Impact of legislation to reduce the drink-drive limit on road traffic accidents and alcohol consumption in Scotland: a natural experiment study

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Scientific summary

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Scientific summary

Background

It is well recognised that drink driving is a leading cause of road traffic accidents (RTAs). The first country to introduce a legal blood alcohol concentration (BAC) limit to combat drink driving was Norway in 1936, where it became illegal to drive with a BAC level of ≥ 0.05 g/dl. Since then, many other countries and jurisdictions have followed this 'Scandinavian model' in an effort to deter drink driving; legal BAC limits are in place in countries and regions across Europe, North America, Japan and Australasia. The British Road Safety Act (Ross HL. Law, science, and accidents: the British Road Safety Act of 1967. *J Legal Stud* 1973;**2**:1–78) introduced a legal limit of 0.08 g/dl in 1967, which is still in place today except in Scotland, where the BAC limit was reduced to 0.05 g/dl on 5 December 2014.

The study was based on assessing whether or not the change in drink-driving legislation in Scotland (the intervention) led to a reduction in RTAs in the first 2 years following legislation change. In addition, the study wanted to assess:

- whether or not any legislative effect differed by level of socioeconomic deprivation (SED)
- whether or not the legislation had a wider (unintended) outcome of reducing alcohol consumption per capita
- an economic evaluation to determine the cost-effectiveness of the 2014 legislation.

Research questions

The research answered four primary questions:

1. Has the change in drink-driving legislation in Scotland been effective (i.e. a reduction in RTAs)?
2. Has the change in drink-driving legislation in Scotland led to changes in the relative, and absolute, RTA rates and can these changes be correlated to the level of SED?
3. Has the change in drink-driving legislation in Scotland led to a reduction in population alcohol consumption?
4. Has the change in drink-driving legislation in Scotland provided good value for money (i.e. has the legislation been cost-effective)?

Methods

Research design

The study employed a natural experimental design to measure the causal effect of the change in BAC legislation in Scotland from 0.08 to 0.05 g/dl. The study's control group was England and Wales, the other countries in Great Britain (GB), where the legal BAC limit is still 0.08 g/dl. The data for the intervention and control groups used to measure effectiveness came from the same data sources and cover the same study period (4 years in duration, 2 years pre and post change in legislation, January 2013–December 2016).

A representative from The Royal Society for the Prevention of Accidents was part of the study steering group and contributed to the research design. Furthermore, the study engaged a public involvement group and discussed the research with it. This led to a list of potential confounding variables being created and these variables were then considered for adjustment in the statistical analyses.

Research question 1

Outcome measures
The outcome measures were weekly counts and rates of all RTAs.

Data source
Police accident data (STATS19) were used. The variables used in the study were the accident index, date of accident, age of driver(s), sex of driver(s), postcode of driver(s), and the names of local police force reporting the RTA.

Denominators for road traffic accident rates
The ideal denominator (which does not exist) is the number of miles driven by each person at risk of having a RTA and traffic counts are used as a proxy for this. The traffic counts were obtained from automatic traffic counters that count vehicles passing over them 24 hours a day across the GB road network. In addition, mid-year population estimates were used as an alternative denominator.

Statistical analysis
Descriptive statistics were used to assess the comparability of the intervention and control groups; plots of RTA counts and rates over time were produced. For RTA counts and rates, and separately for the intervention and control group, negative binomial regression models were fitted to panel data sets to test for a change in outcome level after the 2014 legislation was in place. The change in level was measured by fitting a covariate that took the value 0 at all points before the 2014 legislation and took the value 1 at all points thereafter (note that in the control group models, this covariate represents a pseudo-change in legislation). The models were adjusted for an underlying temporal trend by fitting a covariate representing week number, and for seasonality by covariates representing 4-weekly periods of the year. The models were then further adjusted for age, sex and SED. To obtain a 'difference-in-differences' (DiD)-type measure of effect, an interaction term between the intervention group indicator and the binary covariate for indicating pre and post change in legislation ('pseudo'-change for control) was assessed.

Research question 2
To answer this research question, the study followed the same methods as outlined for *Research question 1*.

Measuring socioeconomic deprivation
The study required an area-based measure of SED that was appropriate to use across GB. During the course of the study it became apparent that there was not a gold standard approach to follow. Originally it was planned to use the Carstairs Index. A difficulty to overcome was that postcode sectors and electoral wards, traditionally the levels at which the Carstairs Index is measured, markedly differ in size when comparing Scotland with the rest of GB. Unfortunately, after starting to explore a standardisation approach to address this, it became apparent that it would be logistically impossible to complete because of a lack of bespoke look-up tables. Therefore, the approach was changed and, rather than standardise for the whole of GB, an area-based measure of SED was used, which was derived separately for Scotland and for England and Wales.

Statistical analysis
Effect modification was tested for by including an interaction term between the intervention group indicator and SED. If this interaction was statistically significant, it was planned to measure the slope index of inequality (SII) and relative index of inequality (RII) based on rates of RTAs in the before-and-after intervention periods, and in both the intervention and the control groups, and test for change in SII and RII.

Research question 3

Outcome measures

The outcome measure was alcohol consumption per capita and this was split by whether the estimates were from off- or on-trade alcohol retail sales data.

Data source

Alcohol retail sales data were provided from market research specialists. These data provide population-level estimates based on electronic sales records from large retailers and a weighted stratified sample of smaller retailers. In the absence of a true gold standard, alcohol retail sales data are a high-quality measure of per capita alcohol consumption.

Statistical analysis

Plots of alcohol consumption per capita over time were produced. For off- and on-trade sales, and separately for the intervention and the control group, seasonal autoregressive-integrated moving average (SARIMA) error models were fitted to the relevant time series of data points. A change in level associated with change of legislation was measured by fitting a covariate that took the value zero at all points before the 2014 legislation and took the value one at all points thereafter. The form of the autocorrelation for the SARIMA errors was identified from autocorrelation plots and partial autocorrelation plots. Each SARIMA model controlled for two exogenous variables, off-trade sales from the same intervention group (or on-trade sales, depending on model) and on-trade sales from the other intervention group (or off-trade sales, depending on model). In a sensitivity analysis, the data were adjusted for country-specific Aldi (Essen, Germany) and Lidl (Neckarsulm, Germany) market share percentages (as data from these supermarkets are not part of the market research data).

Research question 4

Three frameworks for economic evaluation [cost-effectiveness, cost–utility and cost–benefit analysis (CBA)] were considered to reflect different outcomes from the effectiveness analysis. If differences in effectiveness were not detected, the economic evaluation reverted to a cost analysis.

Costs

Those costs associated with prevention of accidents were categorised into 'casualty-related costs' and 'accident-related costs'. Using this distinction, casualty-related costs comprise human costs, medical and ambulance costs and lost output. Accident-related costs comprise police costs, insurance and administration costs and costs of damaged property. Additional associated costs related to deaths were estimated (i.e. ambulance, accident and emergency admissions, coroner and legal costs) based on Scottish data sources and estimates from the literature. Costs also included the implementation costs of the law change and the costs associated with the campaign to advertise the reduced limit, as well as the associated surveillance and monitoring costs.

Outcomes

The outcomes included the weekly rate of RTAs (for the cost-effectiveness analysis), years of life lost, quality-adjusted life-years (QALYs) (for the cost–utility analysis) and contingent valuation values related to prevented fatalities as well as human injuries (for the CBA). The estimation of QALYs gained though the prevention of RTAs was informed by a literature review. By utilising health states and QALYs associated with RTAs from previous literature, estimates of QALYs lost per injured survivor were included in the evaluation to generate any resulting QALY impacts associated with the change in drink-driving legislation. If any evidence of effectiveness was found, the cost and outcome results from the 2-year follow-up results would be extrapolated within a lifetime cohort model to identify the likely longer-term impacts of the change in Scottish drink-driving legislation.

Perspective/discounting/sensitivity analysis

The perspective of the economic evaluation is the societal perspective to allow health sector and broader judiciary costs to be included. The time horizon is lifetime costs and outcomes with a population health economics discount rate of 1.5% applied. If there was evidence of effectiveness, a detailed sensitivity analysis would be undertaken to identify thresholds of cost–utility (when using QALYs as the outcome measure) and cost–benefit (when using contingent valuation for prevented injuries).

Results

Research question 1

The distribution of age, sex and SED demographics was very similar for the intervention and control groups and, therefore, risk adjustment for these variables had little impact on the statistical models. The change in drink-drive legislation was associated with a 2% relative decrease in RTA counts in Scotland [relative risk (RR) 0.98, 95% CI 0.91 to 1.04; $p = 0.53$]. However, the pseudo-change in legislation was associated with a 5% decrease in RTA counts in England and Wales (RR 0.95, 95% CI 0.90 to 1.00; $p = 0.05$). For RTA rates, with traffic flow as the denominator, the DiD-type estimate indicated a 7% increase in rates for Scotland relative to England and Wales (unadjusted RR 1.07, 95% CI 0.98 to 1.17; $p = 0.1$).

Research question 2

The effect sizes observed, overall, were similar in value across SED levels and this was reinforced by the *p*-values for the tests of interaction ($p = 0.72$, RTA counts; $p = 0.71$, RTA rates with traffic flow as the denominator; and $p = 0.72$, RTA rates with population as the denominator).

Research question 3

The change in drink-drive legislation was associated with a 0.3% relative decrease in per capita off-trade sales (–0.3%, 95% CI –1.7% to 1.1%; $p = 0.71$) and a 0.7% decrease in per capita on-trade sales (–0.7%, 95% CI –0.8% to –0.5%; $p < 0.001$). The corresponding results for the effect of the pseudo-change in legislation in England and Wales indicated increases in per capita off- and on-trade sales. The results were not sensitive to adjustment for country-specific Aldi and Lidl market share percentages.

Research question 4

With the results revealing no significant change in effectiveness, the economic evaluation became a cost analysis focusing on the resource impacts of the legislation. The cost results showed the financial costs of changing the drink-driving legislation in Scotland were not insubstantial.

Principal findings

Research question 1

It was found that lowering the BAC limit from 0.08 to 0.05 g/dl in Scotland was not associated with a change in the level of RTAs in the first 2 years post change in legislation.

Research question 2

As well as no overall effect for RTA outcome, no effect modification by SED level was found.

Research question 3

The study found that lowering the BAC limit from 0.08 to 0.05 g/dl in Scotland was not associated with a change in the level of off-trade alcohol consumption in the first 2 years post-legislation change; however, the study found that lowering the BAC limit from 0.08 to 0.05 g/dl in Scotland was associated with a small relative reduction (i.e. < 1%) in the level of on-trade alcohol consumption.

Research question 4

Significant costs were incurred in changing the legislation.

Conclusion

The change in drink-drive legislation in Scotland in December 2014 did not have the expected effect of reducing RTAs in the country, and nor did it change Scotland's alcohol drinking levels. The main finding for RTAs was unexpected. In an a priori theory of change, legislation failure was cited as a plausible explanation if the study went on to find no change in the RTAs outcome. The research has shown lack of enforcement as the most likely reason for legislation failure. Another possible reason is that large effect sizes observed in previous high-quality studies of the same intervention are now difficult to achieve given the large improvements over time in road safety and drink-driving becoming increasingly socially unacceptable. Although this study did have limitations (e.g. denominator for rates, unmeasured confounding), it was not felt that any resulting bias would be large enough to change the conclusions.

Trial registration

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