Journal of Public Health | Vol. 44, No. 4, pp. e567–e577 | https://doi.org/10.1093/pubmed/fdac052 | Advance Access Publication April 26, 2022

The impact of lower strength alcohol products on alcohol purchases: ARIMA analyses based on 4 million purchases by 69 803 households, 2015–2019

Peter Anderson[1,2], Amy O'Donnell[1], Eva Jané Llopis[2,3,4], Eileen Kaner[1]

[1]Population Health Sciences Institute, Newcastle University, Baddiley-Clark Building, Newcastle upon Tyne NE2 4AX, UK
[2]Department of Health Promotion, Faculty of Health, Medicine and Life Sciences, Maastricht University, Maastricht, 6200 MD, Netherlands
[3]Institute for Mental Health Policy Research, Centre for Addiction and Mental Health, Toronto, M5S 2S1, ON, Canada
[4]ESADE Business School, Ramon Llull University, Barcelona, 08034, Spain
Address correspondence to Peter Anderson, E-mail: peteranderson.mail@gmail.com

ABSTRACT

Background Lowering the strength of alcohol products could lead to less alcohol being bought and drunk. In its prevention White Paper, the UK Government aims to promote a significant increase in the availability of alcohol-free and low-alcohol products by 2025.

Methods Through descriptive analysis and ARIMA modelling of >4 million alcohol purchases from 69 803 British households, we study the potential impact of lower strength alcohol products in reducing household purchases of grams of alcohol over 2015–2019. Households are divided into predominantly beer, wine or spirits purchasers.

Results Over 5 years, there were decreases in purchases of grams of alcohol within beer amongst beer-purchasing households and increases in purchases of grams of alcohol within wine and spirits amongst, respectively, wine- and spirits-purchasing households. Almost all the changes were due to beer-purchasing households buying less regular strength beer, and wine and spirits-purchasing households buying, respectively, more regular strength wine and spirits, rather than increases in purchases of no- and low-alcohol products.

Conclusions In general, lower strength alcohol products have not contributed to British households buying fewer grams of alcohol over the 5-year follow-up period during 2015–2019.

Keywords public health, alcohol consumption, behaviour

Introduction

The ethanol in alcoholic beverages is toxic to many bodily systems,[1–5] is genotoxic and is a carcinogen.[6,7] Worldwide, alcohol is a cause of 7.1% of all deaths amongst those aged 69 years or less, 2 million deaths a year, with the three top causes of alcohol-related death being cirrhosis of the liver, road injuries and tuberculosis.[8]

The key to reducing the harm caused by ethanol is to drink less alcohol.[9] People can be encouraged to drink less alcohol by making alcohol more expensive, decreasing its availability, banning its advertising, putting in place strict drink-driving laws and providing advice, support and treatment to reduce consumption.[10] An additional measure would be to have less ethanol in alcoholic beverages,[11] following models of less salt[12] and less sugar[13] in drink and food products. Indeed, in its consultation document, 'Advancing our health: prevention in the 2020s,' whilst not without its critics,[14] the UK Government made a commitment to work with the drinks industry to 'deliver a significant increase in the availability of alcohol-free and low-alcohol products by 2025'.[15]

Using the same dataset as the present paper and analyzing the specificities of lower strength beer products, we have previously shown that the introduction of new no- and low-alcohol beers in Great Britain and the reformulation of existing beers to contain less alcohol during 2015–2018 resulted in households purchasing fewer grams of alcohol overall[16]; reductions were greater for the reformulation of existing

Peter Anderson, Professor
Amy O'Donnell, Lecturer
Eva Jané Llopis, Associated Professor
Eileen Kaner, Professor

products than for the introduction of new no- and low-alcohol products. However, we still lack definitive evidence to answer the bigger question; are lower strength alcohol products, including those beyond beer, and beyond newly introduced products,[16] making a dent in the total amount of alcohol (expressed as grams of ethanol) bought and consumed in Great Britain?

In this paper, we examine British (English, Scottish and Welsh) household purchases of alcohol over the years 2015–2019. We exclude 2020 data from the analyses, as household purchases of alcohol were unusually high due to foregone purchases from on-license premises, such as pubs, bars and restaurants that were closed due to COVID-19 mitigation measures.[17,18]

Since it is at the level of the household that purchases are recorded, we are interested in examining the extent to which the household shopping basket of purchases of alcohol, including no- and low-alcohol products, changes at the level of the household over time. We consider if changes differ between households that are predominantly beer-purchasing, wine-purchasing and spirits-purchasing (these 3 groups of products being responsible for about 90% of all grams of ethanol purchased at the household level).[19]
We ask the following two questions:

1. Up to a maximum follow-up time of 5 years, do individual household purchases of grams of alcohol decrease, remain stable or increase over time?
2. If individual household purchases decrease over time, what is the potential contribution of lower strength products to such decreases, and does the contribution differ by geographical region of Great Britain (Scotland, Wales and regions of England)?

Methods

Study design

We undertake descriptive analyses of the changes in purchases of grams of alcohol at the household level over time. We use ARIMA regression analyses to explore potential contributory factors to identified changes in purchases.

Data source

Our data source is Kantar Worldpanel's (KWP) household shopping panel.[16–20] KWP comprises ~30 000 British households at any one time, recruited via stratified sampling, with targets set for region, household size, age of main shopper and occupational group, with the panel being representative of households in Great Britain as a whole.[19] Households provide demographic information when joining the panel, followed by annual updates and quality checks.[21] Using barcode scanners, households record all alcohol purchases brought into the home from all store types, including Internet shopping.

We analysed raw KWP data on take-home purchasing of alcohol products in Great Britain (England, Scotland and Wales) for the years 2015–2019. The data we obtained had no missing values, except for household income, for which just over one in six households (15.7%) did not provide household income data, with this proportion roughly constant over the 5 years. We imputed the missing income data using monotonic multiple imputation.[22] Alcohol purchases are recorded daily. For each individual purchase, the data include the type and volume of the purchase, the brand, the alcohol by volume (ABV) and the price paid. The volume purchased was combined with ABV to calculate grams of alcohol purchased. We classified households by a range of sociodemographic groups (see Supplement, page 1).[23–26]

For each household, we set the first day of a recorded alcohol purchase as Day 1, and numbered days sequentially onwards until the last day of a recorded alcohol purchase. We prepared data for each day of follow-up by, first, for any day that a household bought alcohol, summing the amount of alcohol purchased in both volume and grams, divided by the number of adults in the household. Then, for each day of follow-up, we calculated the mean volume and grams of purchases across all households for each of six categories of products: beers; ciders; wines; spirits; fortified wines and liqueurs and ready-to-drinks. For each day of follow-up, we also calculated the mean ABV and the mean price in GB pence paid per millilitre (ml) of purchased beers, wines and spirits.

We grouped each of the six categories of products by ABV[27] (see Supplementary Table 1, page 1).

Statistical analyses

For all households, for each of the six categories of products, we tabulate the numbers of purchases by ABV group and plot the numbers of purchases over time.

We cluster households into one of the three groups: predominantly beer-purchasing households; wine-purchasing households and spirits-purchasing households. We used K-means clustering specifying the number of three clusters in advance, with clustering based on the proportion of the total grams of alcohol purchased for each household from beer, wines and spirits.

For each cluster of households, we plot the number of households providing data over time, separately for each

calendar year (2015–2019). Since the calculations of volumes and grams purchased are based on days when a household made an alcohol purchase, we plot frequencies of purchases, calculated at the household level as the number of days between any one purchase and its subsequent purchase.

For each cluster of households, using a generalized linear model, we present odds ratios and 95% confidence intervals for household characteristics by predominant beverage purchased (beers, wines and spirits). We describe changes in purchases of grams of alcohol and of volume purchased (ml), and changes in ABV over time.

For each cluster of households (beer, wine or sprits), we use ARIMA modelling to estimate the standardized coefficients and 95% confidence intervals for the associations of changes over time between four independent variables (standardized values of purchases of volume of zero alcohol product, of low-alcohol product, and of all other regular strength products, and ABV of purchased regular strength products) and the dependent variable, standardized values of purchases of grams of alcohol within beer, wine or spirits, depending on the household cluster. For full details of the methods, including sensitivity analyses, see Supplement pages 2–8 and Supplementary Figs 1–6.

All analyses were performed with SPSSv27.[28,29]

Results

Households and purchases

We analysed data from 69 803 British households with 4.06 million separate alcohol purchases during 2015–2019. The total number of purchases for the full 5-year period by product category and ABV group is reported in Supplementary Table 2, page 9, with trends of purchases over time plotted in Supplementary Figs 7–12, pages 10–12. The only product category with a relatively large number of no-alcohol purchases was beer (n = 19 969, 1.9% of all beer purchases), for which purchases increased from 2017 onwards (Supplementary Fig. 7, page 10). There were 1567 purchases of no-alcohol wine-type products (0.1% of all wine purchases), for which purchases also increased from 2017 onwards (Supplementary Fig. 9, page 11).

Of all households, 16 716 (23.9%) were predominantly beer-purchasing households, 35 536 (50.9%) predominantly wine-purchasing households and 17 551 (25.1%) predominantly spirits-purchasing households.

For each cluster of households, Supplementary Figs 13–15, pages 13–15, plot the number of households by length of follow-up (as determined by the number of days between first and last recorded purchase). At least 4 years' follow-up of purchase data was provided by 1077 beer-cluster households (7.2% of all beer-cluster households), by 2817 wine-cluster households (9.1%) and by 1598 spirit-cluster households (9.6%).

For each cluster of households, the frequency of purchases remained stable over follow-up time, Supplementary Fig. 16, page 16.

Characteristics by household cluster

Beer-purchasing households bought less alcohol overall than wine- or spirits-purchasing households (Table 1, row 7), and were, therefore, more likely to be in the lower purchasing group of households (Table 1, rows 10–13). Beer-purchasing households tended to be younger, more socioeconomically disadvantaged and more likely to be from the north of England (Table 1, rows 14–39). Wine-purchasing households tended to be older, more socioeconomically advantaged and more likely to be from the south of England. Spirits-purchasing households tended to be older, more socioeconomically disadvantaged and more likely to be from Scotland and the north of England.

For beer-purchasing households, there was a small reduction in purchases of grams of alcohol in beer over the time, matched by similar decreases in purchases of all grams of alcohol, Table 1, rows 8–9, and Fig. 1 (top graph). For beer-purchasing households, purchases of grams of alcohol in wine and spirits remained fairly stable over the time of follow-up.

For wine-purchasing households, there was a slight increase in purchases of grams of alcohol in wine over time, paralleled by a slight increase in purchases of all grams of alcohol, Fig. 1 (middle graph). For wine-purchasing households, purchases of grams of alcohol in beer and spirits remained fairly low, with a very slight increase in grams of alcohol in spirits over time.

For spirits-purchasing households, there was a steady increase in purchases of grams of alcohol in spirits over time, paralleled by a steady increase in purchases of all grams of alcohol, Fig. 1 (bottom graph). For spirits-purchasing households, purchases of grams of alcohol in beer and wine remained fairly low and steady over time.

Over time, the ABV of beer purchased by beer-purchasing households decreased very slightly, whereas it remained stable for spirits amongst spirits-purchasing households and increased very slightly for wine amongst wine-purchasing households, Table 1, row 41. Most of the volume of no- and low-alcohol beer was purchased by predominantly beer-purchasing households, with very minor increases over time (Table 1, rows 42–43).

Table 1 Characteristics by type of purchasing household

Row		*Beer households* n = *16 716*	*Wine households* n = *35 536*	*Spirits households* n = *17 551*
	Average grams of alcohol purchased per day (95% confidence intervals)			
1	Alcohol in beer	40.59 (40.51–40.67)	7.71 (7.63–7.79)	10.12 (10.04–10.20)
2	Alcohol in wine	10.40 (10.34–10.47)	47.18 (47.12–47.25)	19.31 (19.25–19.37)
3	Alcohol in spirits	7.37 (7.20–7.54)	9.94 (9.77–10.11)	80.23 (80.06–80.40)
4	Alcohol in cider	6.93 (6.89–6.96)	5.00 (4.96–5.03)	5.69 (5.65–5.72)
5	Alcohol in ready-to-drinks	0.55 (0.55–0.55)	0.46 (0.46–0.47)	0.48 (0.48–0.49)
6	Alcohol in fortified wines	3.90 (3.86–3.93)	5.61 (5.58–5.65)	8.55 (8.52–8.59)
7	All alcohol	69.79 (69.57–70.02)	75.91 (75.68–76.13)	124.29 (124.07–124.52)
	Trends in alcohol purchases per person per year, average ml of alcohol (95% confidence intervals)			
8	Product	Beer:	Wine:	Spirits:
		−1.31 (−1.36 to −1.26)	0.78 (0.74–0.82)	3.36 (3.29–3.44)
9	Total grams of alcohol	−0.78 (−0.85 to −0.71)	1.75 (1.70–1.80)	3.64 (3.54–3.73)
	Odds ratios (95% confidence intervals) by sociodemographic characteristics			
	Grams of alcohol normally purchased			
10	0–7	1.478 (1.401–1.561)	1.175 (1.122–1.229)	0.551 (0.522–0.581)
11	>7–21	1.383 (1.312–1.457)	0.945 (0.905–0.987)	0.814 (0.776–0.854)
12	>21–70	1.177 (1.116–1.241)	1.062 (1.017–1.109)	0.815 (0.777–0.854)
13	>70 (reference group)	1.000 (. to.)	1.000 (. to.)	1.000 (. to.)
	Age group of main household shopper			
14	25–44	2.079 (1.965–2.200)	0.877 (0.839–0.917)	0.628 (0.598–0.660)
15	45–64	1.614 (1.526–1.706)	0.909 (0.871–0.949)	0.782 (0.746–0.819)
16	65+ (reference group)	1.000 (. to.)	1.000 (. to.)	1.000 (. to.)
	Social Grade group			
17	AB	0.694 (0.653–0.737)	1.524 (1.448–1.604)	0.809 (0.763–0.858)
18	C1	0.744 (0.708–0.781)	1.379 (1.322–1.439)	0.874 (0.833–0.917)
19	C2	0.990 (0.938–10.046)	1.035 (.986–1.087)	0.966 (0.915–10.020)
20	DE (reference group)	1.000 (. to.)	1.000 (. to.)	1.000 (. to.)
	Household income group			
21	£0–8.75 k	1.151 (1.087–1.219)	0.830 (0.791–0.871)	1.120 (1.059–1.185)
22	>£8.75–15 k	1.057 (1.001–1.116)	0.898 (0.858–0.939)	1.095 (1.039–1.154)
23	>£15–22.5 k	1.167 (1.107–1.229)	0.873 (0.835–0.912)	1.032 (.979–1.088)
24	>£22.5 k (reference group)	1.000 (. to.)	1.000 (. to.)	1.000 (. to.)
	Deprivation group			
25	1 (most deprived)	1.240 (1.179–1.304)	0.706 (0.677–0.737)	1.293 (1.230–1.359)
26	2	1.123 (1.067–1.182)	0.817 (0.782–0.852)	1.183 (1.125–1.244)
27	3	1.082 (1.027–1.141)	0.881 (0.844–0.920)	1.107 (1.051–1.165)
28	4 (least deprived) (reference group)	1.000 (. to.)	1.000 (. to.)	1.000 (. to.)
	Region of England, Scotland & Wales			
29	Scotland	0.903 (0.828–0.984)	0.787 (0.733–0.844)	1.476 (1.364–1.598)
30	North East	1.297 (1.178–1.427)	0.674 (0.621–0.732)	1.308 (1.191–1.436)
31	North West	1.147 (1.060–1.240)	0.783 (0.734–0.836)	1.217 (1.129–1.313)
32	Yorkshire and The Humber	1.478 (1.367–1.597)	0.735 (0.688–0.786)	1.021 (.944–1.105)
33	East Midlands	1.334 (1.231–1.446)	0.782 (0.730–0.838)	1.049 (.968–1.137)
34	West Midlands	1.212 (1.117–1.315)	0.713 (0.665–0.764)	1.301 (1.203–1.408)
35	Wales	1.196 (1.087–1.316)	0.820 (0.756–0.889)	1.102 (1.003–1.211)
36	Eastern	1.175 (1.086–1.271)	0.913 (0.855–0.975)	0.968 (0.895–1.047)

Continued

Table 1 Continued

Row		*Beer households* n = *16 716*	*Wine households* n = *35 536*	*Spirits households* n = *17 551*
37	London	0.953 (0.872–1.042)	0.979 (0.910–1.053)	1.076 (0.988–1.171)
38	South East	1.104 (1.025–1.188)	0.962 (0.905–1.023)	0.959 (0.891–1.031)
39	South West (reference group)	1.000 (. to.)	1.000 (. to.)	1.000 (. to.)
	ABV			
40	Mean ABV of beer amongst beer-purchasing households, wine amongst wine-purchasing households and spirits amongst spirits-purchasing households.	4.385 (4.384–4.386)	12.02 (12.01–12.03)	38.56 (38.55–38.57)
41	Change over time per year over 5 years (relative %)	−0.402 (−0.410 to −0.394)	0.255 (0.249–0.261)	0.113 (0.110–0.116)
	Volume of beer purchased with ABV 0–3.5%			
42	Mean volume purchased (ml)	75.9 (75.3–76.4)	19.4 (19.2–19.5)	23.1 (23.0–23.2)
43	Change over time per year over 5 years (ml)	1.6 (1.2–1.9)	0.5 (0.4–0.6)	0.22 (0.17–0.28)

Estimates of odds ratios (rows 10–39 entered in multivariate model).

ARIMA models to determine potential associations with changes in purchases of grams of alcohol

Based on the ARIMA models, we analyse the extent to which the four independent predictor variables (Table 2, first column) might have contributed to the changes in purchases of grams of alcohol over time within beer (for beer-cluster households), wine (for wine-cluster households), and spirits (for spirits-cluster households). For Great Britain for 2015–2019, there were positive standardized coefficients between changes in the purchase volume and ABV of the regular product over time and changes in purchases of grams of alcohol within beer, wines and spirits. For beers and wines, there were also positive associations between volume of purchases of low-alcohol products and numbers of grams of alcohol purchased over time. For beers, was there a small negative association between volumes of no-alcohol beers purchased and numbers of grams of alcohol purchased within beer, present in the north of England, but not the south. For wines, was there a small negative association between volumes of no-alcohol wines purchased and numbers of grams of alcohol purchased within wine, for the years of 2015 and 2019, but not for other years. The standardized coefficients, which place the coefficients on the same scale, indicate that, by far, the main driver of decreases in purchases of grams of alcohol in beers, and increases in wines and spirits across Great Britain was decreases in purchases of the volume of regular strength beers and increases in the volumes of regular strength wines and spirits.

The first sensitivity analysis, which restricted analysis to the years 2017–2019, found slightly different, but similar sized coefficients. The second sensitivity analysis (which included the first 365 days within each separate calendar year (2015–2019)) also found slightly different, but similar sized coefficients for each of the 5 years. For calendar years 2015 and 2019, there was a (very small) negative association between volumes of no-alcohol wines purchased and numbers of grams of alcohol purchased within wine.

The patterns were similar by country (Scotland and Wales) and regions of England, with one exception: in the northern (but, not in the southern) regions of England, there were, albeit very small, negative coefficients between purchases of zero alcohol beer and purchases of grams of alcohol within beer.

Changes in price over time were not associated with changes in the volumes of regular products purchased, see Supplement page 17 and Supplementary Fig. 17.

Discussion

Main findings

Our analysis of KWP British household panel data between 2015 and 2019 found that 24% of households were predominantly beer-purchasing households, 51% predominantly wine-purchasing households and 25% predominantly spirits-purchasing households. Over the 5-year follow-up time, purchases of grams of alcohol decreased amongst beer-purchasing households but increased amongst wine- and spirits-purchasing households.

For beer-purchasing households in the north of England, there was an association between increases in purchases of no-alcohol beer over time and decreases in purchases of grams of alcohol in all beer over time, albeit with very small-

Table 2 Standardized coefficients (95% confidence intervals) from the ARIMA model of the associations between the independent variables [purchases of no-alcohol product (ml), low-alcohol product, regular strength product (ml) and ABV of all purchased regular strength product], and the dependent variable, purchase of all grams of alcohol within the product

	Standardized coefficient (95% confidence intervals)		
Predictor	*Beer*	*Wine*	*Spirits*
Great Britain, 2015–2019			
Zero alcohol product (volume)	−0.0048 (−0.0088 to −0.0008)	0.0284 (0.0161–0.0408)	Excluded from model
Low-alcohol product (volume)	0.1370 (0.1330–0.1410)	0.1557 (0.1397–0.1716)	Excluded from model
Regular product (volume)	1.0031 (0.9989–1.0073)	0.8773 (0.8595–0.8951)	0.9731 (0.9610–0.9851)
ABV (%) of regular product	0.0685 (0.0644–0.0726)	0.0836 (0.0645–0.1027)	0.0311 (0.0206–0.0415)
Great Britain, 2017–2019 (sensitivity analysis)			
Zero alcohol product (volume)	Excluded from model	0.0309 (0.0104–0.0515)	Excluded from model
Low-alcohol product (volume)	0.1591 (0.1532–0.1650)	0.1248 (0.1045–0.1451)	0.0155 (0.0078–0.0232)
Regular product (volume)	0.9950 (0.9890–1.0010)	0.9337 (0.9115–0.9560)	0.9904 (0.9823–0.9985)
ABV (%) of regular product	0.0697 (0.0636–0.0757)	0.0694 (0.0931–0.0456)	0.0240 (0.0160–0.0320)
Great Britain, 2015 (sensitivity analysis)			
Zero alcohol product (volume)	Excluded from model	−0.0395 (−0.0587 to −0.0202)	Excluded from model
Low-alcohol product (volume)	Excluded from model	0.1388 (0.1113–0.1663)	0.0350 (0.0164–0.0537)
Regular product (volume)	0.9950 (0.9794–1.0106)	0.7774 (0.7402–0.8146)	0.9335 (0.9070–0.9601)
ABV (%) of regular product	0.0909 (0.0746–0.1072)	0.0658 (0.0360–0.0955)	0.0575 (0.0351–0.0798)
Great Britain, 2016 (sensitivity analysis)			
Zero alcohol product (volume)	Excluded from model	Excluded from model	Excluded from model
Low-alcohol product (volume)	0.1002 (0.0906–0.1097)	0.1825 (0.1362–0.2289)	0.0378 (0.0076–0.0681)
Regular product (volume)	1.0061 (0.9961–1.0160)	0.8566 (0.8086–0.9045)	0.9560 (0.9257–0.9862)
ABV (%) of regular product	0.0594 (0.0494–0.0695)	0.0843 (0.0374–0.1312)	
Great Britain, 2017 (sensitivity analysis)			
Zero alcohol product (volume)	Excluded from model	Excluded from model	Excluded from model
Low-alcohol product (volume)	0.1702 (0.1496–0.1909)	Excluded from model	0.0427 (0.0142–0.0713)
Regular product (volume)	0.9714 (0.9505–0.9924)	0.8832 (0.8367–0.9298)	0.9734 (0.9451–1.0016)
ABV (%) of regular product	Excluded from model	Excluded from model	Excluded from model
Great Britain, 2018 (sensitivity analysis)			
Zero alcohol product (volume)	Excluded from model	Excluded from model	Excluded from model
Low-alcohol product (volume)	Excluded from model	0.1729 (0.1308–0.2150)	0.0398 (0.0117–0.0680)
Regular product (volume)	0.9998 (0.9793–1.0204)	0.9156 (0.8728–0.9585)	0.9516 (0.9225–0.9807)
ABV (%) of regular product	0.0872 (0.0667–0.1077)		0.0574 (0.0287–0.0861)
Great Britain, 2019 (sensitivity analysis)			
Zero alcohol product (volume)	Excluded from model	−0.0336 (−0.0657 to −0.0014)	Excluded from model
Low-alcohol product (volume)	Excluded from model	0.1351 (0.1023–0.1679)	Excluded from model
Regular product (volume)	1.0101 (0.9888–1.0314)	0.9251 (0.8908–0.9594)	0.9604 (0.9341–0.9868)
ABV (%) of regular product	0.0980 (0.0767–0.1193)	Excluded from model	Excluded from model
Scotland			
Zero alcohol product (volume)	0.0066 (0.0022–0.0109)	−0.0235 (−0.0410 to −0.0060)	Excluded from model
Low-alcohol product (volume)	0.3108 (0.3062–0.3154)	0.1421 (0.1228–0.1614)	Excluded from model
Regular product (volume)	1.0132 (1.0081–1.0182)	0.9063 (0.8887–0.9239)	0.9798 (0.9693–0.9902)
ABV (%) of regular product	0.0085 (0.0061–0.0109)	0.0638 (0.0468–0.0809)	0.0417 (0.0329–0.0505)
North East			
Zero alcohol product (volume)	−0.0069 (−0.0126 to −0.0013)	Excluded from model	Excluded from model
Low-alcohol product (volume)	0.1658 (0.1602–0.1713)	0.1182 (0.0999–0.1365)	Excluded from model
Regular product (volume)	0.9869 (0.9810–0.9929)	0.9181 (0.9005–0.9357)	0.9892 (0.9772–1.0012)
ABV (%) of regular product	0.0187 (0.0151–0.0224)	0.0680 (0.0512–0.0848)	0.0181 (0.0130–0.0233)

Continued

Table 2 Continued

Predictor	Standardized coefficient (95% confidence intervals)		
	Beer	*Wine*	*Spirits*
North West			
Zero alcohol product (volume)	−0.0101 (−0.0157 to −0.0046)	Excluded from model	Excluded from model
Low-alcohol product (volume)	0.1744 (0.1688–0.1799)	0.1878 (0.1682–0.2075)	Excluded from model
Regular product (volume)	0.9951 (0.9891–1.0010)	0.9024 (0.8829–0.9219)	0.9584 (0.9458–0.9710)
ABV (%) of regular product	0.0272 (0.0234–0.0310)	0.0529 (0.0334–0.0723)	0.0379 (0.0255–0.0503)
Yorkshire and The Humber			
Zero alcohol product (volume)	−0.0102 (−0.0151 to −0.0052)	Excluded from model	Excluded from model
Low-alcohol product (volume)	0.3019 (0.2970–0.3069)	0.2349 (0.2148–0.2549)	Excluded from model
Regular product (volume)	0.9746 (0.9693–0.9800)	0.8667 (0.8464–0.8871)	0.9563 (0.9429–0.9698)
ABV (%) of regular product	0.0322 (0.0284–0.0360)	0.0693 (0.0486–0.0900)	0.0392 (0.0280–0.0504)
East Midlands			
Zero alcohol product (volume)	−0.0045 (−0.0087 to −0.0003)	0.0396 (0.0237 to 0.0555)	Excluded from model
Low-alcohol product (volume)	0.1308 (0.1256–0.1360)	0.1247 (0.1084–0.1410)	Excluded from model
Regular product (volume)	1.0046 (0.9991–1.0100)	0.9329 (0.9163–0.9495)	0.9617 (0.9481–0.9753)
ABV (%) of regular product	0.0215 (0.0179–0.0250)	0.0374 (0.0212–0.0536)	0.0174 (0.0071–0.0276)
West Midlands			
Zero alcohol product (volume)	−0.0081 (−0.0139 to −0.0023)	0.0257 (0.0075–0.0439)	Excluded from model
Low-alcohol product (volume)	0.1803 (0.1746–0.1860)	0.2728 (0.2556–0.2899)	Excluded from model
Regular product (volume)	0.9914 (0.9852–0.9975)	0.9091 (0.8918–0.9263)	0.9783 (0.9678–0.9888)
ABV (%) of regular product	0.0201 (0.0165–0.0237)	0.0489 (0.0331–0.0647)	0.0383 (0.0295–0.0472)
Wales			
Zero alcohol product (volume)	0.0074 (0.0021–0.0127)	0.0299 (0.0101–0.0497)	Excluded from model
Low-alcohol product (volume)	0.1241 (0.1188–0.1295)	0.1513 (0.1313–0.1713)	Excluded from model
Regular product (volume)	1.0033 (0.9974–1.0092)	0.9082 (0.8881–0.9283)	0.9790 (0.9688–0.9892)
ABV (%) of regular product	0.0173 (0.0146–0.0201)	0.0763 (0.0591–0.0936)	0.0023 (0.0009–0.0037)
Eastern			
Zero alcohol product (volume)	Excluded from model	Excluded from model	Excluded from model
Low-alcohol product (volume)	0.1039 (0.0986–0.1091)	Excluded from model	Excluded from model
Regular product (volume)	1.0028 (0.9975–1.0081)	0.9119 (0.8928–0.9310)	0.9557 (0.9420–0.9694)
ABV (%) of regular product	0.0430 (0.0390–0.0470)	0.0296 (0.0109–0.0483)	0.0225 (0.0106–0.0344)
London			
Zero alcohol product (volume)	Excluded from model	Excluded from model	Excluded from model
Low-alcohol product (volume)	0.0989 (0.0925–0.1054)	0.1094 (0.0948–0.1241)	Excluded from model
Regular product (volume)	1.0075 (1.0005–1.0144)	0.9551 (0.9402–0.9700)	0.9735 (0.9615–0.9855)
ABV (%) of regular product	0.0208 (0.0172–0.0244)	0.0528 (0.0377–0.0680)	0.0074 (0.0011–0.0136)
South East			
Zero alcohol product (volume)	0.0076 (0.0021–0.0131)	Excluded from model	Excluded from model
Low-alcohol product (volume)	0.1312 (0.1257–0.1367)	0.1660 (0.1476–0.1845)	Excluded from model
Regular product (volume)	0.9910 (0.9853–0.9967)	0.9066 (0.8883–0.9249)	0.9657 (0.9536–0.9777)
ABV (%) of regular product	0.0634 (0.0583–0.0684)	0.0463 (0.0274–0.0652)	0.0275 (0.0176–0.0374)
South West			
Zero alcohol product (volume)	0.0075 (0.0025–0.0125)	Excluded from model	Excluded from model
Low-alcohol product (volume)	0.0857 (0.0807–0.0907)	0.1777 (0.1605–0.1949)	Excluded from model
Regular product (volume)	1.0086 (1.0033–1.0139)	0.8902 (0.8734–0.9070)	0.9747 (0.9631–0.9862)
ABV (%) of regular product	0.0259 (0.0224–0.0294)	0.0434 (0.0275–0.0594)	0.0304 (0.0222–0.0386)

All analyses undertaken separately for beer within beer-purchasing households, wine within wine-purchasing households, and spirits within spirits-purchasing households. [NB, the ARIMA model excludes predictors with a probability value ≥0.05]

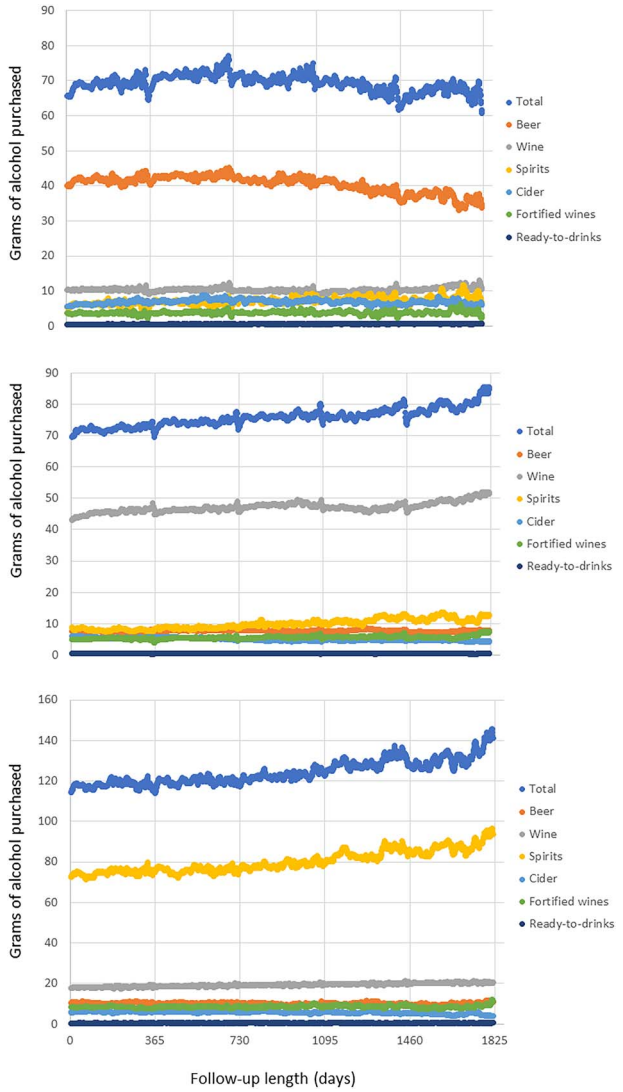

Fig. 1 Grams of alcohol purchased (per adult per household per day of purchase) for all grams of alcohol (Total) and for grams of alcohol in each beverage category, by follow-up length (days since first recorded alcohol purchase). Top graph: predominantly beer-purchasing households; Middle graph: predominantly wine-purchasing households; Bottom graph: predominantly spirits-purchasing households.

sized coefficients. For wine purchasing households, there was an association between an increase in purchases of no-alcohol wine during each of 2015 and 2019 and decreases in purchases of grams of alcohol in all wine over time, again with very small-sized coefficients. As the ABV of beer decreased, purchases of grams of alcohol in beer decreased to a small extent, and as the ABV of wines and spirits increased, purchases of grams of alcohol in wines and spirits, respectively, increased to a small extent. For each cluster of households, by far the largest driver in changes in purchases of grams of alcohol was changes in the volume of regular strength products over time.

What is already known on this topic

We are not aware of any other similar studies that have analysed the overall contribution of lower strength products to household purchases of alcohol over time. Elsewhere, we have analysed specificities of the impact of newly introduced lower strength beer products on beer purchases, rather than the broader picture of household alcohol purchases presented in this paper. For example, through interrupted time series analyses, we have shown that the introduction of new no- and low-alcohol beers leads to replacement purchases from higher strength beers, and thus purchases of fewer grams of alcohol,[16] with such purchases of new products greater amongst younger and more socioeconomically advantaged households compared with other groups.[27] We have also demonstrated that pricing policy,[30] including setting a minimum price per gram of alcohol sold, favours shifts to buying lower strength beers.[31] However as these latest findings highlight, the problems are that the contribution of no-alcohol products is mostly restricted to beers (and thus to beer purchasing households), with some, much smaller, contribution from no-alcohol wines and that the volume of sales of no-alcohol beers and wines, although increasing, remains very low as a proportion of all products sold.

What this study adds

The purchases of grams of alcohol within beer decreased over time almost entirely because households bought less regular strength beer, and purchases of grams of alcohol within wines and spirits increased over time because household bought more wines and spirits, with the volumes purchased over time not associated with changes in price over time. For beer, there were very small contributions to reduced purchases of grams of alcohol within beer from no-alcohol products in the north of England, and for wine to reduced purchases of grams of alcohol within wine from no-alcohol wine purchases during 2015 and 2019.

Limitations of the study

One limitation of our study, which is based on over four million separate alcohol purchases from 69 803 households, is that there is a drop off in the number of households providing follow-up data over time (Supplementary Figs 13–15, supplement pages 16–18). A further key limitation is that we only measure off-trade alcohol purchases and not on-trade purchases. By way of example, for Great Britain, off-trade purchases increased from 69.4% of all alcohol purchases (expressed in volume of absolute alcohol) in 2015 to 72.7% in 2019, with off-trade purchases of beer increasing from 45.6% in 2015 to 53.6% in 2019.[32] The data also have

limitations, with heavy drinkers tending to be underrepresented in household panel data,[33] and with alcohol purchases tending to be underreported in these datasets.[34,35] In addition, we are only able to assess changes in off-trade alcohol purchases as opposed to actual levels of alcohol consumption for these time periods. Adults in a household may not have an equal share of the alcohol purchased, and not all adults in a household may be drinkers of alcohol.

Conclusions

Lower strength alcohol products have not contributed in any significant way to British households buying fewer grams of alcohol over a 5-year follow-up period during the years 2015–2019. The potential public health contribution of lower strength alcohol products[11,16] remains an underresearched area.[36] To reap any public health benefit of lower strength alcohol products, governments would need to introduce pricing policies that favour buying and drinking lower strength products,[30,31] supported by improved product labelling[36] and social norms campaigns.[37] Governments should also enforce stepped-up action by the alcohol industry to produce lower strength products that goes beyond voluntary commitments,[38] and any actions to date,[39] ensuring that no-alcohol products are not used to circumvent brand-specific advertising of alcohol.[40]

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

Contributors

P.A. conceptualized the paper, undertook the analyses and prepared the draft of the paper. A.O'D., E.J-L. and E.K. refined the various versions of the full paper and approved the final manuscript for submission. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. All authors had access to the data used for analyses, and P.A., A.O'D. and E.J-L. verified the raw data sets received from Kantar WorldPanel and are the guarantors for the data used for the analyses.

Acknowledgements

Professor Kaner, supported by a National Institute for Health Research (NIHR) Senior Investigator award, is Director of the NIHR Applied Research Collaboration, North East and North Cumbria. Dr O'Donnell is a National Institute for Health Research (NIHR) Advanced Fellow. The views expressed in this article are those of the authors and not necessarily those of NIHR, or the Department for Health and Social Care. We thank Kantar Worldpanel for reviewing the method description as it describes the data collection.

Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; within the previous 5 years, PA declares receipt of funds from AB InBev Foundation to provide evidence-based public health comment on the proposed content and evaluation of the Foundation's global drinking goals, outside of the submitted work; the remaining authors declare no financial relationships with any organizations in the previous 5 years that might have an interest in the submitted work; all authors declare no other relationships or activities that could appear to have influenced the submitted work. Kantar Worldpanel provided the raw data to Newcastle University under a direct contract, in which it is stated that Kantar Worldpanel collected and owned the data as part of its business activities and provided the data to Newcastle University, which requested access to the anonymized data for the purpose of analyzing the potential impact of changes in the alcohol content of beers on overall alcohol consumption and on alcohol-related harm, taking into account relevant socio-demographic factors and product price. Kantar Worldpanel received reimbursement from AB InBev to cover the costs of the data. Kantar Worldpanel has similar commercial relationships with other customers who pay to have data collected on food and non-food items available for sale in supermarkets and other retail outlets covered by the Worldpanel. Kantar Worldpanel and no other entity had any role in the study design, data analysis, data interpretation or writing of the manuscript.

Ethical approval

Not required.

Data sharing

No additional data available. Kantar WorldPanel data cannot be shared due to licensing restrictions.

Affirmation

P.A. and A.O'D. affirm that the manuscript is an honest, accurate and transparent account of the study being reported;

that no important aspects of the study have been omitted; and that any discrepancies from the study as initially planned have been explained.

References

1. Pohl K, Moodley P, Dhanda A. Alcohol's impact on the gut and liver. *Nutrients* 2021;**13**(**9**):3170. https://doi.org/10.3390/nu13093170.
2. Morojele N, Shenoi S, Shuper P, *et al*. Alcohol use and the risk of communicable diseases. *Nutrients* 2021;**13**(**10**):3317. https://doi.org/10.3390/nu13103317.
3. Popova S, Dozet D, Shield K, *et al*. Alcohol's impact on the fetus. *Nutrients* 2021;**13**(**10**):3452. https://doi.org/10.3390/nu13103452.
4. Chikritzhs T, Livingston M. Alcohol and the risk of injury. *Nutrients* 2021;**13**(**8**):2777. https://doi.org/10.3390/nu13082777.
5. Rehm J, Rovira P, Llamosas-Falcón L, *et al*. Dose–response relationships between levels of alcohol use and risks of mortality or disease, for all people, by age, sex, and specific risk factors. *Nutrients* 2021;**13**(**8**):2652. https://doi.org/10.3390/nu13082652.
6. Okaru A, Lachenmeier D. Margin of exposure analyses and overall toxic effects of alcohol with special consideration of carcinogenicity. *Nutrients* 2021;**13**(**11**):3785. https://doi.org/10.3390/nu13113785. https://www.mdpi.com/2072-6643/13/11/3785.
7. Rumgay H, Murphy N, Ferrari P, *et al*. Alcohol and cancer: epidemiology and biological mechanisms. *Nutrients* 2021;**13**(**9**):3173. https://doi.org/10.3390/nu13093173.
8. Sohi I, Franklin A, Chrystoja B, *et al*. The global impact of alcohol consumption on premature mortality and health in 2016. *Nutrients* 2021;**13**(**9**): 3145. https://doi.org/10.3390/nu13093145.
9. Wood A, Kaptoge S, Butterworth A *et al*. Risk thresholds for alcohol consumption: combined analysis of individual-participant data for 599 912 current drinkers in 83 prospective studies. *Lancet* 2018;**391**:1513–23. https://doi.org/10.17863/cam.20236.
10. World Health Organization. SAFER, Alcohol Control Initiative, 2020. Available online: https://www.who.int/substance_abuse/safer/en/ (accessed on 30 August 2021).
11. Rehm J, Lachenmeier DW, Jané-Llopis E *et al*. On the evidence base of reducing ethanol content in beverages to reduce the harmful use of alcohol. *Lancet Gastroenterol Hepatol* 2016;**1**:78–83.
12. He FJ, MacGregor GA. Role of salt intake in prevention of cardiovascular disease: controversies and challenges. *Nat Rev Cardiol* **15**, 371–377 (2018). https://doi.org/10.1038/s41569-018-0004-1
13. Steenson S, Buttriss JL. The challenges of defining a healthy and 'sustainable' diet. *Nutr Bull* 2020;**45**:206–22.
14. Corfe S, Hyde R, Shepherd J. Alcohol-free and low-strength drinks understanding their role in reducing alcohol-related harms. Available online: https://www.smf.co.uk/publications/no-low-alcohol-harms/ (accessed on 30 August 2021).
15. UK Government. Advancing our Health: Prevention in the 2020s—Consultation Document. 2019. Available online: https://www.gov.uk/government/consultations/advancing-our-health-prevention-in-the-2020s/advancing-our-health-prevention-in-the-2020s-consultation-document (accessed on 30 August 2021).
16. Anderson P, Llopis EJ, O'Donnell A *et al*. Impact of low and no alcohol beers on purchases of alcohol: interrupted time series analysis of British household shopping data, 2015–2018. *BMJ Open* 2020;**10**:e036371.
17. Anderson P, Jané Llopis E, O'Donnell A, Kaner E. Impact of COVID-19 confinement on alcohol purchases in Great Britain: controlled interrupted time-series analysis during the first half of 2020 compared with 2015-2018. *Alcohol Alcohol* 2021;**56**:agaa128. https://doi.org/10.1093/alcalc/agaa128.
18. Anderson P, O'Donnell A, Jané Llopis E, Kaner E. The COVID-19 alcohol paradox: British household purchases during 2020 compared with 2015-2019. *PLos One* 2022;**17**(1):e0261609. https://doi.org/10.1371/journal.pone.0261609.
19. O'Donnell A, Anderson P, Jane-Llopis E *et al*. Immediate impact of minimum unit pricing on alcohol purchases in Scotland: controlled interrupted time series analysis for 2015-18. *Br Med J* 2019;**366**:l5274. https://doi.org/10.1136/bmj.l5274.
20. Anderson P., O'Donnell A., Kaner E., *et al*. Impact of minimum unit pricing on alcohol purchases in Scotland and Wales: controlled interrupted time series analyses. *Lancet Public Health*, 2021;**6**:E557–E565. https://doi.org/10.1016/S2468-2667(21)00052-9
21. Leicester A, Oldfield Z, Oldfield Z. Using scanner technology to collect expenditure data*. *Fisc Stud* 2009;**30**:309–37. https://doi.org/10.1111/j.1475-5890.2009.00098.x.
22. Jakobsen JC, Gluud C, Wetterslev J, Winkel P. When and how should multiple imputation be used for handling missing data in randomised clinical trials – a practical guide with flowcharts. *BMC Med Res Methodol* 2017;**17**:1–10. https://doi.org/10.1186/s12874-017-0442-1.
23. National Readership Survey. Social Class London: National Readership Survey. 2019. Available online: http://www.nrs.co.uk/ nrs-print/lifestyle-and-classification-data/social-grade/ (accessed on 10 July 2019).
24. GOV.UK. National Statistics: English Indices of Deprivation 2019. Available online: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019 (accessed on 22 March 2021).
25. Gov.scot. Scottish Index of Multiple Deprivation (SIMD) 2020 Technical Notes. 2020. Available online: https://www.gov.scot/publications/simd-2020-technical-notes/ (accessed on 21 March 2021).
26. Gov.Wales. Welsh Index of Multiple Deprivation (full Index update with ranks). 2019. Available online: https://gov.wales/welsh-index-multiple-deprivation-full-index-update-ranks-2019 (accessed on 30 August 2021).
27. Anderson P, O'Donnell A Kokole D, *et al*. Is buying and drinking zero and low alcohol beer a higher socio-economic phenomenon? Analysis of British Survey Data, 2015–2018 and Household Purchase Data 2015–2020. *Int J Environ Res Public Health* 2021, **18**, 10347. https://doi.org/10.3390/ijerph181910347
28. IBM Corp. IBM_SPSS_Forecasting, 2019. Available at: http://public. dhe.ibm.com/software/analytics/spss/documentation/statistics/26.0/en/client/Manuals/IBM_SPSS_Forecasting.pdf
29. IBM Corp. *IBM SPSS Statistics for Windows, Version 27.0*. Armonk, NY: IBM Corp, 2020.
30. Jané Llopis E, O'Donnell A, Anderson P. Impact of price promotion, price, and minimum unit price on household purchases of low and no alcohol beers and ciders: descriptive analyses and interrupted time

series analysis of purchase data from 70, 303 British households, 2015–2018 and first half of 2020. *Soc Sci Med* 2021;**270**:113690. ISSN 0277-9536, https://doi.org/10.1016/j.socscimed.2021.113690.

31. Anderson P, Kokole D, Llopis E. Impact of minimum unit pricing on shifting purchases from higher to lower-strength beers in Scotland: controlled interrupted time series analyses, 2015–2020. *Drug Alcohol Rev* 2022;**41**:646–56. https://doi.org/10.1111/dar.13408.
32. Giles L, Richardson E. *Monitoring and Evaluating Scotland's Alcohol Strategy: Monitoring Report 2020*. Edinburgh: Public Health Scotland, 2020, http://www.healthscotland.scot/media/3330/mesas-monitoring-report-2020-english-updated-march-2021.pdf.
33. Gorman E, Leyland AH, McCartney G *et al.* Assessing the representativeness of population-sampled health surveys through linkage to administrative data on alcohol-related outcomes. *Am J Epidemiol* 2014;**180**:941–8.
34. Pechey R, Jebb SA, Kelly MP *et al.* Socioeconomic differences in purchases of more vs. less healthy foods and beverages: analysis of over 25,000 British households in 2010. *Soc Sci Med* 2013;**92**: 22–6.
35. Leicester A. *How Might In-Home Scanner Technology be Used in Budget Surveys?* London: Institute for Fiscal Studies, 2012.
36. Anderson P, Kokole D, Llopis E. Production, consumption, and potential public health impact of low- and no-alcohol products: results of a scoping review. *Nutrients* 2021;**13**(**9**):3153; https://doi.org/10.3390/nu13093153.
37. Anderson P, Jané-Llopis E, Hasan OSM, Rehm J. Changing collective social norms in favour of reduced harmful use of alcohol: a review of reviews. *Alcohol Alcohol* 2018;**53**:326–32. https://doi.org/10.1093/alcalc/agx121
38. Holmes J, Angus C, Meier PS. UK alcohol industry's 'billion units pledge': interim evaluation flawed. *Br Med J* 2015;**350**:h1301. https://doi.org/10.1136/bmj.h1301.
39. Anderson P, Jané Llopis E, Rehm J. Evaluation of alcohol industry action to reduce the harmful use of alcohol: case study from Great Britain. *Alcohol Alcohol* 2020;**55**:424–32. https://doi.org/10.1093/alcalc/agaa029.
40. Kaewpramkusol R, Senior K, Nanthamongkolchai S, Chenhall R. Brand advertising and brand sharing of alcoholic and non-alcoholic products, and the effects on young Thai people's attitudes towards alcohol use: a qualitative focus group study. *Drug Alcohol Rev* 2019 Mar;**38**(**3**):284–293. doi: https://doi.org/10.1111/dar.12910. Epub 2019 Feb 10. PMID: 30740803.