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RESEARCH REPORT

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Evaluating the impact of minimum unit pricing for alcohol on road traffic accidents in Scotland after 20 months: An interrupted time series study

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Abstract

Background and aims: On 1 May 2018, Scotland implemented Minimum Unit Pricing (MUP) of £0.50 per unit of alcohol with the aim to lower alcohol consumption and related harms, and reduce health inequalities. We measured the impact of MUP on the most likely categories of road traffic accidents (RTAs) to be affected by drink-driving episodes (fatal and nighttime) up to 20 months after the policy implementation. Further, we checked whether any association varied by level of socio-economic deprivation.

Methods: An interrupted time series design was used to evaluate the impact of MUP on fatal and nighttime RTAs in Scotland and any effect modification across socio-economic deprivation groups. RTAs in England and Wales (E&W) were used as a comparator. Covariates representing severe weather events, bank holidays, seasonal and underlying trends were adjusted for.

Results: In Scotland, MUP implementation was associated with 40.5% (95% confidence interval: 15.5%, 65.4%) and 11.4% (−1.1%, 24.0%) increases in fatal and nighttime RTAs, respectively. There was no evidence of differential impacts of MUP by level of socio-economic deprivation. While we found a substantial increase in fatal RTAs associated with MUP, null effects observed in nighttime RTAs and high uncertainty in sensitivity analyses suggest caution be applied before attributing causation to this association.

Conclusion: There is no evidence of an association between the introduction of minimum unit pricing for alcohol in Scotland and a reduction in fatal and nighttime road traffic accidents, these being outcome measure categories that are proxies of outcomes that directly relate alcohol consumption to road traffic accidents.

KEYWORDS
alcohol, interrupted time series, natural experiment, minimum unit price, road traffic accidents, Scotland

Francesco Manca and Rakshita Parab are both first authors.

INTRODUCTION

Alcohol-related harm is high in the United Kingdom (UK), with alcohol being the fifth largest risk factor for deaths and ill-health across all ages [1]. Within the UK, in 2020, Scotland had the highest alcohol-specific death rate of the constituent countries—21.5 per 100 000 persons, compared to 19.6, 13.9 and 13.0 in Northern Ireland, Wales and England, respectively [2].

Following a package of other measures aimed at reducing alcohol consumption and subsequent harm in Scotland, the Scottish Government implemented a minimum unit price for alcohol (MUP) on 1 May 2018 [3]. MUP in Scotland sets a floor price of £0.50 per unit of alcohol (one unit = 8 g or 10 mL of ethanol), below which it cannot be legally sold. As well as reducing overall harms, the aim of MUP is to reduce inequalities by targeting sales of cheap and high-strength alcohol products mainly purchased by the most socio-economically disadvantaged groups (who have the highest levels of alcohol-related harms) [4–6]. Scotland was the first country to implement nationally a homogeneous MUP for alcohol volume in beverages. Therefore, evaluations of MUP in Scotland for a range of outcomes have international relevance.

Evidence on the effectiveness of MUP in Scotland is starting to emerge. It has been shown that MUP implementation was associated with a reduction in alcohol sales per adult of 3% [7] after 3 years and with a decline in deaths wholly attributable to alcohol consumption after 32 months [8]. However, MUP was not associated with changes in alcohol-related emergency department visits [9] nor alcohol-related crimes [10] or medical prescriptions for alcohol dependence [11].

It is well established that alcohol use is associated with road traffic accidents (RTAs), with a dose–response relationship between fatal injury and blood alcohol concentration [12]. Further, alcohol consumption by pedestrians is a significant factor in a subset of RTAs that do not involve drink-driving. However, there is only a small evidence base on how minimum alcohol prices are associated with RTAs. A Canadian study [13] observed that increases in provincial minimum alcohol prices were associated with reductions in alcohol-related traffic violations (but not in non-alcohol-related traffic violations). In 2020, a regional report from the Northern Territory of Australia regarding the implementation of MUP at a different extent to that used in Scotland ($1.30 per 'standard drink', which is equal to £0.75 per UK unit -currency conversion in July 2022) reported a significant instant reduction in the level of alcohol-related RTAs resulting in injury or fatality [14]. In 2021, a study investigating the effect of MUP on RTAs in Scotland [15] found a reduction of 0.28 to 0.35 fewer daily motor vehicle collisions per million inhabitants (an important reduction considering an average of 3.23 RTAs per million across the study period). This study (as well as Coomber *et al.*) [14] has short post-intervention periods (8 months). However, it is plausible that MUP's indirect effects on alcohol-related harms have different-size lagged impacts, which take longer follow-up periods to emerge as previously shown for other outcomes and contexts [16, 17]. Further, any differential effects across levels of socio-economic deprivation (an aim of MUP policy in Scotland) were not considered. More recently, another evaluation on severe and alcohol-related RTAs with a longer post-intervention period (20 months) found a non-significant 8% increase in fatal RTAs after the policy implementation [18].

This paper aims to evaluate whether the introduction of MUP in Scotland was associated with any change in the level of RTAs most likely to be affected by drink-driving episodes (fatal and night-time) in the first 20 months after implementation. Further, we evaluated whether any association varied by level of socio-economic deprivation.

METHODS

Design

We used an interrupted time series (ITS) design to establish whether MUP implementation in Scotland was associated with a variation in the level of RTAs most likely to be alcohol-related. Where possible, ITS designs formally use a control group to reduce potential bias because of time-varying confounding. However, a suitable control group should be exposed to common events that potentially influence the intervention series and, at the same time, it should not be exposed to other events that could influence the control series only [19]. Different pre-intervention trends may underline potential different time-varying confounders between the two series, identifying an inappropriate control (i.e. violating the so-called parallel trends assumption). Therefore, we included the comparator in the model only when the parallel trends assumption was satisfied and we limited the analysis to a comparison between the series, focusing on uncontrolled ITS results when it was not. In addition, to provide a controlled result on outcomes not satisfying the parallel trend assumption, we built an 'artificial' counterfactual with the prediction of the series built on the pre-MUP period and then we estimated the policy effect with the difference between the predicted and actual values.

Outcomes

We used as primary outcomes weekly fatal and night-time (from 6 PM to 6 AM) RTAs. These are RTAs subcategories likely to be alcohol-related according to official UK Government figures [20]. For all analyses, we used the corresponding data for England and Wales (E&W) as a geographical comparator group. We assessed the impact of the legislation also on the total number of total weekly RTAs (secondary outcome) to facilitate comparison with previous studies [15]. Regarding night-time and total RTAs, analyses were repeated for two socio-economic deprivation groups: the most deprived 10th and the rest of the population, as measured by either the Scottish Index of Multiple Deprivation (SIMD) (Scotland) [21] or Index of Multiple Deprivation (IMD) (E&W) [22]. We did not run the same analysis for fatal as the number of observations was too low given the level of granularity of the subcategories.

For the two main outcomes, we also repeated the analysis of the number of RTAs per 100 000 residents. This would potentially control for differences in level of road traffic and the number of cars in the two constituencies. However, the number of residents is yearly estimates only approximating the true number of inhabitants that can vary within years, with the number of inhabitants itself only being a proxy of numbers of road users, so we presented both analyses.

Data

To assess the effect of a policy regarding alcohol pricing on RTAs, data on failed breath tests and drink-driving episodes would comprise an ideal outcome, however, such data has numerous difficulties. For instance, the accuracy of drink-driving data strictly depends on breath tests for non-fatal accidents and from coroner reports for fatal accidents. However, toxicology data coming from coroners are usually accessible only for 60% of the cases [20], producing high sampling uncertainty around official drink-driving estimates. Therefore, because drink-driving outcomes have these methodological uncertainties, we used data on certain categories of RTAs more likely to be alcohol-related. Data on RTAs and casualties in the United Kingdom were obtained from the Road Safety Statistics Division at the UK Department for Transport [23]. The routine dataset (STATS19) contains all personal injury accidents on public roads reported to the police [24]. In the dataset, every accident was recorded with the level of severity, date and time and with the number of casualties. The casualties dataset contained a variable on the IMD for RTAs recorded in England or Wales only. For Scotland RTAs, we used the postcode of the casualties to obtain SIMD for each casualty. Whenever RTAs involved more than one person, the lowest socio-economic deprivation level was used for analysis. Alternative analyses using the highest level of deprivation were also run. The data covers the period 1 January 2016 to 31 December 2019, providing 28 months (121 weeks) before the intervention and 20 months (87 weeks) after; to the best of our knowledge, there was no change in the data collection process during the study period. As most other MUP evaluations [9, 11, 25], we preferred to remove the period of the coronavirus disease 2019 lockdown as it was likely to affect the outcomes. Specifically, road traffic limitations and general movement restrictions had a major effect on RTAs. Moreover, as restrictions were different between Scotland, England and Wales, including such period would have added bias to the analysis.

Statistical analysis

We used weeks as level of data aggregation to remove daily 'noise' and multiple seasonalities (weekly and yearly) for easier detection of the trend component of the series. We first ran a descriptive analysis to assess the general trend and patterning of weekly RTAs over time and to detect any outliers. We, then, used Seasonal Autoregressive Integrated Moving Average models (SARIMA) for inferential analyses. To reduce the impact of outliers and remove exponential variance and for ease of comparison with other studies, the outcome variable was log-transformed. With log-transformed series, the coefficient of independent variables in the SARIMA models can be approximately interpreted as the percentage variation in the level of RTAs. The effect of MUP was assessed by introducing a binary variable in the SARIMA model, assuming a value of 0 before the week the policy was introduced and 1 after. An underlying pre-intervention deterministic trend variable [26] considering the time elapsed since the start of the study was used as a model covariate. Alternative models with both a change in level and trend were analysed, but based on information criteria, models including a change in level only were selected for the analysis. Different SARIMA models were assessed using a correlogram of the series and after model estimation assessment of white noise of the residuals using portmanteau test [26]. The best fitting model was then selected based on information criteria, Models were further adjusted for weeks with severe weather events (collected by the Met Office for the United Kingdom) [27] and weeks with bank holidays.

For the two main outcomes, we evaluated the intervention effect in three ways. We first assessed the MUP coefficients in the uncontrolled series and compared them in the two constituencies. Second, for the outcomes satisfying the parallel trends assumption, we considered models of the difference between the series, log (RTAs in Scotland)-log (RTAs in E&W), as the outcome (these models would produce a difference-in-differences type estimate directly accounting for the comparator [28]). Last, we used the forecast built on SARIMA models on the pre-MUP Scottish series as counterfactual and used the difference between the predicted and actual series as estimates for the policy effect [29].

Fatal RTAs had low weekly numbers in both Scotland and E&W. In particular, in Scotland, several weeks had zero records. Therefore, a commonly used $\log(x + 1)$ transformation was applied to the series. However, it has been recently shown that results based on this transformation may provide biased estimates [30], therefore, alternative sensitivity analyses were used to address this (as described below). Regarding socio-economic deprivation groups for E&W, there was a substantial difference in the average amount of weekly missing data in the period before (n = 326) and after MUP (n = 161) implementation (Table 1). This led to an artificial increase in the number of the E&W series analysing socio-economic deprivation, whereas, overall, the number of RTAs decreased overtime (Figure 1). This missingness in the socio-economic deprivation data for the E&W series would limit the meaning of the inferential analyses and results on such series are reported only in Supporting Information for completeness. In contrast, missing data on the level of deprivation in Scotland were similarly distributed between pre- and post-intervention periods, providing more reliable results.

To compare our findings with previous evidence on the effect of MUP on RTAs [15], we reproduced our analysis on total RTAs, using both the full length of our series and also a shorter post-intervention period ending in December 2018 mirroring the previous study. In this analysis, we started our time series in 2016 and 2018 using both weekly and daily time units. For all analyses Stata17 [31] software was used.

Sensitivity analysis

Two alternative analyses for RTAs concerning fatalities were considered to account for an excess of zeros and a general low number of events. Specifically, a different transformation with inverse hyperbolic sine transformation (IHS) with small-sample bias correction [30] and a generalized linear model (negative binomial) were used and compared with the main analysis. Data on RTAs in most socio-economic deprived decile during night times in Scotland contained only 3 zeros in the series, and we used the same alternative sensitivity analyses for this category for completeness. To further validate the analysis, falsification tests anticipating and delaying the intervention by 6 and 12 months were performed.

The planned analyses were not preregistered and results should be considered exploratory.

RESULTS

The average weekly number of RTAs before and after MUP implementation is shown in Table 1 in both Scotland and E&W. The weekly number of RTAs in Scotland and E&W per 100 000 inhabitants between 1 January 2016 and 31 December 2019 is shown in Figure 1. The level of weekly RTA was consistently higher in the period before MUP in both intervention and the comparator for both night-time and total RTAs, but not for fatal RTAs (Table 1). Nevertheless, a declining trend can be identified within both pre- and post-MUP periods for both intervention and the comparator (Figure 1). Again, although this tendency is common to most of the subcategories, for fatal RTAs there was an increasing trend over time in Scotland: +0.7 pre- and +0.5 post-MUP (rise of 20% and 15%, respectively). For E&W, the pattern of the differences was less distinct within the two periods.

The introduction of MUP was associated with a significant increase in fatal RTAs of 40.5% (95% CI = 18.3%–62.7%) and a statistical non-significant rise in night-time RTAs of 11% (95% CI = −1.1% to 24.0%) (Figure 2, full model outputs presented in Supporting Information). For the corresponding period, in E&W there was a statistical non-significant increase in both categories. There was also no statistically significant association between the overall level of RTAs and the introduction of MUP in Scotland for the most socio-economically deprived 10th and for the second to 10th deprived 10th groups. The underlying trend was negative in all the models indicating a decreasing pattern of all series over time, and it was always statistically significant, except for the model regarding fatal RTA in E&W (see Supporting Information). Because the difference in the log of fatal RTAs between the two intervention groups was the only series satisfying common trend requirements (see Supporting Information), we performed the analysis on the difference for this group only. This analysis detected a positive increase in fatal RTAs after MUP introduction (Table 2). The MUP estimates based on the prediction of the pre-MUP period detected a statistically significant effect in the fatal RTAs series (3.5%, CI = 2.6%–4.3%) and statistically non-significant in night-time RTAs (2.9%, CI = −2.3% to 8%). Overall, models on the RTAs per 100 000 inhabitants have the same direction of association.

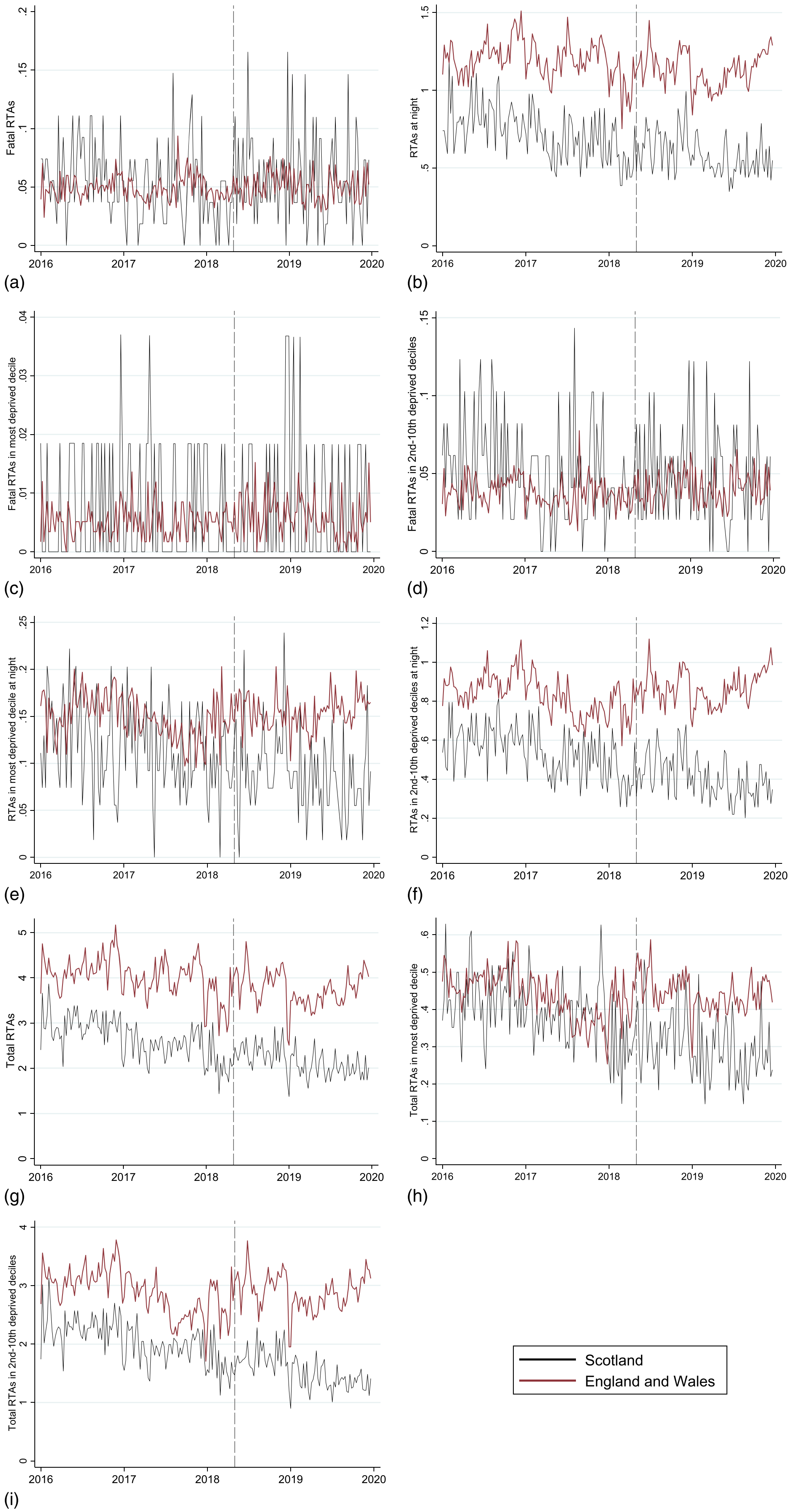
By reproducing a similar analysis to [15] on the total number of RTAs with 8 months post-intervention follow-up and using weekly time units, Scotland was associated with a significant relative increase in total RTAs of ∼10%, with a corresponding increase of 5.8% in E&W. When we used daily time units, the series had parallel trends only if we started and ended the analysis in 2018 (like in Vandoros *et al.*) [15], but

TABLE 1 Average weekly number of RTAs in Scotland and England and Wales before and after MUP implementation.

	Scotland			England and Wales		
	Pre-MUP, 1 January 2016–30 April 2018	Post MUP, 1 May 2018–31 December 2019	Year on year difference	Pre-MUP, 1 January 2016–30 April 2018	Post MUP, 1 May 2018–31 December 2019	Year on year difference
Total RTAs	143.85 (23.9)	117.28 (16.7)	−26.5 (−18%)	2365.26 (247.7)	2227.2 (223.7)	−138.07 (−6%)
Fatal	2.86 (1.7)	3.19 (2.1)	0.33 (+11%)	28.84 (6.0)	29.76 (7.1)	0.91 (3%)
Night-time	39.13 (9.0)	31.83 (6.9)	−7.30 (−19%)	400.45 (71.6)	674.12 (66.3)	−26.33 (−4%)
Most deprived 10th group[a]	21.33 (4.9)	16.36 (4.7)	−4.98 (−23%)	256.88 (36.8)	262.25 (28.4)	5.37 (+2%)
2nd–10th deprived group[a]	110.91 (19.4)	83.68 (16.3)	−27.23 (−25%)	1694.53 (221.6)	1717.72 (189.9)	23.19 (+1%)
Night-time most deprived 10th group[b]	6.34 (2.5)	4.89 (2.3)	1.45 (−23%)	87.26 (13.9)	91.66 (10.8)	4.4 (+5%)
Night-time 2nd–10th deprived group[b]	29.29 (6.8)	22.10 (6.1)	7.19 (−25%)	488.27 (59.4)	514.24 (52.8)	25.97 (+5%)

Note: Values in parentheses are standard deviations (1st–2nd and 4th–5th columns) or percentage variations (3rd–6th columns).
Abbreviations: MUP, minimum unit pricing; RTAs, road traffic accidents.
[a]Missing data for Scotland were 1634 (13 per week on average) pre-intervention and 1006 (12 per week on average) post intervention for Scotland. In England and Wales missing data were 39 388 (326 per week on average) pre-intervention and 14 064 post intervention (161 per week on average).
[b]Missing data for Scotland were 467 (4 per week on average) pre-intervention and 277 (2 per week on average) post intervention for Scotland. In England and Wales missing data were 15 122 (125 per week on average) pre-intervention and post intervention 5809 (68 per week on average).

FIGURE 1 Weekly road traffic accidents (RTAs) per 100 000 residents in Scotland (black) and England and Wales (maroon) between 1 January 2016 and 31 December 2019. Dash vertical line represents date of minimum unit pricing implementation. Comparison across different outcomes: (a) fatal RTAs, (b) night-time RTAs, (c) fatal RTAs in most socio-economically deprived group (lowest 10th of SIMD/IMD), (d) fatal RTAs in all other socio-economically deprived groups, (e) night-time RTAs in most deprived group, (f) night-time RTAs in all other deprived groups, (g) total RTAs, (h) total RTAs in most deprived group and (i) total RTAs in all other deprived groups.



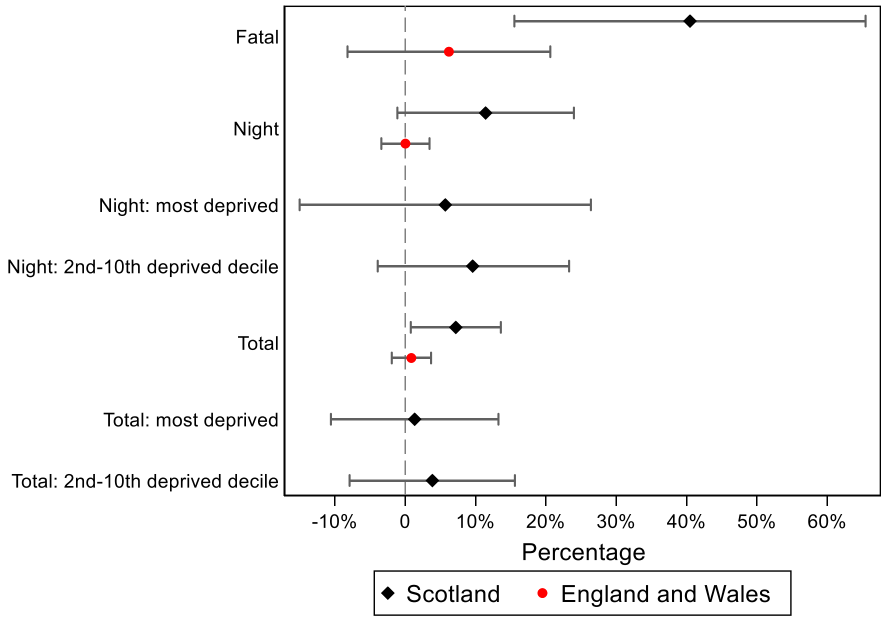


FIGURE 2 Change (%) in different categories of road traffic accidents (RTAs) associated with minimum unit pricing (MUP) implementation. Inferential results from uncontrolled series. Models regarding socio-economic deprivation groups are shown only for Scotland. England and Wales had different number of missing data per week regarding deprivation pre- and post-MUP, likely to generate biased estimates.

Bars represent 95% confidence intervals, with point estimates represented by symbols. Positive estimates represent an increase in RTAs after MUP policy implementation.

not if we started in 2016. By restricting the dataset to 2018 only and analysing the series of the difference between the groups, MUP coefficient was not statistically significant (see Supporting Information).

Sensitivity analysis

Concerning fatal RTAs, IHS transformation with small sample correction produced models with associated increases of 45% for the period after MUP implementation for Scotland and E&W, respectively. In line with these results, the negative binomial model for Scotland provided a significant increase of 53% and 9.5% in the incident rate ratio for Scotland and E&W, respectively. Although all these alternative models produced different point estimates, they did not change the positive association of fatal RTAs with MUP introduction. The only falsification test providing a statistically significant point estimate for the policy coefficient was the one delaying the intervention by 6 months for the night-time series. All others series (including fatal) had not significant estimates.

DISCUSSION

This study found that the introduction of MUP in Scotland was associated with an increase in fatal RTAs, but with no variation in the level of night-time RTAs. Additionally, we did not find differential effects of the policy on RTAs across socio-economic deprivation groups. Overall, we found no evidence that the introduction of MUP could be associated with reductions in the RTAs most likely to be alcohol-related in Scotland for the first 20 months of its implementation. This may be in contrast with the economic theory suggesting a decrease in alcohol-related RTAs as a consequence of an increase in alcohol price (that had already led to a reduction in alcohol consumption in the population) [7].

The increase in fatal RTAs could have multiple explanations, such as some qualitative evidence that MUP led people to switch from consuming strong beers and ciders to drinking spirits and getting more intoxicated [32]. Although the pattern of the Scottish series having a low number of weekly observations may have produced high uncertainty in the estimates, the alternative models taking into account potential floor effects detected a significant positive association between MUP and fatal RTAs in line with the main analysis. Last, falsification tests detecting a null effect at both 6 and 12 months after the introduction of the policy strengthen the reliability of the positive association we found between MUP and fatal RTAs. However, the relevant difference in the magnitude of the coefficients between methods (Table 2, first row, last two columns) underline the high uncertainty of our estimates regarding this series. This could be attributable to potential floor effects in the series of the difference happening only for one of the two groups (Scotland) and not for the other. As a result, we would not recommend an interpretation of the point estimates, but of the overall (positive) association consistent across all the models.

Overall, we found no difference in night-time RTAs and a transient increase in fatal RTAs. One explanation for the lack of decrease is that the floor price of £0.50 could have been too low to generate such an effect with visible repercussions on drink-driving/pedestrian road safety and then in RTAs. Moreover, the general reduction in alcohol consumption because of MUP [33] may not have sufficiently reduced consumption in those most likely to be drink-drive offenders. Further, MUP did not affect all alcohol on sale, such that prices in pubs and restaurants that typically were

TABLE 2 The effect of MUP on fatal and night-time RTAs—uncontrolled ITS, ITS on the difference between the series and difference between predicted and actual values.

		Uncontrolled ITS		ITS on the difference (Scotland–E&W)		Difference with the predicted values	
		Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI
Scotland							
Fatal RTAs	Log (RTAs)	0.405	(0.183–0.627)	0.338	(0.041–0.630)	0.035	(0.027–0.043)
	Log (RTAs per 100 000 residents)	0.021	(0.008–0.034)	0.025	(0.008–0.043)	0.021	(0.012–0.030)
Night-time RTAs	Log (RTAs)	0.114	(−0.011 to 0.240)	-	-	0.029	(−0.023 to 0.080)
	Log (RTAs per 100 000 residents)	0.115	(−0.002 to 0.232)	-	-	0.036	(−0.033 to 0.106)
E&W							
Fatal RTAs	Log (RTAs)	0.074	(−0.082 to 0.206)	-	-	-	-
	Log (RTAs per 100 000 residents)	0.003	(−0.032 to 0.009)	-	-	-	-
Night-time RTAs	Log (RTAs)	0.000	(−0.034 to 0.035)	-	-	-	-
	Log (RTAs per 100 000 residents)	0.009	(−0.40 to 0.570)	-	-	-	-

Abbreviations: E&W, England and Wales; MUP, minimum unit pricing; ITS, interrupted time series; RTAs, road traffic accidents.

already above the floor price of £0.50 did not increase. Another explanation could be that even if RTAs affected by alcohol drinking were theoretically affected by MUP, the period to assess such changes in our analyses (20 months) was too short to allow certain drinking behaviours to change.

As recommended [19], we selected the comparator group based on a priori judgment to avoid potential additional bias to the study. We chose E&W based on theoretical considerations (intervention and comparator are both part of the United Kingdom and likely to have similar underlying temporal trends in RTAs) and other MUP evaluations using the same comparator [8, 15, 18, 33]. However, E&W satisfied the parallel trend assumption only for the fatal RTA outcome. Even for this group, several challenges including the differences concerning RTAs, such as casualty rates [34] between the two groups, the aforementioned concerns in the fatal RTAs data and the wide difference in point estimates between alternative controlled estimates (Table 2) suggest cautious interpretation of our results is required and we do not claim a causal effect. Indeed, when there is no suitable comparator, the interpretation of results should be cautious and limitations should be acknowledged [35] to avoid misleading causal attributions [36]. In contrast, the additional analyses we did on predictions generating a counterfactual can have causal connotations. However, the low goodness of fit (see Supporting Information) of the training pre-intervention model for the fatal series (because of low sample size and potential floor effects) suggests cautious interpretations for these analyses as well. At the same time, there are minor concerns on causal connotations for the night-time outcome.

Additionally, national statistics for Great Britain [20] show a sharper decrease in drink-driving accidents than in all other RTAs, suggesting that some environmental or behavioural factors in the population may act as confounders in both intervention and control areas by generating this RTAs reduction over time. In this scenario, our analysis already identifying an overall decreasing trend for night-time and total RTAs, but an increasing coefficient of MUP, may indicate a variation of this pattern, such as a deceleration of a decrease in RTAs.

Previous evidence

Regarding our main outcomes, Francesconi *et al*. [18] inquiring about fatal RTAs in Scotland after MUP found a statistically non-significant increase of 8% in this outcome. The study used both difference-in-difference and synthetic control methods using E&W and a selection of E&W local authorities as comparators, respectively. The authors preferred synthetic analysis as a few pre-intervention outcomes with potential explanatory power were different between the two groups; this could also explain our challenges in using E&W as a comparator.

On the total number of RTAs, our results contrast with those already published [15]. In the previous evaluation of MUP in Scotland on RTAs [15], the authors, using a difference-in-difference design, found that total RTAs increased in 2018 and by showing that Scotland had lower growth than E&W, associated this relative decrease to

MUP. Using a longer time frame (adding 2 years before intervention and one after), weekly data, a different study design and accounting for underlying trends, we found an increase in total RTAs from our inferential models after MUP. When we ran the analysis only in 2018 with daily data to emulate the previous evaluation, we found evidence of parallel trends, but not a significant MUP effect (still, our results are likely to differ because of different covariate adjustments). However, we did not find evidence of parallel trends, when we extended the pre-intervention period using daily data from 2016. This suggested that the pre-intervention period was not long enough to establish a robust parallel trend assumption and that the two constituencies had some essential differences [34]. The consequences of this are that in Stockwell *et al*. [16] the results were that the effect of MUP implementation may have generated 1.52 to 1.90 fewer daily collisions in Scotland, which, based on our weekly figures (Table 1), is a decrease of 7.4% to 9.2% (a substantial effect considering that overall MUP was associated with a 3.5% reduction in overall alcohol consumption) [33]. We believe that by analysing a longer pre- and post-intervention period and considering seasonality and autoregressive components, we have provided a more robust analysis, especially for medium-term effects. Other studies [17], focusing on emergency department visits rather than on RTAs, showed that raising minimum alcohol pricing in Saskatchewan, Canada was associated with a lagged decrease in motor vehicle-collision-related ED visits only for women over 25 years old. The authors reported that their main hypothesis of a reduction in vehicle-collision-related emergency department visits because of a raise in minimum alcohol pricing was not substantiated by their findings.

CONCLUSION

After 20 months of implementation, there is no evidence of a decrease in fatal, night-time and total volume of RTAs as a consequence of MUP implementation in Scotland. Further, there is no evidence of differential effects by level of socio-economic deprivation.

AUTHOR CONTRIBUTIONS

Francesco Manca: Conceptualization (equal); data curation (equal); formal analysis (lead); methodology (equal); writing—original draft (lead); writing—review and editing (equal). **Rakshita Parab:** Formal analysis (equal); writing—original draft (supporting). **Daniel Mackay:** Supervision (supporting); validation (equal). **Niamh Fitzgerald:** Supervision (supporting); writing—review and editing (supporting). **Jim Lewsey:** Conceptualization (equal); superivison (lead); writing—review and editing (equal).

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DECLARATION OF INTERESTS

None to declare.

DATA AVAILABILITY STATEMENT

Data are publicly available and were obtained on request from the Road safety statistics division at the UK Department for Transport.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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