

Preventing violence-related injuries in England and Wales: a panel study examining the impact of on-trade and off-trade alcohol prices

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ABSTRACT

Objective To examine the influence of real on-trade and off-trade alcohol prices and socioeconomic and environmental factors on rates of violence-related emergency department (ED) attendances in England and Wales over an 8-year period.

Methods Anonymised injury data which included attendance date, age and gender of patients aged over 18 years who reported injury in violence were collected from a structured sample of 100 EDs across England and Wales between 1 January 2005 and 31 December 2012. Alcohol prices and socioeconomic measures were obtained from the UK Office for National Statistics. Panel techniques were used to derive a statistical model.

Results Real on-trade ($\beta = -0.661$, $p < 0.01$) and off-trade ($\beta = -0.277$, $p < 0.05$) alcohol prices were negatively related with rates of violence-related ED attendance among the adult population of England and Wales, after accounting for the effects of regional poverty, income inequality, youth spending power and seasonal effects. It is estimated that over 6000 fewer violence-related ED attendances per year in England and Wales would result from a 1% increase in both on-trade and off-trade alcohol prices above inflation. Of the variables studied, changes in regional poverty and income inequality had the greatest effect on violence-related ED attendances in England and Wales.

Conclusions Small increases in the price of alcohol, above inflation, in both markets, would substantially reduce the number of patients attending EDs for treatment of violence-related injuries in England and Wales. Reforming the current alcohol taxation system may be more effective at reducing violence-related injury than minimum unit pricing.

INTRODUCTION

Interpersonal violence is a major cause of harm; globally, it was the second leading cause of death for young males aged 15–29 years in 2012.¹ In England and Wales, almost half of all violence results in physical injuries to the victim and one-fifth require medical treatment.² Violence therefore places a substantial burden on health services, in particular on emergency department (ED) resources; an estimated 210 215 people attended EDs in England and Wales for treatment following violence-related injury in 2015.³

Alcohol consumption has been associated with increased aggression and injury risk. For example, in a 30-year longitudinal study in New Zealand, likelihood of violent offending was shown to

increase with increasing symptoms of alcohol abuse, after controlling for other factors.⁴ International case-crossover analysis of patients attending 32 EDs also revealed that both within (country-specific) and across (pooled) countries, violence-related injuries were significantly more likely when alcohol was consumed in the 6 hours prior to injury, when compared with injuries which resulted from other causes.⁵ Theories seeking to address the relationship between alcohol and violence generally refer to a pharmacological effect (where alcohol consumption directly causes or indirectly facilitates violent behaviour), an expectancy effect (where alcohol consumption indirectly causes violent behaviour when combined with specific drinking motives) or unknown common factors, for example, personality factors such as impulsiveness.^{6–8}

Despite evidence linking alcohol consumption with violence, the exact nature of this association is less clear and consensus on causality has been difficult to establish. However, a one-way relationship between the price of alcohol and violence has been identified.^{9–12} In the USA, a 1% increase in the ‘real price’ (ie, inflation adjusted) of one ounce of pure alcohol (a weighted average of beer, wine and liqueur prices) has been shown to decrease the likelihood of women being victims to domestic violence by 5.34%.¹³ Causation is argued to involve a two-stage process; first, from the price of alcohol to alcohol consumption and, second, from the consumption of alcohol to acts of violence. The first stage assumes that the price of alcohol directly influences consumption and this is supported by empirical research.¹⁴

Violence and alcohol cannot be considered in isolation however. Many studies have linked structural factors with violence. For example, meta-analysis of estimates from 34 studies showed that both homicide and assault, but not rape or robbery, were closely linked to poverty and income inequality.¹⁵ In England, an ecological study found that risk of violent injury was six times greater in deprived communities compared with affluent.¹⁶ Income inequality, measured using the Gini coefficient, has also been shown to have a positive effect on homicide and self-reported assault in a study of 169 low-income, middle-income and high-income countries, including the UK.¹⁷ Criminological and sociological explanations for the association between poverty and crime, including violent crime, tend to focus on the influence of community structure on criminal behaviour. Factors such as

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low economic status, ethnic heterogeneity, residential mobility and family disruption lead to social disorganisation through a breakdown in social capital (which affects levels of social cohesion).¹⁸ This is suggested to impede the development of informal (ie, friendship groups) and formal (ie, community organisations) social networks, which are required to establish norms to reduce violence.¹⁹

In England and Wales, a 1% increase in the real price of beer has previously been estimated to reduce violence-related ED attendances by 5000 per annum.¹⁰ Findings from this study have, however, fallen foul of time: the dependent variable was based on monthly frequency of violence-related injury rates between May 1995 and April 2000, and the real price of beer was based on the average price of a pint of on-trade beer. Alcohol purchasing trends have since shifted from the on-trade to the off-trade market, where alcohol tends to be cheaper.²⁰ During this time, alcohol licensing laws have also been subjected to change.²¹

The purpose of this study is to examine the relationship between violence-related injury rates and the real price of alcohol, both on-trade (venues where alcohol is sold and consumed) and off-trade (venues where alcohol is sold for household consumption), as well as socioeconomic and environmental factors, among the adult population of England and Wales over the period from January 2005 to December 2012. There are important implications for policy and the findings of this study will inform current debates in the UK and elsewhere around taxation and minimum pricing policies to address alcohol-related harms.

METHODS

Emergency departments and injury records

Anonymised injury data which included attendance date, age (18 years and over) and gender of patients reporting injury in violence were collected from a structured sample of 100 type 1, 3 and 4 EDs (type 1=consultant led 24 hour service with resuscitation capabilities; type 3=other EDs/minor injury units; type 4=NHS walk-in-centres) in the nine English regions (Eastern, East Midlands, London, North East, North West, South East, South West, West Midlands and Yorkshire & Humberside) and in Wales between 1 January 2005 and 31 December 2012 (figure 1). Type 2 EDs (consultant-led single specialty accident and emergency services) were contacted but declined to participate. All EDs included were part of the National Violence Surveillance Network of EDs in England and Wales who agreed to share data on violence-related attendances, and who are compliant with the 1998 Data Protection Act and Caldicott guidance.²² ED attendances were aggregated to regional level and weighted to account for unequal coverage of EDs between regions. Methods used to calculate and apply weights to account for unsampled hospitals have been subject to peer review and published.²³ Population estimates from the UK Office for National Statistics (ONS) were used to calculate regional violence-related injury rates from weighted attendance data.

Real price of alcohol

Prices of purchasable items in the UK are sampled by the ONS and used to inform the Consumer Price Index (CPI), a measure of consumer price inflation. Monthly prices are accessible for the nine regions of England, as well as Wales, Scotland and Northern Ireland. In accordance with the violence-related injury time series, only prices relating to England and Wales from January 2005 to December 2012 were used. Alcohol price quotes were disaggregated by sale type, that is, on-trade and off-trade, and

only items that remained constant throughout the time series were included. Price quotes were categorised by alcohol type (beer, lager, wine, spirits and alcopops) and a geometric mean price calculated. Monthly price indices for each alcohol type were then calculated using the Laspeyres formula.²⁴ Household expenditures on alcoholic drinks by region, year and alcohol type were sourced from the Department for Environment, Food and Rural Affairs family food data sets and were used to annually weigh the indices.²⁵ Regional expenditure for on-trade alcohol by type was not available. For this reason, the assumption was made that the proportion of expenditure on alcohol by type in a particular region would not alter dramatically between off-trade and on-trade markets and that the weights could be used for both sale types. The real price of alcohol was obtained by deflating the regional indices by the UK CPI (excluding alcohol) and rebased at January 2005 (=100).

Socioeconomic and environmental factors

To control for potentially confounding risk factors, regional measures of poverty, income inequality and youth unemployment (a proxy for youth disposable income) were accessed from sources within the public domain and included in the model, as were quarterly seasonal dummies (table 1); the youth unemployment rate was included in the model as youth disposable income is likely to be lower when unemployment is greater and therefore higher unemployment is associated with lower youth spending capacity with which to purchase alcohol.¹⁰

Statistical analyses

Panel techniques were used to derive a statistical model for violence-related injury. Panel techniques were deemed most appropriate owing to the time series and cross-sectional elements of the data.²⁶ This was confirmed when the data rejected the pooled ordinary least-squares specification against the regional fixed-effects specification. Violence-related ED attendance data from the West Midlands in 2009 and the North East in 2011 were unavailable, which resulted in an unbalanced panel. Therefore, in total, 936 observations were included in the regression over 10 cross-sections. The Hausman²⁷ specification test indicated acceptance of the random-effects, which is more efficient and thus preferable under the null hypothesis, over the fixed-effects specification.²⁷ The statistical programme 'R' was used for cleaning and construction of the violence-related injury rates and regional price indices for alcohol, as well as both model fitting and testing (R Core Team. R: A language and environment for statistical computing. 2015; Available from: <http://www.R-project.org/>).

RESULTS

Violence-related ED attendances

In total, 299 381 adult (18 years and over) violence-related ED attendances were recorded in England and Wales in the sample EDs over the 8 year period. Disaggregation by gender and age group showed that the sample was predominantly male (220 526: 73.6%) and aged between 18 and 30 years (174 214: 58.2%). Once weighted, an estimated 2.1 million adults attended EDs across England and Wales for treatment following violence-related injury between January 2005 and December 2012. Overall, monthly injury rates for males (0.74 per 1000 population, 95% CIs 0.63 to 0.83 per 1000 population) were approximately three times greater than for females (0.26 per 1000 population, 95% CI 0.22 to 0.29 per 1000 population). Analysis by region showed variation between northern and southern England and Wales, with higher rates of violence-



Figure 1 Distribution of EDs (n=100) in the study sample by region, January 2005 to December 2012.

related injury in the North West, North East and Wales. Cross-regional comparisons of dependent and independent variable means and SDs are presented in [table 2](#).

Regression analysis

Panel estimates are shown in [table 3](#) and revealed that both real on-trade and off-trade alcohol price were negatively associated with rates of violence-related ED attendance among the adult population of England and Wales ([figure 2](#)), although gender differences were identified. The real price of off-trade alcohol was significantly related to rates of male but not female violence-related ED attendance. Regional measures of poverty and income inequality were positively related to rates of

violence-related ED attendance. This was true for both genders. Youth unemployment was negatively related to violence-related ED attendances, but not among women. Seasonal effects were also evident: violence-related injury rates were negatively correlated to autumn, winter and spring compared with summer, indicating that violence is significantly greater in the summer months of June, July and August.

To control for the effect of the trend in violence-related injury rates over the study period, a time trend was incorporated into Model 1 (Model 2). The time trend showed that rates of violence-related ED attendance were decreasing over time, while a positive interaction between time and on-trade alcohol price indicated that the effect of on-trade alcohol price on

Table 1 Socioeconomic and environmental variables and accompanying descriptions, data sources and frequency

Variable	Description	Source	Frequency
Poverty	Percentage of children (those aged 15 years or younger) living in households where no-one aged 16 years or over is in employment*	Labour Force Survey	Annum
Income inequality	Ratio of median gross weekly pay relative to that of earners in the lowest quintile, calculated using Pay As You Earn records from HMRC†	Annual Survey of Hours and Earnings	Annum
Youth unemployment (proxy for youth spending power)	Rate (per 100) of 18–29 year olds claiming unemployment benefits for up to 2 years	ONS	Month
Seasonal dummies	Spring (March, April and May), autumn (September, October and November) and winter (December, January and February) examined relative to summer (June, July and August)	N/A	Quarter

*Percentages are based on a 3-month average between October and December.

†Does not include the self-employed or those not paid in the April reference period.

violence-related injury reduced over the study period. Although youth unemployment became insignificant in the new specification, all other relationships identified in Model 1 were retained.

Standardisation of the coefficient, or beta coefficient, shows the comparative effect of the independent variables on the dependent variable and, in particular, identifies which of the independent variables have a greater effect on the dependent. Examination of standardised coefficients suggest that, of the risk factors studied, poverty ($\beta=0.227$, $p<0.001$) and income inequality ($\beta=0.251$, $p<0.001$) were the greatest predictors of violence-related injury in England and Wales (table 3).

Table 4 presents estimated reductions in violence-related ED attendances following an appropriate change in each of the independent variables (calculated at means level, estimates are based on coefficients from Models 1, 1a and 1b, $p<0.05$). Overall, a 0.01 decrease in the income inequality ratio had the largest overall effect on attendances (795 fewer violence-related ED attendances per month), followed by a 1% decrease in the rate of poverty (698 fewer violence-related ED attendances per month) and a 1% increase in alcohol prices both on-trade (355 fewer violence-related ED attendances) and off-trade (149 fewer violence-related ED attendances per month).

DISCUSSION

The principal finding of this study is that violence-related ED attendances were negatively associated with both on-trade and off-trade alcohol prices in England and Wales, after controlling for the effects of poverty, income inequality, youth spending capacity and seasonality. Calculated at the mean level, a 1%

sustained increase in the price of alcohol, above inflation, in both markets, could reduce the number of patients requiring ED treatment following injury in violence by over 6000 patients per year. However, of the factors studied, findings reveal that poverty and income inequality are the strongest predictors of violence-related injury in England and Wales, with a 1% decrease in poverty and a 0.01 decrease in the income inequality ratio estimated to yield a combined reduction of almost 18 000 violence-related ED attendances per year. Seasonal variations in violence were also clear: overall, violence-related injuries were more frequent in the summer months of June, July and August relative to other months. Regression estimates suggest that, on average, there are 1573 fewer violent injuries sustained in spring, 2663 fewer in autumn and 3593 fewer in winter in England and Wales relative to summer.

Alcohol consumption (per capita) decreased by 17% in the UK between 2005/2006 and 2013/2014.²⁸ During this time, violence according to the Crime Survey for England and Wales decreased by 33%² and hospital admissions for alcohol-related violence by 27%.²⁰ Establishing a causal association between alcohol and violence has proven difficult, however. This study cuts through the causative debate by re-affirming an association between alcohol price and violence. Findings showed that the price of on-trade alcohol exerted a greater negative influence on violence-related ED attendance compared with off-trade; it is estimated that a 1% increase in real on-trade alcohol prices could lead to 4260 fewer violence-related ED attendances per year, while a 1% increase in real off-trade alcohol prices could result in 1788 fewer attendances. It is likely that this difference results from greater

Table 2 Regional distribution of dependent and independent variables in England and Wales, January 2005 to December 2012

Region	Violence-related injury (rate per 1000)*	On-trade alcohol price (index)	Off-trade alcohol price (index)	Income inequality (ratio)	Poverty (%)	Youth unemployment (rate per 100)
North West	0.97 (0.21)	101.0 (1.47)	99.2 (3.78)	1.49 (0.01)	18.3 (0.97)	6.16 (1.42)
North East	0.69 (0.10)	102.8 (1.88)	99.5 (3.94)	1.44 (0.01)	18.3 (1.26)	7.48 (1.97)
Wales	0.66 (0.12)	102.5 (3.40)	96.9 (5.63)	1.46 (0.02)	18.2 (2.34)	6.10 (1.50)
Yorkshire & Humberside	0.58 (0.09)	106.0 (3.23)	98.4 (4.59)	1.48 (0.01)	16.2 (1.40)	6.05 (1.88)
West Midlands	0.53 (0.22)	100.9 (2.45)	98.6 (3.72)	1.48 (0.01)	17.2 (1.98)	6.74 (1.45)
London	0.47 (0.09)	101.4 (2.24)	97.6 (4.79)	1.52 (0.01)	21.4 (2.86)	4.61 (0.77)
South East	0.41 (0.12)	103.3 (2.31)	98.4 (4.04)	1.54 (0.01)	10.3 (0.52)	3.45 (1.03)
South West	0.41 (0.11)	102.4 (3.97)	99.9 (4.99)	1.47 (0.01)	10.8 (0.52)	3.66 (1.18)
East Midlands	0.38 (0.10)	104.4 (3.77)	101.7 (5.88)	1.48 (0.01)	13.1 (1.21)	5.16 (1.45)
Eastern	0.30 (0.09)	103.7 (4.28)	95.4 (3.22)	1.53 (0.01)	11.4 (0.56)	4.28 (1.17)
Total	0.54 (0.23)†	102.9 (3.34)	98.3 (4.77)	1.49 (0.03)	15.59 (4.02)	5.37 (1.91)

Means and SDs (in parenthesis) are given.

*Violence-related injury rates by gender were used but means and SDs are not reported.

†Mean assaults per month ($n=28\,883$).

Table 3 Random intercepts (panel—random effects); dependent variable=adult violence-related injury rate; sample=January 2005 to December 2012; cross-sections=10

Variable	Model 1 (total) β (beta)	Model 1a (male)	Model 1b (female)	Model 2 (total)
Intercept	2.563*	4.437*	0.884	6.178**
Real on-trade alcohol price†	−0.661 (−0.093)**	−1.089 (−0.099)**	−0.278 (−0.075)*	−1.362 (−0.193)**
Real off-trade alcohol price†	−0.277 (−0.058)*	−0.567 (−0.077)**	0.002 (0.001)	−0.477 (−0.101)***
Income inequality	1.48 (0.205)***	2.578 (0.230)***	0.439 (0.116)*	1.837 (0.251)***
Poverty	0.013 (0.224)***	0.022 (0.248)***	0.004 (0.142)**	0.013 (0.227)***
Youth unemployment	−0.011 (−0.092)*	−0.019 (−0.102)**	−0.005 (−0.074)	—
Spring	−0.029 (−0.056)**	−0.041 (−0.050)*	−0.018 (−0.066)**	−0.033 (−0.062)**
Autumn	−0.050 (−0.094)***	−0.069 (−0.084)***	−0.031 (−0.114)***	−0.045 (−0.086)***
Winter	−0.067 (−0.127)***	−0.096 (−0.118)***	−0.039 (−0.142)***	−0.067 (−0.127)***
Time	—	—	—	−0.145 (−17.632)***
Time×real on-trade alcohol price†	—	—	—	0.031 (17.645)***
R ² (adjusted)	0.192	0.208	0.105	0.240

***p<0.001, **p<0.01, *p<0.05.

†Log.

 β , Unstandardised coefficient; Beta, standardised coefficient.

increases in on-trade alcohol prices over the study period (mean index=102.9) compared with off-trade (mean index=98.3). It is important to note, however, that when the effect of the trend in violence-related injury rates over time is considered, the results from this study suggest that the negative association with on-trade alcohol price may be reducing over time.

Disaggregating the violence rate by gender showed that women's risk of violent injury was not associated with off-trade alcohol price. Reasons for this finding are unclear, especially when much female violent victimisation is domestic and that one-third of domestic violence incidents in England and Wales are alcohol-related.² One possible explanation is that ED data are less able to identify domestic violence victims as victims may not declare the true cause of their injuries on presentation. Having said this, this study did not categorise violence by location, for example, home, pub, club and so on, and the focus, therefore, was not to investigate the effects of alcohol price on

violence by location, but more generally on violence victimisation; performing a similar analysis on information obtained from victimisation surveys such as the Crime Survey for England and Wales for example, which categorises violence by type and location, may provide a better insight into the effect of alcohol price on female violence victimisation and prove a useful measure of comparison in any future work undertaken. Considering that men between 18 and 30 years of age were shown to be most likely to require ED treatment following injury in violence, it is likely that ED data better represent incidents of street-based interpersonal violence, rather than incidents of domestic violence.

There are important implications from these findings for public health and policy. In the long term, evidence from this study suggests that government policies that seek to reduce poverty and financial inequality in England and Wales could lead to substantial reductions in violence nationally, although such

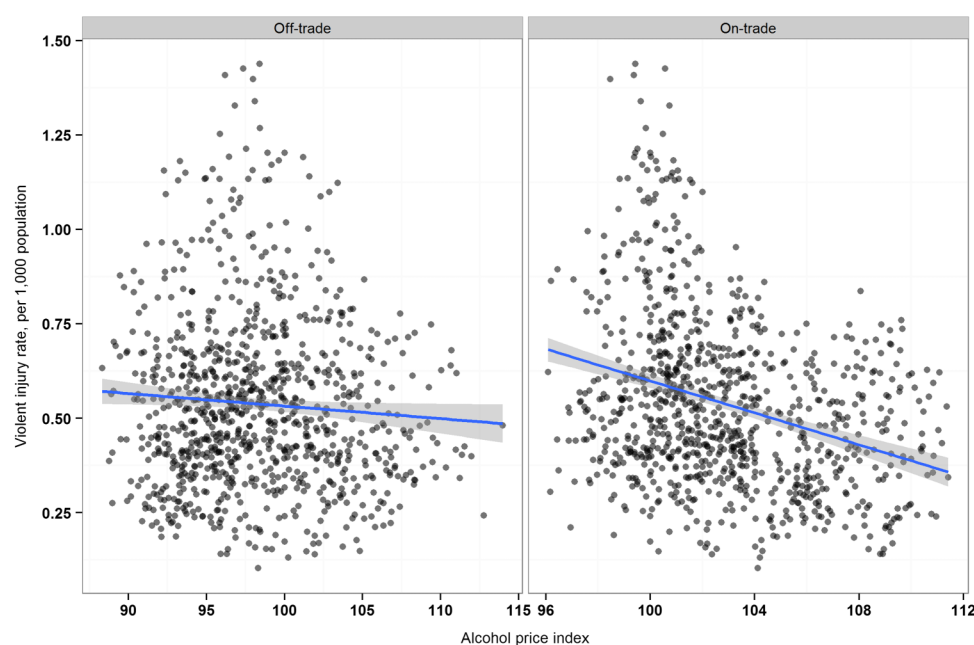
**Figure 2** Linear relationships (with 95% CIs) between real alcohol price and rates of adult violence-related emergency department (ED) attendance in England and Wales, January 2005 to December 2012.

Table 4 Estimated reductions in violence-related emergency department attendance (patients per month) following changes in real alcohol price, income inequality and poverty in England and Wales

Variable	Mean	Change	Male	Female	Total*
Income inequality	1.49	0.01 decrease	-682	-120	-795
Poverty	15.59	1% decrease	-582	-109	-698
Real on-trade alcohol price†	4.63	1% increase	-288	-76	-355
Real off-trade alcohol price†	4.59	1% increase	-150	-	-149

*Models run separately, so columns will not sum to total.

†Log.

policies would have to be viewed as permanent to yield reductions in violence. However, one policy option that could have an immediate impact on violence would be to increase the real price of alcohol. Previous policies aimed at reducing acute alcohol-related harms such as differential closing times and making the sale of alcohol to highly intoxicated patrons illegal have proven ineffective.^{29–30} Consistent with Matthews *et al*¹⁰ and other studies that have shown that raising the price of alcohol could reduce alcohol-related harms,^{31–32} findings presented here have shown that as little as a 1% increase in alcohol price would be expected to substantially reduce violence-related injuries in England and Wales. Importantly, findings suggest that any pricing policy that intends to reduce alcohol-related violence must aim to increase the price of alcohol in both markets, especially the on-trade.

In England, modelling has suggested that minimum unit pricing (MUP) would be most effective at reducing alcohol use among harmful drinkers without disproportionately penalising moderate drinkers and those on lower incomes.³¹ However, MUP would only target the cheapest alcohol most commonly found in the off-trade market and would be likely to have little effect on the price of alcohol sold in the on-trade market.³³ Although MUP has been shown to reduce interpersonal crimes (including assault) in Canada,³⁴ less is known regarding the likely effect on violence in the UK. Reforming the current alcohol taxation system so that excise duty for all alcoholic drinks is relative to strength, for example,³³ may well be more effective at reducing violence-related injuries in England and Wales, as this would lead to a more uniform price increase across both markets. The additional tax revenue gained through such a policy, estimated at close to £1 billion per year,³³ would be at the Treasury's disposal and could be used to offset the costs of alcohol-related harm to the NHS.

STUDY LIMITATIONS

Using information obtained from EDs as a measure of violence has several limitations; ED data are potentially liable to respondent bias as some patients may be unwilling to report that injury was sustained in violence; ED data are a measure of serious violence and only account for people who have sustained injuries serious enough to require medical treatment, and proximity to an ED may affect the likelihood of attendance, particularly in more rural areas.³⁵ In addition, given that men aged between 18 and 30 years represent the majority of the sample, it is probable that ED data better represent incidents of street-based interpersonal violence, rather than other forms of violence such as domestic violence.

Regional expenditure on on-trade alcohol was unavailable. Therefore, the assumption was made that the proportion of expenditure on alcohol by type in a particular region would be

similar in both on-trade and off-trade markets and that the same weights could be applied when aggregating. This was considered a justifiable assumption.

Ecological fallacy is the error of assuming that inferences made about individuals can be made from analyses of aggregate data.³⁶ In this study, aggregate measures of poverty, income inequality and youth unemployment were used to explain regional variation in violence-related injury: relationships that hold for aggregate data may not hold for individuals.

CONCLUSION

Epidemiological research recognises the correlation between alcohol consumption and violence, but correlation does not imply causation and violent individuals may simply consume more alcohol. However, the price of alcohol cannot be determined by violence and, therefore, by identifying a significant inverse relationship between rates of violence-related ED attendance and the price of alcohol in England and Wales, this study has provided evidence which makes a causal relationship between alcohol consumption and violence more feasible; causation can be understood as running from alcohol price to alcohol consumption and from alcohol consumption to acts of violence.

What is already known on the subject?

- ▶ A causal link between alcohol and violence is often assumed but has proven difficult to establish.
- ▶ A link between the price of beer and risk of violence-related injury has been identified in England and Wales; lower beer prices were associated with higher rates of violence-related emergency department attendance.

What this study adds?

- ▶ Risk of violence-related emergency department attendance in England and Wales is greater when on-trade and off-trade alcohol prices are lower.
- ▶ On-trade alcohol prices have a greater impact on violence than off-trade prices.
- ▶ To maximise reductions in alcohol-related violence, alcohol pricing policies must raise the price of alcohol in both markets, but especially in the on-trade.
- ▶ Adjusting alcohol duty may reduce violence more than minimum unit pricing.

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Contributors NP, KM and VS designed the study. VS and JS contacted the clinical leads and collected the anonymised injury records. NP, SH and PM calculated the alcohol price indices. PM, NP and KM conducted statistical analysis. NP, VS and JS prepared the manuscript. All authors commented on the final draft and approved the manuscript prior to submission.

Competing interests None declared.

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