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Alcohol policy and gender: a modelling study estimating gender-specific effects of alcohol pricing policies

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Abstract

Aims—To describe gender differences in alcohol consumption, purchasing preferences and alcohol-attributable harm. To model the effects of alcohol pricing policies on male and female consumption and hospitalisations.

Design—Epidemiological simulation using the Sheffield Alcohol Policy Model v4.

Setting/Participants—Adults aged 18+, England.

Interventions—Three alcohol pricing policies: 10% duty increase and minimum unit prices (MUP) of £0.50 and £0.70 per UK unit.

Measures— *Gender-specific baseline and key outcomes data*: Annual beverage-specific units of alcohol consumed and beverage-specific alcohol expenditure (household surveys). Alcohol-attributable hospital admissions (administrative data). *Key model parameters*: Literature-based own- and cross-price elasticities for 10 beverage-by-location categories (e.g. off-trade beer). Sensitivity analysis with new gender-specific elasticities. Literature-based risk functions linking consumption and harm, gender-disaggregated where evidence was available. *Population subgroups:* 120 subgroups defined by gender (primary focus), age, deprivation quintile and baseline weekly consumption.

Findings—Women consumed 59.7% of their alcohol as off-trade wine while men consumed 49.7% as beer. Women drinkers consumed fewer units annually than men (494 vs. 895) and a smaller proportion of women were high-risk drinkers (4.8% vs. 7.2%). Moderate drinking women had lower hospital admission rates than men (44 vs. 547 per 100,000) but rates were similar for high-risk drinking women and men (14,294 vs. 13,167 per 100,000). All three policies led to larger estimated reductions in consumption and admission rates among men than women. For example, a £0.50 MUP led to a 5.3% reduction in consumption and a 4.1% reduction in

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admissions for men but a 0.7% reduction in consumption and a 1.6% reduction in hospitalisations for women.

Conclusion—Alcohol consumption, purchasing preferences and harm show strong gender patterns among adult drinkers in England. Alcohol pricing policies are estimated to be more effective at reducing consumption and harm for men than women.

Keywords

alcohol policy; gender; taxation; pricing; inequalities; policy appraisal; modelling

Introduction

Women's alcohol consumption and the proportion of women drinking at harmful levels has been increasing in many countries in recent years, particularly among younger women.[1] Health harms of alcohol use tend to start at lower levels of consumption for women, and the onset is more rapid and associated with more severe harm compared to men.[2] Little is known however about the alcohol policies that effectively target women's drinking.[3]

Interventions aimed at reducing the significant burden of disease associated with alcohol include regulating prices, availability, marketing and drinking contexts, early intervention to prevent and treat alcohol dependence, and providing advice and education to promote less harmful use.[4] Pricing interventions are among the most effective of these options and are supported by a strong international evidence base developed over several decades.[5,6] However, apart from overall effectiveness, governments are also concerned with understanding equity effects and targeting interventions on particular at-risk groups, such as heavier drinkers or those in more deprived areas who tend to experience the highest levels of health harm. Our recent research on alcohol pricing in the UK has investigated differential policy effects by drinkers' consumption level and their socio-economic status and has highlighted important health inequity implications of choosing between alternative MUP and taxation policy designs.[7,8]

Wider dimensions of equity in alcohol policy effects remain underexplored and these include gender. Specifically, two recent reviews show that while evaluations of individual-level behaviour change interventions often consider differential impacts by gender, most appraisals and evaluations of population-level policies fail to do so.[3,9] Reviews of alcohol pricing policies in particular report a small and low quality evidence base that offers inconsistent findings, with a handful of studies pointing towards greater price sensitivity or harm reduction effects in women, whilst others report null or contrary findings.[3,10–12]

An investigation in the UK context of gender equity in alcohol pricing policy effects is particularly timely due to the sustained policy attention on alcohol prices. In the past decade, the UK Government implemented and then abolished an "alcohol duty escalator", which involved several years of annual excise duty rises above the rate of inflation, leading to significant cumulative duty increases. This was followed by several years of duty freezes and cuts. In May 2018, the Scottish Government implemented a minimum price of £0·50 per alcohol unit (8g of pure ethanol) for sales to consumers. The Welsh Government

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implemented similar legislation in March 2020, whilst Ireland's Public Health (Alcohol) Act 2018 legislates for a higher minimum price of €1 per standard drink (10g of pure ethanol) but this has yet to be implemented. There is continuing debate around minimum pricing elsewhere in the UK and abroad.

The paper's aim is to estimate the effects of alcohol pricing policies on alcohol purchasing, consumption and health harms. The paper investigates potential mechanisms that may drive differential policy effects. We expected that gender-specific policy effects might arise from a complex interplay of differential 1) baseline spending (total expenditure and preferred price points), 2) choice of beverage type, consumption location, and consumption levels, and 3) rates of alcohol-attributable health harm.

Methods

Overview

The Sheffield Alcohol Policy Model (SAPM) version 4 is a causal deterministic, epidemiological simulation tool providing a comprehensive framework for appraising UK and international alcohol policy options. It comprises an individual-based econometric component that estimates how price changes affect individual-level alcohol consumption, and a cohort-based dynamic epidemiological component that estimates how consumption changes affect the morbidity, mortality, and economic costs associated with 45 alcohol-attributable conditions. A key feature of SAPM is that it accounts for population heterogeneity in model inputs and outputs, permitting an intersectional analysis of how policy impacts vary across and within population subgroups defined by the analyst. Our paper presents the results of computer modelling for policy appraisal rather than exploratory or confirmatory statistical analyses, therefore no pre-registration was undertaken. Detailed conceptual and mathematical descriptions of SAPM are beyond the scope of the current paper but have recently been published open access as a technical appendix elsewhere, allowing the interested reader to get a more thorough understanding of SAPM.[8] A methodological overview is provided below and shown in graphical format in Fig 1.

Modelled Policies

We modelled three illustrative alcohol pricing policy options, 1) an all-beverage relative duty rise, which is a mechanism similar to that seen during the initial phases of the UK duty escalator policy, 2) the current Scottish MUP (MUP50) and 3) a policy to represent a higher MUP using the example of the proposed Irish MUP level converted into pence per unit (MUP70). For the purposes of our modelling, each was assumed to be implemented on top of the current UK status quo (UK duty and VAT rates in effect on 1 January 2019). In brief, alcoholic beverages in the UK (above 1·2% ABV) have two tax components levied on them: 20% Value Added Tax (VAT), an *ad valorem* sales tax levied on most goods and services, and excise duty, which is based on either the volume of product or alcohol content, depending on beverage type. Beer and spirits are taxed in proportion to their alcohol content, with additional strength bands for beer, whilst cider and wine are taxed according to the volume of liquid sold regardless of strength. On average, wine and spirits attract higher rates of duty per unit of alcohol than beer, and cider is taxed at the lowest rate.

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Basecase (status quo):

$Price_0$ = (net price + existing beverage-specific duty) × (100% + 20% VAT).

TAX10 (raising current alcohol duty for all beverage categories by 10%).

$Price_1$ = (net price + existing beverage-specific duty × [100% + 10%]) × (100% + 20% VAT).

MUP50 (introducing a floor price of £0·50 per alcohol unit):

$Price_2$ = maximum of $Price_0$ or (£0·50 × number of alcohol units in product)

MUP70 (introducing a floor price of £0·70 per alcohol unit):

$Price_3$ = maximum of $Price_0$ or (£0·70 × number of alcohol units in product)

Price to spending and consumption model

Demographic, consumption and spending data—We developed a synthesised individual-level dataset bringing together demographic, alcohol purchasing and consumption data from several surveys, government statistics and market research data.

Individuals' demographic data came from the Health Survey for England (HSE) 2015/6, an annual nationally representative survey (N=12,157). HSE was used to define 120 population subgroups by intersections of 1. gender, 2. age (18-24, 25-34, 35-54 and 55+), 3. quintiles of the 2015 English Index of Multiple Deprivation (IMD), a composite, small-area-level measure of deprivation[18] and 4. self-reported baseline consumption level: moderate (≤14 units/week), increasing risk (>14-50 units/week for men and >14-35 units/week for women) and high-risk (>50 units/week for men and >35 units/week for women).

Alcohol purchasing data were taken from the nationally representative Living Costs and Food Survey (LCFS) (2010-15). LCFS includes a two-week purchasing diary which records for each alcohol purchase: location (2 options: on-trade, i.e. pubs, bars, clubs and restaurants, or off-trade, i.e. shops including off-licenses and supermarkets), beverage type (5 options: beer, cider, wine, spirits or ready-to-drinks), quantity and price paid (N=121,913 transactions). Ready-to-drinks results are modelled but not reported separately here as their market share is <0·2%. Prices recorded were inflated to 2016 values using UK Office of National Statistics beverage and location-specific inflation indices and subsequently adjusted to match more robust (but available at total population-level only) sales price distributions from market research companies CGA Strategy (on-trade) and Nielsen (off-trade). Both HSE and LCFS surveys include sampling weights, which are incorporated into our analysis.

Beverage-specific alcohol consumption levels were also taken from the HSE 2015/16. Unlike the LCFS, the HSE does not differentiate between on- and off-trade, nor beer and cider, but these distinctions are important for understanding policy effects. Therefore, we used LCFS information to apportion HSE consumption: For each individual in the HSE, consumption of each beverage type was split between the on- and off-trade, and between beer and cider, based on the average split across LCFS respondents in the same population

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subgroup. The result of these calculations is an individual-level dataset containing individual demographic characteristics and individual-level consumption of 10 beverage categories.

Pre- and post-policy price distributions and tax pass-through—Next, we needed baseline distributions (i.e. distributions of purchases across price-points) for these product types and estimates for how each policy would affect these price distributions, including how retailers would adjust prices in response to tax changes. We also required information on price elasticities, an econometric measure of the average consumer response to a change in retail price. Own-price elasticities estimate the average consumer response to a price change in the same beverage category (e.g. the % change in off-trade beer purchasing after a 1% change in off-trade beer price) and cross-price elasticities the response to price changes in other categories (e.g. the % change in on-trade beer purchasing after a 1% change in off-trade beer price)

We calculated baseline beverage- and location-specific price distributions for each population subgroup from the adjusted LCFS data. To estimate the impact of policies on these price distributions, we calculated the change in price for every purchase implied by each policy. We accounted for evidence from previous analyses that alcohol tax rises are not passed on uniformly to consumers, with undershifting (i.e. passing on less than the implied price change) observed for cheaper products.[15] For each of the 10 beverage categories – beer, wine, spirits, cider and RTDs in on- and off-trade - we then calculated the mean price paid for alcohol before and after a policy change by each modelled population subgroup. This change was converted into a percentage change in consumption of a particular product type for each modelled population subgroup and combined with the individual-level consumption data and published own- and cross-price elasticities for the 10 beverage categories (see Table 1) to generate the post-policy consumption of each category for each modelled individual.

Consumption to hospital admissions model

Health conditions—For each modelled subgroup, SAPM estimates the impact of changes in consumption on hospital admissions for 45 alcohol-related health conditions separately, including those conditions that are wholly- and partially attributable to alcohol, and those linked to chronic drinking (e.g. alcoholic liver disease or ischaemic heart disease) and acute intoxication (e.g. motor vehicle accidents) (see supplementary material Table S1 for a full list). Baseline age, gender, IMD quintile (defined equivalently to the HSE subgroups described above) and condition-specific hospital admissions data for England were derived from NHS Digital’s Hospital Episode Statistics. Data were pooled over 2012/13-2016/17 to ensure robust estimates at the subgroup level.

Risk functions—Changes in alcohol-related harm levels were modelled using condition-specific risk functions linking consumption levels and harm, with full details available elsewhere[19]. For chronic conditions partially attributable to alcohol, risk functions from high-quality published meta-analyses were used, using gender-specific functions where possible (i.e. Type II diabetes, hypertensive diseases, ischaemic heart disease, haemorrhagic and ischaemic stroke, liver cirrhosis, and acute pancreatitis). Where available we used morbidity risk functions, otherwise mortality risk functions. For five health conditions, these risk functions imply that low levels of consumption reduces risk (ischaemic heart disease, haemorrhagic and ischaemic stroke, acute pancreatitis, and type II diabetes), but for cardiovascular conditions, these protective effects are eliminated in the presence of heavy episodic drinking. All else being equal, gender-specific risk functions imply that women benefit from larger protective effects of moderate alcohol consumption than men but are at substantially greater risk of harm than men at higher consumption levels.[20] The baseline hospital admission rates shown in Table 2 reflect this. For conditions wholly attributable to alcohol, gender- and age-specific risk functions were calibrated to the above consumption and harm data. Finally, for partially-attributable acute conditions such as injury, we used published risk functions linking peak daily consumption with risk of harm, and available data on the relationships between mean weekly consumption and peak daily consumption, for different age and gender groups.

Estimation of changes in hospital admissions and time lags—Risk functions were integrated using Gunning-Schepers' Potential Impact Fraction methodology[21] to estimate the change in hospital admissions in each modelled subgroup resulting from the estimated change in consumption in that subgroup following policy implementation. For many chronic health conditions, there is a time lag between changes in consumption and change in risk. The model accounts for this, in line with a systematic review[22], with the full impact of a policy ('full effect') estimated to have occurred by 20 years post-implementation.

Sensitivity analysis

In a sensitivity analysis, we fitted new gender-specific price elasticities using the same approach. We did not use these elasticities in our base case analysis due to the small sample size for some beverage categories and that conceptually, price elasticities are typically deemed a property of the product, not the drinker. These elasticities and associated results can be found in the supplementary material. We have drawn together the results of further sensitivity analyses on other key parameters in the model in an open access technical appendix to a recent paper.[8]

Results

Gender differences in baseline consumption, expenditure and harm

Table 2 and Figure 2 show baselines expenditure, consumption and hospital admissions by gender and consumption level. Table 3 shows baseline beverage type and location preferences by gender and deprivation.

Total consumption—Abstention rates in women (19%) were higher than in men (13%), and overall, women drank just over a third (35%) of all alcohol consumed in England in 2016. Their average annual consumption was lower at 494 units compared to men's 895 units (Table 2). For moderate drinkers of both genders, higher deprivation was associated with less consumption. However, for high-risk drinkers of both genders, the relationship was inverse and consumption increased as deprivation increased (Table 3).

Location and beverage type preferences—Our analyses show clear differences in estimated beverage and trade sector preferences by gender (Table 2) and by gender and deprivation (Table 3).

Overall, women were estimated to consume a large majority of their alcohol in the off-trade sector (all women: 85%, women in the high-risk drinker group: 94%). This compared to 61% for all men and 71% for men in the high-risk drinker group. On-trade drinking only accounted for a sizeable share of women's consumption among moderate drinkers.

Men in more deprived areas were estimated to have a preference for beer whereas men in less deprived areas had a stronger preference for off-trade wine, and this was the case for all consumption levels. Men also had a stronger preference for on-trade compared to off-trade beer except for the most deprived increasing and high-risk drinkers for whom off-trade beer was the dominant beverage.

For women, off-trade wine was estimated to be the dominant beverage in all deprivation and consumption groups, but accounted for particularly large shares in in increasing and high-risk drinkers and those in less deprived areas. Off-trade spirits represented a larger estimated consumption share for women, particularly those in highly deprived areas, than for other groups.

Spending patterns and preferences for cheap alcohol units— Figure 3 illustrates estimated preferences for different price points by population group, showing the subgroup's average number of units bought in each price band (Fig 3: top) and the share of each subgroup's consumption that is bought in each price band (Fig 3: bottom). We defined: 1. ultra-low price alcohol - <£0·30 per unit (affected by MUP50 and MUP70, with large price rises required to meet even the MUP50 threshold), 2. very low price alcohol <£0·50 per unit (affected by MUP50 and MUP70, with large price rises for the latter), and 3. low price alcohol <£0·70 a unit (affected by MUP70 only). Low and very low price alcohol represented a greater relative share (Fig 3: bottom) of women's total units than men's, across all drinking and deprivation groups. However, the higher consumption volume of high-risk drinking men meant that in absolute terms (Fig 3: top), the number of cheap alcohol units bought was higher for men than women.

Ultra-low price units, most affected by price policies, are a relatively small proportion of total units (Fig 3: top). This type of alcohol was bought almost exclusively by high-risk drinkers, especially men in deprived areas for whom it accounts for around 10% of all consumption.

Baseline hospital admissions—Alcohol-related health harm is concentrated in the heaviest drinkers, especially for women (Fig 3). Five percent of women consumed at high-risk levels and these 5% were estimated to account for more than two-thirds of women's hospital admissions. In contrast, the 7% of men who were high-risk drinkers were estimated to account for just over a third of men's hospital admissions. Among moderate drinkers, the estimated admission rate for men is 547 per 100,000 for men and just 44 per 100,000 for women (see earlier note on protective effects), whereas for high-risk drinkers it is 13,167 per 100,000 (men) and 14,294 per 100,000 (women).

Modelled effects of tax and minimum unit pricing (MUP) policies

Table 4 shows the estimated gender-specific effects of a £0·50 MUP, a £0·70 MUP and a 10% all-product tax rise policy. Figure 3 further splits policy effects by deprivation quintile to explore the intersection of gender and deprivation.

Modelled policy effects on consumption and spending— Table 4 shows that all policies are estimated to reduce overall consumption, but reduce men's consumption by substantially more than women's. There are also clear effects of policy scale, with a £0·70 MUP having larger effects than a £0·50 MUP and a 10% tax increase having the smallest effect. All policies are estimated to reduce high-risk drinkers' consumption by far more than moderate drinkers' but within each consumption group, reductions in men's drinking were estimated to be larger than reductions in women's drinking (e.g. high-risk drinkers: Estimated MUP70 consumption reductions are -7·6% for women and -20·3% for men, see Figure 4: consumption). For both genders, there were clear deprivation gradients in policy effects, with the largest consumption reductions occurring among more deprived drinkers.

Estimates of spending changes show a very different gender pattern compared to consumption effects (see Table 4 and Figure 4: spending). In response to all policies and across all drinker groups, women's spending is estimated to increase more than men's. For example, male high-risk drinkers in deprived areas are estimated to modestly reduce their expenditure (MUP50:-2·8%; MUP70:-4·9%) whilst substantially reducing their consumption for the two MUP policies (MUP50:-14·8%; MUP70:-28·5%). In contrast, female high-risk drinkers in the most deprived areas are estimated to balance smaller consumption reductions (MUP50:-5·1%; MUP70:-15·5%) with increased expenditure (MUP50:+5·4%; MUP70:+15·9%).

Modelled policy effects on alcohol-attributable hospital admissions— *Estimated* reductions in admissions were estimated to be substantially larger among men than women, reflecting these greater consumption reductions. The model results suggested the tax policy is associated with modest reductions in admissions for both genders. MUP50 affected mainly men's admissions for increasing and high-risk drinkers while MUP70 would lead to substantial reductions across all male drinker groups, with a -12·8% (22 255) decrease in annual admissions for high-risk drinkers once the policy achieved full effect after 20 years. For women, only MUP70 is estimated to produce large reductions in admissions, with admissions among moderate drinkers estimated to fall by 13·0%, albeit from a low baseline, and admissions among high-risk drinkers estimated to fall by 9·5%. Figure 4 (admissions) shows a steep deprivation gradient for men, with larger admission reductions in more deprived groups across policies and consumption levels.

Sensitivity analysis—Using newly-estimated gender-specific price elasticities has a limited impact on the results, leading to overall smaller estimates of the impact of all three policies on consumption and harm, and larger estimates of the impact on spending, but does

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not materially alter our findings. This is likely due to gender differences in price responsiveness still being captured in the base case via differences between the elasticities for each beverage category, which reflect gender differences in purchasing preferences for each category. See supplementary material for full results.

Discussion

This paper is the first to estimate the gender-specific effects of different alcohol pricing strategies. In this paper we estimate how three policies, which each lead to a different price-change profile for different beverage types, would affect male and female drinking behaviour and health harm. Our results highlight the power of detailed policy appraisal models like SAPM which can help us make sense of a complex interplay of factors. The results of our models are driven a) baseline preferences, consumption level and, risk of harm, b) how a policy changes prices of products, c) price elasticities and d) the interplay of these factors, particularly since a) and b) vary at subgroup level (gender x age x deprivation level). Our mathematical modelling deals with this complexity by synthesising data and evidence across a large range of sources, and was able to take account of detailed gendered and socio-economically patterned beverage type and drinking location preferences, the price elasticities associated with these gendered preferences, and differential risk of 45 health conditions by gender and consumption level.

Our results suggest that pricing policies are estimated to be more effective for tackling alcohol consumption and harm in men than in women. Only the strongest policy option modelled, a £0·70 MUP, would lead to sizeable consumption reductions and health gains among women, and these effects were concentrated in high-risk drinking women living in the most deprived areas – that is, the women drinkers who are at greatest risk of harm. In our models, women in other groups responded to pricing policies by maintaining their consumption and increasing their spending, sometimes substantially. In contrast, men responded to price changes by keeping their spending stable and instead reducing consumption leading to significant health gains, particularly in deprived areas. The findings are not in the direction that we might have expected, given previous literature[3,10–12] and that a greater share of women's alcohol consumption involves off-trade alcohol targeted by MUP policies. However, on closer inspection, compared to women, men purchased a greater quantity of the ultra-cheap alcohol units that are subject to the largest price rises under the modelled policies. In addition, a much greater proportion of female consumption comes from off-trade wine, which has a lower own-price elasticity than either on- or off-trade beer which is more widely consumed by men, meaning that a similar change in price would lead to a smaller expected change in consumption, but a greater increase in spending. However, modelled outcomes are driven by a combination of factors including the degree to which each policy affects the price of individual products, the implied consumption change associated with the price change, and how this consumption change translates into changes in risk of harm given the subgroup-specific baseline consumption distribution.

An increasing body of evidence shows that policy effects differ by population subgroups, particularly income and socioeconomic status[7,8], and this paper's intersectional analysis adds modelling evidence that policy effects also differ within subgroups by gender. If properly integrated into policy design through pre-implementation policy appraisals, evaluation and other post-implementation scrutiny, consideration of such differences between and within groups can be invaluable to those seeking to improve population health and reduce health inequities. In particular, understanding how different policies would affect groups not only permits appropriate targeting of key risk groups but can help ensure that, collectively, prevention efforts reach all relevant populations.

The major strength of this study is that it synthesises multiple data sources to analyse the intersectional relationships between gender and deprivation within patterns of alcohol consumption, purchasing and harm, and then uses this detailed understanding to estimate subgroup-specific policy effects. As such, it provides a useful template for gender-specific and other intersectional policy appraisal in alcohol research and related fields. Our study uses SAPM v4, and general strengths and limitations of this model and the underpinning data, e.g. under-reporting of consumption in surveys, are considered elsewhere.[7,8,13,14] A limitation of particular relevance is our combining of the HSE and LCFS to provide comprehensive data on consumption and purchasing across relevant beverage types and trade sectors. This required assumptions that purchasing patterns reflect consumption patterns, but if women disproportionately buy alcohol that is consumed by men this may lead to an overestimation of men's on-trade and underestimation of off-trade drinking (and the reverse for women). A further limitation is the lack of published risk functions for alcohol-related morbidity (as opposed to mortality), due to the dominance of mortality as an outcome in epidemiological cohort studies assessing the impact of alcohol on health. The overall impact on our results of the use of mortality risk functions for morbidity results is hard to assess, however our approach is in line with standard practice in epidemiological modelling (e.g. the Global Burden of Disease study[24]). A final point concerns how uncertainty is handled in the model. Many of the data sources SAPM relies on do not include any measures of uncertainty and even where measures of uncertainty around individual parameters are available, we do not have any data available on the joint uncertainty - for example, it is likely that the epidemiological studies from which we take our risk functions share similar biases and therefore the underlying errors in these parameters are highly likely to be correlated. If we were to consider each parameter to be independent then we would likely substantially overstate the true uncertainty. However, no evidence to inform the structure of any correlation matrix for the errors is available. As such, we believe that a full probabilistic treatment of the model would be at best uninformative and at worst potentially misleading. Instead, we take a broader approach to uncertainty, in line with recommendations in the UK government's 'Green Book'[23] for economic appraisals of policy and use scenario analysis to explore the impact of key uncertainties in the model. In the present study we have used such an analysis to look at the impact of alternative price elasticities. In previous studies referenced in the text we have looked at various scenarios around alternative assumptions including the relationships between alcohol consumption levels and harm and adjusting consumption data to account for underreported consumption. These have consistently shown the results of SAPM to be, if anything, conservative, and have not materially changed the model outcomes.

In conclusion, this paper shows that alcohol purchasing and consumption preferences and baseline rates of health harm all vary by gender. This drives differential responses to alcohol pricing policies, where alcohol taxation and minimum pricing policies are estimated to lead to substantially larger consumption and harm reduction benefits for men than women.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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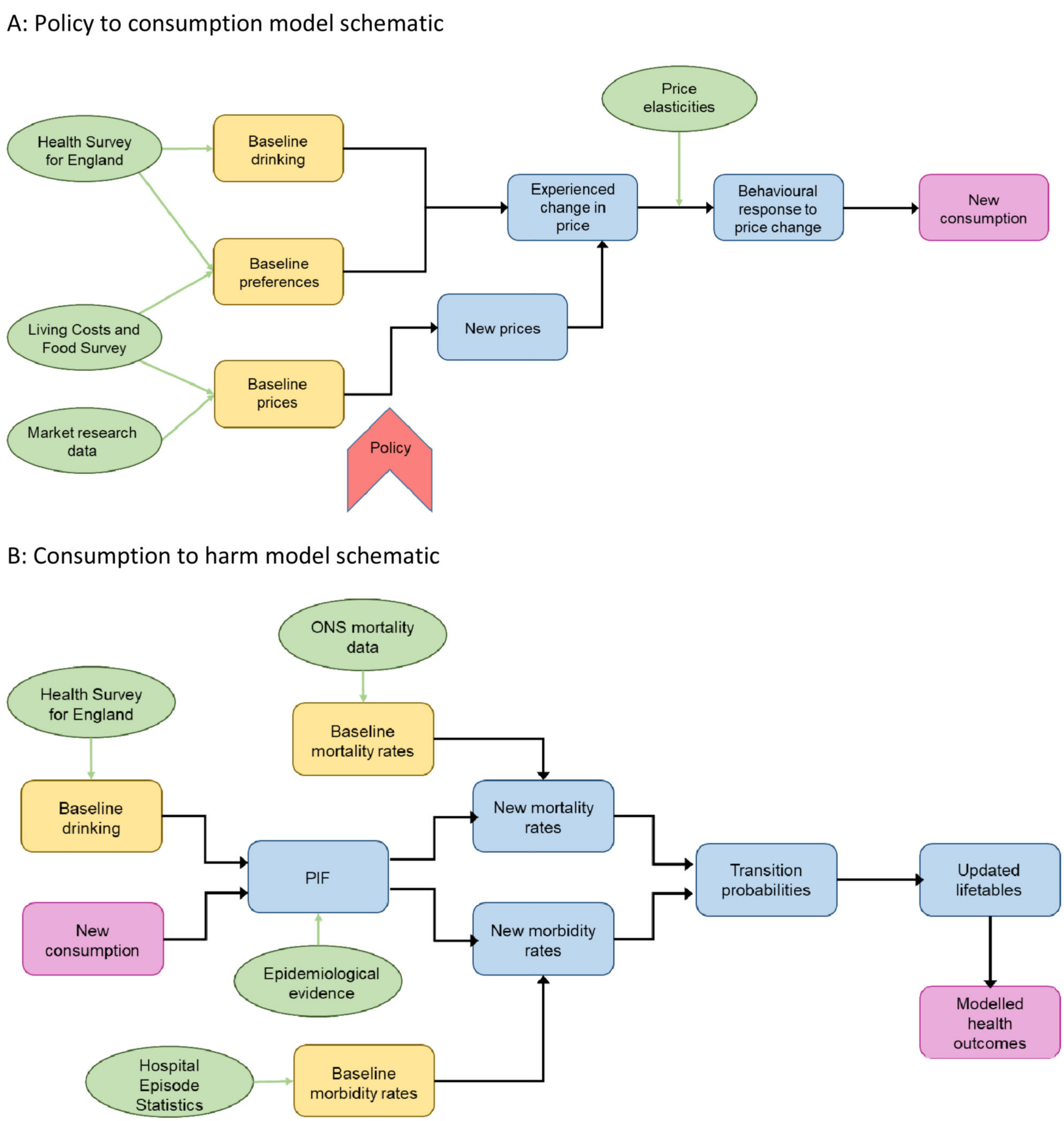

Figure 1. Sheffield Alcohol Policy Model Overview

A: Policy to consumption model schematic

B: Consumption to harm model schematic

Key: Green - data sources, yellow - model inputs, blue – intermediate steps, pink – model outputs

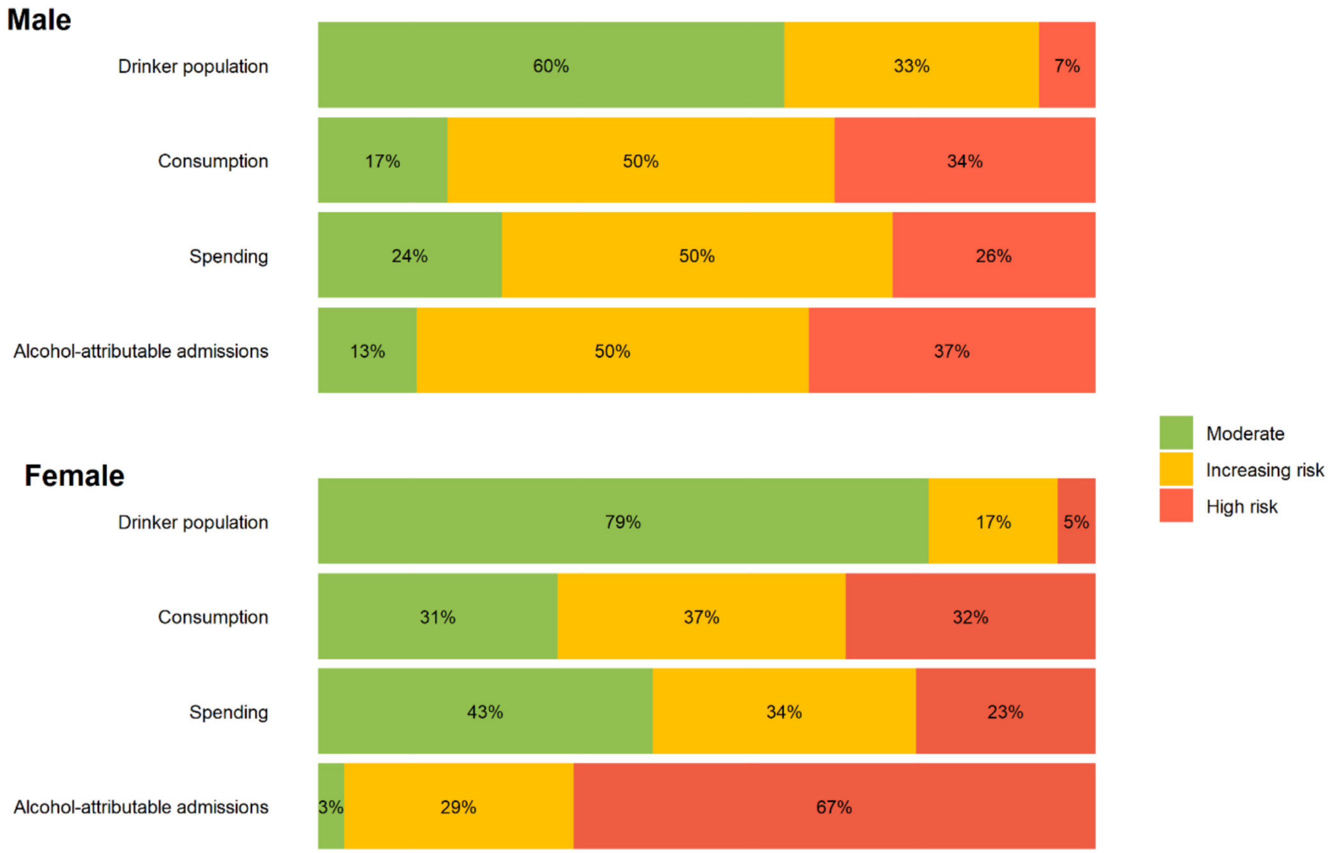

Figure 2.

Moderate, increasing risk and high-risk drinkers' shares of the male/female population, of total alcohol consumption, of total alcohol expenditure and total alcohol-attributable hospital admissions, by gender. Example interpretation: Only 7% of all male drinkers are high-risk drinkers, but they account for 34% of men's consumption, 26% of their spending, and 37% of their admissions.

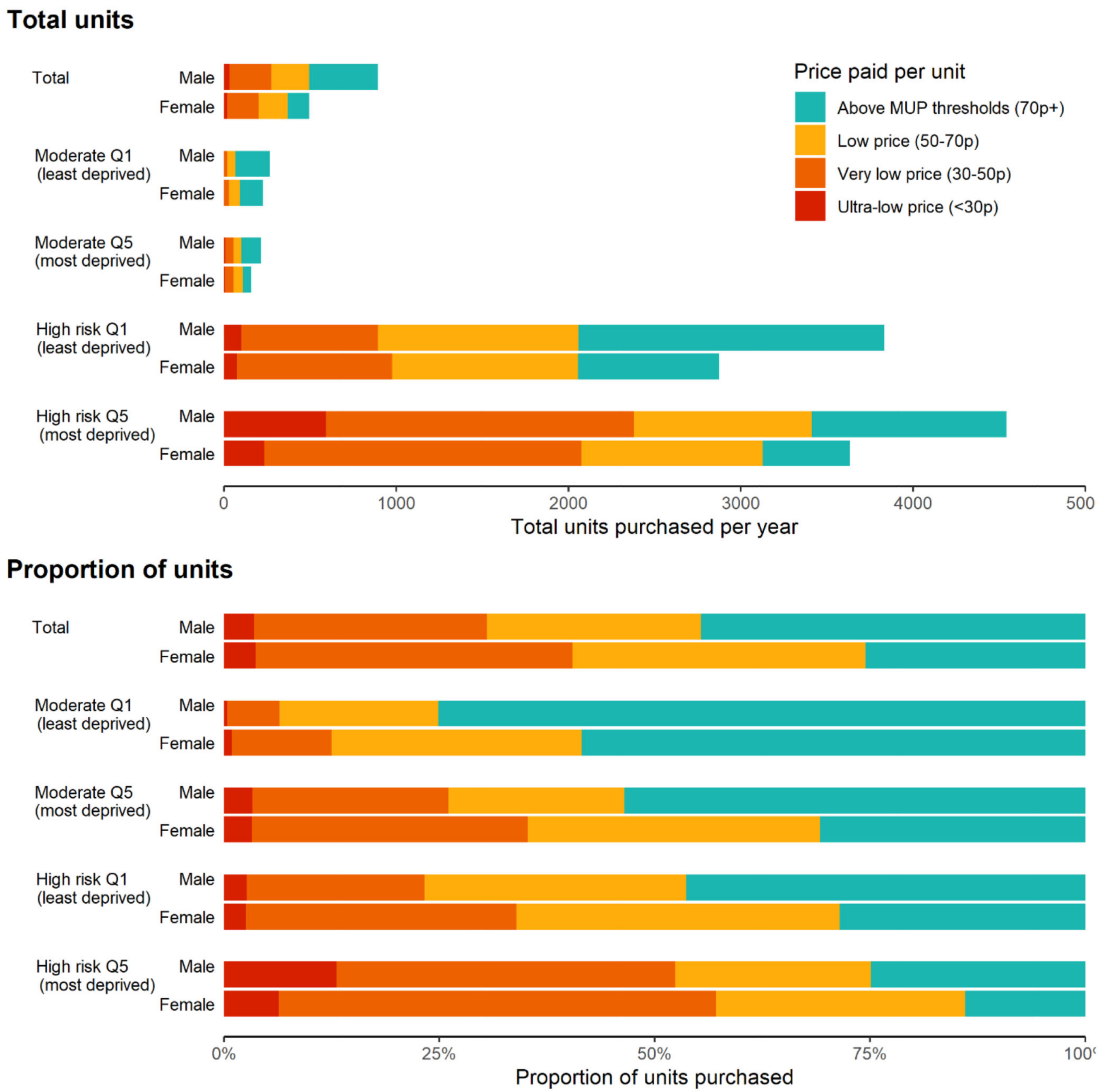

Figure 3.
Price distribution of alcohol purchases by gender, deprivation and drinker level, England 2016: top: total and bottom: relative distributions. Red and dark orange: units affected by MUP50. Red, dark and light orange: units affected by MUP70. Turquoise: units above minimum pricing thresholds.

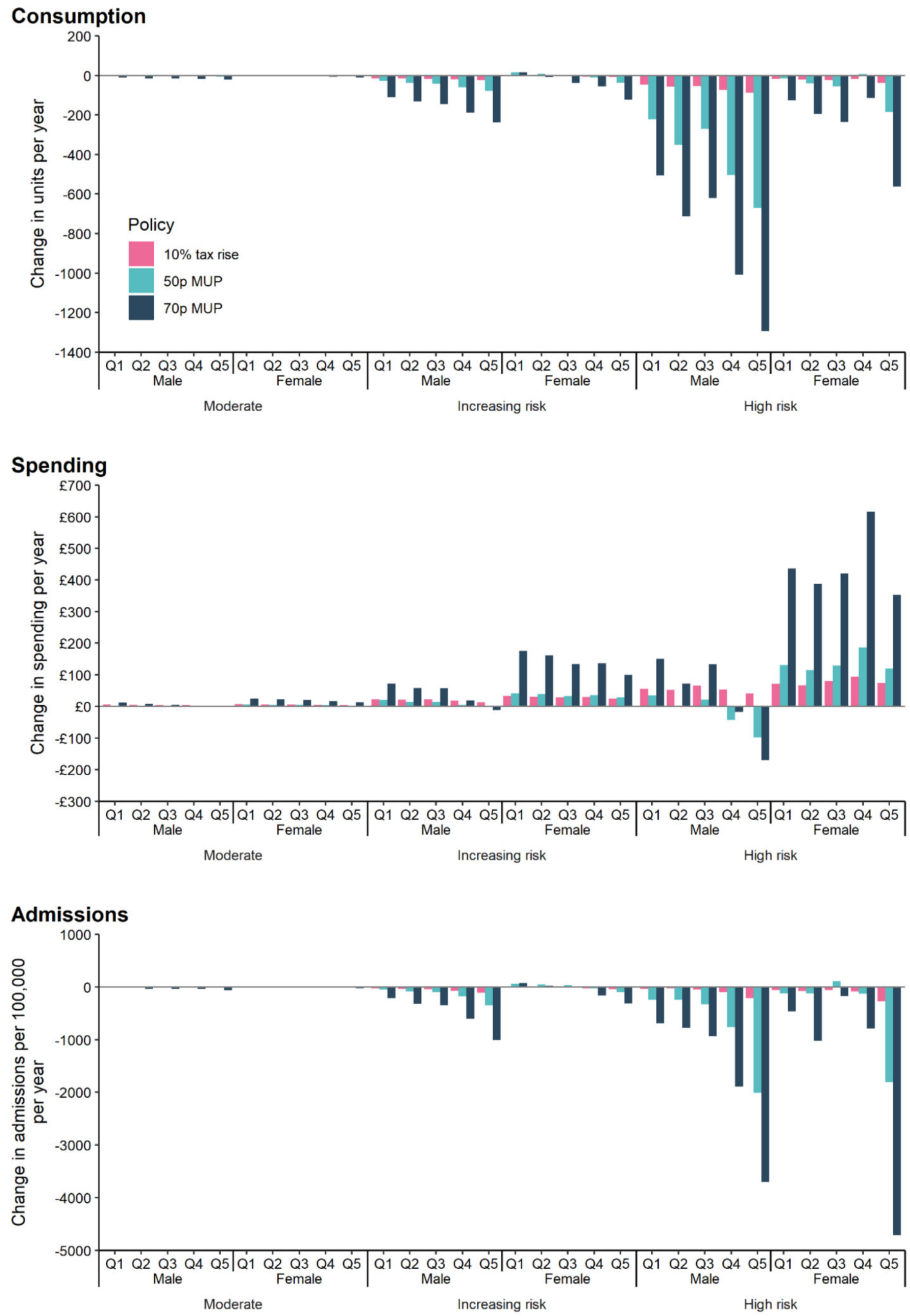

Figure 4. Estimated absolute policy effects on consumption, spending and hospital admission rates, by gender and deprivation quintile (Q1 least deprived, Q5 most deprived)

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Table 1

Estimated own- and cross-price elasticities for off- and on-trade beer, cider, wine, spirits and ready to drink beverages (RTDs) in the UK

	Purchase									
	Off-beer	**Off-cider**	**Off-wine**	**Off-spirits**	**Off-RTDs**	**On-beer**	**On-cider**	**On-wine**	**On-spirits**	**On-RTDs**
Price										
Off-beer	**−0.980***	−0.189	0.096	−0.368	−1.092	−0.016	−0.050	0.253	0.030	0.503
Off-cider	0.065	**−1.268***	0.118	−0.122	−0.239	−0.053	0.093	0.067	−0.108	−0.194
Off-wine	−0.040	0.736 *	**−0.384***	0.363	0.039	−0.245	−0.155	0.043	−0.186	0.101
Off-spirits	0.113	−0.024	0.163	**−0.082**	−0.042	0.167	0.406	0.005	0.084	0.233
Off-RTDs	−0.047	−0.159	−0.006	0.079	**−0.585***	−0.061	0.067	0.068	−0.179 *	0.093
On-beer	0.148	−0.285	0.115	−0.028	0.803	**−0.786***	0.867	1.042 *	1.169 *	−0.117
On-cider	−0.100	0.071	0.043	0.021	0.365	0.035	**-0.591***	0.072	0.237 *	0.241
On-wine	−0.197	0.094	−0.154	−0.031	−0.093	−0.276	−0.031	**−0.871***	−0.021	−0.363
On-spirits	0.019	−0.117	−0.027	−0.280	−0.145	−0.002	−0.284	0.109	**−0.890***	0.809 *
On-RTDs	0.079	0.005	−0.085	−.047	0.369	0.121	−0.394	−0.027	−0.071	**−0.187**

Taken from Meng et al 2014[16], reproduced under the terms of the Creative Commons Attribution License (CC BY). N.B. * $p<0.05$. Own-price elasticities in bold.

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Table 2

Baseline alcohol consumption and expenditure patterns by gender and consumption level, England 2015/16

	Moderate drinkers		Increasing risk drinkers		High-risk drinkers		All drinkers		All drinkers
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Total**
Adult population (millions)	13·8	18·1	6·0	2·9	1·3	0·9	21·1	21·9	43·0
Baseline consumption									16·0%
Number of drinkers (millions)	11·0	14·0	6·0	2·9	1·3	0·9	18·3	17·8	36·1
Proportion (%) of all male/female drinkers	60·0%	78·6%	32·8%	16·6%	7·2%	4·8%	100·0%	100·0%	100·0%
Mean units per drinker per year	248	194	1,358	1,104	4,158	3,277	895	494	698
Share (%) of total men's/women's alcohol consumption	16·7%	30·8%	49·8%	37·1 %	33·6%	32·1%	100%	100%	100%
Off-trade share (%) of group's consumption	45·4%	73·4%	60·6%	86·8%	70·5%	93·6%	61·4%	84·9%	69·6%
On-trade share (%) of group's consumption	54·6%	26·6%	39·4%	13·2%	29·5%	6·4%	38·6%	15·1%	30·4%
Baseline spending									
% of total expenditure that is in off-trade	19·1%	37·1%	32·9%	62·7%	45·2%	79·6%	32·8%	55·6%	39·9%
% of total expenditure that is in on-trade	80·9%	62·9%	67·1%	37·3%	54·8%	20·4%	67·2%	44·4%	60·1%
Mean spending per drinker per year	£376	£244	£1,463	£909	£3,440	£2,123	£954	£445	£704
Mean number of units bought <£0.50 per year	41	50	421	441	1,653	1,596	273	199	246
Mean number of units bought <£0.70 per year	92	115	758	833	2,826	2,679	496	368	449
Proportion of groups' units bought <£0.50	16·5%	26·0%	31·0%	40·0%	39·8%	48·7%	30·5%	40·4%	35·2%
Proportion of groups' units bought <£0.70	36·8%	59·6%	55·8%	75·4%	68·0%	81·8%	55·4%	74·4%	64·4%
Baseline hospital admissions									
Annual alcohol-attributable admissions	60,111	6,189	238,523	54,038	174,397	123,064	473,031	183,291	656,322
Admission rates per 100,000 drinkers	547	44	3,969	1,834	13,167	14,294	2,581	1,031	1,818

Note. 1 UK unit = 10 ml/8g ethanol.

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Table 3

Beverage share of total alcohol consumption at baseline, by gender, drinking level and deprivation

Gender	Drink level	Deprivation	Total units	off-trade beer	off-trade cider	off-trade wine	off-trade spirits	on-trade beer	on-trade cider	on-trade wine	on-trade spirits
All	**All**	**All**	698	16·5%	4·8%	37·8%	10·2%	20·5%	1·7%	6·3%	1·8%
All men			895	20·3%	5·7%	26·1%	9·2%	29·4%	2·2%	5·3%	1·6%
All women			494	9·3%	3·2%	59·7%	12·1%	3·8%	0·7%	8·2%	2·2%
Men	**Mod**	**Q1 least**	265	11·9%	2·9%	22·3%	7·4%	34·6%	2·8%	13·6%	4·4%
		Q2	263	14·1%	3·3%	19·2%	8·6%	36·8%	2·8%	10·9%	4·1%
		Q3	258	14·6%	3·5%	15·4%	10·5%	38·8%	3·0%	8·5%	5·4%
		Q4	233	15·4%	3·6%	15·6%	10·6%	37·3%	3·4%	7·4%	6·3%
		Q5 most	215	18·2%	4·2%	13·6%	12·7%	36·7%	3·3%	5·7%	5·4%
	Incr.	**Q1 least**	1,349	17·5%	3·7%	32·4%	8·5%	28·1%	2·2%	6·7%	0·8%
		Q2	1,328	18·5%	4·1%	29·3%	9·1%	29·4%	2·2%	6·4%	1·0%
		Q3	1,391	18·4%	4·3%	29·1%	9·8%	28·6%	2·3%	5·9%	1·2%
		Q4	1,355	21·9%	5·2%	22·3%	9·9%	31·7%	2·7%	4·5%	1·4%
		Q5 most	1,366	25·0%	6·3%	17·2%	9·0%	35·3%	3·0%	3·2%	0·7%
	High	**Q1 least**	3,832	18·0%	5·8%	34·1%	7·5%	27·7%	1·8%	3·3%	1·9%
		Q2	4,020	22·7%	8·3%	30·7%	5·3%	26·2%	1·6%	4·4%	0·8%
		Q3	4,167	22·7%	5·6%	35·0%	9·3%	22·5%	1·2%	3·2%	0·4%
		Q4	4,144	24·3%	9·2%	24·0%	16·7%	22·2%	1·4%	1·6%	0·4%
		Q5 most	4,542	29·9%	12·1%	23·9%	6·0%	24·4%	1·6%	1·9%	0·2%
Women	**Mod**	**Q1 least**	224	6·3%	2·2%	54·9%	9·6%	4·6%	0·9%	16·2%	4·7%
		Q2	200	6·8%	2·6%	52·6%	12·7%	5·1%	1·2%	14·3%	4·1%
		Q3	195	7·8%	2·9%	49·3%	12·4%	6·0%	1·3%	14·4%	4·9%
		Q4	185	8·8%	3·6%	43·1%	15·8%	6·5%	1·7%	11·8%	6·8%
		Q5 most	156	11·9%	4·8%	35·4%	19·3%	7·7%	1·9%	9·1%	6·2%
	Incr.	**Q1 least**	1,125	4·7%	1·5%	74·2%	8·1%	2·0%	0·3%	8·3%	1·0%
		Q2	1,117	7·1%	2·1%	68·4%	9·4%	3·2%	0·5%	8·5%	0·7%
		Q3	1,070	8·4%	2·4%	61·8%	13·7%	4·0%	0·6%	6·9%	1·7%
		Q4	1,126	10·5%	3·2%	59·1%	11·3%	4·2%	0·7%	8·0%	2·6%
		Q5 most	1,075	14·6%	5·0%	49·4%	15·0%	4·9%	0·8%	7·0%	1·7%
	High	**Q1 least**	2,875	12·0%	2·6%	69·8%	10·3%	1·5%	0·3%	3·4%	0·1%
		Q2	2,822	11·2%	2·7%	65·8%	13·7%	1·5%	0·2%	2·8%	0·4%
		Q3	3,417	9·3%	4·9%	66·2%	10·2%	3·2%	0·3%	4·3%	0·2%
		Q4	3,709	8·0%	2·4%	72·1%	12·6%	1·0%	0·2%	2·8%	0·8%
		Q5 most	3,633	18·4%	6·7%	53·1%	14·2%	3·7%	0·9%	2·7%	0·2%

Note. Table shows the proportion of consumption accounted for by the different beverage types in each population group (row percent). Colour formatting indicates the strength of beverage preferences. Drinking level: Mod - moderate, incr. - increasing risk, high - high-risk. Area deprivation: Q1 least deprived to Q5 most deprived.

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Table 4

Policy effects on alcohol consumption, spending and hospital admissions

		10% tax rise	£0.50 minimum unit price	£0.70 minimum unit price	10% tax rise	£0.50 minimum unit price	£0.70 minimum unit price
		% change			*absolute change*		
a: CONSUMPTION (units per year)							
All drinkers		-1·0%	-3·7%	-10·4%	-7·2	-25·7	-72·2
Male drinkers		-1·3%	-5·3%	-13·6%	-11·9	-47·4	-121·7
Female drinkers		-0·5%	-0·7%	-4·3%	-2·4	-3·2	-21·1
Men	Moderate	-1·0%	-1·5%	-6·3%	-2·4	-3·8	-15·7
	Increasing risk	-1·3%	-3·4%	-11·5%	-17·5	-46·5	-156·2
	High-risk	-1·5%	-9·9%	-20·3%	-64·3	-413·4	-845·7
Women	Moderate	-0·3%	-0·1%	-2·5%	-0·6	-0·3	-4·9
	Increasing risk	-0·4%	-0·1%	-2·9%	-4·7	-1·0	-31·7
	High-risk	-0·7%	-1·8%	-7·6%	-24·0	-59·2	-248·7
b: EXPENDITURE (annual £ spent)							
All drinkers		1·9%	1·4%	5·7%	£13·3	£9·6	£40·1
Male drinkers		1·4%	0·3%	2·1%	£13·3	£3·2	£19·7
Female drinkers		3·0%	3·7%	13·7%	£13·3	£16·3	£61·1
Men	Moderate	1·2%	0·3%	1·5%	£4·5	£1·1	£5·8
	Increasing risk	1·4%	0·8%	3·0%	£20·5	£11·9	£43·6
	High-risk	1·5%	-0·5%	0·8%	£53·2	-£18·9	£26·7
Women	Moderate	2·4%	2·0%	8·2%	£5·9	£4·8	£20·0
	Increasing risk	3·3%	4·0%	16·2%	£29·9	£36·1	£146·8
	High-risk	3·6%	6·3%	20·5%	£76·4	£133·7	£435·0
c: HOSPITALISATIONS (at full effect)							
All drinkers		-1·0%	-3·4%	-10·3%	-6686	-22226	-67585
Male drinkers		-1·1%	-4·1%	-11·4%	-5128	-19323	-53862
Female drinkers		-0·9%	-1·6%	-7·5%	-1559	-2903	-13723
Men	Moderate	-1·1%	-1·5%	-6·8%	-672	-902	-4097
	Increasing risk	-1·4%	-3·5%	-11·5%	-3229	-8265	-27510
	High-risk	-0·7%	-5·8%	-12·8%	-1227	-10155	-22255
Women	Moderate	-1·5%	-1·5%	-13·0%	-95	-93	-806
	Increasing risk	-1·0%	0·9%	-2·3%	-542	504	-1249
	High-risk	-0·7%	-2·7%	-9·5%	-922	-3314	-11669