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Evaluating the impact of the alcohol act on off-trade alcohol sales: a natural experiment in Scotland

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ABSTRACT

Background and Aims A ban on multi-buy discounts of off-trade alcohol was introduced as part of the Alcohol Act in Scotland in October 2011. The aim of this study was to assess the impact of this legislation on alcohol sales, which provide the best indicator of population consumption. **Design, Setting and Participants** Interrupted time-series regression was used to assess the impact of the Alcohol Act on alcohol sales among off-trade retailers in Scotland. Models accounted for underlying seasonal and secular trends and were adjusted for disposable income, alcohol prices and substitution effects. Data for off-trade retailers in England and Wales combined (EW) provided a control group. **Measurements** Weekly data on the volume of pure alcohol sold by off-trade retailers in Scotland and EW between January 2009 and September 2012. **Findings** The introduction of the legislation was associated with a 2.6% (95% CI = -5.3 to 0.2%, $P = 0.07$) decrease in off-trade alcohol sales in Scotland, but not in EW (-0.5%, 95% CI = -4.6 to 3.9%, $P = 0.83$). A statistically significant reduction was observed in Scotland when EW sales were adjusted for in the analysis (-1.7%, 95% CI = -3.1 to -0.3%, $P = 0.02$). The decline in Scotland was driven by reduced off-trade sales of wine (-4.0%, 95% CI = -5.4 to -2.6%, $P < 0.001$) and pre-mixed beverages (-8.5%, 95% CI = -12.7 to -4.1%, $P < 0.001$). There were no associated changes in other drink types in Scotland, or in sales of any drink type in EW. **Conclusions** The introduction of the Alcohol Act in Scotland in 2011 was associated with a decrease in total off-trade alcohol sales in Scotland, largely driven by reduced off-trade wine sales.

Keywords Alcohol consumption, alcohol policy, alcohol sales data, multi-buy discount ban, price legislation, Scotland, time-series.

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INTRODUCTION

Scotland has one of the highest rates of alcohol-related harms in western and central Europe [1]. This is largely a consequence of dramatic rises in the 1990s [2]. Despite recent improvements, alcohol-related mortality rates in Scotland in 2012 remained twice as high as those in England and Wales (EW) [3]. In 2007, the estimated societal costs of alcohol misuse in Scotland was between £2.5 and £4.6 bn [4].

Alcohol sales data provide the most accurate means of estimating population consumption levels [5], which are associated with alcohol-related harm [6]. In Scotland, sales data show that per adult (aged ≥ 16 years) consumption of pure alcohol increased from 10.2 litres in

1994 to a peak of 11.9 litres in 2009 [3]. This was driven by increasing off-trade consumption and declining on-trade consumption. In recent years, consumption in Scotland has declined, with the first notable decrease in off-trade sales observed between 2011 and 2012. A broadly similar pattern has been seen in EW, although the peak in consumption occurred in 2005 and off-trade sales stabilized from between 2006 and 2009 before declining. In 2012, per adult consumption was 19% higher in Scotland than in EW and 82% of this disparity was due to higher off-trade sales, which account for two-thirds of the alcohol market in Great Britain.

The Scottish Government's alcohol strategy seeks to reduce population consumption and related harms through a comprehensive package of policy interventions

and legislation [7]. The *Alcohol etc. (Scotland) Act 2010* ('Alcohol Act'), implemented on 1 October 2011, introduced new regulations concerning the sale of alcohol in the off-trade [8]. These regulations limited alcohol promotions within retail stores to a single area and introduced a ban on quantity-based price discounts. This latter aspect of the legislation was considered to be its main component, and prevented off-trade retailers from providing multi-buy promotions such as 'three for the price of two' or 'three bottles for £10'; however, straight discounting of products remained permissible. The intention was to restrict incentives encouraging consumers to purchase more alcohol than they may otherwise have bought, and thereby reduce consumption.

A recent study evaluated the impact of the Alcohol Act in Scotland. Using a difference-in-differences approach to analyse household shopping panel data, Nakamura *et al.* [9] concluded that the legislation did not reduce alcohol purchasing in the 9-month period after it was introduced. However, results from single natural experiment studies are unlikely to be definitive [10,11]. In this study, we evaluate the impact of the Alcohol Act using time-series analyses of aggregate off-trade alcohol retail sales data for a 52-week period post-implementation.

METHODS

Design overview

Interrupted time-series regression was used to test for a change in off-trade alcohol sales, with data from EW used as a control group. We assessed the impact of the legislation on total off-trade alcohol sales and on specific drink types. Models accounted for underlying seasonal and secular trends and were adjusted for disposable income, alcohol prices and on-trade alcohol sales.

Data

Off-trade alcohol retail sales data were obtained from market research specialists, Nielsen, for each week between January 2009 and September 2012 (week ending 10 January 2009 to the week ending 29 September 2012). These data are based on both electronic sales records from large retailers and a weighted stratified random sample of smaller retailers. Sales by discount retailers, Aldi and Lidl, are not included in the Nielsen data. In 2012, these accounted for 5% of the total off-trade market in Great Britain. Natural volume sales were converted into pure alcohol volumes using alcohol-by-volume (ABV) percentages for each drink category. The volume of pure alcohol sold off-trade per adult (≥ 16 years) (hereafter 'off-trade alcohol sales') was calculated using official mid-year population estimates [12,13];

weekly population estimates were interpolated assuming a linear trend. A detailed description of the methods used by Nielsen and the validity of using retail sales data to estimate population consumption is provided elsewhere [14].

Quarterly gross disposable household income data were obtained for Scotland [15] and the United Kingdom [16] and expressed per adult. As equivalent data were not available directly for EW, a proxy measure was created by subtracting Scottish data from the UK data.

Weekly estimates of the mean sales price of alcohol sold off-trade in Scotland and EW were calculated (for all alcohol and by drink type) using Nielsen data by dividing retail sales value (£) by the volume of pure alcohol sold.

On-trade alcohol sales data (litres of pure alcohol) were obtained from market research specialists, CGA Strategy, whose estimates are based on a combination of delivery, sales and survey data from a stratified sample of on-trade retailers [14]. Linear interpolation was used to calculate weekly on-trade sales data per adult by drink category from the 4-weekly data provided.

Statistical analysis

We used interrupted time-series regression with seasonal autoregressive integrated moving average (SARIMA) errors to assess the impact of the Alcohol Act on off-trade alcohol sales. Off-trade alcohol sales data were log-transformed to reduce positive skew.

Our analytical strategy consisted of initially modelling the off-trade alcohol sales data time-series to obtain an adequate preliminary model and then modelling and testing the effect of the intervention [17]. Several candidate models were investigated using graphs and autocorrelation plots of the stationary time-series and its errors with the most appropriate and parsimonious model selected using the Akaike information criterion (AIC) [18]. For analyses of all alcohol time-series, including those of EW, the final fitted model was a SARIMA with one regular autoregressive term, seasonal differencing at lag 52 and one autoregressive seasonal term: SARIMA (1,0,0) (1,1,0,52).

To analyse the magnitude and statistical significance of the effect that the intervention had on off-trade alcohol sales in Scotland we included a binary explanatory variable, with the value of zero for the time before the ban was introduced (01/09 to 09/11) and the value of 1 after the introduction of the ban (10/11 to 09/12). We used a zero-order transfer function, which assumes an abrupt and permanent effect of the intervention. Analyses were performed with and without adjustment. Covariates entered into adjusted models were disposable income, mean sales price, on-trade alcohol sales and, for analyses of specific drink types, sales of other drink types. In line

with STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidance [19], we present results from both unadjusted and adjusted models; however, we mainly discuss adjusted results within the text.

To enable comparison with a control group, the same analytical technique described above was performed using data for EW, where the legislation does not apply. In addition, we entered the time-series of corresponding alcohol sales in EW as a covariate in the SARIMA models for Scotland [20–22].

Standard diagnostic tests were performed to ensure that the residuals of the fitted models were not significantly different from those expected from white noise or a random series [23,24].

SARIMA analyses were undertaken using Stata version 12.1 software (Stata Corp., College Station, TX, USA; URL <http://www.stata.com>).

Sensitivity and supplementary analyses

We performed sensitivity analyses to assess the impact of applying adjustment factors to off-trade alcohol sales data to account for the exclusion of sales by Aldi and Lidl (Supporting Information, Table S1). We also supplemented our main analyses by extending the study time-period using off-trade alcohol sales data for the 2-year period after the legislation was introduced; only unadjusted models could be fitted, as data for covariates were not available.

Ethical approval

Ethical approval was not required for this study.

RESULTS

Descriptive trends

Figure 1 shows the weekly volume of pure alcohol sold through the off-trade per adult in Scotland and EW between January 2009 and September 2012. There are clear seasonal trends in off-trade alcohol sales; these trends are very similar across Great Britain and for individual drink types (Supporting Information, Figs S1–S5). Off-trade alcohol sales are consistently higher in Scotland than in EW; 25% more alcohol was sold off-trade per adult in Scotland in the 52-week period before the Act was introduced. The disparity is driven largely by higher spirits sales in Scotland (2.5 litres per adult compared with 1.4 litres per adult in EW), although annual sales of all drink types are higher in Scotland. Trends in covariates (gross disposable household income, mean sales price and on-trade alcohol sales) during the time-period are described elsewhere [24].

Visual inspection of the data does not reveal a clear impact of the Alcohol Act on off-trade alcohol sales. However, comparing the percentage change in off-trade alcohol sales when aggregated across 52-week periods before and after the Alcohol Act is more instructive (Table 1). In the 52-week period before the Alcohol Act was introduced, total off-trade sales in Scotland and EW



Figure 1 Volume of pure alcohol sold in Scotland and England & Wales, January 2009–October 2012

Table 1 Percentage change in off-trade alcohol sales aggregated across 52-week periods before and after the Alcohol Act in Scotland and England & Wales.

Drink type	52-week period before the Alcohol Act ^a		52-week period after the Alcohol Act ^a	
	Scotland	England & Wales	Scotland	England & Wales
All alcohol	-0.8	-2.6	-4.3	-2.6
Spirits	-0.2	-0.7	-4.8	-2.4
Wine	0.7	-3.0	-4.6	-3.2
Beer	-3.6	-4.8	-4.3	-1.7
Cider/perry	4.8	1.2	-0.5	-2.5
RTDs	1.9	4.2	-6.2	-6.6

^aPercentage change from the corresponding 52-week period 12 months previously.

were lower than the previous year (-0.8% and -2.6%, respectively). After the Alcohol Act, total off-trade sales in EW continued to decrease at a similar rate (-2.6%), whereas in Scotland the relative decline was larger (-4.3%). While off-trade sales fell across all drink types in both geographies after the Alcohol Act, there was a notable change in wine sales in Scotland, which had increased by 0.7% in the 52-week period pre-implementation, but fell by 4.6% in the 52-week period post-implementation. This was not observed in EW, where the percentage change in wine was similar before (-3.0%) and after (-3.2%) the Scottish legislation. A relatively large percentage decrease in off-trade ready-to-drink (RTD, pre-mixed alcohol) sales in the 1-year period after the Alcohol Act was observed in both Scotland (-6.2%) and EW (-6.6%).

Time-series analysis

The adjusted time-series analyses show that the introduction of the Alcohol Act was associated with a 2.6% decrease in off-trade alcohol sales in Scotland (Fig. 2). Although this association was not statistically significant ($P = 0.07$), a similar decrease was not observed in EW. The decline in Scotland was driven by changes in off-trade wine sales, which decreased by 4.0% after the Act was introduced. The Act was also associated with reduced RTD sales in Scotland, although these make up a very small proportion (1%) of the off-trade market. A statistically significant decrease in RTDs was also observed in EW in unadjusted analyses, but this effect did not remain after adjustment for covariates (Fig. 2).

There was little evidence to suggest that the introduction of the Act was associated with any changes in off-trade beer, spirits or cider/perry sales in Scotland. There

were also no statistically significant associations between off-trade sales of these drink types and the dummy Alcohol Act variable in EW (Fig. 2).

Broadly similar results were observed when off-trade sales in EW were adjusted for in the Scotland SARIMA models (Table 2). Specifically, the Alcohol Act was found to be associated significantly and negatively with off-trade sales of wine, RTDs and all alcohol, while there was no effect on spirits or cider/perry. For beer, adjustment for EW resulted in a significant association between the legislation and off-trade beer sales in Scotland. This reflects the fact that the intervention effects in the individual SARIMA models for beer sales in Scotland and EW were in opposite directions (Fig. 2). Coefficients for the EW covariate were statistically significant ($P < 0.001$) in all time-series models (Supporting Information, Table S4).

Sensitivity and supplementary analysis

Adjusting off-trade alcohol sales data to account for the exclusion of Aldi and Lidl produced results broadly consistent with the main analysis (Supporting Information, Table S2). For example, statistically significant associations between the Alcohol Act and off-trade sales of wine and RTDs in Scotland were consistent with the main analysis even though the effect sizes varied. However, there was no evidence to suggest that the Alcohol Act was associated with a reduction in total off-trade sales in Scotland when the market share of Aldi and Lidl were accounted for. Further adjustment for EW sales did not change these interpretations (Supporting Information, Table S3).

Supplementary analysis using data for a 2-year post-legislation period suggested that the intervention effect on wine remained in Scotland and the association with RTDs was weakened, but there was no effect on total off-trade sales (Supporting Information, Table S5). However, when controlling for sales in EW, the Alcohol Act was associated significantly with a 2.0% (-3.7 to -0.2%; $P = 0.03$) reduction in total off-trade sales in Scotland in the 2-year period after it was introduced (Supporting Information, Table S6).

DISCUSSION

This study provides evidence that the introduction of the Alcohol Act in Scotland was associated with a decrease in total off-trade alcohol sales, driven largely by reduced off-trade wine sales. The legislation was also associated with reduced sales of pre-mixed alcohol beverages, although these account for a very small proportion of total off-trade sales. Similar changes were not observed in EW, nor could confounding factors explain the differences in

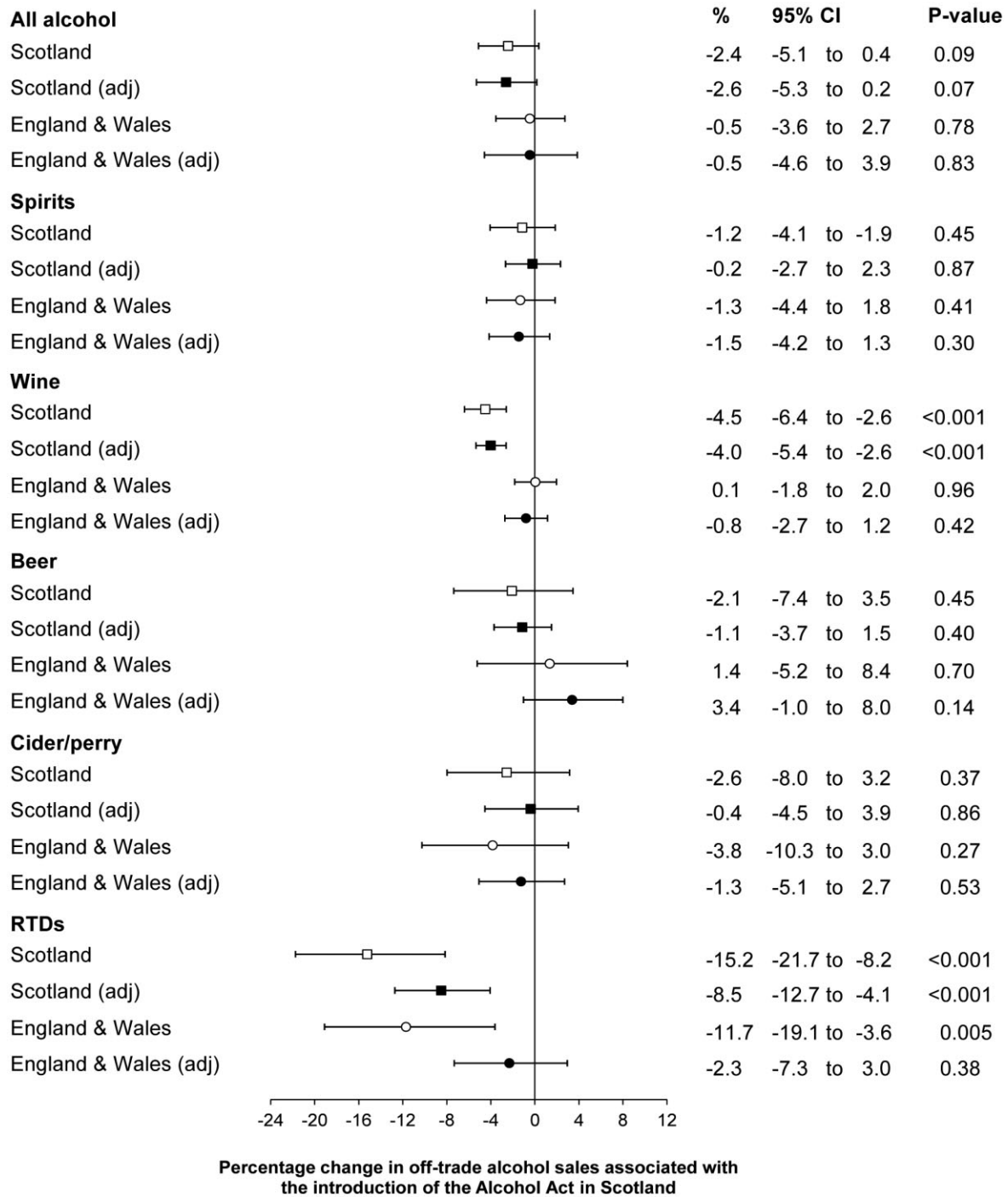


Figure 2 Percentage change in off-trade alcohol sales after the introduction of the Alcohol Act in Scotland. Adj=adjusted models that include adjustment for changes in disposable income, alcohol prices (mean sales price), on-trade alcohol sales and, for models where the outcome variable is a particular drink type, off-trade sales of all other drink types combined; RTDs=ready-to-drink (pre-mixed) drinks

trends, and so it is likely that the Scottish decline was due to the legislation rather than other unmeasured factors or biases.

Our findings contradict those recently published by Nakamura *et al.* [9], who concluded that the Alcohol Act had no impact on off-trade alcohol purchases based on household shopping panel data. A number of reasons

might explain the incongruent findings. First, self-reported data, such as those used by Nakamura *et al.*, are particularly prone to biases relating to representativeness and under-reporting [25,26]. In contrast, the alcohol retail sales data used in our study are recommended for the evaluation of population interventions because, while subject to their own limitations and biases, they produce

Table 2 Percentage change in off-trade alcohol sales associated with the introduction of the Alcohol Act in Scotland with off-trade alcohol sales in England & Wales (EW) entered as a covariate.

ARIMA model	Estimated Alcohol		
	Act effect (%)	95% CI	P-value
All alcohol			
Unadjusted	-1.9	-3.3 to -0.4	0.01
Adjusted	-1.7	-3.1 to -0.3	0.02
Spirits			
Unadjusted	0.0	-1.8 to 1.9	0.97
Adjusted	0.1	-1.5 to 1.7	0.92
Wine			
Unadjusted	-4.5	-6.1 to -2.9	<0.001
Adjusted	-4.3	5.6 to -3.0	<0.001
Beer			
Unadjusted	-3.2	-5.6 to -0.7	0.01
Adjusted	-2.7	-4.7 to -0.6	0.01
Cider/perry			
Unadjusted	0.6	-2.8 to 4.1	0.73
Adjusted	1.1	-2.6 to 4.9	0.58
RTDs			
Unadjusted	-8.2	-12.4 to -3.8	<0.001
Adjusted	-7.3	-11.6 to -2.7	0.002

Unadjusted models include EW off-trade sales as a covariate. Adjusted models include adjustment for changes in disposable income, alcohol prices (mean sales price), on-trade alcohol sales, off-trade sales in England and Wales and, for models where the outcome variable is a particular drink type, off-trade sales of all other drink types combined. CI = confidence interval; RTD = ready-to-drink (pre-mixed) drinks.

more valid and reliable estimates of per capita consumption [5,27].

Secondly, different analytical techniques were used to assess the impact of the intervention. Nakamura and colleagues used a difference-in-differences approach, an appropriate pre-post study design when analysing household-level data with a small number of data points in the time-series. However, when analysing aggregated data with a relatively large number of data points interrupted time-series regressions with SARIMA errors prove more powerful, as such designs enable better control of secular and seasonal trends in the data series (the latter being particularly important given the seasonality in alcohol sales). In addition, while both studies were strengthened by the inclusion of control groups, we were also able to control for potential substitution effects.

Finally, the Nakamura *et al.* study was unlikely to be sufficiently powered to detect the magnitude of changes expected from the Alcohol Act [28]. Although not interpreted in this way by the study authors, their results indicate that if household purchases of any drink type in Scotland were likely to be lower after the Alcohol Act they were wine and RTDs, with best estimates of a 2.1 and 19.4% decline, respectively [9]. However, the confidence

intervals around these estimates were very wide, which makes the definitiveness of their conclusion surprising. Indeed, one could argue that, despite the different study designs and contrasting conclusions, there are consistent patterns in the results.

The results from our study show that the drink types most affected by the Alcohol Act were wine and RTDs. Nakamura *et al.* reported that, as a proportion of category-specific purchases, wine and RTDs were the most likely to be bought as part of a multi-buy deal in Scotland before the legislation, although beer and cider (combined) accounted for a much larger volume of alcohol sold on promotion [9]. In separate analyses, we have shown that the prevalence of promotional wine sales declined significantly in Scotland, but not in EW, after the Alcohol Act was introduced [24]. This seemed to be driven by a dampening effect on brief spikes of promotional activity, which were common in Scotland before the Alcohol Act and remained common in EW afterwards. However, the promotional sales data incorporated all types of promotion, thus limiting the extent to which definitive conclusions could be drawn.

Retailers in Scotland have responded to the multi-buy discount ban on alcohol by enhancing other promotions. Indeed, an average of 50% of all off-trade alcohol sales in Scotland in the year after the ban was introduced was on promotion [24]. This includes straight discounting of products from the list price, which remains legal, and has enabled consumers to purchase individual alcohol products for the same price as they had been on promotion (e.g. replacing an offer of three bottles of £4 wine for £10 by reducing the price of the individual bottles to £3.33). Nakamura *et al.* [9] hypothesized that this was the main reason why their study revealed no effect of the Alcohol Act, and we agree that it is likely to have reduced the overall effectiveness of the policy. Legislation to prevent retailers from straight discounting alcohol products to a price below that based on its alcohol content has been passed by the Scottish Parliament [29], but currently faces legal challenges. If implemented, the combination of minimum pricing and a ban on multi-buy promotions is likely to have greater effectiveness than either policy in isolation [28].

Small changes in population consumption levels can have potentially important public health consequences. For example, the Sheffield Alcohol Research Group used an epidemiological model that takes into account the effect of changes in consumption on alcohol-related harm to appraise the potential impacts of different policy scenarios in Scotland [28]. They estimated that a total ban on off-trade discounting would reduce consumption by 3% and lead to related reductions in alcohol-attributable deaths and hospital admissions of 4 and 3% within the first year of implementation, respectively. We

are currently extending our evaluation of the Alcohol Act to assess whether the reduction in population consumption we observed in this study translated into any positive effects on population levels of alcohol-related harms.

A number of limitations should be noted. The weekly off-trade alcohol sales data exclude data from Aldi and Lidl. These discount retailers tend to maintain lower prices rather than promote special offers, so it is plausible that consumers responded to the Alcohol Act by purchasing more alcohol from these stores. In our sensitivity analyses, applying drink and country-specific adjustment factors to account for the increasing market share of these retailers over the study time-period did not affect our conclusions regarding the negative association between the legislation and off-trade sales of wine and RTDs; however, there was no association with total off-trade sales. Alcohol sales through certain internet and mail order retailers are also not captured by the data providers. It is therefore possible that the decline in off-trade sales in Scotland may, at least in part, have been offset by increased sales through such retailers, thus overestimating the magnitude of effects.

Unmeasured confounding poses a particular threat to natural experimental studies [10]. Internal validity may be compromised if there are genuine alternative explanations for an observed effect rather than the intervention. The Licensing (Scotland) Act 2005 was implemented in September 2009 and contained a number of provisions aimed at controlling the availability of alcohol [3]. Results from a qualitative evaluation indicated that while it had successfully ended irresponsible promotions in the on-trade, it was unlikely to have had a major impact on population consumption because the off-trade sector was largely unaffected [3,30]. The ongoing national programme of delivering alcohol brief interventions (ABIs) may have had an impact on population consumption over the time-period analysed [31]. However, any impact is likely to have been small, and because ABIs were delivered gradually over time it is likely that any small impacts would have been picked up in the adjustment for underlying trends in the time-series models.

Lastly, alcohol retail sales data do not enable disaggregation by different population subgroups. It was therefore not possible to assess the differential impact of the Alcohol Act on individuals with different alcohol consumption patterns, demographic characteristics and socio-economic circumstances. This prevented, for example, a better understanding of whether the observed reduction in RTD sales associated with the Alcohol Act in Scotland was driven by younger drinkers who favour these flavoured alcoholic beverages [32]. This highlights one of the major challenges in alcohol epidemiological research. Aggregate sales data provide the most reliable

consumption estimates for monitoring trends and assessing impacts of population-level policies, but limit a more nuanced understanding of consumption behaviour. Conversely, self-reported methods can provide detailed individual and household-level data; however, consumption among the heaviest drinkers is never likely to be captured fully. Recent calls for the collection of improved data on alcohol behaviours are welcome [33,34], but synthesis of various forms of evidence using multiple indicators of consumption and harm will remain crucial to the alcohol policy appraisal process.

Overall, the results from this study suggest that the introduction of the Alcohol Act was associated with reduced off-trade alcohol sales in Scotland, driven largely by a decrease in off-trade wine sales. The Alcohol Act was also associated with reduced RTD sales, although these account for a very small proportion of total off-trade sales. Our analyses took into account trends in EW, where the legislation does not apply, as well as other potential confounders, which lends weight to the hypothesis that the effects observed in Scotland were as a result of the Alcohol Act rather than due to other unmeasured factors. Thus, legislation to ban alcohol discounting appears to be an important policy in the mix to reduce population alcohol consumption levels.

Declaration of interests

None.

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Supporting information

Additional Supporting information may be found in the online version of this article at the publisher's web-site:

Figure S1 Weekly off-trade sales of spirits in Scotland and England & Wales, January 2009–October 2012

Figure S2 Weekly off-trade sales of wine in Scotland and England & Wales, January 2009–October 2012

Figure S3 Weekly off-trade sales of beer in Scotland and England & Wales, January 2009–October 2012

Figure S4 Weekly off-trade sales of cider/perry in Scotland and England & Wales, January 2009–October 2012

Figure S5 Weekly off-trade sales of ready-to-drink beverages (RTDs) in Scotland and England & Wales, January 2009–October 2012

Table S1 Market share (%) estimates of alcohol sales by Aldi and Lidl in Scotland and England & Wales, by drink type

Table S2 Percentage change in off-trade alcohol sales (including adjustment for Aldi and Lidl) associated with the introduction of the Alcohol Act in Scotland and England & Wales

Table S3 Percentage change in off-trade alcohol sales (including adjustment for Aldi and Lidl) associated with the introduction of the Alcohol Act in Scotland with off-trade alcohol sales in England & Wales entered as a covariate

Table S4 Association between off-trade alcohol sales in England & Wales (entered as a covariate) and off-trade alcohol sales in Scotland

Table S5 Percentage change in off-trade alcohol sales associated with the introduction of the Alcohol Act in Scotland and England & Wales in the 2-year period after its introduction

Table S6 Percentage change in off-trade alcohol sales associated with the introduction of the Alcohol Act in Scotland and England & Wales in the 2-year period after its introduction with off-trade alcohol sales in England & Wales entered as a covariate