Received: 23 April 2021 | Accepted: 21 October 2022

DOI: 10.1111/add.16084

RESEARCH REPORT

ADDICTION SSA

Effectiveness of subnational implementation of minimum unit price for alcohol: policy appraisal modelling for local authorities in England

Alan Brennan[1] | Colin Angus[1] | Robert Pryce[1] | Penny Buykx[1,2] | Madeleine Henney[1] | Duncan Gillespie[1] | John Holmes[1] | Petra S. Meier[1,3]

[1]School of Health and Related Research, University of Sheffield, Sheffield, UK

[2]School of Humanities and Social Science, University of Newcastle, Callaghan, NSW, Australia

[3]MRC/CSO Social and Public Health Sciences Unit, University of Glasgow, Glasgow, UK

Correspondence
Professor Alan Brennan, School of Health and Related Research University of Sheffield, Regent Court, 30 Regent Street, Sheffield S1 4DA, UK.
Email: a.brennan@sheffield.ac.uk

Funding information
Main funding source: NIHR Public Health Research Board - project number 15/129/19.; Additional small consultancy grant from: PHE Yorkshire & Humber - small consultancy grant 1083.

Abstract

Aims: Evidence exists on the potential impact of national level minimum unit price (MUP) policies for alcohol. This study investigated the potential effectiveness of implementing MUP at regional and local levels compared with national implementation.

Design: Evidence synthesis and computer modelling using the Sheffield Alcohol Policy Model (Local Authority version 4.0; SAPMLA).

Setting: Results are produced for 23 Upper Tier Local Authorities (UTLAs) in North West England, 12 UTLAs in North East England, 15 UTLAs in Yorkshire and Humber, the nine English Government Office regions and England as a whole.

Cases: Health Survey for England (HSE) data 2011–13 (n = 24 685).

Measurements: Alcohol consumption, consumer spending, retailers' revenues, hospitalizations, National Health Service costs, crimes and alcohol-attributable deaths and health inequalities.

Findings: Implementing a local £0.50 MUP for alcohol in northern English regions is estimated to result in larger percentage reductions in harms than the national average. The reductions for England, North West, North East and Yorkshire and Humber regions, respectively, in annual alcohol-attributable deaths are 1024 (−10.4%), 205 (−11.4%), 121 (−17.4%) and 159 (−16.9%); for hospitalizations are 29 943 (−4.6%), 5956 (−5.5%), 3255 (−7.9%) and 4610 (−6.9%); and for crimes are 54 229 (−2.4%), 8528 (−2.5%), 4380 (−3.5%) and 8220 (−3.2%). Results vary among local authorities; for example, annual alcohol-attributable deaths estimated to change by between −8.0 and −24.8% throughout the 50 UTLAs examined.

Conclusions: A minimum unit price local policy for alcohol is likely to be more effective in those regions, such as the three northern regions of England, which have higher levels of alcohol consumption and higher rates of alcohol harm than for the national average. In such regions, the minimum unit price policy would achieve larger reductions in alcohol

Submission manager on behalf of author team: Julie Johnson (julie.johnson@sheffield.ac.uk)

consumption, alcohol-attributable mortality, hospitalization rates, NHS costs, crime rates and health inequalities.

KEYWORDS
Alcohol policy, local, modelling, national, policy appraisal, pricing, subnational

INTRODUCTION

Alcohol causes considerable harms [1]. In England, it is the fifth largest cause of lost life-years [2], affecting National Health Service (NHS) resources [3], crime [3], families and children needing social services and care [4] and employer work outcomes [3]. Health harms per population vary geographically within the country [2, 5] and by age, gender and deprivation [measured by the Index of Multiple Deprivation (IMD)] [5].

Minimum unit pricing (MUP) for a unit of alcohol (10 ml pure ethanol) was proposed UK-wide in 2012 [6]. Substantial debate followed and, 6 years later, a MUP of £0.50 per unit (approximately €0.885/12 g or US$1.132/14.5 g standard drink at a 2022 exchange rate) was implemented from May 2018 by the devolved national government of Scotland [7]. A MUP of £0.50 per unit was also implemented from April 2020 by the devolved national government of Wales [8]. England does not have devolved government, and to date the UK government has decided not to implement MUP in England.

Because of this lack of national level implementation in England, stakeholders in some English local authorities want to explore subnational implementation of MUP—a policy they term 'MUPLocal'. The main focus of local decision-making in England is the Upper Tier Local Authority (UTLA)—there are 152 of these and they are grouped into nine Government Office regions. A group of UTLAs in the North West region of England commissioned a law firm to provide UK legal advice on possible routes for achieving MUPLocal implementation. The resulting advice [9], suggested submitting a request to central government for local powers under the UK 'Sustainable Communities Act', and indicated that this would require local evidence on the current harms caused by alcohol [2, 5] and on the potential impact of MUPLocal. This requirement motivated our research study.

Previous evidence on the potential impact of national MUP implementation was provided to governments using the Sheffield Alcohol Policy Model (SAPM). This model estimates country-level impact upon alcohol-attributable deaths and hospitalizations for more than 40 ICD-10-defined conditions, on NHS costs, alcohol-attributable crimes and work absence [8, 10–13]. It also examines population subgroups by age, sex, socio-economic status and moderate-, increasing- and high-risk drinkers. SAPM helped to decide the MUP threshold (£0.50 per unit in Scotland) and informed legal cases before implementation [14].

Our study was designed to provide evidence on the potential impact of subnational implementation of £0.50 per unit MUP in UTLAs in the North of England (also testing £0.30, £0.40, £0.60 and £0.70 thresholds). The study gathers evidence on local consumption, purchasing, prices paid and harms, creating the 'Sheffield Alcohol Policy Model for Local Authorities' (SAPMLA). The National Institute for Health Research commissioned the research to focus on the UTLAs in the North of England, where several stakeholders had expressed strong policy support and were keen to collaborate on the research programme. This study reports detailed results for 50 UTLAs in the three northern Government Office regions—Yorkshire and Humber, North West and North East—as well as comparison throughout the nine Government Office regions and with the whole of England. Effects are estimated on alcohol consumption, consumer spending, retailers' revenues, hospitalizations, NHS costs, crimes and, most importantly, alcohol-attributable deaths and health inequalities in deaths categorized by the IMD.

This study has international relevance, because there are ongoing implementations and debates with respect to MUP-type interventions in many countries. A related policy, minimum alcohol pricing, has been implemented in British Columbia in Canada, demonstrating effects on reduced harms [15]. Raising minimum alcohol prices in Saskatchewan, Canada has impacted consumption and crime [16, 17]. Debates on the potential subnational impact of MUP are ongoing in Australian states/territories [18–20] and Canadian provinces such as Quebec [21], and are relevant globally.

Patient and public involvement

We involved a wide stakeholder group throughout the development, conduct and delivery of this project. The idea for the project arose directly from conversations with Directors of Public Health and public health advocacy organizations in the North West region of England. The research was designed to be directly relevant to their evidence needs: specifically, the need for local level evidence regarding alcohol consumption, related harms and the estimated effects of MUP. Engagement continued throughout the project and was extended to include public health stakeholders in the North East of England. During the project, quarterly meetings were held with a core group of stakeholders, the 'Tackling Cheap Alcohol Group', which included representatives from local authorities and other agencies across the North West with roles in public health, wellbeing, licensing, commissioning and service delivery. This stakeholder involvement directly influenced the project by making us reconsider (a) the outcomes to be modelled; as a consequence of stakeholder input we added crime, and (b) the nature and design of project outputs—input from stakeholders encouraged us to develop locally relevant dissemination resources that were more interactive and of a higher quality design than originally planned. These 'evidence assets' were designed to support the communication needs of public health stakeholders. Draft versions

were tested with the TCAG before being shared more widely. Two large dissemination events were held in the North West and North East of England (each attended by 80–100 stakeholders) to present the final draft findings and seek further feedback on results presentation and issues of importance in potential future implementation. The study was approved by the University of Sheffield School of Health and Related Research (ScHARR) Ethics Committee; submission was made on 8 May 2017, ethics application number 014245.

METHODS

The key components of the methods are as follows. The first step is to estimate alcohol consumption patterns for each local authority by taking individual data from a national survey and adjusting the sample weight of respondents to incorporate evidence from statistical models of drinking related to both individual variables (e.g. people of the same age/sex drink similarly) and local geographical-level variables (e.g. alcohol-attributable hospital admission rates, i.e. people in the North of England drink more than people in the South even after adjusting for age/sex, etc.). Secondly, we develop local estimates of how much of each type of alcohol is purchased at each price point, using national survey adjusted for local market research data. The modelling then compares keeping prices exactly as they are currently, with implementing a minimum price whereby prices below £0.50 per unit are increased to exactly £0.50 per unit. The model estimates the change in consumption that would occur when prices rise using previously published evidence on price elasticities for 10 beverage categories. Then, having calculated the estimated consumption change, the model uses local evidence on rates of hospitalization and mortality for 45 different diseases followed by estimates of reductions in these harms, given reduced consumption using published risk relationships between the amount of alcohol consumed and the risk of each disease. A similar analysis is undertaken using local data on recorded crime and previously published estimates of the relationship between level of alcohol consumption and crime. More detail is given below and in the on-line supporting information and the previously published National Institute for Health Research project report [22]. The pre-registered protocol for the project is available at https://fundingawards.nihr.ac.uk/award/15/129/19.

Estimating local consumption of alcohol

We generate simulated local Health Surveys for each UTLA [23]. Health Survey for England (HSE) data 2011–13 (n = 24 685) contain mean weekly alcohol consumption, age, sex, ethnicity and a sample population weight for each respondent. We obtained each respondent's UTLA and appended two local authority-level variables—alcohol-attributable hospital admissions rate 2013/14 and alcohol-related mortality rate 2013. This data set was used to generate two statistical models: (a) a logistic regression estimating the probability of abstaining and (b) a multinomial regression estimating the probability of drinking in six categories of mean weekly consumption. These regression results enable the calculation of a new sample weight for each individual if they were in a particular UTLA—the sample weight is the number of people in that geographical region that each individual in the sample data set represents. For example, one individual with a national sample weight of 6000 might be anticipated to have a Newcastle UTLA weight of approximately 30 (because Newcastle is approximately 0.5% of the England population), but after adjustment for covariates could actually have a sample weight of, for instance, 43. Results showed that the probability of drinking at a particular level was statistically related to the individual's age group (18–24, 25–34, 35–54, 55+ years), sex, index of multiple deprivation quintile (IMDQ—relative deprivation accounting for small area data on local income, employment, education/training, health/disability, crime, housing/services and environment), ethnicity and UTLA-level alcohol-attributable admission rate, UTLA alcohol-related mortality rate and Government Office region.

At the end of these statistical processes we are left with a respondent-level data set, with each respondent having their own reported level of mean weekly consumption and their own weight (the number of people the survey respondent represents within the geographical region of interest).

Finally, we allocate respondents to one of three defined 'drinker types'; (1) 'moderate' drinkers within current UK guidelines of up to 14 units/week, (2) 'increasing-risk' drinkers who exceed 14 units, but not 50/35 units weekly for men/women, respectively, and (3) 'higher-risk' drinkers consuming 50+/35+ units weekly for men/women. Detailed methods, results and validity testing for 151 UTLAs are shown in Supporting information, Technical Appendix 1.1.

Estimating price distributions and purchasing preferences for each LA by beverage category and population subgroup

Prices paid for alcohol are estimated for 10 beverage categories, splitting beer, cider, wine, spirits and ready-to-drinks (RTDs) by off-trade (shops) and on-trade (bars), using the Living Costs and Food Survey (LCFS) 2-week purchasing diary (n = 10 065 having 57 581 alcohol transactions from 2012 to 2014). Our statistical model estimates the probability of buying each beverage category in a particular price band (5 p/unit to 250 p/unit: see Supporting information, Technical Appendix 1.2.4.1). Predictors include the individual's age group, sex, equivalized income quintile and drinker type and UTLA variables—alcohol outlet density, alcohol-attributable hospital admissions rate 2013/14 and average house price for 2017 (Supporting information, Technical Appendix 1.2). LCFS slightly underestimates the purchasing of cheap alcohol, so we recalibrated prices to match CGA and Nielsen market research data on total Government Office region sales volume by beverage category using 24 off-trade and 38 on-trade price bands (Supporting information, Technical Appendix 1.2.6).

For each person in the simulated UTLA Health Survey, we use LCFS to partition consumption into the 10 beverage categories for

each population subgroup. Some population subgroups have small numbers (< 50) of LCFS transactions and we combine subgroups where necessary, following a hierarchical process starting with merging according to age, then sex, then drinker type, and then Government Office region (Supporting information, Technical Appendices 1.2.3 and 1.2.8).

Mortality, hospitalization and crime data

National administrative data on mortality, hospitalizations, and crimes were analysed by UTLA. Forty-five separate ICD-10-defined conditions (e.g. oesophageal cancer, falls) were examined. Mortality rates per 1000 population aggregate data were obtained from the Office for National Statistics (ONS) for each condition for each UTLA by four age groups, sex and IMDQ using 5 years' pooled data from 2012 to 2016. Hospital episode statistics (HES) individual-level data for 2012/13 to 2016/17 in England were analysed to count numbers of person-specific admissions (whereby the same person admitted twice in a year only counts once) using the 'broad measure' approach to count hospitalizations for alcohol-related conditions for UTLA residents, recommended by Public Health England (PHE) as the most appropriate measure 'of the total burden that alcohol has on community and health services'—see Supporting information, Technical Appendix 1.3.13 [24]. Police-recorded aggregate crime statistics were obtained from ONS by UTLA (April 2016–March 2017) in 14 offence categories [25]. We separated total offence counts into four age groups (18–24, 25–34, 35–54, 55+ years) and sex using information from previous publications [26]. Not all crime is recorded, and these figures were uplifted for under-recording using Home Office 'multipliers' [27] (Supporting information, Technical Appendix 1.3.18).

Risks of harm

Modelling the risks of harm caused by alcohol used previously published methods [8, 10–13]. Detailed data sources, methods and risk curves for SAPM version 4.0 are provided elsewhere [28]. Briefly, relative risk of mortality and of hospitalization for chronic conditions that are partially attributable to alcohol are modelled as risk function curves related to mean weekly alcohol consumption from the international literature. This process involves the estimation of the number of hospitalizations and number of deaths that are alcohol-attributable (see Supporting information, Technical Appendices 1.3.6 and 1.3.9), so that all model results are reporting alcohol-attributable admissions and deaths. Acute conditions (i.e. affected by intoxication) use risk functions, which probabilistically relate mean weekly consumption to occasion-level patterns of drinking and hence risk (see Supporting information, Technical Appendix 1.3.10) [29–31]. For conditions wholly attributable to alcohol, we calibrate the slope of a linear risk curve for each age, sex and IMDQ subgroup to the observed numbers of cases (see Supporting information, Technical Appendix 1.3.8) [32]. For crime risk, previously used alcohol-attributable fractions [32] derived from the Offending and Justice Survey were used to calculate the slope of a UTLA-specific linear risk function, which estimated the probability of committing each of 14 different offence categories for males/females as a function of maximum HSE-recorded daily consumption in the previous 7 days.

Adaptations to create the SAPMLA

The national SAPM model estimates changes in consumption after a price policy and then changes in harm [8, 10, 13, 26, 33]. Data on alcohol consumption and prices paid are combined to estimate baseline purchasing patterns for each age, sex, IMDQ and drinker group. To model MUP implementation we compute a new price distribution by subgroup; for example, all cheaper alcohol products assumed to increase price to exactly £0.50/unit. These population subgroup price increases are then combined with price elasticities evidence to estimate changes in consumption. The base case price elasticities use a pseudo-panel analysis of UK LCFS transaction data over 9 years to estimate the percentage change in purchasing for each of the 10 beverage categories, given a 1% price increase [34]. This accounts for 'own-price elasticities', i.e. change in off-trade beer purchasing when the off-trade beer price changes. It also accounts for 'cross-price elasticities', i.e. change in purchasing for each of the other nine beverage categories when the off-trade beer price changes. The changes in population subgroup consumption are then combined with the harm risk curves to estimate changes in mortality, hospitalizations and crimes after MUPLocal implementation. Outcomes are modelled over a 20-year period post-policy [35]. Financial impact was estimated on NHS budgets [32] and on the costs of crime using Home Office estimates [27]. Costs were inflated to 2017 values and future costs discounted at 3.5%, in line with national guidance [36].

In summary, five important adaptations of the previously published national SAPM work [8, 10–13] have been undertaken to generate SAPMLA version 4.0. First, we now include full stratification of the data inputs on consumption, prices and harms by IMD quintile to enable examination of model outputs with respect to health inequalities. Secondly, we revised the list of included health conditions based on recent systematic reviews of diseases causally related to alcohol (see pp. 3–5 of [28]). Thirdly, for alcohol-related injuries, updated risk curves have been taken from a major international Emergency Department study [37], rather than our earlier method assuming linear risk functions and calibrating a slope parameter. Fourthly, the new method described above has been used to estimate local authority alcohol consumption and produce the simulated UTLA Health Survey (Supporting information, Technical Appendix 1.1 and [23]). Fifthly, national SAPM used transaction level data to analyse subgroups' price distributions, but this is unavailable for UTLAs, so we developed statistical modelling of prices paid by subgroup (Supporting information, Technical Appendix 1.2.6). These local adaptations are now available for each of the 151 UTLAs in England.

TABLE 1 Estimated baseline alcohol consumption, consumer expenditure and alcohol-attributable harms for six example local authorities, three regions and England.

	Local authority		Region	Local authority		Region	Local authority		Region	National
	York	Wakefield	Yorkshire and Humber	Lancashire	Liverpool	North West	Newcastle	Middlesbrough	North East	England
Adult 18+ population	163 270	256 539	4 129 465	919 325	376 291	5 500 855	228 107	105 634	2 050 703	41 641 894
Alcohol consumption (units)										
Mean weekly consumption per drinker	14.0	13.9	13.7	14.2	14.4	14.4	16.9	17.3	16.4	13.3
Mean weekly consumption: moderate	4.5	4.3	4.2	4.4	4.1	4.3	4.4	4.2	4.4	4.3
Mean weekly consumption: increasing-risk	25.3	25.0	25.3	24.8	24.7	24.8	25.7	25.6	25.2	24.7
Mean weekly consumption: high-risk	69.2	77.6	74.9	75.7	82.0	77.5	77.1	79.7	79.0	75.6
Mean weekly consumption of alcohol < 50 p per unit	4.5	5.7	5.3	5.2	5.9	5.4	6.7	7.5	6.7	4.6
Mean weekly consumption of alcohol < 50 p per unit: moderate	0.9	1.1	1.0	1.0	1.1	1.0	1.0	1.1	1.0	0.9
Mean weekly consumption of alcohol < 50 p per unit: increasing-risk	7.5	9.3	9.0	8.4	9.1	8.5	9.2	10.1	9.4	8.2
Mean weekly consumption of alcohol < 50 p per unit: high-risk	31.9	42.3	39.9	37.2	43.2	38.5	39.1	42.6	41.1	35.7
% Abstain	14.1%	17.7%	19.5%	16.4%	20.4%	17.9%	19.4%	20.7%	15.7%	17.1%
% Moderate (under 14 units per week)	57.0%	56.6%	55.2%	56.3%	55.4%	55.5%	50.2%	49.8%	53.8%	57.4%
% Increasing-risk (14–35 units females, 14–50 units males)	24.0%	20.6%	20.7%	22.1%	18.7%	21.2%	23.5%	22.0%	23.4%	21.0%
% High-risk (35 + units females, 50+ units males)	4.9%	5.0%	4.6%	5.2%	5.5%	5.3%	7.0%	7.5%	7.1%	4.5%
Alcohol expenditure per drinker per year										
Mean annual expenditure on alcohol per adult (£)	£551	£473	£493	£507	£471	£500	£585	£556	£570	£483
Mean annual expenditure: moderate	£230	£193	£210	£209	£191	£203	£217	£197	£208	£209
Mean annual expenditure: increasing-risk	£1137	£1010	£1045	£1027	£989	£1021	£1077	£1017	£1028	£1019
Mean annual expenditure: high-risk	£2370	£2432	£2603	£2461	£2572	£2504	£2589	£2581	£2616	£2529
Mean annual expenditure on alcohol per adult (£) < 50 p per unit	£79	£94	£86	£89	£95	£90	£108	£118	£113	£79
Mean expenditure per adult (£) < 50 p per unit: moderate	£19	£23	£22	£21	£22	£21	£20	£22	£22	£19
Mean expenditure per adult (£) < 50 p per unit: increasing-risk	£157	£189	£185	£175	£188	£177	£187	£202	£191	£170
Mean expenditure per adult (£) < 50 p per unit: high-risk	£646	£831	£794	£756	£863	£777	£779	£836	£817	£730

(Continues)

TABLE 1 (Continued)

	Local authority		Region	Local authority		Region	Local authority		Region	National
	York	Wakefield	Yorkshire and Humber	Lancashire	Liverpool	North West	Newcastle	Middlesbrough	North East	England
Alcohol-related crime harms										
Alcohol-attributable crimes per year	9372	16 709	255 685	50 507	27 196	341 202	15 684	9988	125 625	2 299 140
Alcohol-attributable crimes per 100 000 adult population (18+)	5740.4	6513.4	6191.7	5494.0	7227.4	6202.7	6875.7	9455.3	6125.9	5521.2
Alcohol-related health harms: admissions										
Alcohol-attributable admissions per year	2189	4579	66 693	16 779	7881	108 403	4266	2600	41 159	650 879
Alcohol-attributable admissions per 100 000 adult population (18+)	1340.7	1784.8	1615.1	1825.2	2094.3	1970.7	1870.3	2461.1	2007.1	1563.0
% Difference from national average admissions rate	−14%	14%	3%	17%	34%	26%	20%	57%	28%	0%
Alcohol-related health harms: NHS costs (£millions)										
Alcohol-attributable NHS cost per year (£million)	£10	£21	£293	£75	£38	£505	£20	£12	£186	£2855
NHS cost per year (£million) per 100 000 adults population (18+)	£6.0	£8.2	£7.1	£8.2	£10.2	£9.2	£8.6	£11.5	£9.0	£6.9
Alcohol-related health harms: deaths										
Alcohol-related deaths per year	28	71	939	254	146	1791	74	40	697	9862
Alcohol-related mortality per 100 000 adult population (18+)	17.2	27.7	22.7	27.7	38.7	32.6	32.3	38.1	34.0	23.7
% Difference from national average mortality rate	−27%	17%	−4%	17%	64%	37%	36%	61%	43%	0%

NHS, National Health Service.

Analysis plan

The analysis base case examines implementing a MUPLocal of £0.50/unit versus no change in prices. We test four further thresholds—£0.30, £0.40, £0.60 and £0.70.

We estimate effects in 23 UTLAs in the North West region, 12 in the North East, 15 in Yorkshire and Humber and each Government Office region (and by summing nine Government Office regions) for England. We compare changes in alcohol-attributable deaths, hospitalizations and crime, as well as savings in NHS costs, changes in alcohol purchasing and consumption and change in revenue to off- and on-trade retailers. Harm reduction outputs are stratified by moderate-, increasing-risk and high-risk drinker group and IMDQ. Reductions in health inequalities are estimated using the Slope Index of Inequality (SII) for alcohol-attributable mortality [38].

RESULTS

Table 1 shows that estimated current mean weekly alcohol consumption is higher in in these UTLAs and regions than the national average; the North East is highest, with both Middlesbrough and Newcastle higher than the regional average. Indeed, all 50 northern UTLAs have higher estimated mean weekly consumption than the national average (Supporting information, Appendix Table A1). The proportions drinking above the Chief Medical Officer's 14 units/week guideline are also higher. The proportions drinking at high-risk levels are 4.6, 5.3 and 7.1% for Yorkshire and Humber, North West and North East, respectively (England = 4.5%) and specific UTLAs are even higher; for example, Newcastle 7.0% and Middlesbrough 7.5%. Most importantly, concerning MUP policy, consumption of alcohol currently sold below £0.50/unit is much greater, particularly for high-risk drinkers. In the North West, 55.5% of people are moderate drinkers, buying on average 1.0 units/week below £0.50/unit and spending £21 per year on cheap alcohol. In contrast, 5.3% of people are high-risk drinkers, purchasing on average 38.5 units below £0.50/unit (equivalent to 1.2 75 cl bottles of 40% ABV vodka per week); spending is £777 per year on cheap alcohol. These figures vary by local authority (e.g. UTLAs of Liverpool, Wakefield and Middlesbrough have even greater estimated consumption of cheap alcohol by high-risk drinkers) and the vast majority of the 50 UTLAs in northern regions show higher levels of exposure to cheap alcohol.

The estimated current harms caused by alcohol are also greater in these northern UTLAs and regions (Table 1). Current alcohol-attributable admissions per 100 000 adults are 1615.1, 1970.7 and 2007.1 for Yorkshire and Humber, North West and North East, respectively (+3, +26 and +28% higher than nationally) and the highest of the UTLAs shown is Middlesbrough (2461.1, +57%). This represents approximately 216 000 hospital admissions and NHS costs annually totalling £0.98 billion (£293 million, £505 million and £186 million for Yorkshire and Humber, North West and North East, respectively). Alcohol-related crime is also estimated to be higher than nationally, with rates per 100 000 adults of 6191.7, 6202.7 and 6125.9 for Yorkshire and Humber, North West and North East, respectively, totalling approximately 160 000 offences of criminal damage, 164 000 thefts/robberies and 405 000 violent crimes.

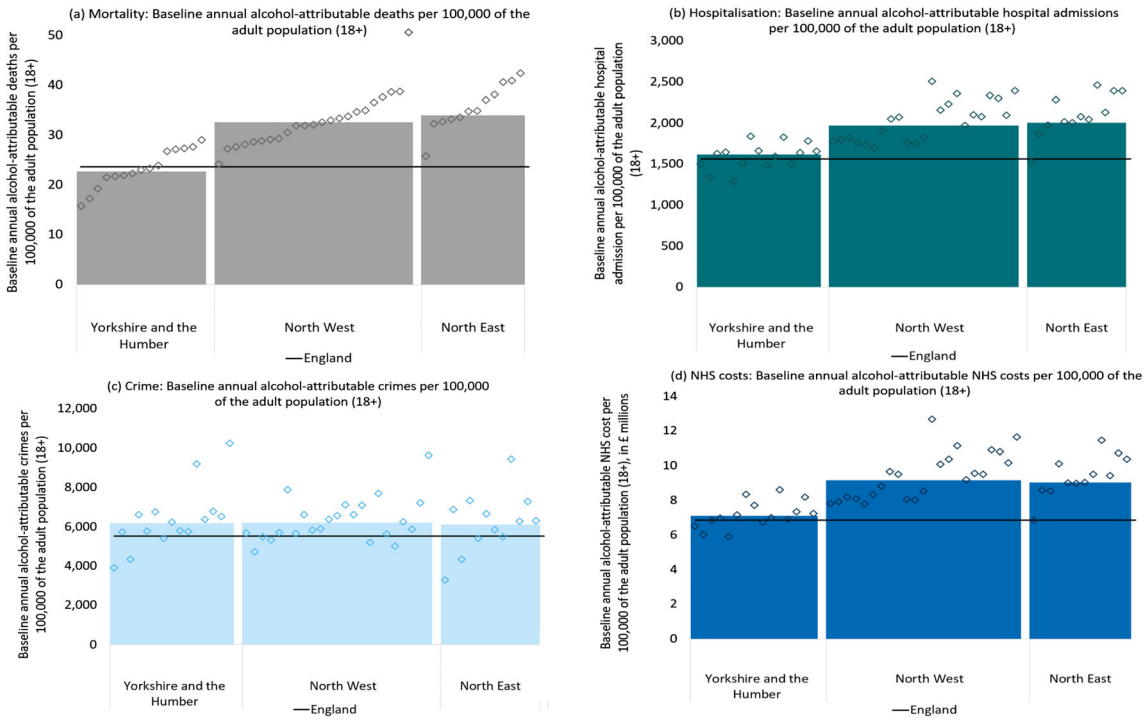


FIGURE 1 Baseline rates of alcohol-attributable harm per 100 000 adults (18+) for 50 local authorities and three regions compared to national. Upper Tier Local Authorities (UTLAs) ordered in the same sequence in each chart—based on mortality rate at baseline within each region

TABLE 2 Estimated changes in consumption, consumer expenditure and harms if a 50 p MUP were implemented locally for six example local authorities, three regions and England.

	Local authority		Region	Local authority		Region	Local authority		Region	National
	York	Wakefield	Yorkshire and Humber	Lancashire	Liverpool	North West	Newcastle	Middlesbrough	NorthEast	England
Change in mean weekly units										
All drinkers	−0.5	−0.9	−0.7	−0.5	−0.8	−0.6	−1.0	−1.3	−1.1	−0.4
Moderate drinkers	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1
Increasing-risk drinkers	−1.0	−1.6	−1.3	−1.0	−1.4	−1.1	−1.7	−2.1	−1.7	−1.0
High-risk drinkers	−5.3	−9.2	−7.6	−5.2	−7.5	−6.0	−8.1	−10.3	−8.8	−4.3
% Change in mean weekly consumption										
All drinkers	−3.9%	−6.4%	−5.3%	−3.8%	−5.2%	−4.3%	−6.0%	−7.7%	−6.6%	−3.6%
Moderate drinkers	−1.6%	−3.0%	−2.4%	−1.6%	−2.5%	−1.9%	−2.1%	−2.9%	−2.2%	−1.5%
Increasing-risk drinkers	−3.9%	−6.6%	−5.3%	−3.9%	−5.7%	−4.5%	−6.5%	−8.3%	−6.7%	−3.9%
High-risk drinkers	−7.7%	−11.8%	−10.1%	−6.9%	−9.1%	−7.7%	−10.5%	−12.9%	−11.1%	−5.7%
Change in mean £ annual expenditure										
All drinkers	£4.98	£1.83	£3.91	£8.30	£5.61	£7.11	£1.91	−£1.57	£2.07	£8.84
Moderate drinkers	£1.65	£1.42	£2.55	£2.55	£2.04	£2.34	£2.05	£1.89	£2.25	£2.61
Increasing-risk drinkers	£8.29	£1.75	£5.90	£13.44	£6.91	£10.99	£0.98	−£4.80	£1.93	£14.63
High-risk drinkers	£37.27	£8.39	£16.96	£66.66	£50.30	£57.23	£3.66	−£24.66	£0.70	£85.31
% Change in mean £ annual expenditure										
All drinkers	0.9%	0.4%	0.8%	1.6%	1.2%	1.4%	0.3%	−0.3%	0.4%	1.8%
Change in revenue to retailers (£million per annum)										
Off-trade	£1.5	£2.6	£50.5	£10.8	£4.5	£63.6	£2.8	£1.4	£26.9	£440.4
On-trade	−£0.1	−£0.4	−£7.3	−£0.6	−£0.4	−£4.7	−£0.4	−£0.3	−£4.8	−£7.9
Change in alcohol-attributable crimes										
Reduction in number of crimes per year	−220	−654	−8220	−1109	−799	−8528	−509	−436	−4380	−54 229
Reduction in crime rate per 100 000 adult population	−134.7	−255.1	−199.1	−120.6	−212.4	−155.0	−223.1	−412.9	−213.6	−130.2
% Change in crime rate	−2.3%	−3.9%	−3.2%	−2.2%	−2.9%	−2.5%	−3.2%	−4.4%	−3.5%	−2.4%
Change in alcohol-attributable hospital admissions										
Reduction in number of admissions per year	−140	−352	−4610	−777	−589	−5956	−398	−256	−3255	−29 943
Reduction in admission rate per 100 000 adult population	−85.5	−137.2	−111.6	−84.5	−156.5	−108.3	−174.5	−242.0	−158.7	−71.9
% Change in hospital admission rate	−6.4%	−7.7%	−6.9%	−4.6%	−7.5%	−5.5%	−9.3%	−9.8%	−7.9%	−4.6%

(Continues)

TABLE 2 (Continued)

	Local authority		Region	Local authority		Region	Local authority		Region	National
	York	Wakefield	Yorkshire and Humber	Lancashire	Liverpool	North West	Newcastle	Middlesbrough	NorthEast	England
Costs savings to NHS (£million)										
Reduction in annual NHS costs (£million)	−£0.3	−£0.9	−£10.7	−£1.8	−£1.0	−£12.2	−£1.1	−£0.6	−£8.4	−£71.6
Reduction in annual NHS costs (£million) per 100 000 adult population (18+)	−£0.19	−£0.35	−£0.26	−£0.20	−£0.27	−£0.22	−£0.48	−£0.59	−£0.41	−£0.17
% Change in NHS costs	−3.1%	−4.2%	−3.6%	−2.4%	−2.7%	−2.4%	−5.6%	−5.1%	−4.5%	−2.5%
Change in alcohol-attributable deaths										
Annual deaths reduction	−4	−13	−159	−28	−18	−205	−13	−8	−121	−1024
Deaths reduction over 20-year horizon	−66	−212	−2513	−460	−285	−3332	−203	−133	−1970	−16 369
Change in death rate per 100 000 adult population	−2.6	−5.1	−3.8	−3.0	−4.9	−3.7	−5.8	−7.9	−5.9	−2.5
% Change in death rate	−15.3%	−18.4%	−16.9%	−11.0%	−12.6%	−11.4%	−17.9%	−20.7%	−17.4%	−10.4%

MUP, minimum unit price; NHS, National Health Service.

Finally, for the crucial measure on deaths, alcohol-attributable mortality rates per 100 000 adults are estimated to be substantially higher in the North West and North East regions; 22.7 (−4%), 32.6 (+37%) and 34.0 (+43%) for Yorkshire and Humber, North West and North East, respectively, with a total of alcohol-attributable deaths at (939 + 1791 + 697=) 3427 per year. The highest of the UTLAs shown for the alcohol-attributable death rate is Liverpool (38.7, +64%). Figure 1 shows rates for admissions, NHS costs, crimes and mortality for the 50 UTLAs (sorted by mortality rate) and demonstrates that the North East has highest rates of harm. Forty-one of the 50 UTLAs have higher alcohol-attributable mortality rates than the national average, reflecting drinking patterns (Supporting information, Table S1). Broadly speaking, UTLAs with high mortality harms also have high estimated harms rates for crime, admissions and NHS costs, although there are some variations.

The estimated impact of local implementation of a 50 p MUP on alcohol consumption and expenditure is greater in the northern regions than nationally (Table). Changes in alcohol units consumed are −4.3, −6.5 and −5.3% (North West, North East, Yorkshire and Humber) compared to −3.6% nationally. Estimated reductions are largest among high-risk drinkers; for example, mean consumption reducing by 6 units per week (−7.7%) for the North West's 294 000 high-risk drinkers (equivalent to 3½ pints of beer/week). For most UTLAs the consumer expenditure rises, but by a smaller amount than the fall in consumption, because although people are estimated to purchase fewer units of cheap alcohol, the prices for these products have risen. For the North West's moderate drinkers, currently purchasing on average 1.0 units/week below £0.50/unit, the estimated reduction consumption is −0.1 units per week (−1.9%) and estimated average spending increased by just £2.34 per year. In contrast, high-risk drinkers are estimated to reduce consumption by 6 units and increase annual spending by approximately £57. The patterns of relative effects on moderate- versus increasing- versus high-risk drinkers are broadly consistent throughout the three regions and 50 UTLAs examined (Supporting information, Appendix Table A2).

The model also estimates effects on retailers. The main impact would be increased alcohol revenues for off-trade supermarkets and shops; for example, +£63.6 million per year (+11.7%) in the North West alongside a small estimated fall in alcohol revenues for on-trade pubs, bars and so on; for example, −£4.7 million (−0.6 or −£7.62 per outlet per week). The latter calculation assumes that previously seen patterns of 'cross-price elasticities' would occur under a MUPLocal implementation (Supporting information, Appendix Table 1.6).

For harms, the estimated impact of £0.50 MUP is substantial (Table 2; Fig. 2). Alcohol-attributable admissions per 100 000 adults are estimated to reduce by −111.6 (−6.9%), −108.3 (−5.5%) and −158.7 (−7.9%) for Yorkshire and Humber, North West and North East, respectively (cf. −71.9 nationally). The absolute annual reductions in admissions are approximately −4600, −6000 and −3250 (total −14 000). Annual NHS cost reductions are: −£10.7, −£12.2 and −£8.4 million. Alcohol-attributable crime rates per 100 000 adults are estimated to reduce by −199.1 (−3.2%), −155.0 (−2.5%) and −213.6 (−3.5%), respectively. The bottom line in Table 2 shows reductions in

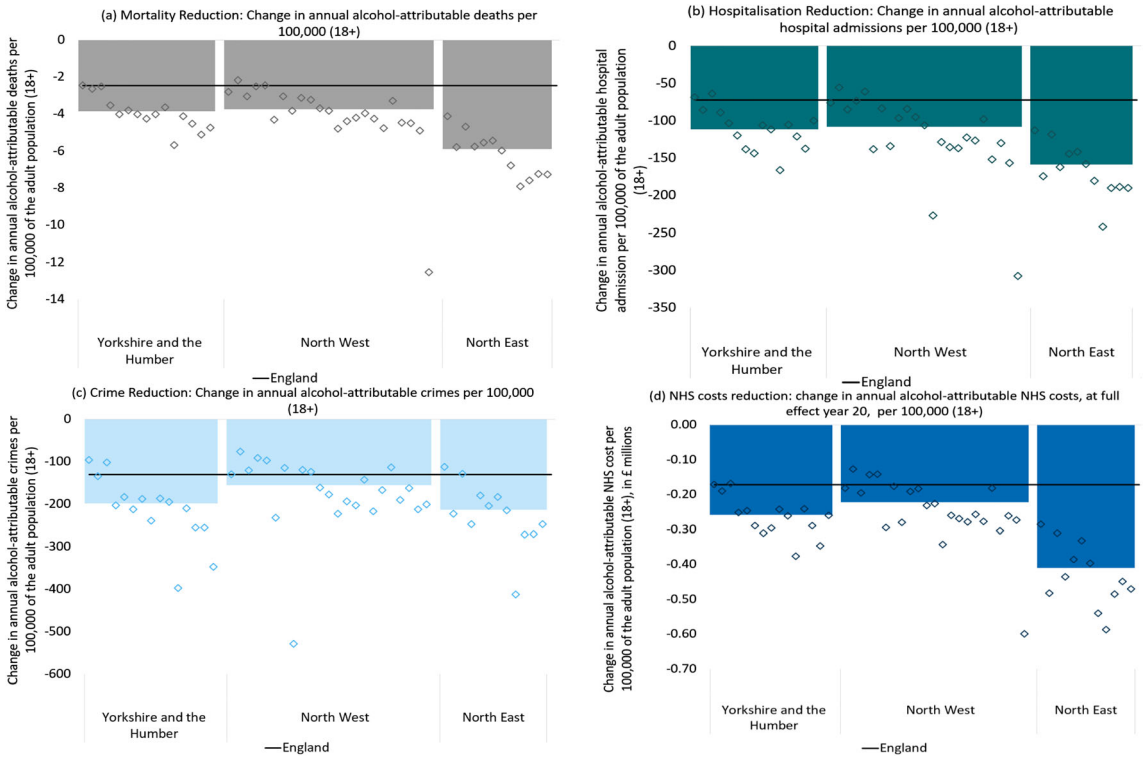


FIGURE 2 Estimated reduction in harm rates per 100 000 adult population (18+) if a 50 p minimum unit price (MUP) were implemented locally for 50 local authorities and three regions compared to national

alcohol-attributable mortality per 100 000 adults estimated at −3.8 (−16.9%), −3.7 (−11.4%) and −5.9 (−17.5%) for Yorkshire and Humber, North West and North East, respectively, an absolute reduction in deaths of (159 + 205 + 121=) 485 per annum. Annual alcohol-attributable deaths are estimated to change by between −8.0% and −24.8% throughout the 50 UTLAs examined (see Table A2 in supplementary material). Accumulated over a 20-year horizon, there are an estimated 7816 deaths avoided in the three regions. Figure 2 shows variations throughout the UTLAs. The reduction in death rates is greater than the national average for 48 of 50 UTLAs examined; North East UTLAs have the greatest mortality reductions. Broadly, UTLAs with higher current mortality and the largest proportions of high-risk drinkers have the greatest mortality reductions; for example, Middlesbrough, Newcastle, Liverpool and Manchester all have greater estimated reductions in mortality than York (Table), because York has a much lower baseline mortality rate (although still higher than the national average) and percentage drinking at high-risk levels (Table). This picture of relative harm reductions across UTLAs is broadly similar for the other modelled outcomes of crimes, hospital admissions and NHS costs per 100 000 adults (Supporting information, Appendix Table A2).

Health inequalities between subgroups within local authorities are also estimated to reduce (Figure 3). The SII for alcohol-attributable mortality rates is substantial, with some UTLAs having more than 10-fold difference between their very most and very least deprived areas (see length of pink bar, Figure 3a). The estimated impact of £0.50 MUP is twofold. First, it lowers the overall average mortality rate within each UTLA (Figure 3b; post-MUP solid purple dots are lower than pre-MUP hollow purple dots). Secondly, £0.50 MUP reduces the inequality between the most and least deprived people within a UTLA's population (length of pink bars reduces in Figure 3b compared to Figure 3a). Model-estimated reductions in inequalities for hospitalization rates were similar (not shown).

Figure 4a,b explain why MUP impacts upon inequalities by examining the five IMD deprivation quintiles and separating moderate-risk (green), increasing-risk (amber) and high-risk drinkers (red). The red high-risk drinkers have much greater current alcohol-attributable mortality rates, and within those it is the most deprived subgroup who are at greatest risk (Figure 4a). Figure 4b then shows that the reduction in deaths is greatest for the red high-risk drinkers in the most deprived areas. This subgroup is estimated to benefit most from MUP implementation because they are (a) at highest baseline mortality risk and (b) purchasing the largest amount of cheap alcohol currently sold below £0.50/unit.

Finally, we tested sensitivity to different thresholds (£0.30, £0.40, £0.60 and £0.70 MUP) compared to £0.50 MUP (Figure 5). In the North West, a £0.30 MUP is estimated to have approximately one-tenth of the mortality impact of £0.50 MUP, while a £0.40 MUP would have approximately half the impact of £0.50 MUP. Increasing to £0.60 or £0.70 per unit would increase the effect substantially by a factor of 1.8 and 3.0, respectively. These relative differences between different MUP thresholds are broadly stable across regions and UTLAs and across the admissions, crimes and mortality outcomes.

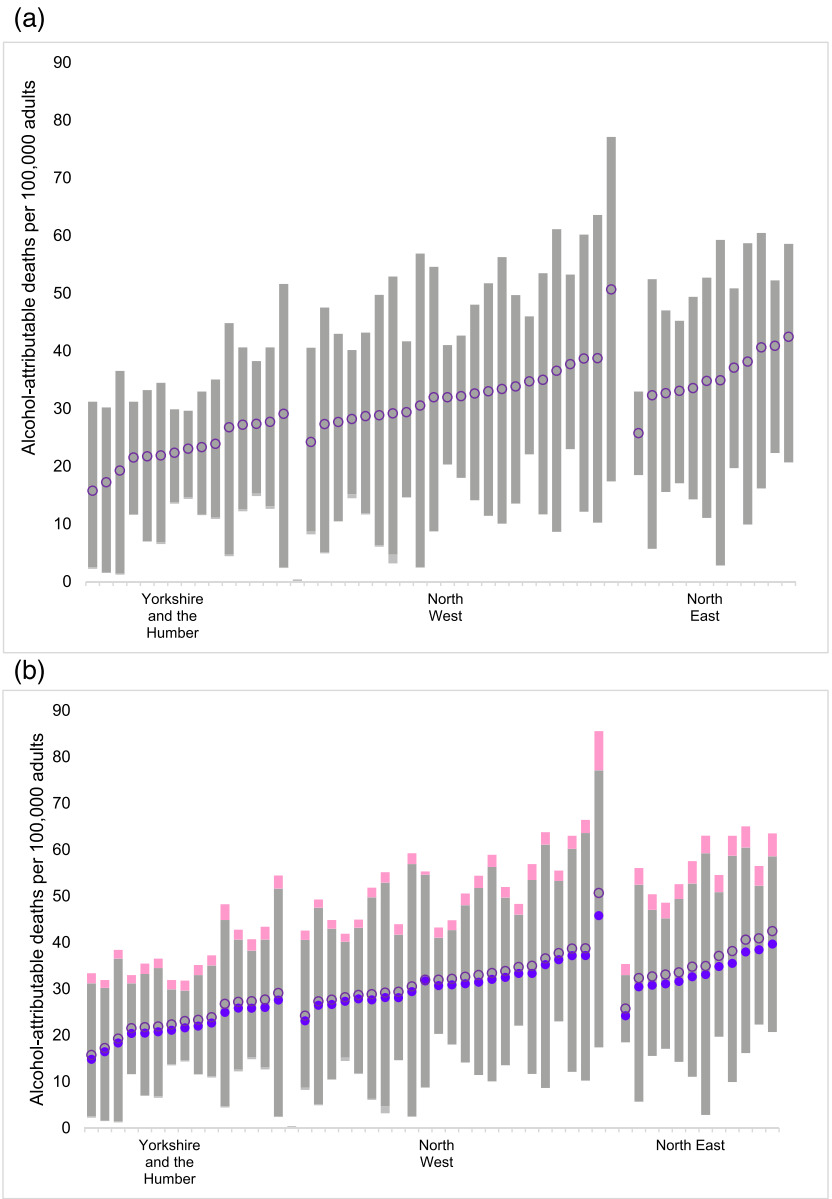


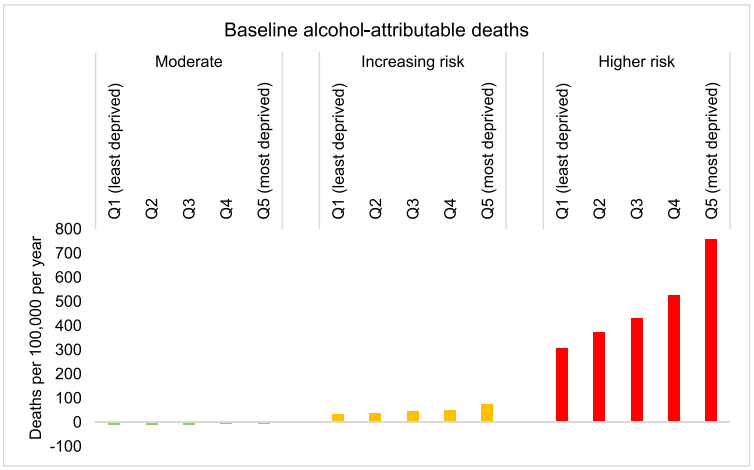
FIGURE 3 Slope Index of Inequality in alcohol-attributable deaths (a) before and (b) after a £0.50 minimum unit price (MUP). Top of grey bar is estimated alcohol-attributable mortality rate for most deprived 1% of the population in the local authority. Bottom of grey bar is estimated mortality rate for least deprived 1% of the population in the local authority. Hollow circle is the estimated population average alcohol-attributable mortality rate currently. Solid circle is the estimated population average alcohol-attributable mortality rate after £0.50 MUP policy is introduced. Pink areas represent reduction in inequalities post-policy.

DISCUSSION

This is the first study, to our knowledge, to examine the effectiveness of MUP for alcohol at subnational level in the United Kingdom. Model results suggest that a £0.50 MUP could effectively reduce alcohol-attributable deaths, hospitalizations and crimes in all the 50 UTLAs examined. The policy could reduce health inequalities and would be expected to have a greater impact in places with a greater prevalence of heavy drinking, higher purchasing of cheap alcohol and higher current levels of harm. The impact is focused upon the 4–7% of the population who drink at 'high-risk' levels and consume a substantial proportion of the very cheap alcohol. The estimated reductions in deaths over 20 years (approximately −2500 in Yorkshire and Humber, −3300 in North West and −1970 in North East regions) are mainly in this high-risk drinker group, where the percentage reductions in consumption are greatest. People in this high-risk drinking group are estimated to spend a little more money per annum on alcohol (e.g. North West region high-risk drinker average annual increase of £57 is approximately £1.10 per week). Because we estimate the greatest impacts on health to occur in the most deprived groups, MUP would reduce health inequalities within UTLAs as well as reducing inequality between UTLAs. This, and the fact that current rates of alcohol harm are highest in the North of England, suggests that both national and local MUP policies have the potential to contribute to the 'levelling-up agenda' of the current UK government, which aims to reduce geographical inequalities [39].

This study builds upon previous studies of potential impacts of national MUP implementation and relates to other evidence. The previous UK national studies showed similar patterns to those found here, i.e. that MUP is a targeted intervention that could reduce consumption and harms, mainly impacting upon those who buy and drink the highest volume of cheap alcohol [8, 10–13]. Our study's novelty is

(a) Baseline Alcohol Attributable Mortality per 100,000 adults (18+) by population subgroup for North West region



(b) Change in Absolute Numbers of Deaths Annually by population subgroup for North West region

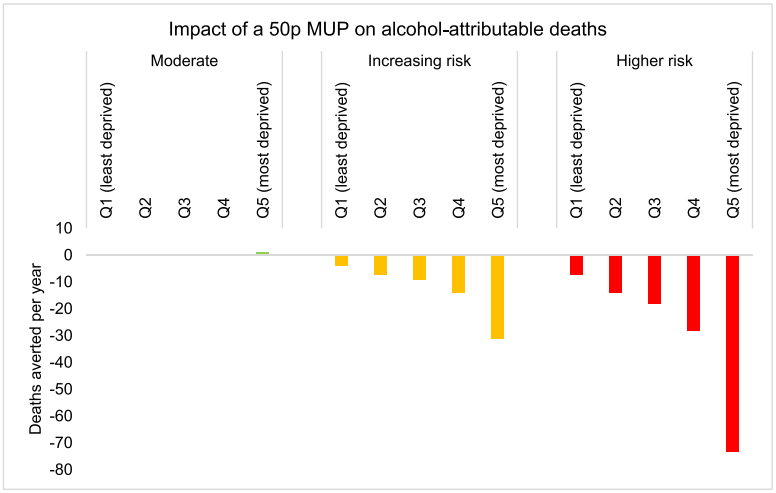


FIGURE 4 Impact on inequalities: changes in alcohol-attributable mortality for population subgroups. (a) Baseline alcohol-attributable mortality per 100 000 adults (18+) by population subgroup for North West region. (b) Change in absolute numbers of deaths annually by population subgroup for North West region

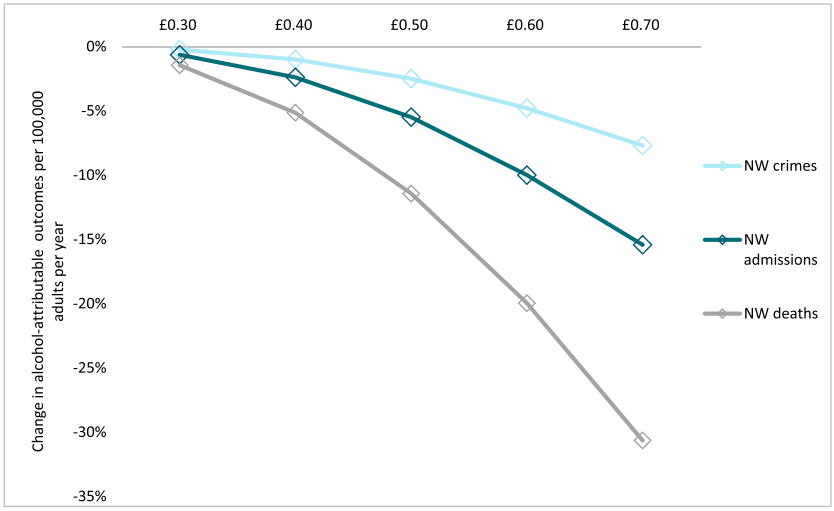


FIGURE 5 Effects of different possible minimum unit price (MUP) thresholds: percentage change in alcohol-attributable deaths, hospital admissions and crimes for the North West region

really to push forward on the local data analysis and methods development to enable impacts to be assessed at subnational, i.e. regional and local authority, levels. Direct comparison against previous SAPM analyses is difficult to undertake because the time-periods and some details regarding the data used have changed. Our main and most robust comparison between subnational and national impact comes from this study, where we have used SAPMLA for England as a whole as well as for UTLAs and regions, and that comparison shows that the

local authorities and regions in the North could have substantially higher estimated potential impact from MUPLocal than the national average.

Looking internationally, the general themes from subnational studies' results in other countries also reflect our own study, i.e. interventions very similar to MUPLocal could have or have shown impacts upon consumption and/or harms including hospitalization and crime [15–20]. Again, however, it is not possible to make a direct and analytically robust comparison of the scale of impact in, for example, Canadian provinces with impact in a UK local authority, because different methods have been used and different outcomes measured.

The strengths and limitations of our study mainly relate to evidence coming from multiple sources, because no single longitudinal individual-level data set exists measuring alcohol consumption, prices paid, incidence of diseases, mortality and crimes committed. Price elasticities used are a previously published UK level analysis of the Living Costs and Food Survey [34], because regional or local estimates are unavailable. Sensitivity to using alternative price elasticities was performed previously [11, 13, 33], showing that while effectiveness could be somewhat higher or lower than our base case, patterns of impact, for example, comparing moderate- with high-risk drinkers or comparing MUP thresholds remain broadly the same. Thirdly, we have not modelled 'cross-border' purchasing, either through people travelling to areas where the MUP is not implemented or via on-line purchases. The effects of cross-border purchasing would vary depending upon how large an area MUP implementation was covered, and we note that residents of Scotland are prevented from purchasing on-line alcohol at below the MUP price. Also, recent analysis of sales data in Scotland (versus northern England as control) provided 'reassurance of no major dilution in effect due to cross border purchases' [40]. Our analysis is conservative in assuming that retailers would not adjust prices for products currently higher than the £0.50 threshold and in other base case assumptions. When we previously compared our Canadian adaptation of SAPM results with the actual observed impact of implementation, the model underestimated the effects [15, 41]. SAPM's strengths and limitations have been deeply discussed through scientific peer-review of research reports, leading academic journals and critiques produced by consultants commissioned by industry. Point-by-point evidence explanation and critique rebuttal has been reviewed by Scottish, European and UK Supreme Courts [42].

Decision-makers in localities will next decide how to take these findings forward. An option some UTLAs have considered is applying to the Secretary of State to implement MUPLocal via the 'Sustainable Communities Act'. This requires 'evidence on the likely impact of the policy on health and well-being of the local population' and a public consultation exercise. National MUP implementation for England is a decision for the UK government, which is reviewing and considering evidence on an ongoing basis [6, 43].

Further research on the impact of MUP on locality social care costs and especially harms experienced by from parents'/carers' alcohol consumption would be useful. Approximately 90 000 recorded cases where alcohol is a factor are referred and assessed annually [44], and between 189 000 and 207 000 children estimated as in a household with an adult with symptoms of alcohol dependence potentially in need of specialist assessment and treatment [4]. Research on the impact on work-places and the wider economy is also a priority. Nationally, we recently estimated approximately 8 million days of work absence per year caused by alcohol [12].

Generalizability of these findings is complex. Results throughout the 50 different UTLAs modelled in the three North of England regions vary considerably. One cannot easily estimate effects in each of the other 101 UTLAs without undertaking explicit full modelling of the specific UTLA in question (which is possible, but was not part of the original project scope). However, it is clear that some consistent patterns in the patterns of estimated effects exist—moderate drinkers would be less affected than high-risk drinkers, and high-risk drinkers in deprived areas would have most health gain. International generalizability of the modelling is also achievable. SAPM has been adapted for several countries already [41], and further projects are under way in Australia and South Africa. Subnational adaptation for other countries would be possible, given data sets similar to those described here.

In conclusion, our study estimates suggest that a MUPLocal policy would be more effective in the three northern regions of England than for the national average, i.e. in terms of achieving larger reductions in alcohol consumption, alcohol-attributable mortality, hospitalization rates, NHS costs, health inequalities and crime.

ACKNOWLEDGEMENTS

The main funding source for this study was the NIHR Public Health Research Board, project number 15/129/19. An additional small consultancy grant came from PHE Yorkshire and Humber, grant no. 1083. A.B., C.A. and D.G. are also part-funded by the UKPRP SPECTRUM collaboration. We are grateful to Naomi Gibbs, Genevieve David, Jenny Doole and Heather Mottishaw in our own team for support to the Stakeholder events. Thanks to Sacha Wyke of Public Health England for provision of data. Thank also to:- Ali Wheeler for support on stakeholder events; Jude Hackett, Gary Wootten and Jon Dickson at Hitch Marketing for support on Infographics; Colin Shevills and staff at Fresh Balance (North East) and Amanda Healy and Alice Wiseman in the North East and many stakeholders across the North West Region who have contributed to the work; Scott Crosby in Yorkshire and Humber for additional support to analyse the UTLAs in that region; and especially to Margaret Carney of Sefton UTLA, Julie Webster, Adam Major and Tessa Woodhouse of Wirral UTLA, who helped co-design and organize much of the stakeholder engagement. The study funders had no input into the design, analysis or interpretation of data.

DECLARATION OF INTERESTS

All authors declare no conflicts of interest. The authors report grants from NIHR and PHE during the conduct of the study. P.S.M. is a member of the NIHR Public Health Research Funding Board (2016–present). All other authors declare no conflicts of interest. The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate and transparent account of the study being reported; and that no important aspects of the study have been omitted.

AUTHOR CONTRIBUTIONS

Alan Brennan: Conceptualization (lead); formal analysis (equal); funding acquisition (equal); investigation (equal); methodology (equal); project administration (lead); supervision (lead); validation (equal); writing-original draft (lead); writing-review and editing (lead). **Colin Robert Angus:** Conceptualization (equal); formal analysis (equal); funding acquisition (equal); investigation (equal); methodology (equal); project administration (equal); software (equal); supervision (equal); validation (equal); visualization (equal); writing-original draft (equal); writing-review and editing (equal). **Robert Pryce:** Conceptualization (equal); data curation (equal); formal analysis (equal); funding acquisition (equal); investigation (equal); methodology (equal); project administration (equal); software (equal); validation (equal); visualization (equal); writing-original draft (equal); writing-review and editing (equal). **Penny Buykx:** Conceptualization (equal); data curation (equal); funding acquisition (equal); investigation (equal); methodology (supporting); project administration (equal); supervision (supporting); writing-original draft (supporting); writing-review and editing (supporting). **Madeleine Henney:** Formal analysis (equal); investigation (equal); methodology (equal); visualization (equal); writing-original draft (equal); writing-review and editing (equal). **Duncan Gillespie:** Conceptualization (lead); data curation (equal); formal analysis (equal); funding acquisition (equal); investigation (lead); methodology (lead); resources (equal); writing-original draft (equal); writing-review and editing (equal). **John Holmes:** Conceptualization (equal); funding acquisition (equal); investigation (equal); methodology (equal); supervision (equal); validation (equal); visualization (equal); writing-original draft (equal); writing-review and editing (equal). **Petra Sylvia Meier:** Conceptualization (supporting); formal analysis (supporting); funding acquisition (equal); investigation (supporting); methodology (supporting); validation (supporting); writing-original draft (supporting); writing-review and editing (supporting).

ORCID

Alan Brennan https://orcid.org/0000-0002-1025-312X
Colin Angus https://orcid.org/0000-0003-0529-4135
Robert Pryce https://orcid.org/0000-0002-4853-0719
Penny Buykx https://orcid.org/0000-0003-4788-4002
Madeleine Henney https://orcid.org/0000-0003-2368-6677
Duncan Gillespie https://orcid.org/0000-0003-3450-5747
John Holmes https://orcid.org/0000-0001-9283-2151
Petra S. Meier https://orcid.org/0000-0001-5354-1933

REFERENCES

1. Griswold MG, Fullman N, Hawley C, Arian N, Zimsen SR, Tymeson HD, et al. Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the global burden of disease study 2016. Lancet. 2018;392:1015–35.
2. Steel N, Ford JA, Newton JN, Davis AC, Vos T, Naghavi M, et al. Changes in health in the countries of the UK and 150 English local authority areas 1990–2016: a systematic analysis for the global burden of disease study 2016. Lancet. 2018;392:1647–61.
3. Leontaridi R. Alcohol Misuse: How Much Does It Cost? London, UK: Cabinet Office; 2003.
4. Pryce R, Buykx P, Gray L, Stone T, Drummond C, Brennan A. Estimates of Alcohol Dependence in England Based on APMS 2014, Including Estimates of Children Living in a Household with an Adult with Alcohol Dependence, Prevalence, Trends and Amenability to Treatment London, UK: Public Health England; 2017.
5. Public Health England. Local Alcohol Profiles for England (LAPE). 2018. Available at: https://fingertipspheorguk/profile/local-alcohol-profiles/data (accessed 1 September 2018).
6. HM Government. The Government's Alcohol Strategy. 2012. Available at: https://www.gov.uk/government/publications/alcohol-strategy (accessed 30 September 2019).
7. Meier P, Brennan A, Angus C, Holmes J. Minimum unit pricing for alcohol clears final legal hurdle in Scotland. BMJ. 2017;359:j5372.
8. Angus C, Holmes J, Brennan A, Meier P. Model-based appraisal of the comparative impact of minimum unit pricing and taxation policies in Wales: final report. GSR report number 11/2018. 22 Feb 2018. Available at: www.gov.wales/docs/caecd/research/2018/180222-comparative-impact-minimum-unit-pricing-taxation-policies-en.pdf (accessed 30 September 2019).
9. Kolvin P. In The Proposed Matter Of A Byelaw For Minimum Unit Pricing For Alcohol—Advice. 2014.
10. Purshouse RC, Meier PS, Brennan A, Taylor KB, Rafia R. Estimated effect of alcohol pricing policies on health and health economic outcomes in England: an epidemiological model. Lancet. 2010;375:1355–64.
11. Holmes J, Meng Y, Meier PS, Brennan A, Angus C, Campbell-Burton A, et al. Effects of minimum unit pricing for alcohol on different income and socioeconomic groups: a modelling study. Lancet. 2014;383:1655–64.
12. Angus CHJ, Pryce R, Meier P, Brennan A. Alcohol and Cancer Trends: Intervention Scenarios. In: Projecting Trends in Alcohol Consumption and Alcohol-Related Harm in England From 2015 to 2035 and Estimating the Impact of Potential Minimum Unit Pricing and Taxation Policies Using the Sheffield Alcohol Policy Model, version 3.1 UK: Sheffield, UK: University of Sheffield and Cancer Research; 2016.
13. Angus C, Holmes J, Pryce R, Meier P, Brennan A. Model-based appraisal of the comparative impact of Minimum Unit Pricing and taxation policies in Scotland: an adaptation of the Sheffield Alcohol Policy Model, version 3. Sheffield, UK: University of Sheffield; 2016. Available at: https://www.sheffield.ac.uk/polopoly_fs/1.565373!/file/Scotland_report_2016.pdf (accessed 30 September 2019).
14. Scotch Whisky Association and others (Appellants) v The Lord Advocate and another (Respondents) (Scotland). [2017] UKSC 76. London, UK: Supreme Court; 2017.
15. Zhao J, Stockwell T, Martin G, Macdonald S, Vallance K, Treno A, et al. The relationship between minimum alcohol prices, outlet densities and alcohol-attributable deaths in British Columbia, 2002–09. Br J Addict. 2013;108:1059–69.
16. Stockwell T, Zhoa J, Giesbrecht N, Macdonald S, Thomas G, Wettlaufer A. The raising of minimum alcohol prices in Saskatchewan, Canada: impact on consumption and implications for public health. Am J Public Health. 2012;102:103–10.
17. Stockwell T, Zhao J, Sherk A, Callaghan RC, Macdonald S, Gatley J. Assessing the impacts of Saskatchewan's minimum alcohol pricing regulations on alcohol-related crime. Drug Alcohol Rev. 2017;36:492–501.
18. Jiang H, Livingston M, Room R, Callinan S, Marzan M, Brennan A *et al*. Modelling the effects of alcohol pricing policies on alcohol consumption in subpopulations in Australia. Addiction 2020;115:1038–1049.
19. Keatley DA, Hardcastle SJ, Carragher N, Chikritzhs TN, Daube M, Lonsdale A, et al. Attitudes and beliefs towards alcohol minimum pricing in Western Australia. Health Promot Int. 2018;33:400–9.

20. Taylor N, Miller P, Coomber K, Livingston M, Scott D, Buykx P, et al. The impact of a minimum unit price on wholesale alcohol supply trends in the Northern Territory, Australia. Aust NZ J Public Health. 2021;45:26–33.
21. Sherk A, Stockwell T, April N, Churchill S, Sorge J, Gamache P. The potential health impact of an alcohol minimum unit price in Québec: an application of the international model of alcohol harms and policies. J Stud Alcohol Drugs. 2020;81:631–40.
22. Brennan A, Angus C, Pryce R, Buykx P, Henney M, Gillespie D, et al. Potential effects of minimum unit pricing at local authority level on alcohol-attributed harms in North West and North East England: a modelling study. Publ Health Res. 2021;9:1–106.
23. Pryce R, Angus C, Holmes J, Gillespie D, Buykx P, Meier P, et al. Reweighting national survey data for small area behaviour estimates: modelling alcohol consumption in local authorities in England. Popul Health Metr. 2020;18:1.
24. Perkins CHM. 2014. Available at: https://publichealthmatters.blog.gov.uk/2014/01/15/understanding-alcohol-related-hospital-admissions/ (accessed 30 September 2018).
25. Office of National Statistics (ONS). Recorded crime data by Community Safety Partnership area [internet]. ONS 2017 [cited 2018 March 8]. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/datasets/recordedcrimedatabycommunitysafetypartnershiparea/current (accessed 30 September 2018).
26. Brennan A, Meier P, Purshouse R, Rafia R, Meng Y, Hill-Macmanus D, et al. The Sheffield alcohol policy model—a mathematical description. Health Econ. 2015;24:1368–88.
27. Home Office. Revisions made to the multipliers and unit costs of crime used in the Integrated Offender Management Value for Money Toolkit. 2011. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/118042/IOM-phase2-costs-multipliers.pdf (accessed 30 September 2018).
28. Angus C, Henney M, Webster L, Gillespie D. Alcohol-attributable diseases and dose-response curves for the Sheffield Alcohol Policy Model version 4.0. Sheffield, UK: University of Sheffield; 2018. https://figshare.shef.ac.uk/articles/Alcohol-attributable_diseases_and_dose-response_curves_for_the_Sheffield_Alcohol_Policy_Model_version_4_0/6819689 (accessed 30 September 2019).
29. Hill-MacManus D, Angus C, Meng Y, Holmes J, Brennan A, Meier P. Estimation of usual occasion-based individual drinking patterns using diary data. Drug Alcohol Depend. 2013;134:136–43.
30. Hill-Mcmanus D, Angus C, Meng Y, Holmes J, Brennan A, Meier P. Injury Alcohol-Attributable Fractions: Methodological Issues and Developments. Sheffield, UK: University of Sheffield; 2014.
31. Taylor BJ, Shield KD, Rehm JT. Combining best evidence: a novel method to calculate the alcohol-attributable fraction and its variance for injury mortality. BMC Public Health. 2011;11:265.
32. Purshouse R, Brennan A, Latimer N, Meng Y, Rafia R, Jackson R, Meier P. Modelling to assess the effectiveness and cost-effectiveness of public health related strategies and interventions to reduce alcohol attributable harm in England using the Sheffield Alcohol Policy Model, version 2.0. 2009. NICE. Available at: https://www.nice.org.uk/guidance/ph24/evidence/economic-modelling-report-371533357 (accessed 30 September 2018).
33. Meier PS, Holmes J, Angus C, Ally AK, Meng Y, Brennan A. Estimated effects of different alcohol taxation and Price policies on health inequalities: a mathematical modelling study. PLOS Med. 2016;13:e1001963.
34. Meng Y, Brennan A, Purshouse R, Hill-McManus D, Angus C, Holmes J, et al. Estimation of own and cross price elasticities of alcohol demand in the UK—a pseudo-panel approach using the living costs and food survey 2001–2009. J Health Econ. 2014;34:96–103.
35. Holmes J, Meier PS, Booth A, Guo Y, Brennan A. The temporal relationship between per capita alcohol consumption and harm: a systematic review of time lag specifications in aggregate time series analyses. Drug Alcohol Depend. 2012;123:7–14.
36. National Institute for Health and Care Excellence (NICE). Developing NICE guidelines: the manual. Process and methods [PMG20] Published date: October 2014; last updated: October 2018. Chapter 7 Incorporating economic evaluation. Available at: https://www.nice.org.uk/process/pmg20/chapter/incorporating-economic-evaluation2014 (accessed 30 September 2019).
37. Cherpitel CJ, Ye Y, Bond J, Borges G, Monteiro M. Relative risk of injury from acute alcohol consumption: Modeling the dose–response relationship in emergency department data from 18 countries. Addiction. 2015;110:279–88.
38. Regidor E. Measures of health inequalities: Part 2. J Epidemiol Community Health. 2004;58:900–3.
39. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1052706/Levelling_Up_WP_HRES.pdf
40. O'Donnell A, Anderson P, Jané-Llopis E, Manthey J, Kaner E, Rehm J. Immediate impact of minimum unit pricing on alcohol purchases in Scotland: controlled interrupted time series analysis for 2015–18. BMJ. 2019;366:l5274.
41. Hill-McManus D, Brennan A, Stockwell T, Giesbrecht N, Thomas G, Zhao J, et al. Model-based appraisal of alcohol minimum pricing in Ontario and British Columbia: a Canadian adaptation of the Sheffield Alcohol Policy Model, version 2 Sheffield, UK: ScHARR, University of Sheffield; 2012.
42. Brennan A, Purshouse R, Holmes J, Meng Y. A public response to the Adam Smith Institute's critique of the Sheffield Alcohol Policy Model Sheffield, UK: School of Health and Related Research; 2013.
43. Home Office. Next steps following the consultation on delivering the Government's alcohol strategy. 2013. Available at: https://wwwgovuk/government/uploads/system/uploads/attachment_data/file/223773/Alcohol_consultation_response_report_v3.pdf [internet]. 7/16/2014. Available at: http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223773/Alcohol_consultation_response_report_v3.pdf (accessed 30 September 2018).
44. Department for Education. Characteristics of children in need: 2017 to 2018 London, UK: Department for education; 2018.

SUPPORTING INFORMATION

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

How to cite this article: Brennan A, Angus C, Pryce R, Buykx P, Henney M, Gillespie D, et al. Effectiveness of subnational implementation of minimum unit price for alcohol: policy appraisal modelling for local authorities in England. Addiction. 2023;118(5):819–33. https://doi.org/10.1111/add.16084