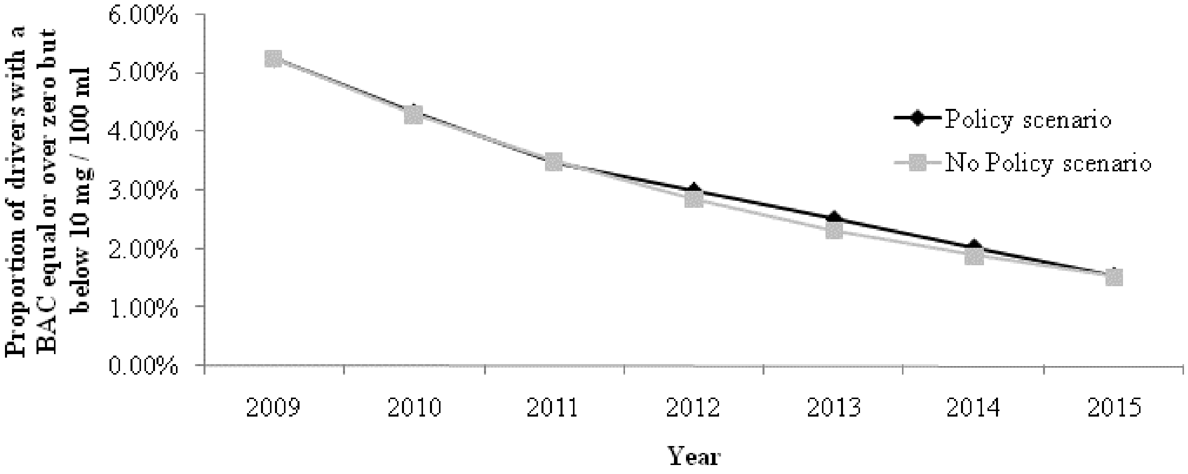


figure 13: Modelled proportion of drivers with a BAC equal to or over 10 but below 50 mg/100 ml for the ‘policy’ and ‘no policy’ scenario

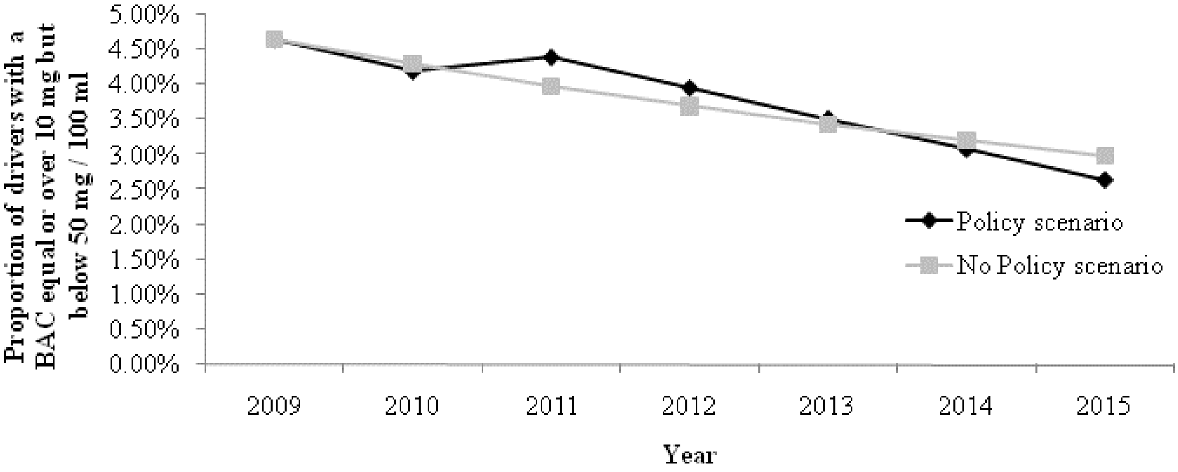


figure 14: Modelled proportion of drivers with a BAC equal to or over 50 but below 80 mg/100 ml for the 'policy' and 'no policy' scenario

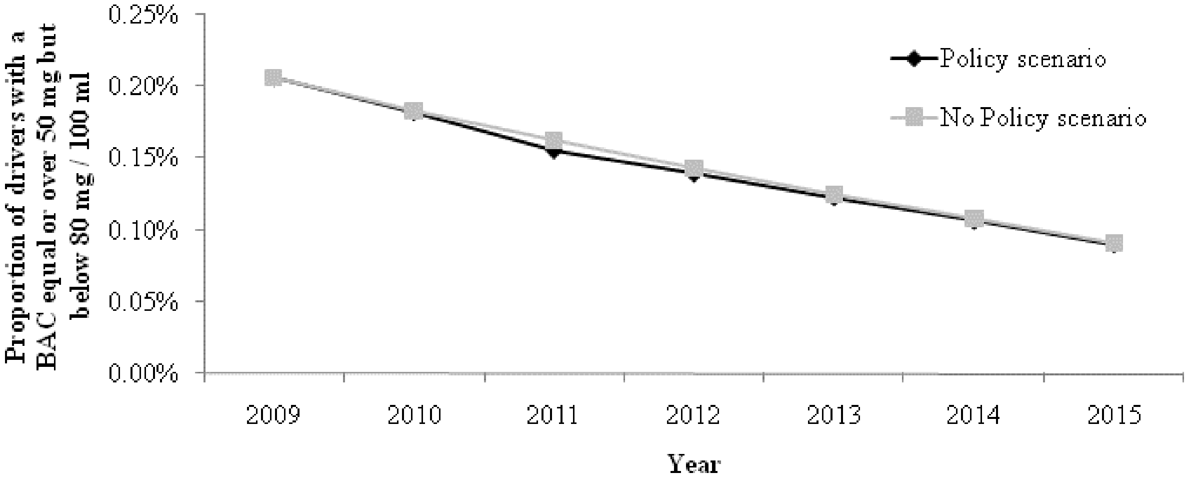
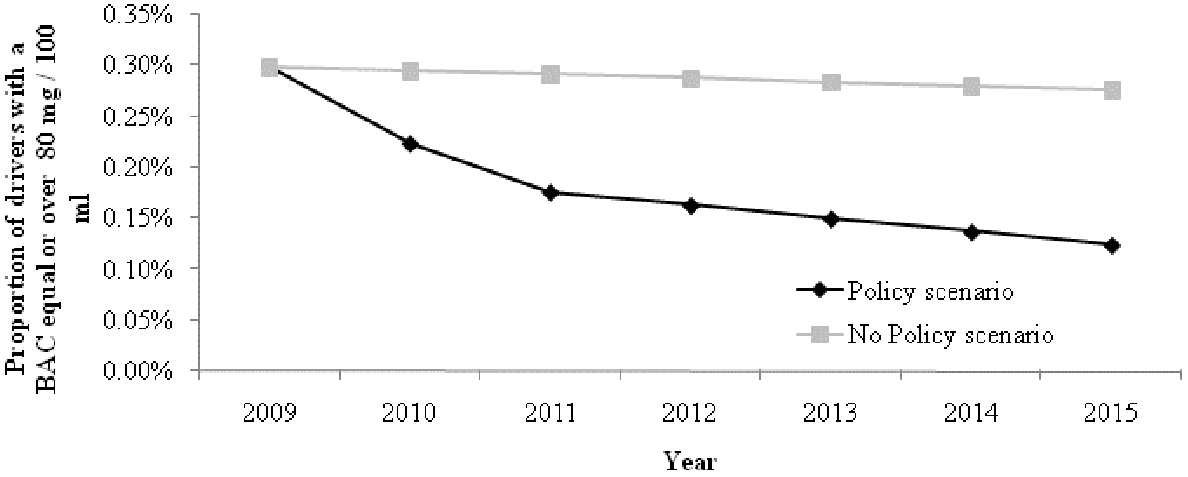


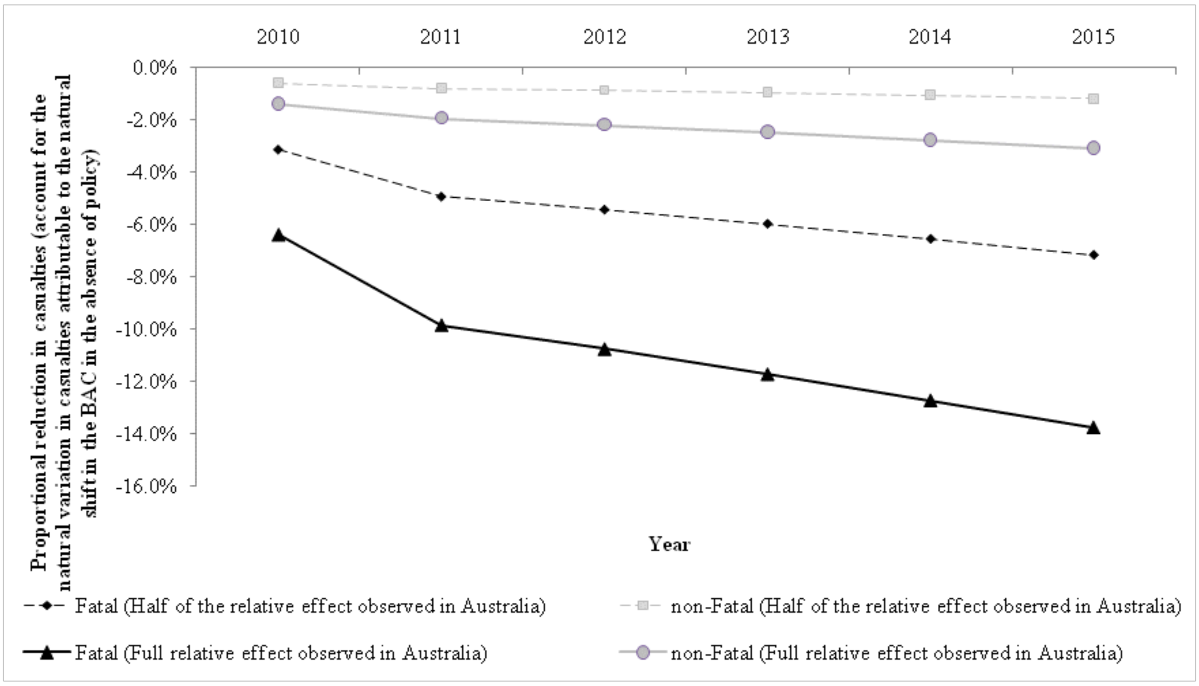
figure 15: Modelled proportion of drivers with a BAC equal to or over 80 mg/100 ml for the 'policy' and 'no policy' scenario



3.1.2 Estimate of the number of casualties avoided

Accounting for the natural variation in casualties attributable to the shift in the BAC distribution in the absence of policy change and assuming the same relative effect as observed in Australia, the model estimated that 6.4% of all fatal casualties (i.e not only attributable to drink-drivers defined as drivers over the current legal limit) could be avoided the first year after the implementation of the legal 50 mg/100 ml BAC limit. The reduction in all fatal casualties is estimated to be sustained over 6 years (figure 16) with an expected proportional reduction of 13.8% at 6 years. Reductions in all non-fatal casualties (not specific to drink-driving) were less pronounced but still significant, with an estimated reduction of 1.4% the first year after the implementation of the BAC law and 3.1% after 6 years.

figure 16: Proportional reduction in fatal and non-fatal casualties after the implementation of the 50 mg/100 ml BAC law (taking account of the natural variation in the absence of policy change)



A secondary analysis was conducted assuming only half of the relative effect of the policy observed in Australia. Accounting for the natural variation in casualties attributable to the shift in the BAC distribution in the absence of policy change, the model estimated that 3.1% of all fatal casualties could be avoided the first year after the implementation of the legal 50 mg/100 ml BAC limit assuming half of the relative effect observed in Australia. The expected proportional reduction at 6 years is estimated to be 7.2%. The estimated reductions in all non-fatal casualties are 0.6% and 1.2% at 1 and 6 years respectively under this assumption.

Accounting for the natural variation in casualties attributable to the shift in the BAC distribution in the absence of policy change and assuming the same relative effect as observed in Australia, the model estimated that 3,073 casualties (fatal and non-fatal) out of the 214,582 casualties predicted by the model for 2010 in the absence of policy change could be avoided the first year after the implementation of the 50 mg/100 ml BAC law compared to 6,726 at 6 years (out of the 211,680 casualties estimated by the model in 2015 in the absence of policy change). Among the 6,726 casualties avoided at 6 years, 4.5% are estimated to be fatal (n=303), 10.5% serious injuries (n=708), and 85% (n=5,715) minor injuries.

table 6: Estimated number of casualties avoided as a consequence of the policy assuming the full relative effect observed in Australia

Year	Fatal	Serious injuries	Minor injuries	Total
2010	144	323	2,606	3,073
2011	221	451	3,637	4,309
2012	240	507	4,090	4,837
2013	260	569	4,591	5,421
2014	281	636	5,135	6,052
2015	303	708	5,715	6,726

Assuming half of the relative effect observed in Australia, the number of casualties avoided at 1 and 6 years is estimated to be 1,330 and 2,645 respectively (table 7).

table 7: Estimated number of casualties avoided as a consequence of the policy assuming half of the relative effect observed in Australia

Year	Fatal	Serious injuries	Minor injuries	Total
2010	70	139	1,121	1,330
2011	111	188	1,518	1,817
2012	121	202	1,626	1,949
2013	133	221	1,781	2,135
2014	145	245	1,978	2,369
2015	158	274	2,213	2,645

Finally, we estimated the change in the number of casualties from 2009 onwards attributable to the shift in the BAC distribution, assuming all other factors remain constant. The estimated numbers of fatal, serious and minor casualties from 2010 onwards are presented in figure 17, figure 18 and figure 19 respectively.

figure 17: Estimated number of fatal casualties attributable to the shift in the BAC distribution, all other factors remaining constant

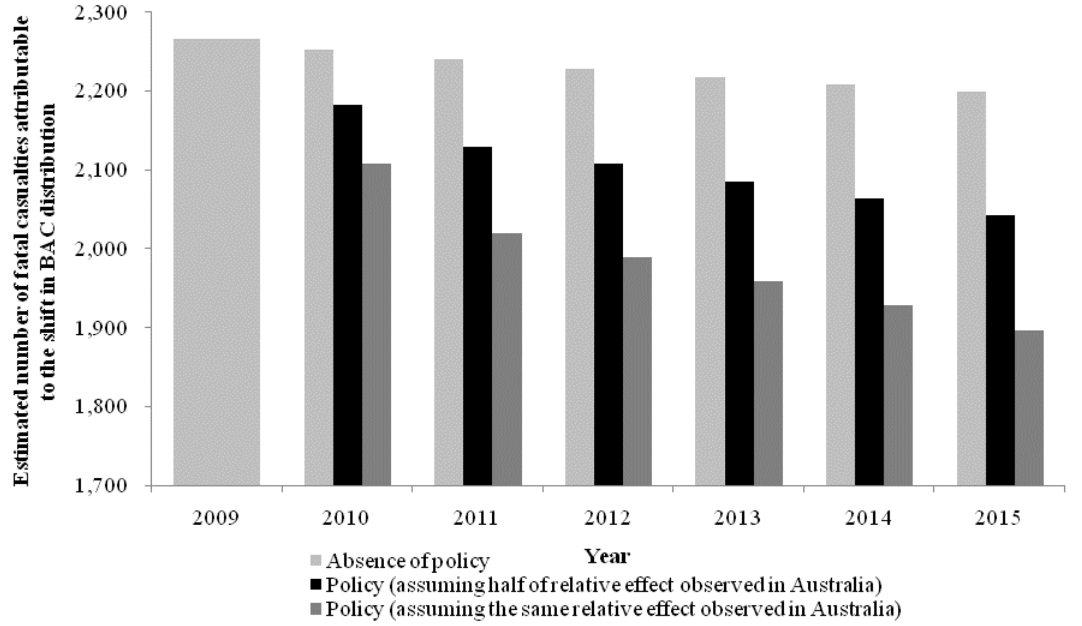


figure 18: Estimated number of serious casualties attributable to the shift in the BAC distribution, all other factors remaining constant

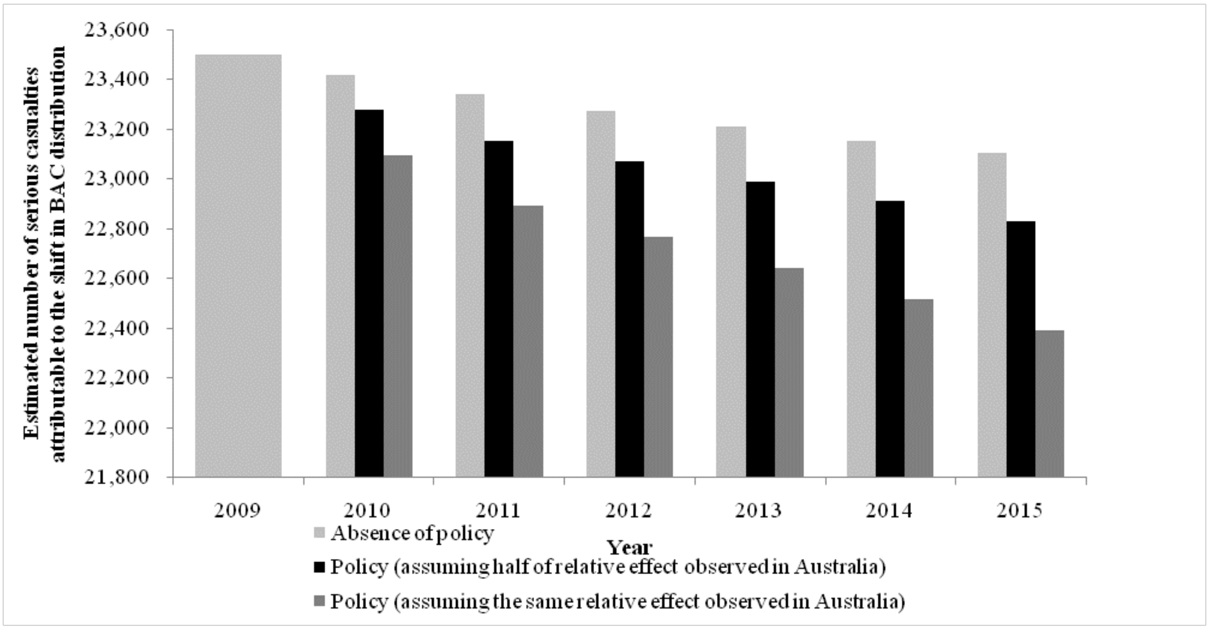
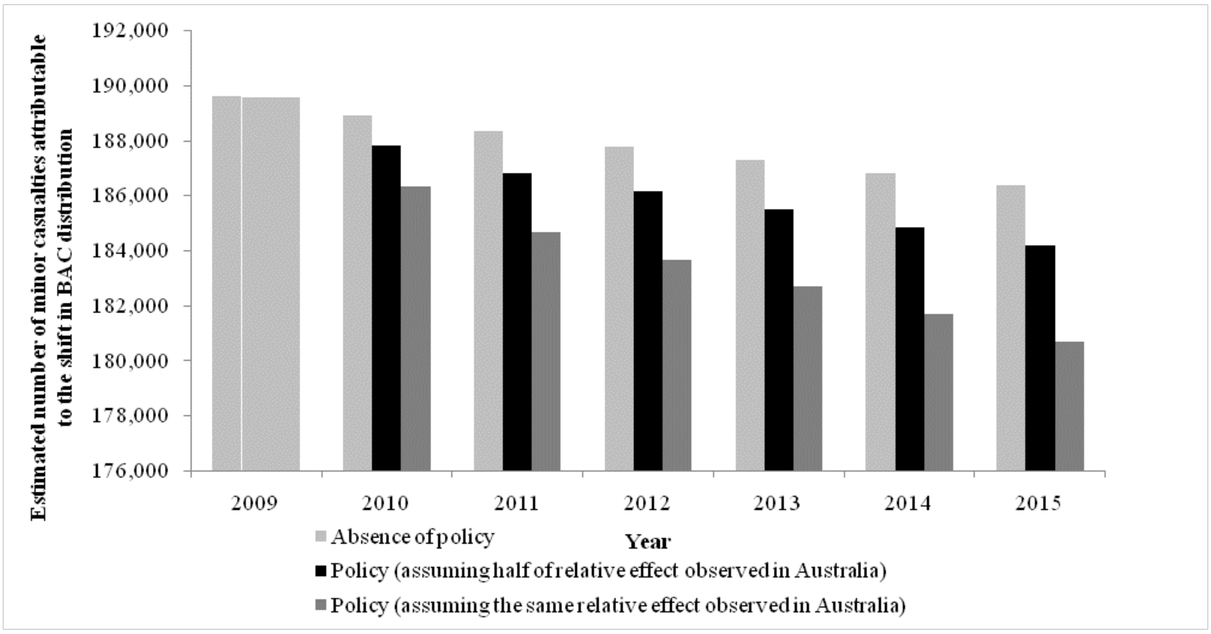


figure 19: Estimated number of minor casualties attributable to the shift in the BAC distribution, all other factors remaining constant

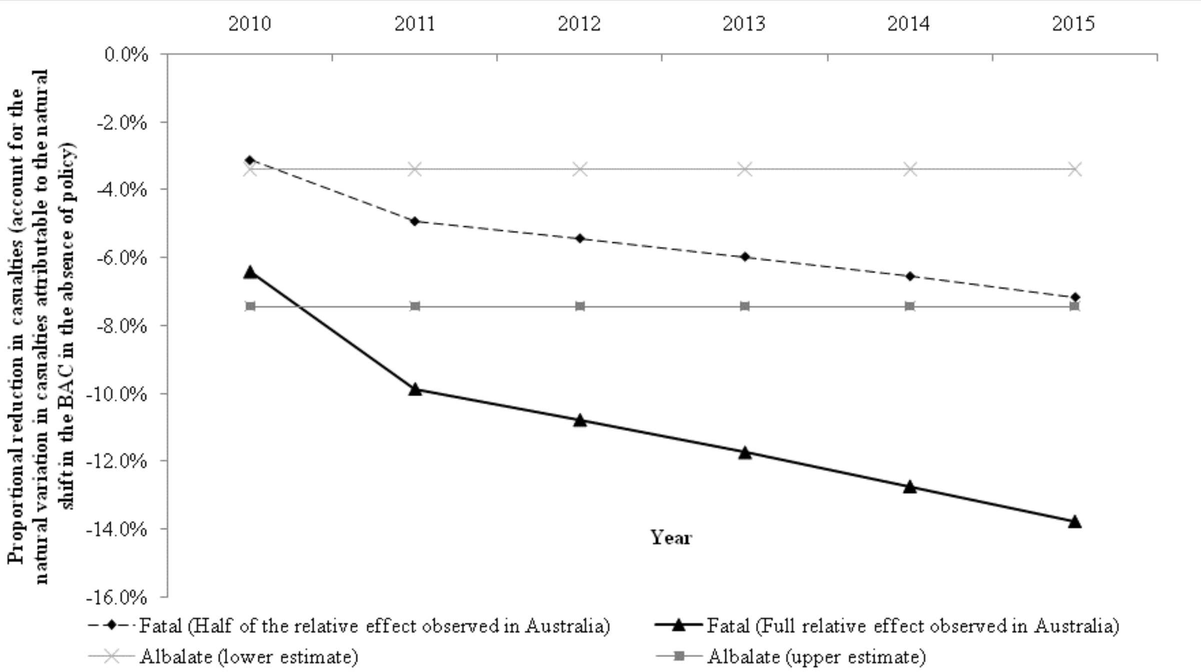


3.2 Simple direct approximation of the impact of the policy using data from the Albalate study[3]

Assuming a proportional reduction in fatal casualties ranging from 3.39% to 7.43%, we estimated that the implementation of the 50 mg/100 ml BAC law will translate into a saving of between 77 to 168 lives. The estimated number of serious and minor injuries avoided is estimated to range between 797 and 1,746 and 6,427 and 14,086 respectively, assuming the same proportional reduction as for fatal casualties equating to a total number of casualties avoided ranging between 7,300 and 16,000. If we assume that reduction for non fatal casualties is only half of that observed for fatal, the number of serious injuries avoided would range between 398 to 873 while the number of minor injuries would range between 3,213 and 7,043, for a total number of casualties avoided ranging between 3,688 and 8,084.

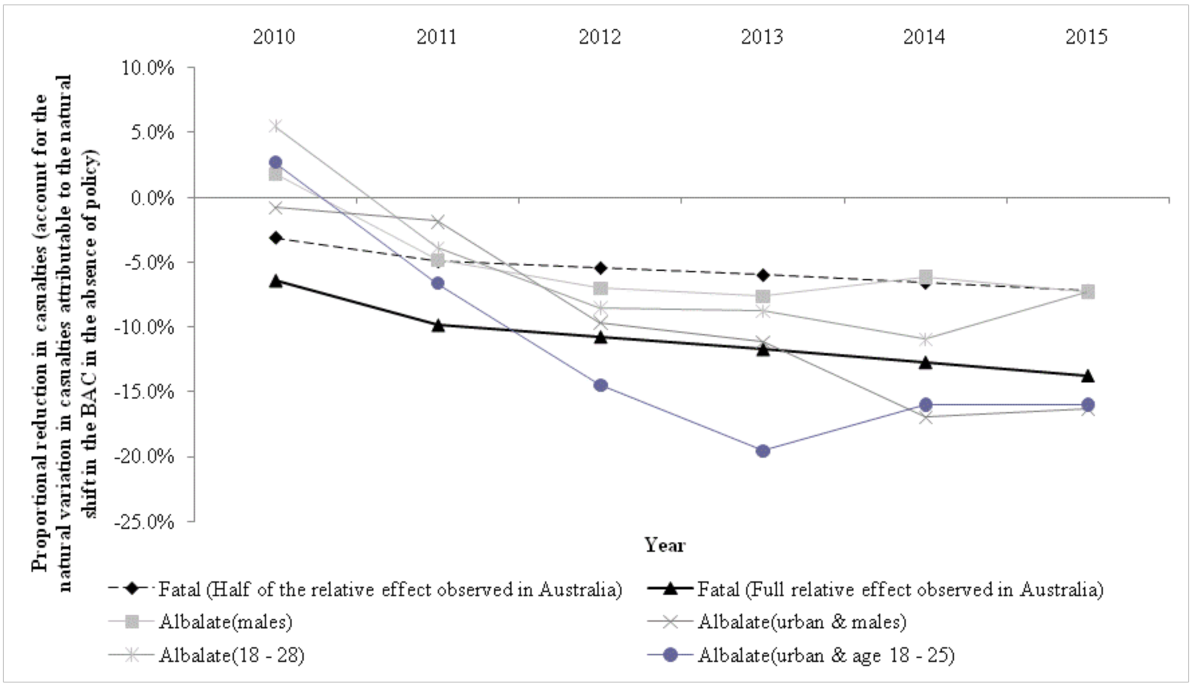
The proportional reduction for fatal casualties from the Albalate study[3] was compared to the model prevision (figure 20). While the comparison needs to be considered with caution due to potential differences in outcomes (the proportional reduction estimated in our model takes into account the natural variation in casualties in the absence of policy change attributable to the natural shift in the BAC distribution), our model estimates were in the range of the benefits observed in Europe in the Albalate study only when we assumed half of the relative effect of the policy[3].

figure 20: Comparison of the per cent reduction in fatal casualties using the direct and indirect approach



This comparison was also limited by the absence of definition of a time horizon. However, Albalate[3] also reports the trend in the reduction of the number of casualties for four road user groups; males, males and urban, 18–25, 18–25 and urban, showing a benefit ranging from 7.2% to 16.9% 6 years after the implementation of the policy. This compares well to model outcomes using the indirect approach, with a predicted reduction in casualties ranging from 7.2% to 13.8% taking into account the variation in casualties attributable to the natural shift in the BAC distribution and assuming half or the full relative effect of the policy as observed in Australia respectively (figure 21). The model predictions were in the range to the trends in the proportional reduction reported in the Albalate study[3] for the four subgroups.

figure 21: Comparison of the per cent reduction in fatal casualties using the direct and indirect approach (trend in subgroup)



3.3 *Sensitivity analyses*

Different sensitivity analyses were performed to test the robustness of the model prediction to the main model assumptions and are presented in figure 22, figure 23, figure 24 and figure 25. Only outcomes at 6 years are presented, assuming the same relative effect of the policy as observed in Australia.

Univariate sensitivity analyses were first examined using different starting years for the estimation of regression models to estimate the natural history of the BAC distribution in the absence of policy change. This is shown to have a considerable impact on the number of casualties avoided, with an estimated overall number ranging from 4,332 to 10,580 (compared to 6,726 for the central case).

Then the effect of the policy was explored using a proxy for the upper and lower 95% CI from the Kloeden et al., study[5]. Benefits were almost double using the lower 95% CI, while no benefits were observed using the upper 95% CI.

Different thresholds for truncation were also tested and results were not sensitive to this assumption, with the number of casualties avoided ranging between 6,555 and 8,366.

We also examined the impact of using the risk function for fatal casualties to represent the risk for serious injuries. The number of serious casualties avoided increased considerably using this assumption (from 708 to 3,140).

We also tested a different approach to model the shift with narrow BAC categories in the 'policy' scenario assuming a constant proportion increase/decrease within the three wider BAC categories. This is shown to have little impact on model outcome.

Finally, we assumed a constant BAC distribution after 2009 in the absence of policy change. Not surprisingly, benefits were almost twice as high using this assumption.

figure 22: Univariate sensitivity analysis for the reduction in casualties in 2015 accounting for the natural change in casualties in the absence of the policy attributable to the natural shift in the BAC distribution

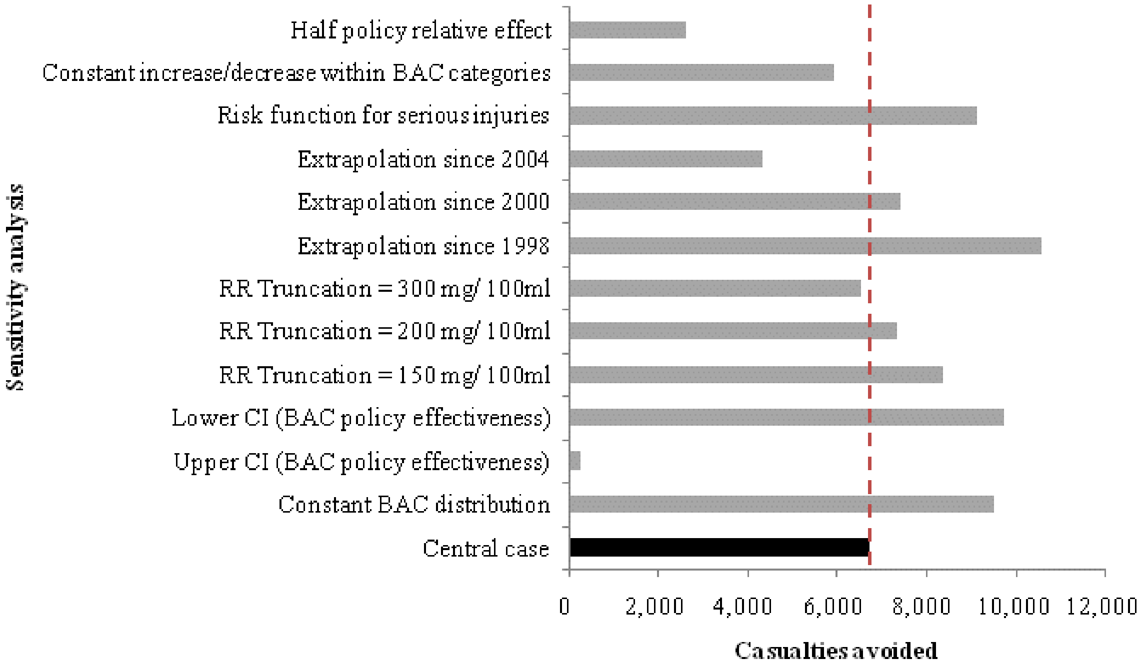


figure 23: Univariate sensitivity analysis for the reduction in minor casualties in 2015 accounting for the natural change in casualties in the absence of the policy attributable to the natural shift in the BAC distribution

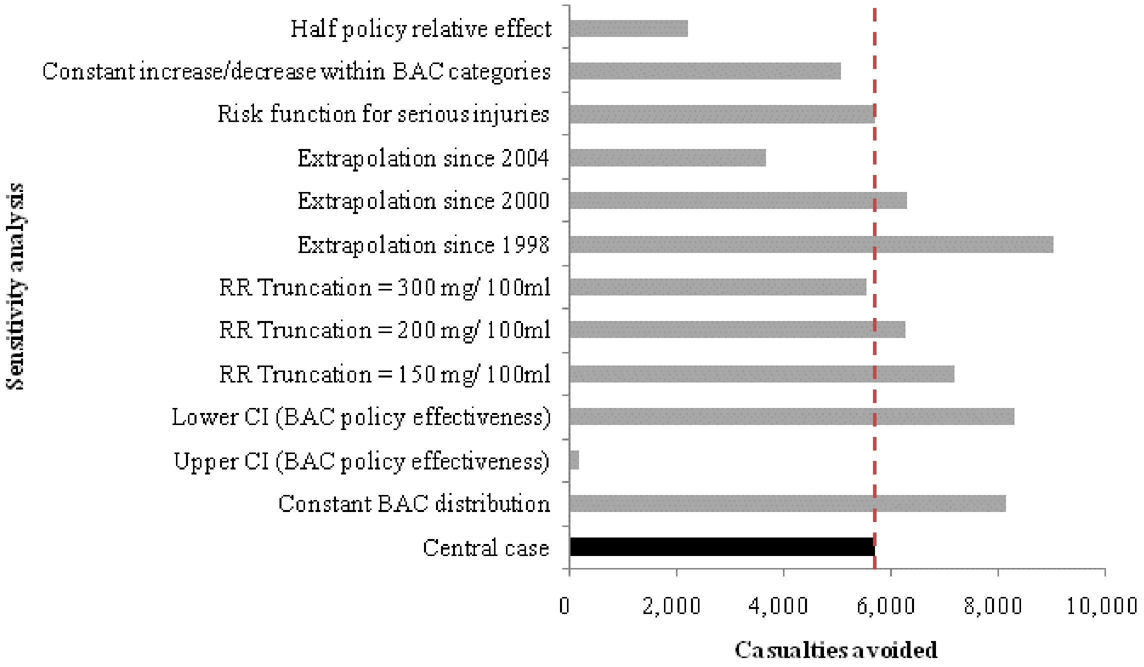


figure 24: Univariate sensitivity analysis for the reduction in serious casualties in 2015 accounting for the natural change in casualties in the absence of the policy attributable to the natural shift in the BAC distribution

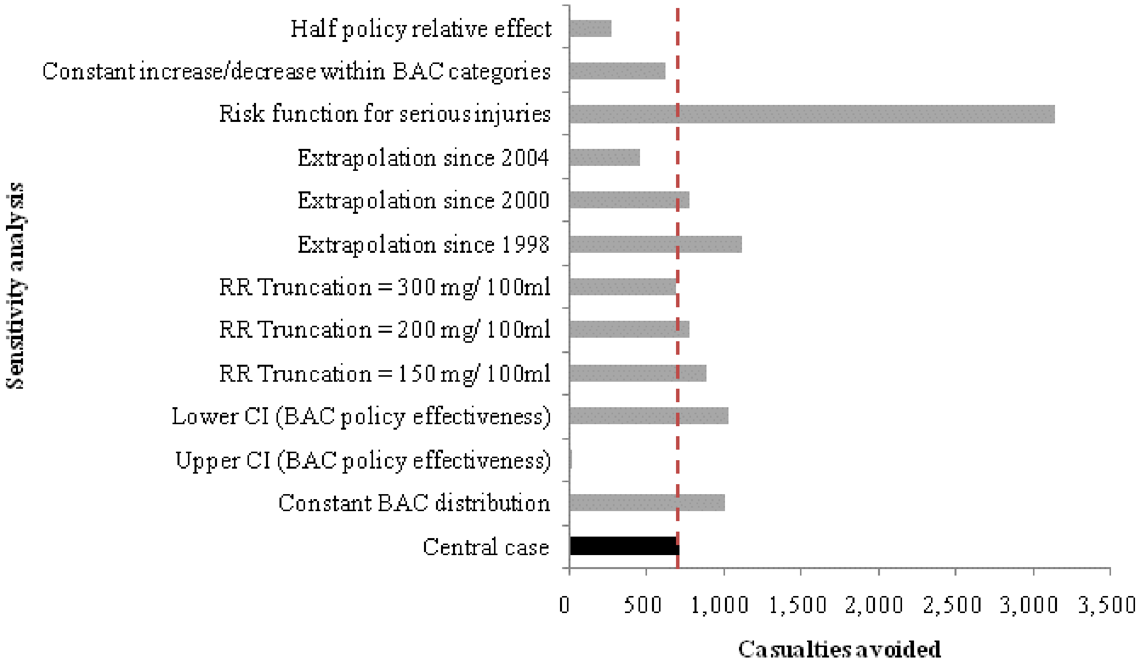
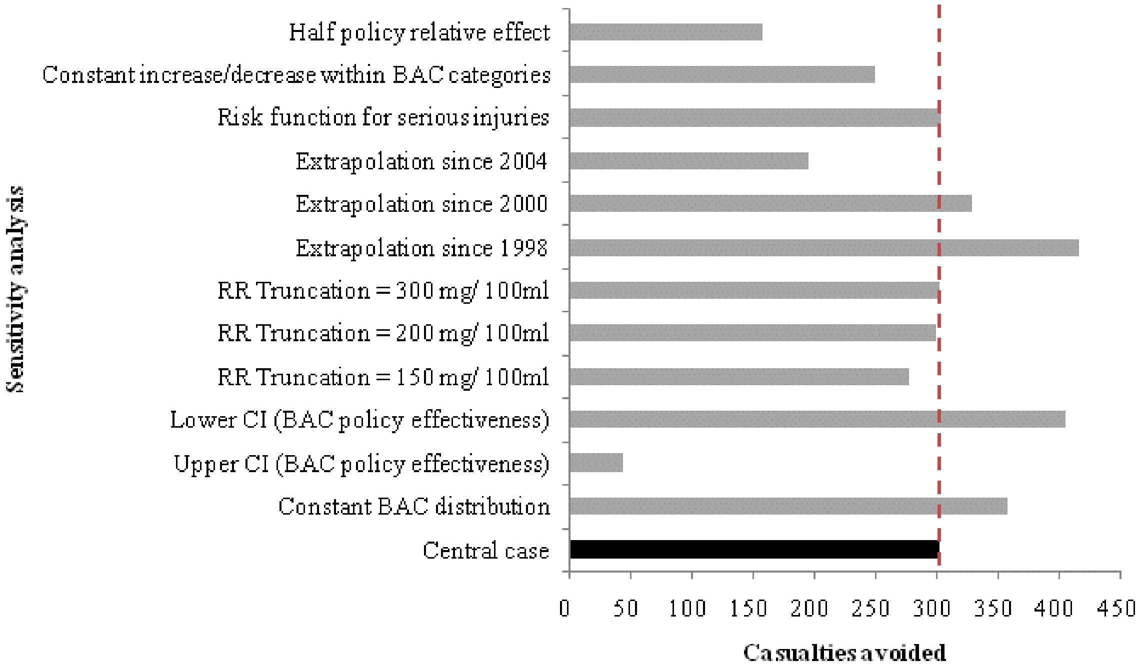


figure 25: Univariate sensitivity analysis for the reduction in fatal casualties in 2015 accounting for the natural change in casualties in the absence of the policy attributable to the natural shift in the BAC distribution



Given the uncertainty about the method used to extrapolate the BAC distribution after 2007, multivariate sensitivity analysis was also performed varying both the starting year for the regression model and the effectiveness of the policy (lower and upper CI) or the threshold for truncation (150, 200, 300 mg/100 ml). Results of the multivariate sensitivity analysis using the number of fatal casualties avoided at 6 years are presented below in table 8. Not surprisingly, the uncertainty in the natural shift in the BAC distribution (using different regression models) combined with the uncertainty in the effectiveness of the policy (proxy of the CI in the Kloeden et al., study[5]) has the most impact on the model results. As before, the threshold for truncation of the relative risk function has only a small effect.

table 8: Multivariate sensitivity analysis (fatal casualties)

	Starting year of the regression model used for extrapolation								
	1998	1999	2000	2001	2002	2003	2004	2005	2006
Central case	**416**	**366**	**329**	**299**	**296**	**303**	**195**	**311**	**588**
Policy effectiveness (Upper CI)	130	88	57	33	32	44	-38	75	335
Policy effectiveness (Lower CI)	530	476	436	404	400	405	286	407	694
Threshold for truncation (150 mg/100 ml)	389	340	303	273	270	277	173	288	565
Threshold for truncation (200 mg/100 ml)	412	363	326	296	293	299	191	307	585
Threshold for truncation (300 mg/100 ml)	416	365	332	298	296	302	194	310	594
Constant BAC	393	382	373	368	365	358	325	331	357
Half relative effect	256	211	177	150	149	158	63	175	440
Constant increase/decrease within BAC categories	359	310	274	244	241	249	146	265	541

3.4 *Comparison of findings with experience in other countries or other evaluations carried out in the UK*

3.4.1 Evaluations carried out in the UK

Several attempts have been made to estimate the potential impact of lowering the legal limit from 80 mg/100 ml to 50 mg/100 ml in the UK. Starks et al.,[10] estimated that lowering the legal limit would be associated with a reduction of 21% in both drink driving and casualties using an econometric model.

More recently, Allsop et al.,[11] estimated that the reduction in the legal limit would save 65 lives each year and prevent 230 serious injuries. Our detailed model central estimate was 144 fatal casualties and 323 serious injuries avoided in the first year after the implementation of the 50 mg/100 ml BAC limit. At 6 years, our model estimated that about 303 fatal casualties and 708 serious injuries might be avoided. Our estimates are slightly different from previous estimations given differences in methodologies and limitations inherent to both studies.

Allsop et al.,[11] made several assumptions on the policy effect. First, it was assumed that those driving with a BAC greater than 110 mg/100 ml would not be affected much by the policy given that they already drink beyond the current legal limit, and that if benefits occurred, it is regarded as a bonus. While it is reasonable to assume that drivers who already drink well beyond the limit would not reduce their consumption to the new limit, evidence in Australia[6] showed that drivers with a higher BAC are likely to reduce their consumption. This shift in the BAC distribution at higher BAC bands may translate into considerable benefits given the exponential form of the risk function and that drivers at higher BAC bands represent a high proportion of deaths among accidents involving drivers with a BAC different from zero (between 35 and 50%). Second, Allsop et al.[11] assumed that drivers who currently drink slightly more compared to the current legal limit would reduce their drinking just enough to exceed a 50 limit by the same margin as they now exceed 80. No strong evidence supports this assumption. Drivers who were drinking over the current legal limit may choose to reduce their consumption well enough to comply with the new limit. This group of drivers represented most of the savings predicted by Allsop et al.,[11] but they only represent between 5 and 6.5% of deaths among accident-involved drivers with a BAC different from zero. Third, Allsop et al.,[11] assumed that those driving with a BAC between 50 and 80 would reduce their drinking just enough to comply with the new limit, which again is a simplified assumption in the absence of supportive evidence. Finally, no benefits were assumed for drivers with a BAC greater than 0 but not greater than 50 mg. This assumption is likely to underestimate the benefits of the policy given the high number of deaths in these BAC categories. Indeed, it is possible and even likely that drivers who already comply with the current legal limit could still reduce their consumption as observed in Kloden et al.[5]

Our detailed model used evidence about the effect of the policy observed in another country. We were also interested in the shifting across all the BAC distribution using 10 mg/100 ml BAC bands to account for small changes in the risk. This is particularly important at higher BAC bands given the exponential form of the risk function. Finally, our model is not only interested in drivers considered as drink-drivers but covers the wider population to estimate the number of casualties avoided across all of the BAC distribution.

3.4.2 Individual countries reporting the change in fatalities and injuries

Few studies reported the impact of lowering the legal limit from 80 mg/100 ml to 50 mg/100 ml in terms of reduction in fatalities and/or injuries.

Bartl and Esberger[23] in Austria showed a 9.4% decrease in alcohol-related crashes relative to the number of crashes at 1 year compared to 3.0% predicted in our model. Bernhoft and Behrensdorff[24] in Denmark observed that despite a change in drinking habits (measured during a survey), the proportion of fatal accidents with drink drivers compared to all fatal accidents has increased following the implementation of the 50 mg/100ml limit.

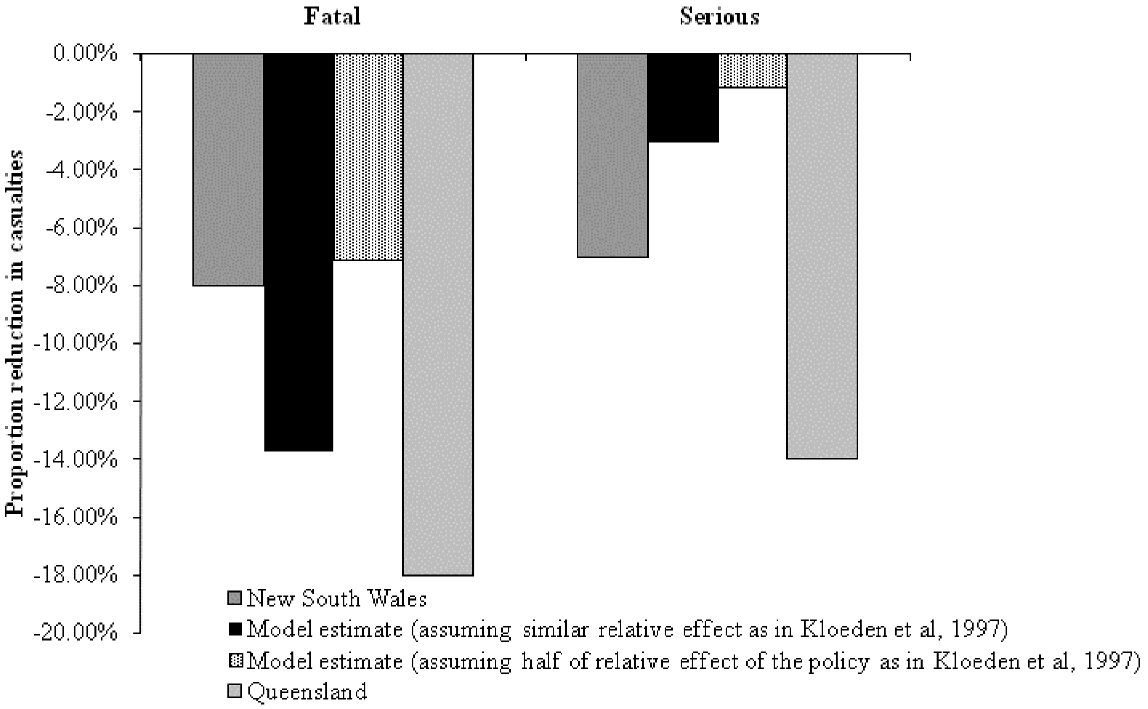
In France[25], the total number of fatalities involving a drink-driver was found to have declined faster after the implementation of the policy (64 per year compared to 100 per year). The impact of the new law was more pronounced for drivers at higher BAC (over 80 mg/100 ml) than for drivers in the range 50 mg/100 ml to 80 mg/100 ml.

The legal limit was lowered in Switzerland from 80 mg/100 ml to 50 mg/100 ml in 2005. The introduction of the policy in conjunction with breath testing had a significant impact in the number of alcohol-related road deaths, with a reduction by

25% between 2005 and 2006 and by a further 19% between 2006 and 2007[26]. On the downside, a negative effect was observed for injuries, with an increase by about 9% for alcohol-related road injuries between 2005 and 2006.

In Australia, Henstridge et al.,[8] reported a long-term reduction in the numbers of serious collisions, fatal collisions and single vehicle night-time collisions in New South Wales and Queensland between 1982 and 1992. This study showed that the reduction of the legal limit resulted in significant reductions in all collisions and fatalities in the long run. For instance, in New South Wales (NSW), the new legal limit was estimated to be associated with a reduction of 7% for serious injuries, 8% for fatal collisions and 11% for single vehicle night-time fatal collisions. In Queensland, the new legal limit was associated with a reduction of 14% for serious collisions and 18% for fatal collisions. Our findings were in the range of benefits observed in this study for fatalities (figure 26) but not for serious injuries (assuming the relative-risk function for non-fatal casualty). Similarly, in Australia, Smith et al.,[9] reported significant reductions in the numbers of collisions that involved drink-drivers, with either a high BAC (-12% over 150 mg/100 ml) or lower BAC (-8% between 80 mg/100 mg and 150 mg/ml).

figure 26: Comparison of the model's prediction at 6 years with data from Henstridge[8]



Note that our estimate takes into consideration the number of casualties that would be avoided in the absence of policy change, given the natural shift in the BAC distribution.

3.4.3 Individual countries reporting the change in drink driving behaviour

In the Netherlands, Mathijssen et al.,[27] reported the reduction in the proportion of drivers with illegal BAC (greater than 50 mg/100 ml) before and after introducing the policy. This study showed that an average of 15% of drivers surveyed had a BAC greater than 50 mg/100 ml before introduction. The short-term effect of the introduction of the 50 mg/100 ml BAC law was huge, with only 1% of motorists exceeding the legal limit. However, this proportion rebounded to 11% a year after and stabilised around this level after 7 and 9 years. This equates to a reduction of about 27% in the number of drivers with a BAC greater than 50 mg/100 ml in the long term.

For comparison, evidence from Australia (used in the model) reported a reduction of drivers with a BAC greater than 50 mg/100 ml of 31% at 2 years and 55% at 6 years.

To conclude, while comparisons between studies are difficult given differences in methodologies and outcomes, our estimations were consistent with what is observed in the literature.

4 Discussion

The bulk of the modelling work employed an indirect approach to model a shift in the BAC distribution which might translate into savings in fatal or non-fatal casualties. A simpler direct approach was also employed extrapolating results from the Albalate study[3] to England and Wales. The model estimates have to be considered with caution given the absence of observable data to populate the model, but these modelling exercises confirm the findings from the systematic review that lowering the legal limit to 50 mg/100 ml in England and Wales would be very likely to be effective in reducing road traffic injuries and deaths. The model estimates were also in the range of the benefits observed in other countries, but the range of benefits in these countries was wide.

There are several limitations to the analysis due to the available evidence and some assumptions have been made. We assume that drivers would change their behaviour after implementation of the policy, modelled as a relative shift in the BAC distribution using data from Australia. There may be other factors that are relevant to drivers changing their behaviour, such as the risk of being caught and the severity of the penalty. The benefits to other road users were also extrapolated from the benefits observed among drivers.

One major uncertainty concerns the distribution of the BAC among drivers in England and Wales. Indeed, calibration approach was necessary, building on the distribution of fatalities and the Maycock et al.,[4] relative-risk function. However, we were also uncertain about the relative risk function used during our modelling exercise while this was estimated using UK data[4]. This study presented several limitations as consumption data was constrained to weekend and peak hours, data about crashes and the exposure group were also not matched, and no adjustment was made for the time, location, number of passengers and age of drivers.

Data used to perform this study were collected more than 15 years ago. It is likely that the risk function has changed since these data were collected. We also had to assume a constant relative-risk function over time in the absence of information about the natural variation in the risk over time. It is possible that the relative risk was and is not constant over time. We were also uncertain about the most appropriate threshold for truncation although this shows to have a limited impact on results in our study.

It was also unclear which risk function was the most appropriate to represent the risk for serious injuries. We also needed information about the natural shift in the BAC distribution in the absence of policy change, but this was not directly available. A simple approach assuming a linear increase/decrease in the proportion of drivers in a particular BAC band over time was employed. More sophisticated approaches could be considered in the future including estimating a matrix of transition probabilities from one BAC band to the next using historical data or fitting a parametric distribution to the BAC proportions and examining trends in the parameter over time.

We were also limited by evidence available about the shift in the distribution of BAC after the implementation of the 50 mg/100 ml limit. Obviously, the 50 mg/100 ml limit has not been yet introduced in the UK and there is no direct UK evidence of its effects on the BAC distribution for drivers.

We reviewed all of the available international evidence and selected two Australian studies to form the evidence for the model base case. These were selected because they were the only studies that reported sufficient detailed information on the changes in BAC distribution over a long follow-up period. However, the applicability of findings from these studies to the UK context remains uncertain. Differences may exist in terms of cultural, societal and drinking behaviour between England and Wales and Australia. There is some uncertainty about the applicability of Australian evidence to the UK context, given that progress in the reduction of drink driving usually follows a curve with higher progress at the start of the curve.

Given that the evidence from Australia was extracted in the 1990s, it is possible that the gain obtained in Australia is greater than the potential gain expected to occur in the UK in 2009. In our study, we applied the relative change in the BAC distribution observed in Australia to the UK context. There is a different profile of drink-drivers in both countries. Kloeden et al.,[5] indicated that before the implementation of the 50 mg/100 ml limit, the proportion of surveyed drivers with a BAC over 10, 50 and 80 mg/100 ml was 16.2%, 5.1% and 2.5% respectively. For comparison, the estimated proportion of drivers for these categories in England and Wales in 2009 in the model is 10.37%, 0.5% and 0.3%. It is possible that the relative shift in BAC observed in Australia could be larger than the shift that might occur in England and Wales.

In the absence of evidence, a secondary analysis was performed assuming only half of the relative effect observed in Australia. Assumptions were also needed to model the shift across all the BAC distribution, for which only a partial picture was provided by these studies. We used a very simplified assumption assuming a linear decline/decrease based on findings from Brooks et al.,[6] in Australia. Again, there was some uncertainty about the applicability to the UK context and we also anticipated that results from this study may have been biased by the small sample size of drivers at higher BAC. Consequently, a sensitivity analysis was performed assuming a constant increase/decrease with wider BAC categories.

There is also the issue of potential confounding factors such as an increase in enforcement or media campaign. The author stated in his paper[5] that before the implementation of the 50 mg/100 ml limit, the province of Adelaide introduced breath testing and this was associated with a media campaign. It is unclear if an increase in breath testing/media campaign occurred after the implementation of the BAC law. The principal author of the Australian study[5] was contacted regarding this issue, but no additional information was received at the time of the writing of this report.

Finally, most of the evidence used focuses on drivers. Evidence for passengers and pedestrians is limited and better data would have allowed us to model passengers and pedestrians separately.

Further research needed

This modelling exercise highlights several areas for further data collection or research.

More research would be useful to describe the profile of drivers in England and Wales, notably in terms of distribution of BAC. In the absence of observable data we had to calibrate the BAC distribution. Ideally, observed data about the BAC distribution in England and Wales collected from a random roadside survey would be used to represent the distribution of alcohol consumption among drivers. We recommend performing regular roadside surveys to determine the profile of drivers in England and Wales. Compared to previous roadside surveys, we also recommend that data should not be confined to weekend and peak hours.

The relationship between BAC and the risk of fatal and non-fatal casualties has already been described by Maycock et al.,[4] but this may be dated. We would recommend further data analysis matching data about crashes and the exposure group as in Peck et al.,[16] and if possible adjusting the risk function for the time, location, number of passengers and age of drivers.

We were limited by the amount of evidence available about the shift in the BAC distribution after the implementation of the 50 mg/100ml BAC law. Research describing the shift in other countries that had implemented this legal limit would be useful. If the 50 mg/100 ml legal limit is implemented in England and Wales, we would recommend collection of data on shifts in the BAC distribution using a series of roadside surveys over time in order to assess how well the Australian evidence assumptions are reflected in a UK context.

It is possible, but was not within the scope of this project, to examine the health economic consequences of the proposed policy in terms of both the quality-adjusted life years that would accrue and the cost reductions to the NHS, drivers, insurers and employers of reduced fatalities and serious or other injuries.

In conclusion, the modelling exercises undertaken here are limited by the evidence available and the presence of unknown or uncertain parameters. Our estimates are based on a summary of best available evidence to date. Despite these limitations, our study suggests, in line with the findings from the systematic review, that the implementation of the 50 mg/100 ml BAC law would very likely be effective in reducing road traffic injuries and deaths.

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