

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

<sup>1</sup>Nicholas Page

<sup>1</sup>Vaseekaran Sivarajasingam

<sup>2</sup>Kent Matthews

<sup>2</sup>Saeed Heravi

<sup>2</sup>Peter Morgan

<sup>1</sup>Jonathan Shepherd

<sup>1</sup>Violence Research Group, School of Dentistry, Cardiff University, Heath Park, Cardiff, United Kingdom, CF14 4XY, <sup>2</sup>Cardiff Business School, Aberconway Building, Colum Drive, Cardiff University, Cardiff, United Kingdom, CF10 3EU

Corresponding author:

Dr Nicholas Page

Room 108

School of Dentistry

Heath Park

Cardiff University

Cardiff

CF14 4XY

Tel: +44(0)7584066502

Email: PageNA@cardiff.ac.uk

## **KEYWORDS**

Violence;

Alcohol;

Policy

Word count

3,397 (excluding title page, abstract, references, tables and figure legend)

3,203 (excluding key message, competing interests, contributors and the above)

References: 37

## **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 eight 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 January 1st 2005 and December 31st 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 6,000 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.

### Conclusion

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.

## **KEY MESSAGE**

### **What is already known on this 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.

## 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 211,514 people attended EDs in England and Wales for treatment following violence-related injury in 2014.[3]

Alcohol consumption has been associated with increased aggression and injury risk. For example, in a thirty-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 thirty-two 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 six 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 United States, a 1% increase in the 'real price' (i.e. 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 to 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, middle and high income countries, including the United Kingdom (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 low economic status, ethnic heterogeneity, residential mobility and family disruption lead to social disorganisation through a breakdown in social capital (social cohesion).[18] This is suggested to impede the development of informal (i.e. friendship groups) and formal (i.e. 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 5,000 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 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 Types 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 January 1<sup>st</sup> 2005 and 31<sup>st</sup> December 2012 (Figure 1). Type 2 EDs (consultant led single speciality 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 un-sampled 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.

[Insert Figure 1 here]

### **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, i.e. on-trade and off-trade, and only items that remained constant throughout the time series were included. Price quotes were categorized 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

expenditure on alcoholic drinks by region, year and alcohol type were sourced from the Department for Environment, Food and Rural Affairs family food datasets and were used to annually weight 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 re-based 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]

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

<b>Variable</b>	<b>Description</b>	<b>Source</b>	<b>Frequency</b>
Poverty	Percentage of children (those aged 15 years or younger) living in households where no-one aged 16 years or over is in employment. <sup>a</sup>	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. <sup>b</sup>	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 two 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

<sup>a</sup> Percentages are based on a three month average between October and December; <sup>b</sup> Does not include the self-employed or those not paid in the April reference period



## **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 ten cross-sections. The Hausman (1978) 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.[28]

## **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 eight 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% Confidence Intervals (CI): 0.63-0.83 per 1000 population) were approximately three times greater than for females (0.26 per 1000 population, 95% CI: 0.22-0.29 per 1000 population). Analysis by region showed variation between northern and southern England and Wales, with higher rates of violence-related injury in the North West, North East and in Wales. Cross-regional comparisons of dependent and independent variable means and standard deviations are presented in Table 2.

**Table 2** Regional distribution of dependent and independent variables in England and Wales for period January 2005 to December 2012. Means and standard deviations (in parenthesis) are given.

<b>Region</b>	<b>Violence-related injury (rate per 1,000) <sup>c</sup></b>	<b>On-trade alcohol price (index)</b>	<b>Off-trade alcohol price (index)</b>	<b>Income inequality (ratio)</b>	<b>Poverty (%)</b>	<b>Youth unemployment (rate per 100)</b>
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)
<b>Total</b>	<b>0.54 (0.23) <sup>d</sup></b>	<b>102.9 (3.34)</b>	<b>98.3 (4.77)</b>	<b>1.49 (0.03)</b>	<b>15.59 (4.02)</b>	<b>5.37 (1.91)</b>

<sup>c</sup> Violence-related injury rates by gender were used but means and standard deviations are not reported; <sup>d</sup> Mean assaults per month (n=28,883)

## 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 to summer, indicating that violence is significantly greater in the summer months of June, July and August.

In order 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 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.

Standardization 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 standardized 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).

[Insert Figure 2]

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

<b>Variable</b>	<b>Model 1 (Total)</b>	<b>Model 1a (Male)</b>	<b>Model 1b (Female)</b>	<b>Model 2 (Total)</b>
	$\beta$ (Beta)			
Intercept	2.563*	4.437*	0.884	6.178**
Real on-trade alcohol price <sup>e</sup>	-0.661 (-0.093)**	-1.089 (-0.099)**	-0.278 (-0.075)*	-1.362 (-0.193)**
Real off-trade alcohol price <sup>e</sup>	-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 x Real on-trade alcohol price	-	-	-	0.031 (17.645)***
R-squared (adjusted)	0.192	0.208	0.105	0.240

$\beta$  = Un-standardized coefficient; Beta = standardized coefficient; \*\*\* p<0.001, \*\* p<0.01, \* p<0.05; <sup>e</sup> Log

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).

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

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

<sup>e</sup>Log; <sup>f</sup>Models run separately, so columns will not sum to total

## 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 6,000 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.[29] 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 to off-trade; it is estimated that a 1% increase in real on-trade alcohol prices could lead to 4,260 fewer violence-related ED attendances per year, while a 1% increase in real off-trade alcohol prices could result in 1,788 fewer attendances respectively. It is likely that this difference results from greater 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 etc., 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 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.[30, 31] Consistent with Matthews et al[10] and other studies that have shown that raising the price of alcohol could reduce alcohol-related harms,[32, 33] 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.[32] 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.[34] Although MUP has been shown to reduce interpersonal crimes (including assault) in Canada,[35] 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,[34] 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,[34] 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.[36] In addition, given that men aged between 18 and 30 years represent the majority of our sample, it is probable that ED data better represents 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.[37] 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.

## **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.

### **FIGURE LEGENDS**

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

Figure 2 Linear relationships (with 95% confidence intervals) between real alcohol price and rates of adult violence-related ED attendance in England and Wales for period January 2005 to December 2012

## REFERENCES

1. World Health Organisation. Global health estimates 2014 summary tables: DALY by cause, age and sex, 2000-2012. 2014 19th January 2015; Available from: <http://www.who.int/healthinfo/global-burden-disease/en/>.
2. Office for National Statistics. Crime statistics, focus on violent crime and sexual offences, 2013/14. Office for National Statistics, 2015. <http://www.ons.gov.uk/ons/rel/crime-stats/crime-statistics/focus-on-violent-crime-and-sexual-offences--2013-14/index.html> (Accessed 31 July 2015).
3. Sivarajasingam, V., Moore, S., Page, N., et al. Violence in England and Wales in 2014: an accident and emergency perspective. 2015. [http://www.cardiff.ac.uk/\\_data/assets/pdf\\_file/0009/95778/nvit\\_2014.pdf](http://www.cardiff.ac.uk/_data/assets/pdf_file/0009/95778/nvit_2014.pdf) (Accessed 6 May 2015).
4. Boden, J., D. Fergusson, and L. Horwood, Alcohol misuse and violent behaviour: findings from a 30-year longitudinal study. *Drug Alcohol Depend*, 2012. **122**: 135-141.
5. Cherpitel, C. and Y. Ye, Alcohol and violence-related injuries among emergency room patients in an international perspective. *J Am Psychiatr Nurses Assoc*, 2010. **16**(4): 227-235.
6. Fagan, J., Intoxication and aggression. *Crime and Justice*, 1990. **13**: 241-320.
7. Graham, K., Leonard, K., Room, R., et al., Current directions in research on understanding and preventing intoxicated aggression. *Alcohol and Aggression*, 1998. **93**(5): 659-676.
8. Graham, K., Theories of intoxicated aggression. *Can J Behav Sci*, 1980. **12**(2): 141-158.
9. Wagenaar, A., A. Tobler, and K. Komro, Effects of alcohol tax and price policies on morbidity and mortality: a systematic review. *American Journal of Public Health*, 2010. **100**(11): 2270-2278.
10. Matthews, K., J. Shepherd, and V. Sivarajasingam, Violence-related injury and the price of beer in England and Wales. *Applied Economics*, 2006. **38**: 661-670.
11. Markowitz, S., Criminal violence and alcohol beverage control: evidence from an international study, NBER Work Pap Ser 7481. 2000, National Bureau of Economic Research: Massachusetts.
12. Markowitz, S., Nesson, E., Poe-Yamagata, E., et al. Estimating the relationship between alcohol policies and criminal violence and victimization. *German Economic Review*, 2012. **13**(4): 416-435.
13. Markowitz, S., The price of alcohol, wife abuse, and husband abuse. *South Econ J*, 2000. **67**(2): 279-303.
14. Wagenaar, A., M. Salois, and K. Komro, Effects of beverage alcohol price and tax levels on drinking: a meta-analysis of 1003 estimates from 112 studies. *Addiction*, 2009. **104**(2): 179-190.
15. Hsieh, C. and M. Pugh, Poverty, income inequality and violent crime: a meta-analysis of recent aggregate data studies. *Crim Justice Rev*, 1993. **18**:182-202.
16. Bellis, M., Hughes, K., Wood, S., et al. National five-year examination of inequalities and trends in emergency hospital admission for violence across England. *Inj Prev*, 2011. **17**(5): 319-325.
17. Wolf, A., R. Gray, and S. Fazel, Violence as a public health problem: An ecological study of 169 countries. *Soc Sci Med*, 2014. **104**: 220-227.
18. Shaw, C. and H. McKay, Juvenile delinquency and urban areas. 1942, Chicago: University of Chicago Press.
19. Sampson, R. and J. Laub, Urban poverty and the family context of delinquency: a new look at structure and process in a classic study. *Child Development*, 1994. **65**(2): 523-540.
20. Health and Social Care Information Centre. Statistics on alcohol: England, 2015. Health and Social Care Information Centre, 2015. <http://www.hscic.gov.uk/catalogue/PUB17712/alc-eng-2015-rep.pdf> (Accessed 25 July 2015).
21. HM Government, Licensing Act 2003. 2003, The Stationery Office: London.
22. Department of Health. Information: To share or not to Share – Government Response to the Caldicott Review. Department of Health, 2013.

- [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/251750/9731-2901141-TSO-Caldicott-Government\\_Response\\_ACCESSIBLE.PDF](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/251750/9731-2901141-TSO-Caldicott-Government_Response_ACCESSIBLE.PDF) (Accessed 1 March 2016).
23. Sivarajasingam, V., Page, N., Morgan, P., et al. Trends in community violence in England and Wales 2005-2009. *Injury*, 2014. **45**: 592-598.
  24. Silver, M., Business statistics. second edition ed. 1997, Maidenhead: McGraw-Hill.
  25. Department for Environment, F.a.R.A. *Family food datasets*. 2013 10th February 2013; Available from: <http://webarchive.nationalarchives.gov.uk/20130103014432/http://www.defra.gov.uk/statistics/foodfarm/food/familyfood/datasets/>.
  26. Brooks, C., Introductory econometrics for finance. 2008, Cambridge: Cambridge University Press.
  27. Hausman, J., Specification tests in econometrics. *Econometrica*, 1978. **46**: 1251-1271.
  28. R Core Team. R: A language and environment for statistical computing. 2015; Available from: <http://www.R-project.org/>.
  29. British Beer and Pub Association. Alcohol consumption per head down again in 2014 - but remarkable cheer for beer adds to 'overwhelming' case for beer duty cut. British Beer and Pub Association, 2015. [http://www.beerandpub.com/news/alcohol-consumption-per-head-down-again-in-2014-but-remarkable-cheer-for-beer-adds-to-overwhelming-case-for-beer-duty-cut?from\\_search=1](http://www.beerandpub.com/news/alcohol-consumption-per-head-down-again-in-2014-but-remarkable-cheer-for-beer-adds-to-overwhelming-case-for-beer-duty-cut?from_search=1) (Accessed 12 April 2015).
  30. Humphreys, D. and M. Eisner, Do flexible alcohol trading hours reduce violence? A theory-based natural experiment in alcohol policy. *Soc Sci Med*, 2014. **102**: 1-9.
  31. Hughes, K., Bellis, M., Leckenby, N., et al. Does legislation to prevent alcohol sales to drunk individuals work? Measuring the propensity for night-time sales to drunks in a UK city. *J Epidemiol Community Health*, 2014. **68**: 453-456.
  32. Holmes, J., Meng, Y., Meier, P., et al. Effects of minimum unit pricing for alcohol on different income and socioeconomic groups: a modelling study. *Lancet*, 2014. **383**(9929): 1655-1664.
  33. Purshouse, R., Meier, P., Brennan, A., et al. Estimated effect of alcohol pricing policies on health and health economic outcomes in England: an epidemiological model. *Lancet*, 2010. **375**: 1355-1364.
  34. Griffith, R., A. Leicester, and M. O'connell, Price-based measures to reduce alcohol consumption: IFS Briefing Note BN138. 2013, London: Institute for Fiscal Studies.
  35. Stockwell, T., Zhao, J., Marzell, M., et al. Relationships between minimum alcohol pricing and crime during the partial privatization of a canadian government alcohol monopoly. *J Stud Alcohol Drugs*, 2015. **76**: 628-634.
  36. Baker, R., Bankart, M., Rashid, A., et al. Characteristics of general practices associated with emergency department attendance rates: a cross-sectional study. *BMJ Qual Saf*, 2011. **20**: 953-958.
  37. Freedman, D., Ecological inference and the ecological fallacy. *International Encyclopedia of the social & Behavioral sciences*, 1999. **6**: 4027-4030.